Benefit-Cost Analysis of Westside Express Project

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ACRONYMS

AIS	Abbreviated Injury Scale (AIS)
AADT	Annual Average Daily Traffic
BCA	Benefit-Cost Analysis
CO_2	Carbon Dioxide
FHWA	Federal Highway Administration
FY	Fiscal Year
GDP	Gross Domestic Product
mph	Miles per Hour
MVC	Mountain View Corridor
NO_x	Nitrogen Oxide
NPV	Net Present Value
O&M	Operating and Maintenance
PDO	Property Damage Only
$PM_{2.5}$	Particulate Matter
PV	Present Value
SO_2	Sulfur Dioxide
UDOT	Utah Department of Transportation
USDOT	United States Department of Transportation
UTA	Utah Transit Authority
VHT	Vehicle Hours Traveled
VMT	Vehicle Miles Traveled
VOT	Value of Time
YOE	Year of Expenditure

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I. INTRODUCTION

This report documents the Benefit-Cost Analysis (BCA) that evaluates the benefits to society resulting from the Utah Transit Authority (UTA) improvements associated with the Westside Express Project (Project). The BCA demonstrates the cost effectiveness of the Project for which the sponsors are seeking federal support, measured in terms of a Benefit Cost (B/C) ratio and Net Present Value (NPV).

I.1. Westside Express Project

The UTA, in partnership with the Utah Department of Transportation (UDOT), is submitting this Fiscal Year (FY) 2022 RAISE Grant application for the Westside Express in Salt Lake City.

In the Salt Lake City metropolitan area, UTA's rail and bus service is concentrated on the east side of the Wasatch Front, the historic core of the region. However, recent—and future—growth is occurring on the west side of Salt Lake County, including the municipalities of West Valley, West Jordan, and Kearns. The Westside Express bus service constitutes the first significant transit investment in this growing area. The Westside Express will provide—for the first time—a one-seat transit ride for residents that live along 5600 West to Salt Lake City International Airport, downtown Salt Lake City, and other regional job centers.

I.2. Benefit Cost Analysis (BCA) Model Development

The Benefit Cost Analysis is based on expected transit ridership, vehicle crashes, automobile operating costs, and greenhouse gas emissions when comparing the Build and No-Build scenarios.

A spreadsheet-based BCA model was constructed for the purposes of this analysis. The model utilizes various region or corridor specific statistics in addition to global parameters provided by the United States Department of Transportation (USDOT) specifically for the purposes of completing BCAs in support of federal grant applications. Project-specific inputs are discussed in Section III. Global parameters as defined by the USDOT are shown in Appendix A.

Using Project-specific inputs, the BCA model calculates life-cycle costs, life-cycle benefits, annual benefits, the NPV of quantifiable costs and benefits, and the resulting B/C ratio, utilizing a methodology that aligns with the most recent USDOT guidance.

Figure 1: Project Map

I.3. Organization of BCA Memorandum

Section II describes the mechanisms that generate the benefits of the Project and the classes of benefits evaluated.

Section III describes the Project-specific inputs to the BCA model.

Section IV describes the detailed methodology for computing Project benefits, including an illustration of the benefits calculated for an example year for the Project.

Section V summarizes the BCA results and the resulting B/C ratio.

Appendix A describes the global parameters referenced in the BCA model.

Appendix B provides detailed tabulations of annual benefits and costs for the overall Project.

II. PROJECT BENEFITS AND COSTS

II.1. Benefits of the Project

The Westside Express Project improves regional mobility by reducing roadway congestion and by supporting increased transit mobility in the Salt Lake County in Utah. The Mountain View Corridor (MVC) cuts through the whole of Salt Lake City and is a major supporting vein connecting major economic centers. Improvements to the Mountain View Corridor must be made in order to keep up with the transit demand in the region. This project is intended to increase ridership of transit, reduce overall transit times, and improve safety along the corridor under full-build conditions.

The following benefits are quantified for this analysis:

1. Avoided Crashes resulting from the Build Scenario
2. Operating Cost Savings resulting from the Build Scenario
3. External Maintenance Cost Savings resulting from the Build Scenario
4. Emissions Cost Savings resulting from the Build Scenario
5. Travel Time Savings associated with Existing Bus Users
6. Transit and Pedestrian Amenity Improvements

The methodology for evaluating the benefits is discussed in Section IV.

Table 1: Project Matrix

Current Status / Baseline & Problem to be Addressed	The Project improves regional mobility by reducing roadway congestion and by supporting increased transit availability.
Change to Baseline / Alternatives	The Build Scenario accounts for construction of an express bus transit service, improved efficiency in the bus service, construction of shelters, construction of benches, installation of lighting, installation of reader boards for bus arrival times, and construction of park and ride lots.
Type of Impacts	Greater Roadway Safety, New Ridership, and Operating Cost Savings, Emissions Savings, and Travel Time Savings.
Affected Population	The surrounding community including all residents of Salt Lake County.
Economic Benefit	The BCA indicates that the Project will result in safety benefits, operating cost savings, maintenance cost savings, emissions savings, and travel time savings.
Summary of Results	Benefit/Cost ratio of greater than 1.0 indicates that the Project generates benefits to society that exceed its costs.

