CITY OF CINCINNATI

CINCINNATI MODERN STREETCAR

TIGER II DISCRETIONARY GRANT PROGRAM

ECONOMIC ANALYSIS SUPPLEMENTARY DOCUMENTATION

AUGUST 23, 2010

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This document provides detailed technical information on the economic analyses conducted in support of the Grant Application for the Cincinnati Modern Streetcar project. Section 1 introduces the conceptual framework used in the Benefit-Cost Analysis. Section 2 provides an overview of the project, including a brief description of existing conditions and proposed alternatives; a summary of cost estimates and schedule; and a description of the types of effects that the Cincinnati Streetcar is expected to generate. Section 3 discusses the general assumptions used in the estimation of project costs and benefits, while estimates of travel demand and traffic growth can be found in Section 4. Specific data elements and assumptions pertaining to the long-term outcome selection criteria are presented in Section 5 along with associated benefit estimates. Estimates of the project's Net Present Value (NPV), its Benefit/Cost ratio (BCR) and other project evaluation metrics are introduced in Section 6. Next, Section 7 provides the outcomes of the sensitivity analysis. Detailed economic impact estimates can be found in Section 8, along with descriptions of the data sources and modeling tools used in the analysis. Additional data tables are provided in Section 9, including annual estimates of benefits and costs, as well as intermediate values to assist DOT in its review of the application.[1]

1. Methodology

Benefit-Cost Analysis (BCA) is a conceptual framework that quantifies in monetary terms as many of the costs and benefits of a project as possible. Benefits are generally broadly defined. They represent the extent to which people to whom they accrue are made better-off, as measured by their own willingness-to-pay. In other words, central to BCA is the idea that people are best able to judge what is "good" for them, what improves their well-being or welfare. BCA also adopts the view that a net increase in welfare (as measured by the summation of individual welfare changes) is a good thing, even if some groups within society are made worse-off. And a project or proposal would be rated positively if the benefits to some are large enough to compensate the losses of others. Finally, BCA is typically a forward-looking exercise, seeking to anticipate the welfare impacts of a project or proposal over its entire life-cycle. Future welfare changes are weighted against today's changes through discounting, which is meant to reflect society's general preference for the present, as well as broader inter-generational concerns.

The specific methodology developed for this application borrows from the above BCA principles and is consistent with the TIGER II guidelines. In particular, this approach involves:

- Establishing existing and future conditions under the build and no-build scenarios, and considering an alternative to the full build;
- Assessing benefits with respect to each of the five long-term outcomes identified in the Notice of Funding Availability (NOFA)[2];

[1] While the models and software themselves do not accompany this appendix, greater detail can be provided, including spreadsheets presenting additional interim calculations and discussions on model mechanics and coding, if requested.

[2] U.S. Federal Register, Federal Register / Vol. 75, No. 104 / Tuesday, June 1, 2010 / Notices, Notice of Funding Availability for the Department of Transportation's National Infrastructure Investments Under the Transportation, Housing and Urban Development, and Related Agencies Appropriations Act for 2010, http://www.dot.gov/docs/TIGER_II_Discretionary_Grant_Program_Final_Notice_1_June_2010.pdf.

- Describing the indirect effects of the project on land use and community development;
- Measuring benefits in dollar terms whenever possible and expressing benefits and costs in a common unit of measurement;
- Using DOT guidance for the valuation of travel time savings, safety benefits and the reduction in air emissions, while relying on industry best practice for the valuation of other effects;
- Discounting future benefits and costs with the real discount rates recommended by the USDOT (7 percent and 3 percent); and
- Conducting sensitivity analysis to assess the impacts of changes in key estimating assumptions.

The BCA framework recognizes and estimates three broad categories of benefits:

- **User Benefits**: Benefits to users of the transportation system (including those who would travel in the base case, referred to as "existing users"; and those who would travel only in the build scenario, referred to as "new users");
- **External Benefits**: Changes in emission volumes, changes in the number and severity of accidents, and other changes that may impact users and non-users of the transportation system alike; and
- **Community Development Benefits**: Existence and option value of the proposed transportation investment, along with livability improvements brought about by the investment (e.g., more destinations within a walking distance; increase in productivity associated with densification; and other community attributes that people value).

1.1 Estimation of User Benefits

The framework used in the estimation of user benefits is based upon the theory of demand, and involves the estimation of changes in consumer surplus.

The demand for travel is an inverse relationship between the number of trips "demanded" and the generalized cost of travel, which includes both travel time and out-of-pocket costs (such as vehicle operating and parking costs for auto users, or fare payments for transit riders). That relationship is depicted in Figure 1, below. The term "consumer surplus" refers to the area between the demand curve and the actual cost of travel at any point in time. It is a measure of welfare to the extent that people who are traveling at that cost are "paying" less than what they would be willing to pay; in other words the value they are placing on a trip (as measured by their willingness-to-pay along the demand curve) is higher than what they are actually paying.

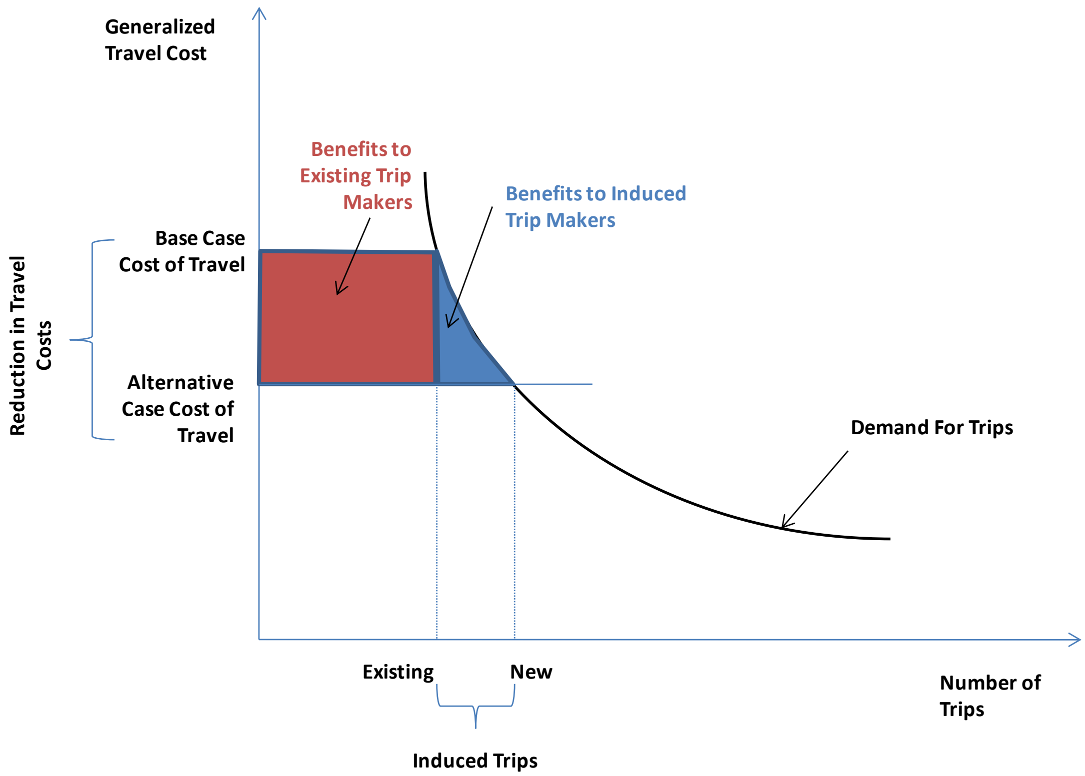
The proposed transportation investment would reduce the general cost of travel and result in benefits to both exiting and new trip-makers.

Benefits to existing trip-makers are represented by the red rectangle in Figure 1. They are estimated as the difference between the generalized cost of travel in the base case and the generalized cost of travel in the build scenario *times* the number of existing trips.

In addition, as the generalized cost of travel is being reduced, additional trips (beyond those diverted from other modes) are expected. These induced trip-makers represent a portion of all potential trip-makers who did not make a trip (or as many trips) in the no-build scenario, but are now "attracted" to the lower generalized cost allowed by the investment.

User benefits resulting from new trips are depicted by the blue triangle in Figure 1. They are estimated using the "rule-of-a-half". Please note that the change in generalized cost from no-build to build conditions only represents the change in user costs (travel time plus out-of-pocket costs). Social costs, including air emissions, accident occurrences, and congestion externalities are assumed not to affect trip making or modal decisions in this analysis. The elasticity of demand (the slope of the demand curve) is estimated based on existing knowledge about travel costs in the corridor and ridership forecasts developed by the Project Team.

Figure 1: Framework for the Estimation of User Benefits



1.2 Estimation of External Benefits

External benefits (changes in air emissions and accident costs) are calculated as the difference between total costs in the base case and total costs in the alternate, build scenario. As explained later in this document, the unit cost estimates used in these calculations are those identified in Appendix A of the Notice of Funding Availability.

1.3 Estimation of Community Development Benefits

Community development benefits are estimated on the basis of expected changes in residential and commercial property value beyond and above growth projections in the base case. A benefit transfer approach is employed to predict the extent of property appreciation in Cincinnati following completion of the project. To avoid double counting, the capitalized value of future expected transportation cost savings are netted out of the resulting development benefit estimates. Alternative approaches to estimating the extent of incremental benefits are explored as sensitivity analysis.

1.4 Principles Guiding this Analysis

The following principles guide the estimation of benefits and costs:

- *Only incremental benefits and costs are measured*
    - The incremental benefits of the project include the transportation cost savings for the users of the service, as well as increases in asset values as a result of the implementation of the transportation improvements. For instance, as explained above, only the incremental real estate value associated with the implementation of the project is considered a benefit of the project. Increases in values associated with benefits measured elsewhere, such as those that are a product of additional, unaccounted for investment, or that are a result of the general economic cycle are not considered in the estimation of station area development benefits.
    - The incremental costs of implementation of the project include initial and recurring costs. Initial costs refer to the capital costs incurred for design, ROW, rolling stock and construction of the streetcar facility. Recurring costs include incremental operating costs in addition to administration and marketing expenses. Only additions in costs to the current operations and planned investments are considered in this analysis.
- *Benefits and costs are valued relative to the next-best alternative*
    - The benefits stemming from the implementation of the transportation improvement are those above and beyond the benefits that could be obtained from the next-best transportation alternative. For instance, the transportation cost savings for users are measured relative to the best existing alternative, which may be using personal automobiles or bus services on the roadway, depending on the type of user. The benefit in this case is the net cost saving in transportation costs relative to the best alternative.
    - The costs imputed to the project only include those incremental costs that represent an opportunity cost to the funding entities. Expenditures are considered foregone opportunities to investment in the next-best alternative.
- *All benefits and costs are estimated in 2010 dollars*. The valuation of benefits makes use of a number of assumptions that are required to produce monetized values for all non-

pecuniary benefits. The different components of time, for instance, are monetized by using a "value of time" that is assumed to be equivalent to the user's willingness to pay for time savings in transit. These, as with all other values used in the analysis are taken from the USDOT guidance on the preparation of TIGER II applications. Where USDOT has not provided valuation guidance or a reference to guidance, standard industry practice has been applied. Estimates used in the monetization of benefits include the cost of operating a vehicle, including fuel, maintenance, repair, and depreciation. The exact values applied in the economic analysis are provided in this document.

