

UTAH TRANSIT AUTHORITY
SUGAR HOUSE MODERN STREETCAR PROJECT
APPENDIX IN SUPPORT OF THE TIGER APPLICATION
BENEFIT-COST AND ECONOMIC IMPACT ANALYSIS
SEPTEMBER 10, 2009

The following Benefit Cost Analysis (BCA) measures benefits against costs throughout the study period beginning at the start of construction and including twenty years of benefits (2009-2031). The monetized benefits and costs are estimated in 2009 dollars with future dollars discounted in compliance with TIGER requirements at a real 7 percent rate with sensitivity testing at 3 percent.

1. Framework

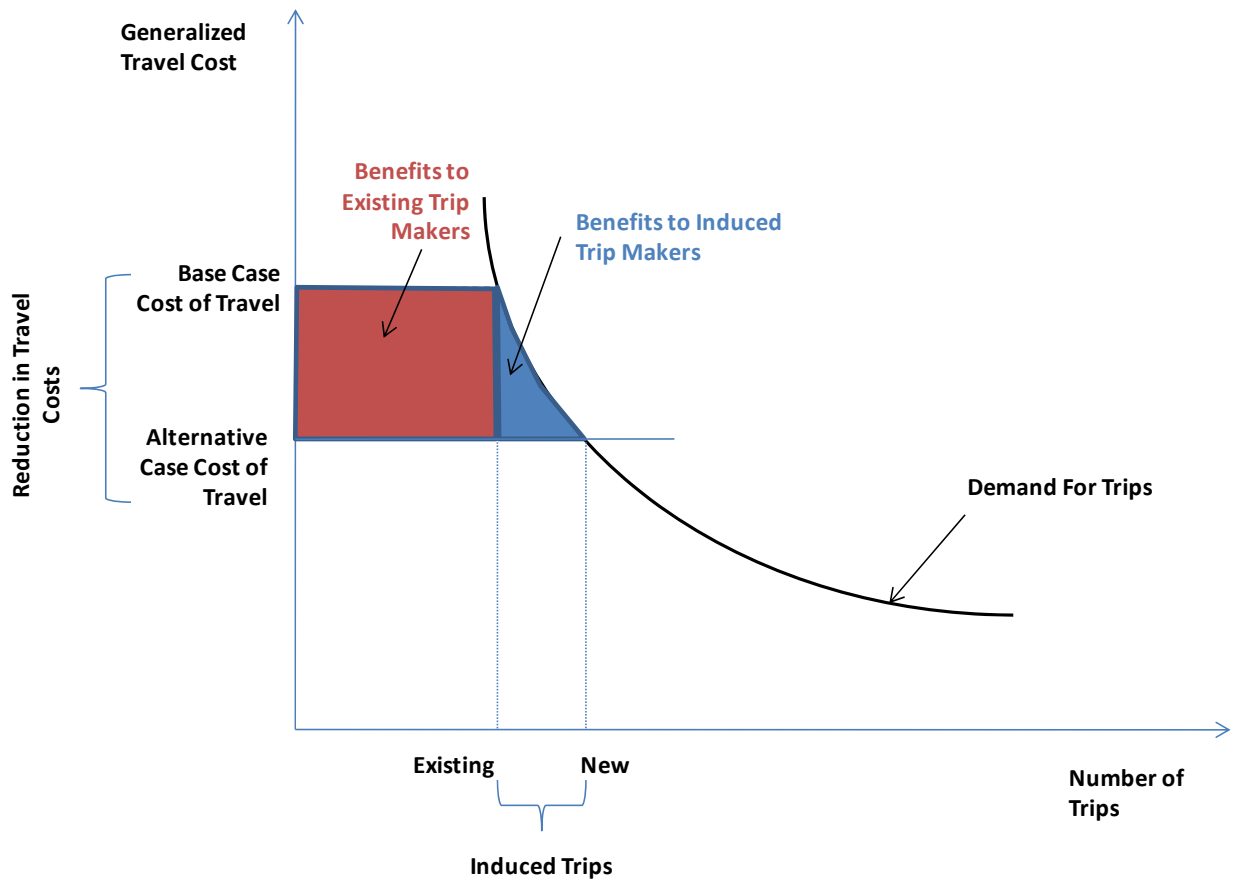
The BCA framework is structured around a fundamental relationship between the demand for travel and the cost of trip making. Though each travel benefit is estimated separately, the BCA assumes a relationship between the quantity of travel demanded, the generalized costs of trip to trip makers and the benefits to existing and new travelers. The demand for transit increases due to the reduction in travel time and costs resulting from the investment.

Furthermore, additional induced trips (beyond diversion from personal auto and current transit modes) are expected. These induced trip makers represent a portion of potential trip makers who previously did not make trips (or as many trips) in the no-build scenario but now will be attracted to the lower costs (reduction in time and trip costs) of the new transit trip.

The diagram below presents this general framework. The red square represents the benefit of reduced travel cost accruing to existing trip makers. The blue triangle represents the benefit resulting from new trips. Readers should note that the change in generalized cost from no-build to build represents only the change in user cost, which is specific to travel time and monetary trip costs.