II.2. Costs of the Project

Project costs used in this analysis are estimated in year of expenditure dollars and converted to base year dollars using a GDP deflator as summarized in Table 2. Capital project costs occur between 2024 and 2025.

Additional costs such as Operating and Maintenance (O&M) Costs are referred to as Other Costs and accumulate over the life of the project. Build scenario O&M costs are those associated with the Project. No Build O&M costs are those associated with service made redundant by the Project that will be eliminated. These costs are summarized in Table 3.

Table 2: Project Costs

Total Capital Cost	Cost	Units
Cost Estimate	$76,042,196	*YOE$*
Undiscounted Cost	$68,593,775	*2020$*
Discounted Cost	$50,636,486	*2020$*

Table 3: Operating and Maintenance Costs

Total O&M Cost	Annual Cost	Units
No Build	$1,070,000	*2020$/year*
Build	$8,400,000	*2020$/year*

II.3. Residual Value

The residual value of the project is estimated based on an estimated 25 year aggregate useful life of all project elements. Since the analysis period is 25 years, no additional residual value is added at the end of the analysis period for calculating the B/C ratio and NPV.

III. PROJECT-SPECIFIC INPUTS

III.1. Period of Analysis

This analysis considers a 25-year analysis period beginning in the opening year of the Project. Because revenue service begins in the second half of 2025, only half of annual benefits are assumed for the opening year.

Table 4: Construction Project Schedule

Factor	Year
Improvement Construction Start	2024
Improvement Opening Year	2025

III.2. Base Year of Analysis

Per USDOT BCA guidance, this analysis is conducted in constant 2020 dollars. All values other than carbon are discounted to 2020 at a 7% discount rate. Carbon-related benefits are discounted to 2020 at a 3% discount rate.

III.3. Ridership

To quantify benefits associated with avoided crashes, operating cost savings, external cost savings, emissions cost savings, travel time savings, and amenity improvement benefits, information about existing and expected ridership is needed. Existing ridership information is summarized in Table 5, and new ridership information is summarized in Table 6.

This analysis assumes that buses travel at 45 mph, the speed limit along 5600W, and a ridership annualization factor of 292 as informed by the 2019 National Transit Database agency profile for UTA. To estimate benefits associated with mode shift from automobile to transit, an average vehicle occupancy of 1.2 is used, as informed by the CMAQ air quality report by the Wasatch Front Regional Council. As a measure of conservatism, no Project ridership growth over time is assumed.

Table 5: Existing Ridership

Factor	Value	Units
F556 Ridership[A]	106	*person-trips/weekday*
Average Trip Duration[B]	17.5	*minutes/trip*
Segment Overlapping Project Corridor[C]	18%	*percent of corridor*

Source: A: Utah Transit Authority Ridership Statistics. Accessed from https://data-rideuta.opendata.arcgis.com/datasets/rideuta::uta-mode-level-boardings-weekday-averages/explore?showTable=true

Source: B: Derived assuming 1/2 of total one-way trip time + five minute flex service detour

Source: C: Derived based on the segment of the existing F556 route that overlaps the Project corridor

Table 6: New Ridership

Factor	Value	Units
Project Trips[A]	3,050	*person-trips/weekday*
Growth Rate	0%	*percent*
Average Trip Length[B]	19.4	*miles/trip*
Average Trip Duration[C]	34.6	*minutes/trip*

Source: A: Utah Transit Authority. Midpoint of the estimated 2040 ridership forecast range of 2200-3900. Accessed from https://mountainview.udot.utah.gov/wp-content/uploads/2019/09/MVC_TransitReevaluation_FINAL.pdf

Source: B: Derived from Wasatch Front Regional Council (regional MPO) assumption of 2/3 average route length for transit trips for the purposes of air quality modeling.

Source: C: Derived using a bus travel speed of 45mph plus boarding and alighting time

III.4. Crash Statistics

To quantify benefits associated with avoided crashes, historical crash data for Salt Lake County is used. This data is shown in terms of local crash rates and severity of local crashes. Table 7 summarizes this information.

Table 7: Salt Lake County Crash Statistics

Factor		Value	Units
Salt Lake County Crash Rates			
a Crash Rate		180.00	*crashes/100MVMT*
b All Crashes		27,647	*crashes/year*
c Fatalities		66	*persons/year*
d Injuries		11,740	*persons/year*
e Property Damage		38,862	*vehicles/year*
Crash Exposure			
f Fatality Rate	a / b * c	0.43	*persons/100MVMT*
g Injury Rates	a / b * d	76.44	*persons/100MVMT*
h Property Damage Rate	a / b * e	253.02	*vehicles/100MVMT*

Source: Utah Department of Public Safety. Accessed from https://udps.numetric.net/utah-crash-summary#/

III.5. Transit and Pedestrian Amenities

Transit amenities made available by the Project include clocks, seating and weather protection at stops, step-free access to stops and vehicles, and timetables. Additionally, bike and car access facilities are available at park-and-ride stations.

This analysis also assumes that 80% of transit will also benefit from the improvements to pedestrian facilities along the corridor. These improvements include marked crosswalks and pedestrian signals.