- *Annual costs and benefits are computed over a long-run planning horizon and summarized through a lifecycle cost analysis*. The project is assumed to have a useful life of at least 20 years; that is the time horizon of the analysis. Construction costs are incurred within the first three years of implementation of the project, but operating costs continue through the whole horizon of the project. Benefits also accrue during the full operation of the project.
- *The opportunity cost associated with the delayed consumption of benefits and the alternative uses of the capital for the implementation of the project is measured by the discount rate.* All benefits and costs are discounted to reflect the opportunity costs of committing resources to the project. Real discount rates are applied to all future costs and benefits as a representation of how the public sector evaluates investments.

2. Project Summary

Transportation investment in the Hamilton County area over the years has mainly supported roads, freeways, and personal automobile. As there is no rail system in the region connecting to its urban core, the City of Cincinnati aims to develop a streetcar transit system that serves as an urban circulator for Downtown Cincinnati and its adjoining neighborhoods.

The alignment is a 3.7-mile corridor connecting downtown Cincinnati and Findlay Market in the Over-the-Rhine neighborhood. In this BCA the results for a 2.1-mile uptown extension is also included. The streetcars will run on parallel tracks, occupying two of four existing lanes along its proposed route. Aside from improving local circulation, the Cincinnati Streetcar is expected to bring about long-term impacts that will support sustainable community and economic development, and complement other components of the local and regional transportation system.

2.1 Base Case and Alternatives

The project's main route is concentrated in the central business district and includes a downtown portion and an Over-the-Rhine portion. In the Base Case (No-Build Scenario), the downtown portion is served by Main and Walnut streets. Both are two one-way travel lanes, with Main traveling northwest and Walnut traveling southeast. At the southern most point of both corridors are The Great American Ballpark (baseball stadium of the Cincinnati Reds) and Paul Brown Stadium (football stadium of the Cincinnati Bengals). Both corridors mostly serve commuters to-and-from downtown and spectators of both the Reds and Bengals during game days.

In the Base Case, the Over-the-Rhine portion is served primarily by Race and Elm streets. Both are two one-way travel lanes, with Race traveling northwest and Elm traveling southeast. They are bordered by McMicken Avenue to the north and Liberty Street to the south with Findlay Market at the center. The two corridors primarily serve market and other commercial shoppers and have on-street parking on the curb lane.

In the Uptown Extension area, from McMicken Avenue up Vine Street to Calhoun Street, Vine Street is currently a four-lane road with two lanes going in each direction. It serves mostly a residential area and open spaces with Inwood Park at the end of the line. This corridor also provides access to the University of Cincinnati (the University) area from the central business district of Cincinnati.

Under the Alternative Case (Build Scenario), the modern streetcar will function as an urban circulator or pedestrian accelerator to promote “walkable urbanism” in Cincinnati’s central business district. The streetcar delivers short-haul transportation to the central business district area, including Findlay Market and complements other long-haul modes of transportation such as commuter rail. The Build Scenario will have the streetcar run in a loop between the downtown and Over-the–Rhine portion on Main, Elm, Walnut, and Race streets. An extension is also planned on Vine St. connecting the uptown and University residential areas to Over-the-Rhine, downtown, and both stadiums.

2.2 Effects on Long-Term Outcomes

The Cincinnati Streetcar project is expected to complement other components of the local and regional transportation system. But the benefits of the streetcar are expected to reach far beyond local and regional commuters and leisure trip makers. As the system attracts commercial and residential development, property and business owners will gain from the amenity effects of the streetcar that are capitalized into property values. Aside from urbanization and revitalization of the area, the system will also induce renovation and rehabilitation of older buildings in Over-the-Rhine, thus preserving the city’s most historical neighborhood. Additionally, the streetcar system will provide greater mobility for low income households, persons with disabilities, and senior citizens of the area. Overall, the City of Cincinnati will benefit from the zero-emission standards of the streetcars and reduction in congestion. Key components of the streetcar benefits are listed in Table 1.

Table 1: Expected Effects on Long Term Outcomes and Benefit Categories

Long-Term Outcomes	Benefit Categories	Description	Monetized	Quantified	Qualitative
State of Good Repair	Pavement Maintenance Savings	Reductions in pavement maintenance costs due to changes in roadway usage	Yes	Yes	No
Economic Competitiveness	Travel Time Savings	Door-to-door travel time savings to transit users and remaining roadway users	Yes	Yes	Yes

Long-Term Outcomes	Benefit Categories	Description	Monetized	Quantified	Qualitative
	Out-of-Pocket Cost Savings	Reductions in monetary costs to drivers switching to public transit	Yes	Yes	No
Livability	Community Development	Option value and amenity value of proposed transit alignment, as measured in property appreciation (net of capitalized travel cost savings)	Yes	Yes	Yes
	Benefits to Low Income Households	Portion of travel time savings and out-of-pocket cost savings to low income households	Yes	Yes	No
	Cross-Sector Benefits	Resource savings resulting from reductions in the provision of home care	Yes	Yes	No
Environmental Sustainability	Reductions in Air Emissions	Reductions in pollutants and green house gasses due to changes in private vehicle use relative to base case	Yes	Yes	Yes
Safety	Accident Reduction	Reductions in property losses, injuries and deaths due to modal shifts	Yes	Yes	Yes

2.3 Project Cost and Schedule[3]

The downtown alignment is estimated to cost **$117.4 million** over three years of construction beginning in 2010 and 20 years of service immediately thereafter. The sum consists of $95.4 million in total capital costs and $21.9 million in total operation and maintenance expenditures. Key components of capital costs include vehicle procurement, track construction, pre-construction engineering and rail procurement, and traction power construction.

The overall project cost will rise to **$147.4 million** if the uptown extension is also included. In particular, the estimate includes total capital costs of $119.8 million and total operation and maintenance expenditures of $27.6 million.

For the BCA, construction of the full alignment is assumed to begin in 2010 and end by 2013. By the end of 2011, slightly less than three quarters of pre-construction work and utility relocation will be completed. Over 90 percent of track construction and traction power construction is expected to be completed by the end of 2012. Service is to begin immediately after construction at the beginning of 2013.

[3] All cost estimates in this section are in millions of dollars of 2010, discounted to 2010 using a 7 percent real discount rate.

3. General Assumptions

The BCA measures benefits against costs throughout the study period beginning at the start of construction and including twenty years of operations. The monetized benefits and costs are estimated in 2010 dollars with future dollars discounted in compliance with TIGER II requirements at a seven percent real rate and sensitivity testing at three percent.

The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically,

- Input prices are inflated to 2010 dollars;
- The duration of analysis begins in 2010 and ends in 2032. It includes construction years (2010-2012) and twenty years of operations (2013-2032);
- A seven percent discount rate is assumed throughout the study. A three percent discount rate is used for sensitivity analysis;
- Opening year ridership is an input to the BCA and is assumed to be fully realized in year one (no ramp-up); and
- Unless specified otherwise, the results shown in this document correspond to the effects of the full alignment (Downtown loop plus Uptown Extension).

4. Ridership Projections

The success of a transit system hinges on its ability to provide local and regional connectivity and generate societal welfare in the long run. In quantifying the system's lifecycle utilization as well as its induced economic worthiness, its level of and growth in demand must be analyzed, given other existing transportation alternatives.

Throughout this BCA, various long-term outcomes of the Cincinnati Streetcar Project are monetized using the outputs of the travel demand model. In particular, traffic volumes of different modes are translated into vehicle-miles traveled (VMT). Given average trip length or other roadway assumptions, existing and projected travel conditions are estimated. Ultimately, economic benefits that stem from the reduction in demand for motorized vehicles are computed as changes in VMT and speed improvements throughout the network.

For the Cincinnati Streetcar project, demand for multiple modes of transportation (automobiles, bus, and taxis) in the form of average annual daily traffic (AADT) were estimated by HDR Engineering using a travel demand model. Such a model estimates the level of demand of potential riders by first estimating the cost of traveling in various transportation options, using local factors such as income, mobility, and origin and destination pairs. Travel demand is then estimated by aggregating the number of potential riders who have the lowest general cost of traveling in each mode. Specifically, the estimates are for both peak and off-peak periods and special events such as sporting events.

Assumptions

While travel demand models have been used to accurately forecast demand, other assumptions on the implied ridership estimates are made. The first assumption is that the diversion breakdown of ridership from multiple modes of transportation will remain the same throughout the study. The table below lists the assumed percentages of diversion for each mode of transportation.

Table 2: Diversion Rates to Streetcar

Mode of Transportation	Percentage of Total Ridership	Source
Diverted from Autos	31%	HDR Assumptions, Travel Demand Model
Diverted from Other Transit (Bus)	27%	
Diverted from Taxi	5%	
Diverted from Walking/Biking[4]	15%	
Induced Riders	22%	

Another assumption is a constant ridership growth rate of 2.75[5] percent through the study horizon. This analysis also makes the assumption that no other major construction of a transportation infrastructure in Cincinnati will affect streetcar ridership.

Daily Ridership Estimates

The resulting projections for ridership are presented in Table 3, along with the number of diverted users of other transportation alternatives.

Table 3: Daily Ridership by Transportation Alternatives Considered

Year	Total Daily Trips	Diverted from Auto	Diverted from Bus	Diverted from Taxi	Diverted from Walking and Biking	Induced Demand
Opening Year 2013	**6,640**	2,081	1,769	312	1,040	1,438
2022	**8,711**	2,730	2,320	409	1,365	1,887
2032	**11,427**	3,581	3,044	537	1,790	2,475
Total	**178,581**	**55,962**	**47,567**	**8,394**	**27,981**	**38,677**

As discussed earlier, VMT forecast corresponding to the streetcar ridership projections are produced for the BCA. Table 4 provides these estimates.

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[4] Benefits for riders who divert from walking/biking were not calculated in this CBA due to data limitations.

[5] Ridership was estimated for the opening year and 2018. The annual growth rate was calculated between these two years and applied throughout.

Table 4: Traffic Conditions over the Period of Analysis

	2013	2022	2032
Daily VMT Without Streetcar	23,882	26,575	29,355
Daily VMT Reduced Because of Streetcar	5,029	6,597	8,653
Daily Auto Trips Reduced	1,734	2,275	2,984

5. Benefits Measurement, Data and Assumptions

This section describes the measurement approach for each category of long-term outcomes estimated in this analysis and provides an overview of the associated data, assumptions, and methodology.

5.1 State of Good Repair

In this BCA, enhancement to the local and regional transportation systems is one of the societal welfare improvements that the proposed alignment is expected to deliver. To quantify the economic benefits of maintaining the existing transportation network in a state of good repair, pavement maintenance savings are estimated.

Pavement Maintenance Savings

The streetcar project is expected to improve existing roadway conditions (relative to the base case) by reducing demand for other form of motorized vehicles. This benefit is monetized into pavement maintenance cost savings. Essentially the difference in the levels of road-surfacing due to traffic volume in the build and no-build scenarios is computed.

Assumptions

The savings in pavement maintenance are due to the reduction in vehicle-miles on nearby arterials as trips are diverted onto the streetcar. This analysis combines and estimates per-unit savings of pavement maintenance costs, estimated at $0.001 per vehicle-mile avoided (Federal Highway Administration, 1997 Cost Allocation Study, May 2000 Addendum), with the estimated reduction in vehicle-mile traveled (VMT) from autos.

Benefit Estimates

The opening year savings in pavement maintenance is calculated at approximately $1,000. This amounts to $14,718 for the study period, based on an opening year of 1.3 million VMT avoided. The opening year and lifecycle results are compared in Table 5. In Section 9 (Supplementary Data Tables), results are presented annually.

Table 5: Estimates of State of Good Repair Benefits for the Full Alignment, in Millions of 2010 Dollars

	Opening Year	Lifecycle
VMT Avoided	1,257,186	33,810,189
Pavement Maintenance Savings	$1,026	$14,718

5.2 Economic Competitiveness

The long-term economic productivity of individuals - and ultimately a region - is found to be enhanced through higher human and physical capital. In many cases, increases in capital accumulation are expected to be achieved through improvements in resource allocation. For the proposed streetcar project, increases in productivity would arise through improvements in workers' mobility. In this analysis, two measures of mobility are presented: travel-time savings and out-of-pocket cost savings.

Travel-Time Savings

Travel-time savings for travelers are dependent upon their value of time (VOT) and the reduction of time spent traveling (travel-time). For travelers who remain auto users after streetcar operations begin, they experience a reduction in travel-time as a result of less congestion. Travelers who divert from autos, buses, or taxis may experience a reduction in travel-time depending on their origin and destination. VOT is then applied to each reduction in travel-time to estimate travel-time savings.

Out-of-Pocket Costs

Savings in vehicle operating costs (VOC) apply to auto users and are experienced by remaining auto users and streetcar riders who diverted from autos. VOC is composed of four categories; fuel, oil, tires, maintenance, and depreciation. The consumption rates for these costs are derived from the average speed and combined with unit costs for each to estimate total VOC per mile and VOC per trip. VOC are combined with parking to estimate the total out-of-pocket cost per trip for auto users. The decrease in out-of-pocket cost in the alternative relative to the base case scenario represents VOC savings for remaining auto users. For travelers who divert from auto to streetcar, out-of-pocket cost savings are estimated as the difference between auto costs and fare payments.

Assumptions

As described above, travel-time savings are estimated with a VOT estimate and expected reductions in travel times. The VOT estimate used in this BCA is the same for all transportation alternatives and modes, following US DOT Guidance.

Table 6: Value of Time for all Transportation Modes Considered

Variable	Value ($2010)	Source
Value of Time, Local Travel, All Surface Modes	$14.07	USDOT OST, Revised Departmental Guidance: Valuation of Travel Time in Economic Analysis, Sep 2003; adjusted for income growth and inflation to dollars of 2010

The reduction in travel-time is a function of speed and distance. The speeds for all modes vary throughout the study horizon as more travelers divert to the streetcar system and congestion on the roads decreases.

The average trip length is assumed the same for all travelers across all modes and is shown in the table below.

Table 7: Trip Length by Study Area

Average Door-to-Door Trip Length	Value (miles)	Source
Downtown Loop Only	1.85	HDR Assumption 50% of the length of alignment
Full Alignment	2.90	

VOC is estimated using consumption rates for fuel, oil, tires, maintenance, and depreciation and is a function of average vehicle speed. Estimates of vehicle miles traveled and unit costs are applied to these consumption rates to calculate total vehicle operating costs. The table below provides the unit cost estimates used in this analysis, along with other out-of-pocket costs such as parking and streetcar fares.

Table 8: Out-of-Pocket Transportation Costs

VOC	Value ($2010)	Source
Fuel ($ per gallon)*	$3.42	Retail Gasoline Price, 20-Year Average, US DOE EIA Annual Energy Outlook, 2010
Oil ($ per liter)	$8.10	Federal Highway Administration HERS Technical Report, 2002
Tires ($ per 4 tires)	$348.40	
Maintenance ($ per 1000 mi)	$154.60	
Depreciation (avg. depreciable cost per vehicle)	$20,837.80	
Parking ($ per day)	$5.25	HDR Assumption
Average Streetcar Fare	$1.00	HDR Assumption

*Note: * the fuel cost estimate used in this BCA includes all applicable taxes but does not include any external costs, such as those considered by NHTSA in its regulatory impact analysis of corporate average fuel economy standards.*

Benefit Estimates

Travel-time costs combined with out-of-pocket costs make up the generalized trip cost for each traveler. Table 9 reports the average generalized travel cost per-mile for auto, bus, taxi, and the streetcar.

Table 9: Generalized Travel Costs by Transportation Mode

Mode of Transportation	Opening Year Cost per Mile ($2010)
Auto (Base Case)	**$1.79**
Time	$0.64
Out-of-Pocket	$1.15
Auto (Alternative)	**$1.69**
Time	$0.55
Out-of-Pocket	$1.14
Bus	**$0.77**
Time	$0.51
Out-of-Pocket (Fare)	$0.26
Taxi	**$3.34**
Time	$0.56
Out-of-Pocket (Fare)	$2.78
Streetcar	**$0.68**
Time	$0.42
Out-of-Pocket (Fare)	$0.26

Table 10 lists the opening year and lifecycle cost savings calculated from each traveler who remain auto users and those who divert to streetcar (refer to Section 9 for annual estimates). Induced riders are included in these benefits. Since induced riders previously did not travel, and therefore have no generalized trip cost, their willingness-to-pay is assumed, essentially, to be halfway between the cost of the “next best” alternative and the cost of a streetcar trip (the “rule-of-a-half”). The next best alternative is considered to be bus because it is the cheapest transit other than streetcar.

As reported, the majority of the benefits estimated for improvements in economic competitiveness is due to diversion from automobiles to streetcar, followed by diversion from taxis to streetcar, and then remaining automobiles (as driving conditions improve on the road network).

Table 10: Estimates of Generalized Travel Cost Savings for the Full Alignment, in Millions of 2010 Dollars

Travelers	Opening Year	Lifecycle
Remaining Autos	$0.39	$8.17
Diverted from Autos	$1.14	$17.57
Diverted from Bus	$0.12	$3.19
Diverted from Taxi	$0.60	$8.79
Induced Riders	$0.05	$1.29
Total General Trip Cost Savings	**$2.30**	**$39.00**

5.3 Livability

Community cohesiveness stems from individuals’ mobility and goods and services’ accessibility. In this BCA two types of livability improvements are presented: community development and low-income mobility.

Community Development

A majority of benefits from the transit alignment result from community development and appreciation of land and building values. This type of benefits is associated with the amenity effect of the transit line, which is found to induce property appreciation that is often referred to as “Transit Premium”.

For a new property[6] near the transit alignment, its market price or rental rate at the time of purchase or lease is assumed to capture the expected lifecycle stream of benefits. The amount

[6] A new property is one that is newly impacted by transit. All existing properties are considered new in the first year of transit operation, while only those that are newly constructed in subsequent years will be considered for the remaining lifecycle of the transit alignment.

of transit premium is then realized by the property owner or lessee, annually at an increasing rate to reflect growing certainty over time. As a result of these two assumptions, the transit premium rate (as a percentage of property value) is applied once to the price of new property only, and the dollar amount of benefits is spread over the analysis horizon, subject to time discounting.

There are five key data elements used in estimating community benefits: number of properties in the opening year, growth in the number of properties, property values in the opening year, growth in the value of property (in the base case), and transit premium rate. The first four are derived through historic, current, and forecast (or planned) land use and property data of the impact area. These estimates are assumed to remain unchanged with or without transit. The last component, the transit premium rate, is estimated based on current literature of transit impacts on property values generated by comparable systems. Since many studies rely on data after transit opening, this analysis only applies the transit premium rates to new properties after streetcar opening and not during construction.

To standardize the results from the various studies, the premium rates found are weighted by each of the corresponding system ridership and city population. Table 11 provides the list of studies and corresponding premiums applied in this BCA.

Table 11: Transit Premium Rates from Other Transit Systems

System	City	Ridership	City Population	Rider to Population Ratio	Premium Applicable		
					Residential	Condos	Commercial
DART	Dallas, TX	229,200	2,412,827	9.50%	12.2%		
LRT- South	San Diego, CA	103,900	3,001,072	3.46%		3.5%	-9.0%
LRT- East	San Diego, CA	103,900	3,001,072	3.46%		6.4%	-1.0%
LRT- Downtown	San Diego, CA	103,900	3,001,072	3.46%	5.1%	2.2%	4.4%
LRT- North	San Diego, CA	103,900	3,001,072	3.45%		3.0%	71.9%
LRT	Los Angeles, CA	136,400	3,849,378	3.54%		-6.2%	0.7%
LRT	San Jose, CA	34,400	929,936	3.70%	45.0%		
LRT	St. Louis, MO	59,000	347,181	16.99%	32.0%		

Sources:

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- *Weinberger, R. "Light Rail Proximity: Benefit or Detriment in the Case of Santa Clara County, California?" Transportation Research Record 1747, (2001): 104-113.*
- *Garrett, T., 2004. "Light-Rail Transit in America: Policy Issues and Prospects for Economic Development." St. Louis: Federal Reserve Bank of St. Louis, pp.1-30.*

In addition, the transit premium rates are neighborhood-specific, so that land use and zoning (and even transit-oriented development) are appropriately accounted for. In order to identify variations among different neighborhoods, a panel of developers, planners and other subject matter experts evaluated each neighborhood within the study area for a variety of development-supporting characteristics.

Property prices are multiplied by the transit premium rates to compute the lifetime amount of value appreciation due to the streetcar project. For any property, it will take 30 years for all premiums to be realized, independent of this BCA's analysis horizon. The rate at which a premium amount is realized over time is computed according to the formulas in Table 12. The first ten years of streetcar service is assumed to be a ramp-up period and the ramp-up parameters (*a* and *b*) are chosen for formulation continuity.

Table 12: Formulation of Transit Premium Realization

Time Horizon	Formulation
First Ten Years	a * Property Price* Transit Premium Rate / b + (1-a) Property Price* Transit Premium Rate / b *(Years of Service+1)/ (Years of Gradual Realization+1)
Rest of Realization Years (=20)	Property Price* Transit Premium Rate / b
Parameters: a=0.3, b=26.5	

Assumptions

The analysis area for the project is defined by a three-city blocks buffer. The distance specified aligns with hedonic pricing literature on measuring consumer willingness to pay for the accessibility and nuisance impacts of a transit system.

There are eight zones within the Downtown Loop analysis area, and three additional zones in the Uptown Extension analysis area.

Each zone is land use and zoning-specific (if not neighborhood-specific) so that their respective development potential can be reflected in the economic development benefits.

Figure 2 is a map of the analysis zones and Table 13 provides each zone's street boundaries.