IV. BENEFIT-COST ANALYSIS METHODOLOGY

IV.1. Benefit 1: Avoided Crashes

Avoided crashes result from the reduction of automobile vehicle miles due to mode shift to transit. Applying crash rates to the decreased VMT results in a quantifiable benefit of crash reduction.

Table 8 describes the methodology used to calculate the undiscounted value of avoided crashes due to the Project in 2026, the first full year of benefits.

Table 8: Avoided Crash Cost

Input			2026 Value	Units
Avoided Vehicle Miles[A]				
a	Transit Trips		3,050	*person-trips/weekday*
b	Trip Distance		19.40	*miles/trip*
c	Annualization Factor		292	*weekdays/year*
d	Vehicle Occupancy Factor		1.20	*persons/vehicle*
e	Avoided Vehicle Miles	(a * b * c) / d	14,375,616	*vehicle-miles/year*
Crash Exposure[B]				
f	Fatality Rate		0.43	*persons/100MVMT*
g	Injury Rate		76.44	*persons/100MVMT*
h	Property Damage Rate		253.02	*vehicles/100MVMT*
Avoided Crashes				
i	Fatality Rate	(e * f) / 100000000	0.062	*persons/year*
j	Injury Rate	(e * g) / 100000000	10.988	*persons/year*
k	Property Damage Rate	(e * h) / 100000000	36.373	*vehicles/year*
Monetization[C]				
l	Fatality		$11,600,000	*2020$/person*
m	Injury		$210,300	*2020$/person*
n	Property Damage Only		$4,600	*2020$/vehicle*
Value of Avoided Crashes				
o	Fatality	i * l	$716,561	*2020$/year*
p	Injury	j * m	$2,310,779	*2020$/year*
q	Property Damage Only	k * n	$167,315	*2020$/year*
r	Value of Avoided Crashes	o + p + q	$3,194,654	

Source: A: See Section III.3. Ridership on page 5

Source: B: See Table 7: Salt Lake County Crash Statistics on page 6

Source: C: See Table A-4: BCA Value of Reduced Fatalities and Injuries (2020 dollars) on page A-III

IV.2. Benefit 2: Operating Cost Savings

Operating cost savings are estimated from the avoided vehicle miles resulting from automobile to transit mode shift and the average operating cost of a vehicle per mile.

Table 9 describes the methodology used to calculate the undiscounted value of operating cost savings due to the project in 2026.

Table 9: Operating Cost Savings

Input			2026 Value	Units
a	Avoided Vehicle Miles[A]		14,375,616	*vehicle-miles/year*
b	Vehicle Operating Cost[B]		$0.45	*2020$/vehicle-mile*
c	Total Benefit per year	a * b	$6,469,027	*2020$/year*

Source: A: See Table 8: Avoided Crash Cost on page 7

Source: B: See Table A-2: Vehicle Operating Cost Factor (2020 dollars) on page A-II

IV.3. Benefit 3: External Cost Savings

External cost benefits are driven by the reduction in annual VMT and reflect the avoided or reduced pavement damage, congestion, and noise associated with automobile use.

Table 10 describes the methodology used to calculate the undiscounted benefits from the external cost savings, using the year 2026 as an example.

Table 10: External Cost Savings

Input			2026 Value	Units
a	Avoided Vehicle Miles[A]		14,375,616	*vehicle-miles/year*
Unit Costs[B]				
b	Congestion Unit Cost		$0.12	*2020$/vehicle-mile*
c	Pavement Damage Unit Cost		$0.001	*2020$/vehicle-mile*
d	Noise Unit Cost		$0.003	*2020$/vehicle-mile*
Value of Benefit				
e	Avoided Congestion Cost	a * b	$1,653,196	*2020$/year*
f	Avoided Pavement Damage	a * c	$16,963	*2020$/year*
g	Avoided Noise Cost	a * d	$40,252	*2020$/year*
h	Total Benefit	e + f + g	$1,710,411	*2020$/year*

Source: A: See Table 8: Avoided Crash Cost on page 7

Source: B: See Table A-3: External Cost Unit Values (2020 dollars) on page A-II

IV.4. Benefit 4: Emissions Cost Savings

The benefits from avoided automobile emissions are estimated from the assumed avoided vehicles and avoided vehicle-miles each year, and from the emissions rates and assumed cost of emissions for certain pollutants associated with vehicle travel.

Table 11 describes the methodology used to calculate the undiscounted benefits resulting from the build scenario associated with emissions cost savings in 2026. The carbon-related elements of this benefit class are discounted at 3% while other emissions are discounted at 7% per USDOT BCA guidelines.