Figure 2: BCA Zones with respect to Project Route

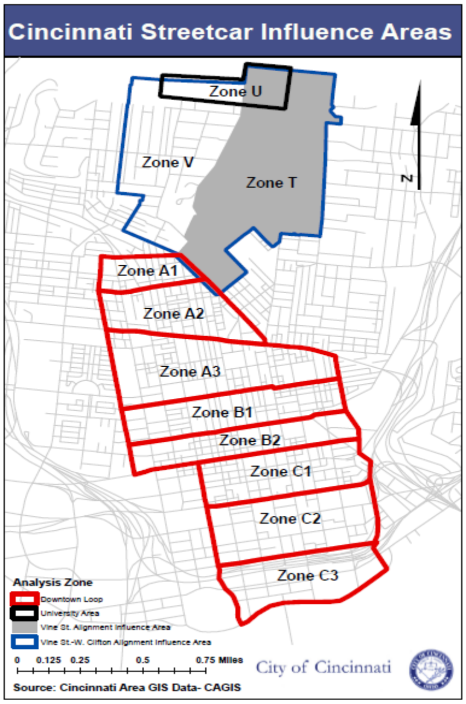

Table 13: Streetcar Zones Location

Streetcar Zones	Location
A1	Riverfront to 3rd Street, East to beyond Broadway, West to Elm
A2	3rd Street to 6th Street, East to beyond Broadway, West to Elm
A3	6th to 9th, East to beyond Broadway, West to Elm
B1	9th to Central Parkway, East to Broadway, West to Elm
B2	Central Parkway to 13th, East to Broadway, West to Central Parkway
C1	13th to Liberty, East to Broadway, West to beyond Central Avenue
C2	Liberty to Findlay, East to Broadway, West to beyond Central Avenue
C3	Findlay to McMicken , East to Broadway, West to beyond Central Avenue
T	Vine Street Up the Hill, West to Ohio Avenue, East to Auburn Avenue
U	University of Cincinnati Campus
V	Clifton Avenue North, West to Victor Street, East to Ohio Avenue

The property data used in this analysis is obtained from the City of Cincinnati Recorder's Office (2007 and 2009 ESRI ArcGIS Parcel Data- CAGIS). Due to data limitations, City of Cincinnati appraisal values are used instead of market transaction prices. Also, zone U (University of Cincinnati) is removed from the BCA as there is no reliable property data available at the time the analysis was conducted. Instead, a qualitative description of the area's development potential is provided. Table 14 provides the baseline property number and property value from the 2009 dataset by analysis zones as well as property type.

Table 14: Baseline Property Number and Value

Streetcar Zones	Property Number			Property Value		
	Residential	Commercial	Condos	Residential	Commercial	Condos
A1	355	328	92	$0.12	$0.13	$0.14
A2	140	323	1	$0.08	$0.07	$0.25
A3	36	78	6	$0.06	$0.12	$0.23
B1	44	346	14	$0.36	$0.57	$0.30
B2	172	436	107	$0.15	$0.33	$0.20
C1	186	36	1	$2.00	$2.43	$0.24
C2	26	585	47	$2.60	$2.45	$0.34
C3	31	612	50	$2.71	$1.03	$0.31
T	572	259	35	$0.10	$1.31	$0.19
V	951	150	7	$0.12	$0.45	$0.18
Total	**2,513**	**3,153**	**360**	**$0.31**	**$0.94**	**$0.22**

As discussed earlier, only new properties will be impacted by the streetcar project. The rates for new construction are estimates using historical CAGIS data and are provided in Table 15. Property value growth rates based on the City of Cincinnati and CAGIS are also included in the same table.

Table 15: Growth in Property Number and Value

Streetcar Zones	Property Number Growth Rate *			Property Value Growth Rate		
	Residential	Commercial	Condos	Residential	Commercial	Condos
A1	0.3%	0.3%	0.3%	2.0%	2.1%	2.1%
A2	0.3%	0.3%	0.3%	2.1%	1.8%	1.8%
A3	0.3%	0.3%	0.3%	1.8%	2.2%	2.2%
B1	0.3%	0.3%	0.3%	1.8%	1.8%	2.2%
B2	0.3%	0.3%	1.2%	1.8%	2.2%	2.2%
C1	2.8%	0.3%	1.2%	1.8%	2.2%	1.8%
C2	5.1%	0.3%	1.2%	2.2%	2.2%	2.2%
C3	5.1%	0.3%	1.2%	2.2%	2.2%	2.2%
T	0.3%	0.3%	0.3%	1.8%	1.8%	1.8%
V	0.3%	0.3%	0.3%	1.8%	1.8%	1.8%

** Property number growth rates are applied for 10 years only to reflect construction capacity.*

In this analysis, transit premium rates vary between 1.1 percent and 8.8 percent, as they are property type-specific and neighborhood-specific. These rates are based on medium transit premium rates that are found in the recent literature presented earlier, as the alignment is not drastically different from those referenced studies in terms of land use and development potential. The resulting variations in these rates are based on adjustment factors (or multipliers) derived from a panel evaluation workshop (conducted by HDR Engineering in 2007), under the assumption that opinions were formed based on market conditions and are aligned with city planning guide. Table 16 presents the development potential ratings for each of the analysis zones.

Table 16: Transit Premium Adjustment Factors by Zone

Streetcar Zones	Transit Premium Rate Multiplier (maximum=1.5, minimum=0.5)		
	Residential	Commercial	Condos
A1	1.11	1.10	1.11
A2	1.05	1.02	1.05
A3	1.00	0.99	1.00
B1	0.92	0.90	0.92
B2	1.08	1.07	1.08
C1	1.22	1.22	1.22
C2	1.10	1.14	1.10
C3	1.09	1.09	1.09
T*	0.92	0.90	0.92
U*	0.92	0.90	0.92
V*	0.92	0.90	0.92

** Multipliers for these zones are not available. They are taken as the minimum of all other zones.*

The transit premium rates applied to the full alignment, by analysis zones as well as property type, based on premiums obtained from other comparable system and development potential multipliers, are reported in Table 17.

Table 17: Transit Premium Rates for the Full Alignment

Streetcar Zones	Transit Premium Rates		
	Residential	Commercial	Condos
A1	7.0%	7.9%	1.3%
A2	6.6%	7.4%	1.2%
A3	6.3%	7.2%	1.2%
B1	5.8%	6.5%	1.1%
B2	6.8%	7.7%	1.2%
C1	7.7%	8.8%	1.4%
C2	6.9%	8.2%	1.3%
C3	6.8%	7.9%	1.3%
T	5.8%	6.5%	1.1%
V	5.8%	6.5%	1.1%

Benefit Estimates

Over the study horizon there will be $211.30 million economic development benefits generated by the streetcar project. The majority of the estimated premium amount will be due to commercial development, summing to about $160.1 million, which is over 75 percent of the total for all property types.

In terms of analysis zone, the downtown Riverfront neighborhood (Zone C2 and Zone C3) is expected to capture over 60 percent of all transit premium. Since Zone A1, Zone A2, and Zone A3 are expected to have relatively low commercial development potential, these zones will less than 3.2 percent of all economic development benefits.

Table 18 provides the estimated transit premium amount by analysis zone and by property type.

There are several reasons for the less than proportional increase in community development benefits when the Uptown Extension is included. First, properties in proximity to the University of Cincinnati are not included in the BCA due to data limitations. Second, properties are appraised with lower values as their distances from the central business district (CBD) decrease. Lastly, the number of commercial properties is not estimated to grow proportionally when the extension is included.

Table 18: Economic Development Benefits for the Full Alignment, in Millions of 2010 Dollars unless Specified Otherwise

Streetcar Zones	Residential	Commercial	Condos	Total By Zone	Percent Total
A1	$1.97	$2.31	$0.11	**$4.38**	2.1%
A2	$0.54	$1.18	$0.00	**$1.72**	0.8%
A3	$0.10	$0.48	$0.01	**$0.59**	0.3%
B1	$0.61	$8.71	$0.03	**$9.35**	4.4%
B2	$1.22	$7.73	$0.18	**$9.13**	4.3%
C1	$26.14	$5.34	$0.00	**$31.48**	14.9%
C2	$5.95	$81.94	$0.16	**$88.04**	41.7%
C3	$7.30	$34.56	$0.15	**$42.01**	19.9%
T	$2.34	$14.92	$0.06	**$17.32**	8.2%
V	$4.33	$2.94	$0.01	**$7.28**	3.4%
Total By Property	**$50.48**	**$160.11**	**$0.71**	**$211.30**	**100.0%**
Percent Total, %	**23.9%**	**75.8%**	**0.3%**	**100.0%**	
Downtown Loop Only (Zone A-C)	**$37.07**	**$120.35**	**$0.54**	**$157.97**	**74.8%**

In Section 9, economic development benefits are reported by calendar year and by property type, for the full alignment.

As previously discussed, the streetcar project is also expected to generate transit premium near the University of Cincinnati area (zone U). According to the Economics Department at the University of Cincinnati, there is an estimated $382.0 million worth of property value in Zone U and transit premium capitalization of these properties may be significant.

However due to data limitations, the project's impact on this area is not included. Consequently, this analysis excludes any monetized benefits of the streetcar that stem from its connectivity to the University of Cincinnati and from its services to the university community.

Incremental Community Development Benefits

The community development benefits presented so far may capture other impacts of the streetcar that are also capitalized in property values. These other impacts are indeed estimated in this analysis and they include travel-time savings as well as vehicle-operating cost savings. To avoid double-counting and provide to the conservative estimates in the BCA, travel cost savings are completely removed from community development benefits. Details of the estimation can be found in Table 19. In addition, a sensitivity analysis of the incremental community development benefits using 25, 50, and 75 percents of the total are presented in Section 7.

Table 19: Incremental Community Development Benefits for the Full Alignment, in Millions of 2010 Dollars unless Specified Otherwise

	Average Property Value in Year 2013 (discounted)	Number of Properties Affected in Year 2013	20-Year Lifecycle Benefits (discounted)	20-Year Lifecycle Benefits NET of Capitalized Travel Cost Savings (discounted)
Downtown Loop				
Residential	$701,284	1,240	$37.61	$33.45
Commercial	$951,624	2,770	$120.35	$107.02
Total	**$869,595**	**4,010**	**$157.97**	**$140.46**
Downtown Loop and Uptown Extension				
Residential	$586,359	2,820	$51.19	$41.74
Commercial	$947,090	3,180	$160.11	$130.56
Total	**$774,104**	**6,000**	**$211.30**	**$172.29**

Low Income Mobility

Low Income Mobility is the portion of General Trip Cost Savings accruing to low income households. Low income riders tend to benefit the most from additional transit implementation in urban areas. Since they depend more heavily on transit, a streetcar can prevent forgone trips that affect other sectors of the economy. These are called Cross-Sector benefits.

Assumptions

Low income riders are expected to make up a significant portion of streetcar users in the Cincinnati area. In the absence of precise information, however, it was assumed that the percentage of low income riders in total ridership would be equal to the percentage of low income households in the general population (derived from Census data). Assumed diversion rates for these riders are presented in the table below.

Table 20: Ridership by Transportation Mode among Low Income Groups

Variable	Percentage of Ridership	Source
Low Income Ridership as Percentage of Total Ridership	21.9%	U.S. Census, 2000
Diverted from Auto	31%	HDR Assumptions, Travel Demand Model
Diverted from Bus	27%	
Diverted from Taxi	5%	
Diverted from Walking/Bicycling	15%	
Induced Demand	22%	

From the population of low-income riders, an assumption is made on the number of medical and related trips that are foregone in the no-build scenario. These trips would be made in the alternate case, with access to a streetcar. The assumptions on the number of foregone trips are listed in the table below.