Table 11: Emissions Cost Savings

Input			2026 Value	Units
Avoided Vehicle Miles[A]				
a	Avoided Vehicles		741,011	*vehicles/year*
b	Avoided Vehicle Miles		14,375,616	*vehicle-miles/year*
Emissions[B]				
Emissions Rate				
c	Nitrogen Oxides (NO_x)		0.0598	***grams/mile***
d	Sulfur Oxides (SO_x)		0.0026	***grams/mile***
e	Particulate Matter ($PM_{2.5}$)		0.0009	***grams/mile***
f	Carbon Dioxide (CO_2)		256.67	***grams/mile***
Avoided Emissions				
g	Nitrogen Oxides (NO_x)	(b * c) / 1,000,000	0.8601	***metric tons/year***
h	Sulfur Oxides (SO_x)	(b * d) / 1,000,000	0.0367	***metric tons/year***
i	Particulate Matter ($PM_{2.5}$)	(b * e) / 1,000,000	0.0131	***metric tons/year***
j	Carbon Dioxide (CO_2)	(b * f) / 1,000,000	3689.8	***metric tons/year***
Cold Starts				
Emissions Rate				
k	Nitrogen Oxides (NO_x)		0.2227	grams/vehicle
l	Sulfur Oxides (SO_x)		0.0006	grams/vehicle
m	Particulate Matter ($PM_{2.5}$)		0.0015	grams/vehicle
n	Carbon Dioxide (CO_2)		57.84	grams/vehicle
Avoided Emissions				
o	Nitrogen Oxides (NO_x)	(a * k) / 1,000,000	0.1650	***metric tons/year***
p	Sulfur Oxides (SO_x)	(a * l) / 1,000,000	0.0004	***metric tons/year***
q	Particulate Matter ($PM_{2.5}$)	(a * m) / 1,000,000	0.0011	***metric tons/year***
r	Carbon Dioxide (CO_2)	(a * n) / 1,000,000	42.86	***metric tons/year***

Input			2026 Value	Units
Monetization				
Value of Emissions[C]				
s	Nitrogen Oxides (NO_x)		$16,800	*2020$/metric ton*
t	Sulfur Oxides (SO_x)		$45,700	*2020$/metric ton*
u	Particulate Matter ($PM_{2.5}$)		$801,700	*2020$/metric ton*
v	Carbon Dioxide (CO_2)		$57	*2020$/metric ton*
Avoided Emissions Costs				
w	Nitrogen Oxides (NO_x)	s * (g + o)	$17,222	*2020$/metric ton*
x	Sulfur Oxides (SO_x)	t * (h + p)	$1,698	*2020$/metric ton*
y	Particulate Matter ($PM_{2.5}$)	u * (i + q)	$11,387	*2020$/metric ton*
z	Carbon Dioxide (CO_2)	v * (j + r)	$212,761	*2020$/metric ton*
aa	All Emissions	w + x + y + z	$243,068	*2020$/year*

Source: A: See Table 8: Avoided Crash Cost on page 7

Source: B: See A-VIII. Emissions Rates on page A-VI

Source: C: See A-V. Transit Amenities on page A-III

IV.5. Benefit 5: Travel Time Savings

The benefits from the reduced travel time are estimated based on the existing transit ridership on the corridor, the expected travel time savings, and the typical value of time.

Table 12 describes the methodology used to estimate the Travel Time Savings for the year 2026 as an example.

Table 12: Travel Time Savings

Input			2026 Value	Units
Ridership[A]				
a	No-Build		106	*person-trips/weekday*
b	Build		3,050	*person-trips/weekday*
c	Annualization Factor		292	*weekdays/year*
Average Travel Time[A]				
d	No-Build		17.50	*minutes/trip*
e	Build		34.62	*minutes/trip*
f	Segment of Existing Route that Overlaps Project		0.183	*miles/miles*
g	Adjusted Build Travel Time	e * f	6.33	*minutes/trip*

Input			2026 Value	Units
Avoided Travel Time				
h	Existing Users	a * c * (d- g) / 60	5,770	*person-hours/year*
i	New Users	(b - a) * c * (d- g) / 60 / 2	79,912	*person-hours/year*
Value of Benefit				
j	Value of Time[B]		$17.80	*2020$/person-hour*
k	Existing Users	h * j	$102,709	*2020$/year*
l	New Users	i * j	$1,422,431	*2020$/year*
m	Total Benefit	k + l	$1,525,140	*2020$/year*

Source: A: See Section III.3. Ridership on page 5

Source: B: See Table A-1: Value of Time Factor (2020 Dollars) on page A-II

IV.6. Benefit 6: Transit and Pedestrian Amenity Improvements

The benefits associated with the amenities available to transit users and pedestrians are estimated based on the build scenario ridership on the corridor and the amenities available to each user.

Table 13 describes the methodology used to estimate the Travel Time Savings for the year 2026 as an example.

Table 13: Transit and Pedestrian Amenity Improvements

Input			2026 Value	Units
Ridership[A]				
a	Build		3,050	*person-trips/weekday*
b	Annualization Factor		292	*weekdays/year*
c	Annual Trips	a * b	889,213	*person-trips/year*
Amenity Availability[A]				
Transit Facility Amenities				
d	Clocks		100%	*% of users benefiting*
e	Platform/Stop Seating Availability		100%	*% of users benefiting*
f	Platform/Stop Weather Protection		100%	*% of users benefiting*
g	Step-Free Access to Station/Stop		100%	*% of users benefiting*
h	Step-Free Access to Vehicle		100%	*% of users benefiting*
i	Timetables		100%	*% of users benefiting*
j	Bike Facilities		20%	*% of users benefiting*
k	Car Access Facilities		20%	*% of users benefiting*
Pedestrian Facility Amenities				
l	Crossings and Signals		80%	*% of users benefiting*