Table 21: Composition of Forgone Trips without Streetcar

Variable	Percentage	Source
Low Income Trips for Medical Purpose, % of low income ridership	15%	HDR Assumptions, Travel Demand Model
Medical Trips Foregone Without Transit, % of medical trips	30%	
Number of Lost Medical Trips Leading to Home Care, % of lost medical trips	60%	

The streetcar project produces cost savings to low-income riders because they avoid more expensive home care treatment. The incremental unit cost of a medical home care visit is shown in the table below.

Table 22: Average Home Care Cost

Variable	Cost Estimate ($2010)	Source
Home Care Cost per Recipient	$53	Based on Lewis, David and Fred Laurence Williams, "Policy and Planning as Public Choice", 1999

Benefit Estimates

Low-income mobility cost savings and cross-sector benefits are shown in the tables below. The former are a subset of generalized transportation cost savings but are presented here, separately.

Table 23: Estimates of Low Income Mobility Benefits for the Full Alignment, in Millions of 2010 Dollars

Low Income Mobility Trips	Opening Year	Lifecycle
Diverted from Auto	$0.11	$1.76
Diverted from Bus	$0.06	$1.64
Diverted from Taxi	$0.07	$0.99
Induced Ridership	$0.01	$0.28
Total General Trip Cost Savings	**$0.25**	**$4.67**

Table 24: Estimates of Cross Sector Benefits for the Full Alignment, in Millions of 2010 Dollars

Cross Sector Benefits	Opening Year	Lifecycle
Home Care Medical Cost Savings	$0.42	$6.03
Total Cross-Sector Benefits	**$0.42**	**$6.03**

5.4 Sustainability

By reducing local and regional dependency on other form of motorized vehicles and thus improving energy efficiency, the proposed streetcar project is expected to generate positive environmental impacts, in addition to the roadway impacts discussed in Section 5.1.

Reduction in Environmental Emissions

Reduction in emission volumes are dependent upon the reduction in vehicle-miles resulting from diversion to the streetcar. The emission rates used in this BCA were produced using the EPA Mobile 6 model and take into account future regulations and trends. Per-unit emission costs were applied to the estimated consumption rates in the base case and multiplied by the reduction in VMT caused by modal shifts. Emissions from streetcar operations are assumed negligible.

Assumptions

There are five types of emissions being measured; Nitrogen oxide (NOx), sulfur dioxide (SO2), particulate matter (PM10 and PM2.5), volatile organic compounds (VOC), and carbon dioxide (CO2). Table 25 lists the unit cost assumptions used in the estimation of emission cost savings.

Table 25: Unit Emission Cost Estimates by Pollutant

Pollutant	Cost in $2010 per Short Ton	Source
Volatile Organic Compounds	$1,360	Final Regulatory Impact Analysis Corporate Average Fuel Economy for MY 2012-MY 2016 Passenger Cars and Light Trucks, March 2010; inflated to 2010 dollars
Nitrogen Oxide	$5,560	
Particulate Matter 2.5	$304,160	
Particulate Matter 10	$304,160	
Sulfur Dioxide	$32,510	
Carbon Dioxide ($ per metric ton)	$34.6	Interagency Working Group on the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866; inflated to 2010 dollars; average over 2010 – 2050

Benefit Estimates

Table 26 shows the total tonnage of emission reduction in the opening year (2013) and over the life cycle of the project. The monetized value of emission savings can be found in Table 27. As can be seen in the table, total lifecycle emission cost savings are expected to amount to $0.54 million.

Table 26: Expected Reductions in Emissions for the Full Alignment

Pollutant	Opening Year Emission Savings in Tons	Lifecycle Emission Savings in Tons
Volatile Organic Compounds	0.96	16.9
Nitrogen Oxide	0.63	10.4
Particulate Matter 2.5	0.02	0.4
Particulate Matter 10	0.03	0.9
Sulfur Dioxide	0.01	0.3
Carbon Dioxide	510.12	13,715

Table 27: Estimates of Emission Cost Savings for the Full Alignment, in Millions of 2010 Dollars

Pollutant	Opening Year	Lifecycle
Volatile Organic Compounds	$0.001	$0.01
Nitrogen Oxide	$0.003	$0.027
Particulate Matter 2.5	$0.004	$0.055
Particulate Matter 10	$0.009	$0.122
Sulfur Dioxide	$0.000	$0.004
Carbon Dioxide	$0.016	$0.322
Total Vehicle Emission Cost Savings	**$0.033**	**$0.541**

5.5 Safety

An efficient and reliable transit system reduces the likelihood of surface transportation-related accidents, as other forms of motorized vehicles are expected to reduce in number. In this analysis, safety benefits are monetized through the reduction in total accident costs imposed on society.

Accident Cost Savings

The reduction in accident costs depends upon the reduction in vehicle-miles traveled. The expected reduction in VMT is combined with a cost estimate expressed in dollar per VMT. Accident rates for the streetcar are assumed negligible.

Assumptions

The unit accident cost used in this BCA is reported in the table below.

Table 28: Unit Accident Cost Estimate

Variable	Cost Estimate ($2000)	Source
Average Accident Cost per VMT *	$0.158	Parry, Ian W. H., Margaret Walls, and Winston Harrington, "Automobile Externalities and Policies", Resources For the Future, January 2007, page 9; based on U.S. Department of Transportation, National Highway Traffic Safety Administration, "The Economic Impact of Motor Vehicle Crashes 2000", May 2002

*Note: * includes quality adjusted life years, property damage, travel delay, medical and emergency services, market and household productivity, and insurance and legal costs*

Benefit Estimates

The above cost estimate is a weighted average cost of fatal, injury and property damage only (PDO) accidents.

In the BCA, the opening year reduction in total accident costs was estimated at approximately $197,000; and total net accident savings throughout the study period would reach $2.8 million.

Table 29: Estimates of Safety Benefits for the Full Alignment, in Millions of 2010 Dollars unless Specified Otherwise

Variable	Opening Year	Lifecycle
VMT Avoided	1,257,186	33,810,189
Accident Cost Savings	$204,847	$2,937,848

6. Summary of Findings and BCA Outcomes

The tables below summarize the BCA findings. Annual costs and benefits are computed over the lifecycle of the project (20 years). As stated earlier, construction is expected to be completed by 2013. Benefits accrue during the full operation of the project.

Included in the total benefits along with State of Good Repair, Economic Competitiveness, Livability, Environmental Sustainability, and Safety benefits – are **fare revenues**. Fare revenues, or "Agency Benefits" are added to total benefits to offset the (transfer) payments made by streetcar users as part of the general cost of travel and avoid double-counting the portion of the project costs paid for indirectly through fares (once as a user cost, in the estimation of consumer surplus; and a second time as direct project costs, in the estimation of O&M and other expenses).

Table 30: Overall Results of the Benefit Cost Analysis in Millions of 2010 Dollars unless Specified Otherwise

Project Evaluation Metric	7% Discount Rate	3% Discount Rate
Total Discounted Benefits	$240.25	$414.81
Total Discounted Costs	$147.39	$166.16
Net Present Value	$92.87	$248.65
Benefit / Cost Ratio	1.63	2.50
Internal Rate of Return (%)	12.0%	
Payback Period (years)	13 years	

Considering all monetized benefits and costs, the estimated internal rate of return of the project is 12 percent. With a 7 percent real discount rate, the $147 million investment would result in $240 million in total benefits and a Benefit/Cost ratio of approximately 1.6.

With a 3 percent real discount rate, the Net Present Value of the project would increase to $248.6 million, for a Benefit/Cost ratio of 2.5.

Table 31: Benefit Estimates by Long-Term Outcome for the Full Alignment

Long-Term Outcomes	Benefit Categories	7% Discount Rate	3% Discount Rate
State of Good Repair	Pavement Maintenance Cost Savings	$0.01	$0.02
Economic Competitiveness	Generalized Travel Cost Savings (Travel Time Savings + Out-of-Pocket Cost Savings)	$34.34	$55.11
Livability	Community Development	$172.29	$306.87
	Mobility Benefits to Low Income Households	$4.67	$7.60
	Cross-Sector Benefits	$6.03	$9.46
Environmental Sustainability	Reductions in Air Emissions	$0.54	$0.66
Safety	Accident Reduction	$2.94	$4.61
Agency Benefits	Fare Revenue	$19.43	$30.47
Total Benefit Estimates		**$240.25**	**$414.81**

To demonstrate how the benefits of the streetcar might be distributed, Table 32 below provides a distribution of the total number of households within the study area by analysis zone. Each of the zones introduced in Figure 2 of this document is characterized by Census block group[7] demographic statistics.

Table 32: Distribution of Benefits and Assessment of Equity Impacts for the Full Alignment

Analysis Zone	Median Household Income*	Percentage Non-White	Median Owner Occupied Home Value*	Distribution of Total Number of Households
A1	$21,740	77%	$93,861	17%
A2	$8,799	89%	-	5%
A3	$14,459	86%	$93,114	5%
B1	$32,964	59%	$541,857	4%
B2	$17,134	69%	$202,374	10%
C1	$46,007	27%	-	4%
C2	$9,133	36%	-	3%
C3	$33,016	30%	$586,856	8%
T	$23,724	59%	$99,041	27%
V	$28,910	23%	$106,332	17%

** Weighted average of 2000 Census block group total household*

7. BCA Sensitivity Analysis

The BCA outcomes presented in the previous section rely on a large number of assumptions and long-term projections; both of which are subject to considerable uncertainty.

The primary purpose of the sensitivity analysis is to help identify the variables and model parameters whose variations have the greatest impact on the BCA outcomes: the "critical variables." The sensitivity analysis can also be used to:

- Evaluate the impact of changes in the critical variables, of reasonable departures from their "preferred" values; and
- Assess the robustness of the BCA and evaluate, in particular, whether the conclusions reached under the "preferred" set of input values are significantly altered by reasonable departures from those values.

The outcomes of the quantitative analysis for the Full Alignment at a 7 percent real discount rate are summarized in the table below. The table provides the percentage changes in project NPV associated with variations in variables or parameters (listed in row), as indicated in the column headers.

For example, a 30 percent reduction in the value of time leads to a 5 percent reduction in the project NPV. A 20 percent increase in the number of daily riders raises the project NPV by about 14 percent.

[7] A block group is considered to be within an analysis zone if its centroid falls completely within that zone.

Table 33: Quantitative Assessment of Sensitivity, Summary

Variables or Parameters	Change in Parameter Value	New NPV	Change in NPV	New B/C Ratio
Incremental Economic Development Benefits	25% of Full Appreciation Value	-$26.7	-129%	0.82
	50% of Full Appreciation Value	$26.1	-72%	1.18
	75% of Full Appreciation Value	$78.9	-15%	1.54
Value of Time	30% Reduction in Recommended Value	$88.5	-5%	1.60
	20% Increase in Recommended Value	$95.6	+3%	1.65
Ridership	20% Reduction in the Number of Riders	$79.4	-14%	1.54
	20% Increase in the Number of Riders	$106.0	+14%	1.72
Fuel Costs	EIA Low Case Scenario (-38%)	$91.5	-1%	1.62
	EIA High Case Scenario (+45%)	$94.3	+2%	1.64
Shadow Pricing of Labor	About 10% Reduction in Labor Cost [8]	$100.1	+8%	1.72
Capital Cost Estimate	25% Reduction	$122.7	+32%	2.04
Annual O&M Cost Estimate	25% Reduction	$99.7	+7%	1.71

[8] The shadow price estimate was calculated using a formula proposed by the European Commission, where Shadow Price = Market Price x (1 – Regional Unemployment). Furthermore, labor cost was assumed to represent 50 percent of total project cost.

8. Economic Impact Analysis

8.1 Short-Term Employment Impacts from Development Spending

The Minnesota IMPLAN Group's input-output model has been used to estimate the direct, indirect and induced effects of the Cincinnati Streetcar, in terms of employment, value added and labor income. Employment represents full-time and part-time jobs created for a full year. Value added represents total business sales (output) minus the cost of purchasing intermediate products and is roughly equivalent to gross regional/domestic product. Labor income consists of employee compensation (wage and salary payments as well as health and life insurance, retirement payments and any other non-cash compensation) and proprietary income (payments received by self-employed individuals as income).

The project is expected to generate 2,157 job-years during the development phase. It is also expected to create $172.3 million in value added, including $115.0 million in labor income. A breakdown of short-term impacts by type of effect (direct, indirect and induced) is provided in Table 34 below.

Table 34: Direct, Indirect and Induced Impacts during Project Development Phase

Impact Metric	Spending (Millions of 2010 Dollars)	Direct	Indirect	Induced	Total
Employment*	$125.0	778	490	889	**2,157**
Labor Income		$44.2	$30.0	$40.8	**$115.0**
Value Added		$55.7	$46.7	$69.9	**$172.3**

** Employment impacts from IMPLAN should not be interpreted as full-time equivalent (FTE) as they reflect the mix of full and part time jobs that is typical for each sector. On average, the ratio of FTE to full- and part-time jobs is estimated at 90 percent.*

Note that the employment impacts are significantly lower (1,356 job-years) when using CEA's rule that $92,000 creates one job-year.[9]

A breakdown of short-term economic impacts (IMPLAN estimates) in terms of employment (job-hours), labor income and value added is provided by quarter in Table 35 below.

[9] Executive Office of the President, Council of Economic Advisers, "Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009," Washington, D.C., May 11, 2009.

Table 35: Short-Term Economic Impacts Resulting from Project Development

Period	Spending (Millions of 2010 Dollars)*	Total Job-Hours**	Direct Job-Hours**	Total Labor Income (2010 $M)	Total Value Added (2010 $M))
2010 - Q1	$3.4	123,590	46,680	$3.9	$5.3
2010 - Q2	$6.5	177,982	58,704	$5.7	$8.9
2010 - Q3	$6.7	186,534	62,256	$5.9	$9.2
2010 - Q4	$8.1	234,874	80,997	$7.2	$11.1
2011 - Q1	$15.3	485,297	177,426	$14.3	$21.2
2011 - Q2	$18.3	588,743	217,381	$17.2	$25.3
2011 - Q3	$19.3	625,303	231,481	$18.2	$26.8
2011 - Q4	$20.1	596,872	211,700	$17.6	$27.0
2012 - Q1	$17.0	490,020	170,567	$14.6	$22.7
2012 - Q2	$6.2	218,118	83,754	$6.3	$8.9
2012 - Q3	$2.8	98,162	37,571	$2.9	$4.0
2012 - Q4	$1.3	44,897	17,204	$1.3	$1.8

** Includes engineering ($21.1 million), construction ($75.2 million) and vehicle procurement ($28.7 million); ** Assuming average weekly hours of 34.5 (Bureau of Labor Statistics estimate).*

Table 36 below presents the short-term increase in employment and labor income resulting from the project development in key industries employing low-income people. 1,100 cumulative job-years (or 51 percent of total job-years) are expected to be created in those industries by the end of 2012, bringing in an additional $43.9 million in labor income.

Table 36: Short-Term Impacts in Key Industries Employing Low-Income People

Sectors	Employment (Job-Years)	Labor Income (2010 $M)
Agriculture, forestry, fishing & hunting	25	$0.5
Construction	579	$29.2
Retail trade	165	$4.9
Truck transportation	22	$1.1
Office administrative services, business and facilities support service, waste management and remediation services	116	$3.8
Nursing & residential care facilities, home health care services	63	$1.7
Accommodation & food services	112	$2.4
Personal & laundry services	18	$0.4
Total	**1,100**	**$43.9**

8.2 Long-Term Employment Impacts

In addition to the short-term job creation effect, the operation and maintenance of the Cincinnati streetcar is expected to generate long-term jobs. Unlike construction, these jobs are permanent and exist throughout the life expectancy of the project.

Table 37 below presents long-term job creation resulting from operation of the streetcar and the monetary trip cost savings estimated to accrue to riders, i.e. the portion of VOC savings that is re-spent by riders.

Table 37: Long-Term Job Creation

Impact Metric	Annual O&M Expenditures	Annual Cost Savings to Riders	Total
Estimated incremental spending (Millions of 2010 Dollars)	$2.9	$1.3	$4.2
Total jobs *	73	7	80

** Total long-term job creation is calculated by multiplying the number of jobs associated with the operation and maintenance of the streetcar by the 20 years of operation and then adding the jobs created by the re-spending of VOC savings. Using IMPLAN's social accounting matrix it is estimated that 83 percent of VOC savings would be re-spent on goods and services provided in the US.*

Because some VOC components (e.g., fuel) are imported in the study area, the money retailers have to spend to get these commodities is lost to the overall impact (leakage). Overall, only half of VOC savings are assumed to result in net impacts. These impacts are derived from IMPLAN's social accounting matrix (SAM), which shows household expenditures by industry in the study area and the associated indirect and induced effects.

9. Supplementary Data Tables

This section breaks down all benefits associated with the five long-term outcome criteria (State of Good Repair, Economic Competiveness, Livability, Sustainability, and Safety) in annual form for the **Full Alignment**. Supplementary data tables are also provided for some sections. For example, under Sustainability, tables measuring the tons of emission reduced annually are provided.

Overall Results

Calendar Year	Project Year	Total Benefits ($2010)	Total Costs ($2010)	Undiscounted Net Benefits ($2010)	Discounted Net Benefits at 7%	Discounted Net Benefits at 3%
2010	1	$0	$27,757,000	($27,757,000)	($27,757,000)	($27,757,000)
2011	2	$0	$73,000,490	($73,000,490)	($68,224,757)	($70,874,262)
2012	3	$0	$27,242,510	($27,242,510)	($23,794,663)	($25,678,678)
2013	4	$7,710,446	$2,984,036	$4,726,410	$3,859,893	$4,325,335
2014	5	$9,240,078	$2,984,036	$6,256,042	$4,775,031	$5,558,412
2015	6	$10,883,300	$2,984,036	$7,899,264	$5,634,914	$6,813,975
2016	7	$12,727,604	$2,984,036	$9,743,568	$6,495,898	$8,160,085
2017	8	$14,794,661	$2,984,036	$11,810,625	$7,358,888	$9,603,119
2018	9	$17,108,266	$2,984,036	$14,124,231	$8,224,713	$11,149,798
2019	10	$19,694,734	$2,984,036	$16,710,698	$9,094,232	$12,807,358
2020	11	$22,583,055	$2,984,036	$19,599,019	$9,968,286	$14,583,511
2021	12	$25,805,232	$2,984,036	$22,821,196	$10,847,725	$16,486,518
2022	13	$29,396,521	$2,984,036	$26,412,486	$11,733,382	$18,525,186
2023	14	$33,395,850	$2,984,036	$30,411,814	$12,626,111	$20,708,966
2024	15	$35,914,148	$2,984,036	$32,930,112	$12,777,506	$21,770,683
2025	16	$38,699,670	$2,984,036	$35,715,634	$12,951,965	$22,924,507
2026	17	$41,736,868	$2,984,036	$38,752,832	$13,134,221	$24,149,484
2027	18	$45,051,228	$2,984,036	$42,067,192	$13,324,998	$25,451,343
2028	19	$48,671,113	$2,984,036	$45,687,078	$13,525,053	$26,836,343
2029	20	$52,627,995	$2,984,036	$49,643,959	$13,735,143	$28,311,256
2030	21	$56,956,877	$2,984,036	$53,972,842	$13,956,050	$29,883,454
2031	22	$61,696,709	$2,984,036	$58,712,673	$14,188,576	$31,560,955
2032	23	$66,890,782	$2,984,036	$63,906,746	$14,433,535	$33,352,452
Total		**$651,585,138**	**$187,680,717**	**$463,904,421**	**$92,869,702**	**$248,652,798**

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Calendar Year	Project Year	Annual VMT No Build	Annual VMT Build	Annual VMT Avoided	Daily Streetcar Ridership
2013	4	5,970,454	4,713,268	1,257,186	6,640
2014	5	6,060,011	4,732,701	1,327,310	7,011
2015	6	6,135,761	4,771,936	1,363,825	7,204
2016	7	6,212,458	4,811,113	1,401,345	7,402
2017	8	6,290,114	4,850,217	1,439,897	7,605
2018	9	6,368,740	4,889,230	1,479,510	7,815
2019	10	6,448,350	4,928,137	1,520,213	8,030
2020	11	6,512,833	4,950,798	1,562,035	8,250
2021	12	6,577,961	4,972,954	1,605,008	8,477
2022	13	6,643,741	4,994,578	1,649,163	8,711
2023	14	6,710,178	5,015,646	1,694,533	8,950
2024	15	6,777,280	5,036,129	1,741,151	9,197
2025	16	6,845,053	5,056,002	1,789,051	9,450
2026	17	6,913,503	5,075,234	1,838,270	9,709
2027	18	6,982,639	5,093,797	1,888,842	9,977
2028	19	7,052,465	5,111,659	1,940,805	10,251
2029	20	7,122,990	5,128,791	1,994,199	10,533
2030	21	7,194,219	5,145,159	2,049,061	10,823
2031	22	7,266,162	5,160,730	2,105,432	11,121
2032	23	7,338,823	5,175,469	2,163,354	11,427
Total		**150,810,895**	**117,000,706**	**33,810,189**	**178,581**

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Year	Project Year	Daily Streetcar Ridership	Diverted from Auto	Diverted from Bus	Diverted from Taxi	Induced Demand
2013	4	**6,640**	2,081	1,769	312	1,438
2014	5	**7,011**	2,197	1,867	330	1,518
2015	6	**7,204**	2,257	1,919	339	1,560
2016	7	**7,402**	2,319	1,972	348	1,603
2017	8	**7,605**	2,383	2,026	357	1,647
2018	9	**7,815**	2,449	2,082	367	1,692
2019	10	**8,030**	2,516	2,139	377	1,739
2020	11	**8,250**	2,585	2,198	388	1,787
2021	12	**8,477**	2,657	2,258	398	1,836
2022	13	**8,711**	2,730	2,320	409	1,887
2023	14	**8,950**	2,805	2,384	421	1,938
2024	15	**9,197**	2,882	2,450	432	1,992
2025	16	**9,450**	2,961	2,517	444	2,047
2026	17	**9,709**	3,043	2,586	456	2,103
2027	18	**9,977**	3,126	2,657	469	2,161
2028	19	**10,251**	3,212	2,731	482	2,220
2029	20	**10,533**	3,301	2,806	495	2,281
2030	21	**10,823**	3,392	2,883	509	2,344
2031	22	**11,121**	3,485	2,962	523	2,408
2032	23	**11,427**	3,581	3,044	537	2,475
Total		**178,581**	**55,962**	**47,567**	**8,394**	**38,677**