Input			2026 Value	Units
Value of Amenity				
Transit Facility Amenities[B]				
m	Clocks		$0.03	*2020$/user trip*
n	Platform/Stop Seating Availability		$0.18	*2020$/user trip*
o	Platform/Stop Weather Protection		$0.24	*2020$/user trip*
p	Step-Free Access to Station/Stop		$0.30	*2020$/user trip*
q	Step-Free Access to Vehicle		$0.39	*2020$/user trip*
r	Timetables		$0.22	*2020$/user trip*
s	Bike Facilities		$0.09	*2020$/user trip*
t	Car Access Facilities		$0.11	*2020$/user trip*
Pedestrian Facility Amenities[C]				
u	Marked Crossing		$0.18	*2020$/use*
v	Pedestrian Signal		$0.46	*2020$/use*
Value of Benefit				
w	Transit Amenities	c * [d:k] * [m:t]	$1,244,899	*2020$/year*
x	Pedestrian Amenities	c * l * [u:v]	$455,277	*2020$/year*
y	Total Benefit	w + x	$1,700,176	*2020$/year*

Source: A: See Section III.5. Transit and Pedestrian Amenities on page 6

Source: B: See Table A-5: Value of Transit Benefits (2020 Dollars) on page A-III

Source: C: See Table A-6: Value of Pedestrian Benefits (2020 Dollars) on page A-IV

V. BENEFIT-COST ANALYSIS RESULTS

The BCA indicates that the Project will result in reduced crash exposure, reduced travel time for transit users, reduced emissions from vehicles, reduced external costs from vehicles, reduced operating cost, and amenity improvements for transit users and pedestrians. The Project produces a benefit/cost ratio greater than 1.00, indicating that the benefits to society exceed the Project's costs. A summary of the discounted costs and benefits is shown in Table 14. All elements are discounted to 2020 at 7% except carbon-related benefits which are discounted at 3%.

Appendix B provides detailed tabulations of annual benefits and costs for the Project.

Table 14: Discounted Quantified Benefits

Factor	Value
Avoided Crashes	$27.26
Operating Cost Savings	$55.21
External Cost Savings	$14.60
Emissions Cost Savings *	$3.31
Travel Time Savings	$13.02
Transit and Pedestrian Amenity Improvements	$14.51
Residual Value	$0
less Other Costs	$62.55
Net Benefits	$65.35
Capital Cost	$50.64
B/C Ratio	1.29
Net Present Value	$14.71

* includes carbon-related benefits discounted at 3%

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APPENDIX A
BCA Global Parameters

This BCA uses the following global parameters based on values provided by the USDOT and other sources.

A-I. PASSENGER VALUE OF TIME

To estimate the benefits associated with travel time savings, USDOT-provided factors for Value of Time (VOT) were used.

Table A-1: Value of Time Factor (2020 Dollars)

Trip Purpose / Vehicle Type	Value	Units
In-Vehicle Travel, All Purposes	$17.80	*2020$/ person-hour*

Source: U.S. Department of Transportation, Benefit Cost Analysis Guidance for Discretionary Grant Programs, March 2022. Accessed at https://www.transportation.gov/sites/dot.gov/files/2022-03/Benefit%20Cost%20Analysis%20Guidance%202022%20Update.pdf

A-II. VEHICLE OPERATING COSTS

To estimate the avoided vehicle operating costs associated with a reduction in vehicle miles traveled, USDOT-provided factors for Vehicle Operating Cost were used.

Table A-2: Vehicle Operating Cost Factor (2020 dollars)

Vehicle Type	Value	Units
Light Duty Vehicles	$0.45	*2020$/ VMT*

Source: U.S. Department of Transportation, BCA Guidance for Discretionary Grant Programs, March 2022.

A-III. EXTERNAL COSTS

To estimate the benefits of external costs, unit costs for avoided congestion, pavement damage, and noise are used.

Table A-3: External Cost Unit Values (2020 dollars)

Factor	Value	Units
Congestion[A]	$0.115	*2020$/vehicle-mile*
Noise[A]	$0.0028	*2020$/vehicle-mile*
Pavement Damage[B]	$0.001	*2020$/vehicle-mile*

Source: A: U.S. Department of Transportation, BCA Guidance for Discretionary Grant Programs, March 2022.

Source: B: GAO-11-134 Freight Transportation. 2011.Table 3. Accessed at https://www.gao.gov/new.items/d11134.pdf

A-IV. CRASH COSTS

To estimate the benefits of avoided crashes, USDOT-provided factors for Value of Reduced Fatalities and Injuries were used.

Table A-4: BCA Value of Reduced Fatalities and Injuries (2020 dollars)

Factor	Value	Units
No Injury	$3,900	*2020$/person*
Possible Injury	$77,200	*2020$/person*
Non-incapacitating Injury	$151,100	*2020$/person*
Incapacitating Injury	$554,800	*2020$/person*
Killed	$11,600,000	*2020$/person*
Injured (Unknown Severity)	$210,300	*2020$/person*
Unknown if Injured	$159,800	*2020$/person*
Property Damage	$4,600	*2020$/vehicle*

Source: U.S. Department of Transportation, BCA Guidance for Discretionary Grant Programs, March 2022.