State of Good Repair

Calendar Year	Project Year	Annual VMT Avoided	Pavement Maintenance Savings 7% Discount Rate	Pavement Maintenance Savings 3% Discount Rate
2013	4	1,257,186	$1,026	$1,151
2014	5	1,327,310	$1,013	$1,179
2015	6	1,363,825	$972	$1,176
2016	7	1,401,345	$934	$1,174
2017	8	1,439,897	$897	$1,171
2018	9	1,479,510	$861	$1,168
2019	10	1,520,213	$827	$1,165
2020	11	1,562,035	$794	$1,162
2021	12	1,605,008	$763	$1,159
2022	13	1,649,163	$732	$1,157
2023	14	1,694,533	$703	$1,154
2024	15	1,741,151	$675	$1,151
2025	16	1,789,051	$648	$1,148
2026	17	1,838,270	$623	$1,146
2027	18	1,888,842	$598	$1,143
2028	19	1,940,805	$574	$1,140
2029	20	1,994,199	$551	$1,137
2030	21	2,049,061	$530	$1,135
2031	22	2,105,432	$508	$1,132
2032	23	2,163,354	$488	$1,129
Total		**33,810,189**	**$14,718**	**$23,076**

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Economic Competitiveness

Calendar Year	Project Year	Average Auto Cost per Trip No Build	Average Auto Cost per Trip Build	Average Bus Cost per Trip	Average Taxi Cost per Trip	Average Streetcar Cost per Trip	Annual Auto Trips Build	Streetcar Trips Diverted from Autos	Streetcar Trips Diverted from Bus	Streetcar Trips Diverted from Taxi	Induced Streetcar Trips
2013	4	$5.80	$5.50	$2.91	$12.04	$2.58	1,625,265	433,512	442,183	78,032	359,534
2014	5	$5.84	$5.51	$2.95	$12.07	$2.59	1,631,966	457,693	466,847	82,385	379,588
2015	6	$5.87	$5.52	$2.98	$12.09	$2.60	1,645,495	470,285	479,690	84,651	390,031
2016	7	$5.90	$5.53	$3.02	$12.12	$2.61	1,659,004	483,222	492,887	86,980	400,761
2017	8	$5.94	$5.54	$3.06	$12.14	$2.62	1,672,488	496,516	506,447	89,373	411,787
2018	9	$5.98	$5.55	$3.10	$12.17	$2.63	1,685,941	510,176	520,379	91,832	423,115
2019	10	$6.02	$5.56	$3.15	$12.20	$2.64	1,699,358	524,211	534,695	94,358	434,755
2020	11	$6.05	$5.56	$3.19	$12.23	$2.65	1,707,172	538,633	549,405	96,954	446,716
2021	12	$6.09	$5.57	$3.23	$12.25	$2.65	1,714,812	553,451	564,520	99,621	459,005
2022	13	$6.12	$5.58	$3.27	$12.28	$2.66	1,722,268	568,677	580,050	102,362	471,633
2023	14	$6.16	$5.58	$3.32	$12.31	$2.67	1,729,533	584,322	596,008	105,178	484,608
2024	15	$6.20	$5.59	$3.37	$12.34	$2.68	1,736,596	600,397	612,405	108,071	497,940
2025	16	$6.25	$5.60	$3.42	$12.37	$2.68	1,743,449	616,914	629,253	111,045	511,639
2026	17	$6.29	$5.61	$3.47	$12.40	$2.69	1,750,081	633,886	646,564	114,099	525,714
2027	18	$6.34	$5.61	$3.53	$12.43	$2.70	1,756,482	651,325	664,351	117,238	540,177
2028	19	$6.39	$5.62	$3.59	$12.47	$2.71	1,762,641	669,243	682,628	120,464	555,038
2029	20	$6.44	$5.63	$3.66	$12.50	$2.71	1,768,549	687,655	701,408	123,778	570,307
2030	21	$6.49	$5.63	$3.72	$12.54	$2.72	1,774,193	706,573	720,704	127,183	585,997
2031	22	$6.55	$5.64	$3.80	$12.58	$2.73	1,779,562	726,011	740,531	130,682	602,118
2032	23	$6.61	$5.65	$3.87	$12.62	$2.74	1,784,644	745,984	760,904	134,277	618,683
Total							**34,349,499**	**11,658,686**	**11,891,860**	**2,098,563**	**9,669,149**

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Calendar Year	Project Year	Benefits to Remaining Auto Users 7% Discount	Benefits to Remaining Auto Users 3% Discount	Benefits to Diverted Auto Users 7% Discount	Benefits to Diverted Auto Users 3% Discount	Benefits to Diverted Bus Users 7% Discount	Benefits to Diverted Bus Users 3% Discount	Benefits to Diverted Taxi Users 7% Discount	Benefits to Diverted Taxi Users 3% Discount	Benefits to Induced Riders 7% Discount	Benefits to Induced Riders 3% Discount
2013	4	$391,740	$439,175	$1,139,413	$1,277,382	$117,527	$131,758	$602,896	$675,900	$47,780	$53,566
2014	5	$406,111	$472,967	$1,134,840	$1,321,663	$127,962	$149,028	$596,130	$694,268	$52,022	$60,586
2015	6	$410,207	$496,290	$1,097,387	$1,327,677	$131,833	$159,499	$573,280	$693,585	$53,596	$64,844
2016	7	$413,278	$519,423	$1,061,217	$1,333,778	$135,847	$170,737	$551,362	$692,973	$55,228	$69,412
2017	8	$417,014	$544,473	$1,027,026	$1,340,934	$140,010	$182,803	$530,339	$692,436	$56,920	$74,318
2018	9	$421,847	$572,173	$994,761	$1,349,247	$144,331	$195,764	$510,176	$691,979	$58,677	$79,587
2019	10	$425,649	$599,750	$963,586	$1,357,718	$148,820	$209,691	$490,841	$691,607	$60,502	$85,249
2020	11	$422,602	$618,582	$932,506	$1,364,951	$151,818	$222,223	$472,193	$691,170	$61,721	$90,343
2021	12	$421,055	$640,252	$903,134	$1,373,296	$154,891	$235,526	$454,302	$690,807	$62,970	$95,752
2022	13	$418,100	$660,448	$874,636	$1,381,611	$158,043	$249,651	$437,138	$690,521	$64,252	$101,495
2023	14	$416,129	$682,863	$847,739	$1,391,129	$161,277	$264,654	$420,671	$690,315	$65,566	$107,594
2024	15	$412,827	$703,753	$821,620	$1,400,627	$164,597	$280,591	$404,874	$690,195	$66,916	$114,073
2025	16	$410,456	$726,884	$797,001	$1,411,423	$168,008	$297,528	$389,721	$690,163	$68,303	$120,958
2026	17	$407,879	$750,371	$773,451	$1,422,912	$171,513	$315,531	$375,185	$690,225	$69,728	$128,277
2027	18	$404,084	$772,258	$750,550	$1,434,402	$175,118	$334,674	$361,244	$690,385	$71,193	$136,060
2028	19	$401,142	$796,409	$729,012	$1,447,346	$178,828	$355,038	$347,872	$690,649	$72,702	$144,339
2029	20	$397,693	$820,224	$708,417	$1,461,079	$182,650	$376,707	$335,048	$691,020	$74,255	$153,148
2030	21	$394,398	$845,017	$688,728	$1,475,634	$186,588	$399,775	$322,749	$691,506	$75,857	$162,527
2031	22	$390,928	$870,111	$669,907	$1,491,049	$190,652	$424,344	$310,955	$692,110	$77,508	$172,515
2032	23	$386,427	$893,495	$651,557	$1,506,525	$194,847	$450,523	$299,646	$692,840	$79,214	$183,158
Total		**$8,169,568**	**$13,424,921**	**$17,566,488**	**$27,870,384**	**$3,185,160**	**$5,406,045**	**$8,786,621**	**$13,814,654**	**$1,294,910**	**$2,197,800**

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Livability

Calendar Year	Project Year	Total Benefits (discounted)		
		Residential	Commercial	Condos
2013	4	$0.86	$3.40	$0.01
2014	5	$1.04	$4.01	$0.02
2015	6	$1.22	$4.62	$0.02
2016	7	$1.40	$5.23	$0.02
2017	8	$1.59	$5.84	$0.03
2018	9	$1.79	$6.46	$0.03
2019	10	$1.99	$7.07	$0.03
2020	11	$2.20	$7.69	$0.03
2021	12	$2.42	$8.31	$0.04
2022	13	$2.64	$8.94	$0.04
2023	14	$2.87	$9.56	$0.04
2024	15	$2.96	$9.60	$0.04
2025	16	$3.06	$9.66	$0.04
2026	17	$3.16	$9.72	$0.04
2027	18	$3.26	$9.79	$0.04
2028	19	$3.37	$9.86	$0.04
2029	20	$3.48	$9.95	$0.04
2030	21	$3.60	$10.04	$0.04
2031	22	$3.73	$10.13	$0.04
2032	23	$3.86	$10.23	$0.05
Total		**$50.48**	**$160.11**	**$0.71**

Calendar Year	Project Year	Auto Cost per Trip No Build	Bus Cost per Trip	Taxi Cost per Trip	Low Income Trips Diverted from Autos	Low Income Trips Diverted from Bus	Low Income Trips Diverted from Taxi	Induced Low Income Trips
2013	4	$5.80	$2.91	$12.04	43,387	227,057	8,772	78,738
2014	5	$5.84	$2.95	$12.07	45,807	239,721	9,262	83,130
2015	6	$5.87	$2.98	$12.09	47,067	246,316	9,516	85,417
2016	7	$5.90	$3.02	$12.12	48,362	253,093	9,778	87,767
2017	8	$5.94	$3.06	$12.14	49,693	260,056	10,047	90,181
2018	9	$5.98	$3.10	$12.17	51,060	267,210	10,324	92,662
2019	10	$6.02	$3.15	$12.20	52,465	274,561	10,608	95,211
2020	11	$6.05	$3.19	$12.23	53,908	282,114	10,900	97,831
2021	12	$6.09	$3.23	$12.25	55,391	289,876	11,199	100,522
2022	13	$6.12	$3.27	$12.28	56,915	297,850	11,508	103,288
2023	14	$6.16	$3.32	$12.31	58,481	306,045	11,824	106,129
2024	15	$6.20	$3.37	$12.34	60,090	314,464	12,149	109,049
2025	16	$6.25	$3.42	$12.37	61,743	323,115	12,484	112,049
2026	17	$6.29	$3.47	$12.40	63,441	332,004	12,827	115,131
2027	18	$6.34	$3.53	$12.43	65,187	341,138	13,180	118,299
2028	19	$6.39	$3.59	$12.47	66,980	350,523	13,543	121,553
2029	20	$6.44	$3.66	$12.50	68,823	360,166	13,915	124,897
2030	21	$6.49	$3.72	$12.54	70,716	370,075	14,298	128,333
2031	22	$6.55	$3.80	$12.58	72,661	380,256	14,691	131,864
2032	23	$6.61	$3.87	$12.62	74,660	390,717	15,095	135,492
Total					**1,166,836**	**6,106,358**	**235,921**	**2,117,544**