A-V. TRANSIT AMENITIES

To estimate benefits from added transit amenities or access to amenities, USDOT-provided unit value for each type of amenity were used.

Table A-5: Value of Transit Benefits (2020 Dollars)

Factor	Bus	Light Rail / Street Car	Rail	Units
Clocks	$0.03	$0.03	$0.06	*2020$/user trip*
Electronic Real-Time Information Displays	$0.29	$0.14	$0.82	*2020$/user trip*
Information/Emergency Button	$0.22	$0.22	$0.10	*2020$/user trip*
PA System	$0.29	$0.05	$0.09	*2020$/user trip*
Platform/Stop Seating Availability	$0.18	$0.13	$0.12	*2020$/user trip*
Platform/Stop Weather Protection	$0.24	$0.15	$0.12	*2020$/user trip*
Restroom Availability	$0.14	$0.14	$0.10	*2020$/user trip*
Retail/Food Outlet Availability	$0.10	$0.10	$0.06	*2020$/user trip*
Staff Availability	$0.07	$0.03	$0.17	*2020$/user trip*
Step-Free Access to Station/Stop	$0.30	$0.30	$0.19	*2020$/user trip*
Step-Free Access to Vehicle	$0.39	$0.07	$0.07	*2020$/user trip*
Surveillance Cameras	$0.29	$0.29	$0.30	*2020$/user trip*
Temperature Controlled Environment	$0.59	$0.59	$0.59	*2020$/user trip*
Ticket Machines	$0.10	$0.10	$0.06	*2020$/user trip*
Timetables	$0.22	$0.09	$0.45	*2020$/user trip*

Factor	Bus	Light Rail / Street Car	Rail	Units
Bike Facilities	-	-	$0.09	*2020$/user trip*
Car Access Facilities	-	-	$0.11	*2020$/user trip*
Elevator	-	-	$0.07	*2020$/user trip*
Escalators	-	-	$0.04	*2020$/user trip*
On-Site Ticket Office	-	-	$0.09	*2020$/user trip*
Taxi Pickup/Dropoff	-	-	$0.05	*2020$/user trip*
Waiting Room	-	-	$0.19	*2020$/user trip*

Source: U.S. Department of Transportation, BCA Guidance for Discretionary Grant Programs, March 2022.

A-VI. PEDESTRIAN AMENITIES

To estimate benefits from added pedestrian amenities, USDOT-provided unit value for each type of amenity were used.

Table A-6: Value of Pedestrian Benefits (2020 Dollars)

Factor	Value	Units
Expand Sidewalk per foot of added width up to 31 feet	$0.10	*2020$/person-mile walked up to 0.86 miles*
Install Marked-Crosswalk on Roadway with volumes >= 10,000 vehicles per day	$0.18	*2020$/use*
Install Signal for Pedestrian Crossing on Roadway with volumes >= 13,000 vehicles per day	$0.46	*2020$/use*

Source: U.S. Department of Transportation, BCA Guidance for Discretionary Grant Programs, March 2022.

A-VII. EMISSIONS COSTS

To estimate the benefits of avoided emissions, USDOT-provided factors for Emissions Cost are used.

Table A-7: BCA Emissions Cost Factors (2020 dollars)

Year	Carbon Dioxide (CO_2)	Nitrogen Oxides (NO_x)	Particulate Matter ($PM_{2.5}$)	Sulfur Dioxide (SO_2)	Units
2021	$52	$15,600	$748,600	$41,500	*$/ short ton*
2022	$53	$15,800	$761,600	$42,300	*$/ short ton*
2023	$54	$16,000	$774,700	$43,100	*$/ short ton*
2024	$55	$16,200	$769,000	$44,000	*$/ short ton*
2025	$56	$16,500	$788,100	$44,900	*$/ short ton*
2026	$57	$16,800	$801,700	$45,700	*$/ short ton*
2027	$58	$17,100	$814,500	$46,500	*$/ short ton*
2028	$60	$17,400	$827,400	$47,300	*$/ short ton*
2029	$61	$17,700	$840,600	$48,200	*$/ short ton*
2030	$62	$18,100	$854,000	$49,100	*$/ short ton*
2031	$63	$18,100	$867,600	$49,100	*$/ short ton*
2032	$64	$18,100	$867,600	$49,100	*$/ short ton*
2033	$65	$18,100	$867,600	$49,100	*$/ short ton*
2034	$66	$18,100	$867,600	$49,100	*$/ short ton*
2035	$67	$18,100	$867,600	$49,100	*$/ short ton*
2036	$69	$18,100	$867,600	$49,100	*$/ short ton*
2037	$70	$18,100	$867,600	$49,100	*$/ short ton*
2038	$71	$18,100	$867,600	$49,100	*$/ short ton*
2039	$72	$18,100	$867,600	$49,100	*$/ short ton*
2040	$73	$18,100	$867,600	$49,100	*$/ short ton*
2041	$74	$18,100	$867,600	$49,100	*$/ short ton*
2042	$75	$18,100	$867,600	$49,100	*$/ short ton*
2043	$77	$18,100	$867,600	$49,100	*$/ short ton*
2044	$78	$18,100	$867,600	$49,100	*$/ short ton*
2045	$79	$18,100	$867,600	$49,100	*$/ short ton*
2046	$80	$18,100	$867,600	$49,100	*$/ short ton*
2047	$81	$18,100	$867,600	$49,100	*$/ short ton*
2048	$82	$18,100	$867,600	$49,100	*$/ short ton*
2049	$83	$18,100	$867,600	$49,100	*$/ short ton*
2050	$85	$18,100	$867,600	$49,100	*$/ short ton*