Calendar Year	Project Year	Benefits to Low Income Diverted Auto Users 7% Discount	Benefits to Low Income Diverted Auto Users 3% Discount	Benefits to Low Income Diverted Bus Users 7% Discount	Benefits to Low Income Diverted Bus Users 3% Discount	Benefits to Low Income Diverted Taxi Users 7% Discount	Benefits to Low Income Diverted Taxi Users 3% Discount	Benefits to Low Income Induced Riders 7% Discount	Benefits to Low Income Induced Riders 3% Discount
2013	4	$114,036	$127,844	$60,349	$67,657	$67,778	$75,985	$10,464	$11,731
2014	5	$113,578	$132,276	$65,707	$76,524	$67,017	$78,050	$11,393	$13,268
2015	6	$109,830	$132,878	$67,695	$81,901	$64,448	$77,973	$11,738	$14,201
2016	7	$106,210	$133,489	$69,756	$87,672	$61,984	$77,904	$12,095	$15,201
2017	8	$102,788	$134,205	$71,894	$93,868	$59,621	$77,844	$12,466	$16,276
2018	9	$99,559	$135,037	$74,113	$100,523	$57,354	$77,792	$12,850	$17,429
2019	10	$96,439	$135,885	$76,418	$107,674	$55,180	$77,750	$13,250	$18,669
2020	11	$93,328	$136,608	$77,957	$114,109	$53,084	$77,701	$13,517	$19,785
2021	12	$90,388	$137,444	$79,535	$120,940	$51,073	$77,661	$13,790	$20,970
2022	13	$87,536	$138,276	$81,154	$128,194	$49,143	$77,628	$14,071	$22,227
2023	14	$84,844	$139,228	$82,814	$135,897	$47,292	$77,605	$14,359	$23,563
2024	15	$82,230	$140,179	$84,519	$144,081	$45,516	$77,592	$14,655	$24,982
2025	16	$79,766	$141,259	$86,270	$152,778	$43,812	$77,588	$14,958	$26,490
2026	17	$77,409	$142,409	$88,070	$162,022	$42,178	$77,595	$15,270	$28,093
2027	18	$75,117	$143,559	$89,921	$171,852	$40,611	$77,613	$15,591	$29,797
2028	19	$72,962	$144,855	$91,827	$182,308	$39,108	$77,643	$15,922	$31,610
2029	20	$70,901	$146,229	$93,789	$193,435	$37,666	$77,685	$16,262	$33,539
2030	21	$68,930	$147,686	$95,811	$205,281	$36,283	$77,739	$16,613	$35,593
2031	22	$67,046	$149,229	$97,898	$217,897	$34,958	$77,807	$16,974	$37,781
2032	23	$65,210	$150,778	$100,052	$231,340	$33,686	$77,889	$17,348	$40,112
Total		**$1,758,107**	**$2,789,352**	**$1,635,550**	**$2,775,953**	**$987,792**	**$1,553,043**	**$283,585**	**$481,318**

Calendar Year	Project Year	Daily Low Income Ridership	Daily Low Income Trips for Medical Purposes	Daily Medical Trips Forgone in Base Case	Daily Lost Medical Trips Leading to Home Care	Home Care Cost Savings 7% Discount	Home Care Cost Savings 3% Discount
2013	4	1,139	218	65	39	$420,671	$471,609
2014	5	1,203	230	69	41	$415,080	$483,412
2015	6	1,236	237	71	43	$398,597	$482,244
2016	7	1,270	243	73	44	$382,769	$481,079
2017	8	1,305	250	75	45	$367,570	$479,916
2018	9	1,341	257	77	46	$352,974	$478,756
2019	10	1,378	264	79	47	$338,957	$477,599
2020	11	1,416	271	81	49	$325,497	$476,445
2021	12	1,454	278	84	50	$312,572	$475,294
2022	13	1,494	286	86	52	$300,160	$474,145
2023	14	1,536	294	88	53	$288,241	$472,999
2024	15	1,578	302	91	54	$276,795	$471,856
2025	16	1,621	310	93	56	$265,803	$470,716
2026	17	1,666	319	96	57	$255,248	$469,578
2027	18	1,712	328	98	59	$245,113	$468,443
2028	19	1,759	337	101	61	$235,379	$467,311
2029	20	1,807	346	104	62	$226,033	$466,182
2030	21	1,857	356	107	64	$217,057	$465,055
2031	22	1,908	365	110	66	$208,438	$463,932
2032	23	1,960	375	113	68	$200,161	$462,810
Total		**30,639**	**5,866**	**1,760**	**1,056**	**$6,033,114**	**$9,459,384**

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Sustainability

Calendar Year	Project Year	VOC Emission Reductions (tons)	NOx Emission Reduction (tons)	PM2.5 Emission Reduction (tons)	PM10 Emission Reduction (tons)	SO2 Emission Reduction (tons)	CO2 Emission Reductions (tons)
2013	4	0.96	0.63	0.02	0.03	0.01	510
2014	5	0.93	0.61	0.02	0.04	0.01	539
2015	6	0.89	0.57	0.02	0.04	0.01	553
2016	7	0.85	0.54	0.02	0.04	0.01	568
2017	8	0.82	0.52	0.02	0.04	0.01	584
2018	9	0.80	0.50	0.02	0.04	0.01	600
2019	10	0.79	0.48	0.02	0.04	0.01	617
2020	11	0.77	0.48	0.02	0.04	0.01	634
2021	12	0.77	0.47	0.02	0.04	0.01	651
2022	13	0.77	0.47	0.02	0.04	0.01	669
2023	14	0.78	0.47	0.02	0.05	0.01	687
2024	15	0.79	0.48	0.02	0.05	0.01	706
2025	16	0.80	0.48	0.02	0.05	0.01	726
2026	17	0.82	0.49	0.02	0.05	0.01	746
2027	18	0.84	0.50	0.02	0.05	0.01	766
2028	19	0.86	0.51	0.02	0.05	0.01	787
2029	20	0.89	0.52	0.02	0.05	0.01	809
2030	21	0.91	0.53	0.03	0.06	0.02	831
2031	22	0.93	0.55	0.03	0.06	0.02	854
2032	23	0.96	0.56	0.03	0.06	0.02	878
Total		**16.95**	**10.37**	**0.42**	**0.92**	**0.25**	**13,715**

Calendar Year	Project Year	VOC Savings 7% Discount	VOC Savings 3% Discount	NOx Savings 7% Discount	NOx Savings 3% Discount	PM2.5 Savings 7% Discount	PM2.5 Savings 3% Discount	PM10 Savings 7% Discount	PM10 Savings 3% Discount	SO2 Savings 7% Discount	SO2 Savings 3% Discount	CO2 Savings 3% Discount
2013	4	$1,063	$1,192	$2,862	$3,208	$3,888	$4,359	$8,533	$9,566	$250	$280	$16,059
2014	5	$965	$1,124	$2,582	$3,007	$3,836	$4,468	$8,420	$9,806	$247	$287	$16,461
2015	6	$859	$1,040	$2,277	$2,754	$3,684	$4,457	$8,053	$9,743	$237	$287	$16,417
2016	7	$771	$969	$2,017	$2,535	$3,506	$4,407	$7,733	$9,719	$228	$286	$16,377
2017	8	$698	$912	$1,800	$2,350	$3,367	$4,396	$7,426	$9,696	$219	$285	$16,337
2018	9	$636	$863	$1,615	$2,190	$3,233	$4,386	$7,131	$9,672	$210	$285	$16,298
2019	10	$584	$824	$1,465	$2,064	$3,105	$4,375	$6,848	$9,649	$202	$284	$16,258
2020	11	$536	$784	$1,343	$1,966	$2,982	$4,365	$6,576	$9,625	$194	$283	$16,219
2021	12	$497	$756	$1,245	$1,894	$2,863	$4,354	$6,315	$9,602	$186	$283	$16,180
2022	13	$463	$732	$1,162	$1,836	$2,750	$4,344	$6,064	$9,579	$178	$282	$16,141
2023	14	$439	$720	$1,092	$1,793	$2,640	$4,333	$5,823	$9,556	$171	$281	$16,102
2024	15	$417	$711	$1,030	$1,757	$2,536	$4,323	$5,592	$9,533	$165	$281	$16,063
2025	16	$396	$701	$966	$1,710	$2,435	$4,312	$5,370	$9,510	$158	$280	$16,024
2026	17	$379	$698	$920	$1,692	$2,338	$4,302	$5,157	$9,487	$152	$279	$15,985
2027	18	$363	$694	$878	$1,677	$2,245	$4,291	$4,952	$9,464	$146	$278	$15,947
2028	19	$348	$690	$841	$1,670	$2,156	$4,281	$4,755	$9,441	$140	$278	$15,908
2029	20	$334	$688	$803	$1,655	$2,071	$4,271	$4,566	$9,418	$134	$277	$15,870
2030	21	$320	$685	$764	$1,637	$1,988	$4,260	$4,385	$9,395	$129	$276	$15,831
2031	22	$307	$683	$732	$1,630	$1,909	$4,250	$4,211	$9,373	$124	$276	$15,793
2032	23	$295	$681	$703	$1,626	$1,834	$4,240	$4,044	$9,350	$119	$275	$15,755
Total		**$10,671**	**$16,147**	**$27,098**	**$40,653**	**$55,369**	**$86,772**	**$121,953**	**$191,183**	**$3,587**	**$5,623**	**$322,026**

Safety

Calendar Year	Project Year	Annual VMT Avoided	Accident Cost Savings 7% Discount Rate	Accident Savings 3% Discount Rate
2013	4	1,257,186	$204,847	$229,652
2014	5	1,327,310	$202,125	$235,400
2015	6	1,363,825	$194,098	$234,831
2016	7	1,401,345	$186,391	$234,263
2017	8	1,439,897	$178,989	$233,697
2018	9	1,479,510	$171,882	$233,132
2019	10	1,520,213	$165,056	$232,569
2020	11	1,562,035	$158,502	$232,007
2021	12	1,605,008	$152,208	$231,446
2022	13	1,649,163	$146,164	$230,887
2023	14	1,694,533	$140,360	$230,329
2024	15	1,741,151	$134,786	$229,772
2025	16	1,789,051	$129,434	$229,217
2026	17	1,838,270	$124,294	$228,663
2027	18	1,888,842	$119,359	$228,110
2028	19	1,940,805	$114,619	$227,559
2029	20	1,994,199	$110,067	$227,009
2030	21	2,049,061	$105,697	$226,461
2031	22	2,105,432	$101,500	$225,913
2032	23	2,163,354	$97,469	$225,367
Total		**33,810,189**	**$2,937,848**	**$4,606,283**