Source: U.S. Department of Transportation, Benefit Cost Analysis Guidance for Discretionary Grant Programs, Feb 2021. Table A-6 Accessed at https://www.transportation.gov/sites/dot.gov/files/2021-02/Benefit%20Cost%20Analysis%20Guidance%202021.pdf.

A-VIII. EMISSIONS RATES

To estimate the emissions reduction benefits associated with vehicle travel distance savings, emission rate factors derived from the California Air Resources Board EMissions FACtors (EMFAC) model were used for five pollutants associated with mobile sources. Using the approach applied in the Cal B/C Benefit-Cost Analysis model developed by the California Department of Transportation, emissions rates were aggregated for automobiles and trucks at different travel speeds based on different vehicle fleet compositions (2016 and 2036) to reflect the changing emissions profile under a range of driving conditions and as the fleet becomes greener over time. A growth rate was applied to estimate emissions rates for intermediate years.

Table A-8: Emission Rate Factors in grams per mile (2016 and 2036)

Year	Carbon Dioxide (CO_2)	Volatile Organic Compounds (VOCs)	Nitrogen Oxides (NO_x)	Particulate Matter ($PM_{2.5}$)	Sulfur Dioxide (SO_2)
Automobiles at 50 mph					
2016	317.14	0.0482	0.1655	0.0014	0.0032
2036	191.32	0.1594	0.0365	0.0006	0.0019
Trucks at 50 mph					
2016	1,116.83	0.1193	4.0528	0.0512	0.0107
2036	1,132.54	0.0301	0.4226	0.0042	0.0108
Automobiles at 55 mph					
2016	328.15	0.0448	0.1694	0.0014	0.0033
2036	198.13	0.015	0.0365	0.0007	0.002
Trucks at 55 mph					
2016	1,197.87	0.1179	4.3131	0.0654	0.0115
2036	1,142.66	0.0237	0.3503	0.004	0.0109

Source: California Department of Transportation Life-Cycle Benefit-Cost Analysis Model, Cal-B/C V6.2 Emissions Tables. Accessed at https://dot.ca.gov/programs/transportation-planning/economics-data-management/transportation-economics.

APPENDIX B
Detailed Benefit–Cost Analysis of UTA Westside Express Project

TABLE B-1: BCA SUMMARY

Undiscounted Costs and Benefits										
Year	Cal-endar Year	Capital Costs	Other Costs	Avoided Crashes	Operating Cost Savings	External Cost Savings	Emissions Cost Savings *	Travel Time Savings	Transit and Pedestrian Amenities	Total Benefits less Other Costs
0	2020	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	2021	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	2022	$0	$0	$0	$0	$0	$0	$0	$0	$0
3	2023	$0	$0	$0	$0	$0	$0	$0	$0	$0
4	2024	$34,664,500	$0	$0	$0	$0	$0	$0	$0	$0
5	2025	$33,929,275	$3,665,000	$1,597,327	$3,234,514	$855,205	$122,451	$762,570	$850,088	$3,757,155
6	2026	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$243,068	$1,525,140	$1,700,176	$7,512,475
7	2027	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$241,206	$1,525,140	$1,700,176	$7,510,614
8	2028	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$242,916	$1,525,140	$1,700,176	$7,512,323
9	2029	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$240,964	$1,525,140	$1,700,176	$7,510,371
10	2030	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$239,083	$1,525,140	$1,700,176	$7,508,490
11	2031	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$236,856	$1,525,140	$1,700,176	$7,506,263
12	2032	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$234,514	$1,525,140	$1,700,176	$7,503,921
13	2033	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$232,206	$1,525,140	$1,700,176	$7,501,613
14	2034	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$229,930	$1,525,140	$1,700,176	$7,499,337
15	2035	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$227,684	$1,525,140	$1,700,176	$7,497,091
16	2036	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$228,512	$1,525,140	$1,700,176	$7,497,919
17	2037	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$226,257	$1,525,140	$1,700,176	$7,495,664
18	2038	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$224,026	$1,525,140	$1,700,176	$7,493,433
19	2039	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$221,819	$1,525,140	$1,700,176	$7,491,226
20	2040	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$219,632	$1,525,140	$1,700,176	$7,489,040
21	2041	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$217,466	$1,525,140	$1,700,176	$7,486,874
22	2042	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$215,319	$1,525,140	$1,700,176	$7,484,727
23	2043	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$215,834	$1,525,140	$1,700,176	$7,485,241
24	2044	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$213,668	$1,525,140	$1,700,176	$7,483,076
25	2045	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$211,519	$1,525,140	$1,700,176	$7,480,927
26	2046	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$209,387	$1,525,140	$1,700,176	$7,478,794
27	2047	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$207,269	$1,525,140	$1,700,176	$7,476,676
28	2048	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$205,166	$1,525,140	$1,700,176	$7,474,573
29	2049	$0	$7,330,000	$3,194,654	$6,469,027	$1,710,411	$203,077	$1,525,140	$1,700,176	$7,472,485
30	2050	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total		$68,593,775	$179,585,000	$78,269,016	$158,491,167	$41,905,065	$5,509,831	$37,365,918	$41,654,311	$183,610,308

TABLE B-1: CONTINUED

Discounted Costs and Benefits										
Year	Calendar Year	Avoided Crashes	Operating Cost Savings	External Cost Savings	Emissions Cost Savings *	Travel Time Savings	Transit and Pedestrian Amenities	Other Costs	Capital Costs	Total Benefits less Other Costs *
0	2020	$0	$0	$0	$0	$0	$0	$0	$0	$0
1	2021	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	2022	$0	$0	$0	$0	$0	$0	$0	$0	$0
3	2023	$0	$0	$0	$0	$0	$0	$0	$0	$0
4	2024	$0	$0	$0	$0	$0	$0	$0	$26,445,381	$0
5	2025	$1,138,872	$2,306,164	$609,750	$103,264	$543,702	$606,101	$2,613,094	$24,191,104	$2,694,757
6	2026	$2,128,733	$4,310,586	$1,139,719	$198,379	$1,016,265	$1,132,899	$4,884,289	$0	$5,042,292
7	2027	$1,989,470	$4,028,585	$1,065,158	$190,592	$949,780	$1,058,784	$4,564,756	$0	$4,717,613
8	2028	$1,859,318	$3,765,033	$995,475	$185,982	$887,645	$989,518	$4,266,127	$0	$4,416,843
9	2029	$1,737,680	$3,518,722	$930,350	$178,736	$829,575	$924,783	$3,987,034	$0	$4,132,812
10	2030	$1,624,000	$3,288,525	$869,486	$171,844	$775,304	$864,283	$3,726,200	$0	$3,867,242
11	2031	$1,517,757	$3,073,388	$812,604	$165,082	$724,583	$807,741	$3,482,430	$0	$3,618,725
12	2032	$1,418,464	$2,872,325	$759,443	$158,566	$677,180	$754,898	$3,254,608	$0	$3,386,270
13	2033	$1,325,668	$2,684,416	$709,760	$152,351	$632,879	$705,513	$3,041,689	$0	$3,168,897
14	2034	$1,238,942	$2,508,800	$663,327	$146,417	$591,475	$659,358	$2,842,700	$0	$2,965,618
15	2035	$1,157,890	$2,344,673	$619,932	$140,744	$552,781	$616,222	$2,656,729	$0	$2,775,512
16	2036	$1,082,140	$2,191,283	$579,375	$137,215	$516,618	$575,908	$2,482,925	$0	$2,599,615
17	2037	$1,011,346	$2,047,928	$541,472	$131,924	$482,820	$538,232	$2,320,490	$0	$2,433,233
18	2038	$945,183	$1,913,952	$506,049	$126,854	$451,234	$503,021	$2,168,683	$0	$2,277,609
19	2039	$883,348	$1,788,740	$472,943	$121,992	$421,714	$470,113	$2,026,806	$0	$2,132,043
20	2040	$825,559	$1,671,720	$442,003	$117,326	$394,125	$439,358	$1,894,211	$0	$1,995,878
21	2041	$771,551	$1,562,355	$413,087	$112,845	$368,341	$410,615	$1,770,291	$0	$1,868,502
22	2042	$721,075	$1,460,145	$386,062	$108,542	$344,244	$383,752	$1,654,478	$0	$1,749,343
23	2043	$673,902	$1,364,621	$360,806	$105,746	$321,723	$358,647	$1,546,241	$0	$1,639,204
24	2044	$629,815	$1,275,347	$337,202	$101,704	$300,676	$335,184	$1,445,085	$0	$1,534,843
25	2045	$588,612	$1,191,913	$315,142	$97,818	$281,006	$313,256	$1,350,546	$0	$1,437,200
26	2046	$550,105	$1,113,937	$294,525	$94,080	$262,622	$292,763	$1,262,193	$0	$1,345,839
27	2047	$514,117	$1,041,063	$275,257	$90,484	$245,441	$273,610	$1,179,620	$0	$1,260,353
28	2048	$480,483	$972,956	$257,250	$87,024	$229,384	$255,710	$1,102,448	$0	$1,180,359
29	2049	$449,050	$909,305	$240,420	$83,694	$214,378	$238,982	$1,030,325	$0	$1,105,502
30	2050	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total		$27,263,078	$55,206,482	$14,596,594	$3,309,205	$13,015,494	$14,509,250	$62,553,998	$50,636,486	$65,346,105

* includes carbon-related benefits discounted at 3%

Discounted Benefit Summary	
Benefit Cost Ratio	1.29
Net Present Value	$14,709,620


UTA