Social costs, including marginal congestion externalities, marginal emissions, and marginal accident occurrences are assumed in this analysis to not affect trip making or modal decisions. The elasticity of demand is estimated based on existing knowledge about travel costs in the corridor and ridership forecasts developed by the Project Team.

Figure 1: Consumer Surplus from Reduction in Travel Cost



Within this framework, the Benefit Cost Analysis estimates lifecycle benefits and costs accruing to both transit and roadway users as well as more widely experienced benefits including emissions reductions, economic development effects, and short-term job creation.

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, 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.
- The creation of new jobs may or may not be an incremental benefit depending on the types of jobs, the population filling those jobs and the likely level of local or regional unemployment at the time those jobs are created. Given the current economic situation and the purpose of the TIGER program, this analysis assumes short-term job creation represents net new employment that can be counted as a project benefit. Long-term job creation is estimated but not included in the measurement of project costs and benefits.
- 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 2009 dollars. The valuation of benefits makes use of a number of assumptions that are required to produce monetized values for all these 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 United States Department of Transportation (USDOT) guidance on the preparation of TIGER 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. A summary of values applied in the economic analysis can be found at the end of 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. Calculated real discount rates are applied to all future costs and benefits as a representation of how the public sector evaluates investments. A 7 percent real discount rate is used in the analysis, with a sensitivity test at 3 percent.

Ridership and Roadway Travel Forecast

Ridership forecasts were developed by Fehr & Peers taking into account population and employment in a quarter mile radius around the streetcar alignment. It is assumed that auto trips diverted to the streetcar will remain constant from 2012 to 2031, but that the new trips in the study area would likely be more 'transit-oriented', which reflects the propensity of developments around transit to induce a higher amount of internal capture, walking, biking and transit use – as opposed to auto use.

Vehicle Miles Traveled (VMT) were also forecasted by Fehr and Peers. Accordingly, It is estimated that 816 auto trips are diverted to the streetcar during the opening year. Estimates of capacity and average speeds on competing roadways and standard speed-flow curve equations (Bureau of Public Roads Updated Speed-Flow Curve) were used to estimate the effect of diversion on remaining roadway users. Table 1 indicates the estimated daily ridership in selected years by mode and in total.

Table 1: Daily Ridership by Source

	2012	2022	2031
Total Daily Trips	2,995	3,549	4,135
Diverted from Auto	816	967	1,127

	2012	2022	2031
Diverted from Bus	481	570	664
Diverted from Walking	359	426	496
Induced Demand	1,339	1,586	1,848

Table 2 indicates the estimated daily net reduction in VMT and auto trips for these same years. The table shows 742 daily auto trips reduced. These are calculated from the riders assumed to be using the streetcar. The 816 riders diverted from autos (Table 1) would have previously taken vehicle trips. Assuming a vehicle occupancy rate of 1.1, this translates into 742 vehicles off the road per day.

Table 2: Daily Net VMT and Auto Trip Reduction

	2012	2022	2031
Daily VMT Without Streetcar	870,077	962,824	1,054,721
Daily VMT Reduced Because of Streetcar	4,600	5,451	6,350
Daily Auto Trips Reduced	742	879	1,024

2. Measurement, Data and Assumptions

This section describes the measurement approach for each category of benefit estimated in this analysis and provides an overview of the data and assumptions used in the analysis. Table 3, below describes each of the benefits estimated in this analysis.

Table 3: Benefits and Description by Evaluation Criteria

Criteria	Benefit(s)	Description
State of Good Repair	Pavement Maintenance Savings	Reductions in pavement maintenance costs due to reductions in roadway usage
Economic Competitiveness	Short Term Employment	Value of new short-term jobs created
	Economic Development	Incremental additional value of induced development due to streetcar proximity, net of travel time savings

Criteria	Benefit(s)	Description
Livability	Vehicle Operating Cost Savings	Reductions in monetary costs to drivers switching to public transit
	Travel Time Savings	Door-to-door trip time savings to both streetcar users and remaining roadway users
	Low Income Mobility & Budgetary Savings to Low Income Population	Portion of total trip cost and time savings accruing to low income users & Short-term employment opportunities benefiting low income workers
Sustainability	Emissions Reductions	Reductions in pollutants and green house gasses due to auto use reductions relative to the no-build condition
Safety	Accident Reduction	Reductions in property losses and injuries and deaths due to reductions in automobile use

2.1 State of Good Repair

2.1.1 Pavement Maintenance Savings

The savings in pavement maintenance, like other variable costs, are due to the reduction in vehicle-miles on nearby arterials as trips are diverted onto transit. The analysis combined and estimated per-unit savings of pavement maintenance costs, estimated at \$0.003 per vehicle-mile avoided¹, with the estimated reduction in VMT. The opening year savings in pavement maintenance is calculated at approximately \$3,247, amounting to \$41,853 for the study period.

Table 4: VMT Reduction and Pavement Maintenance Savings

Variable	Opening Year	Lifecycle
VMT Avoided	1,343,214	31,715,353
Pavement Maintenance Savings	\$3,247	\$41,853

¹ See Addendum to the 1997 Federal Highway Cost Allocation Study Final Report (<http://www.fhwa.dot.gov/policy/hcas/addendum.htm>).

2.2 Economic Competitiveness

2.2.1 Increased Short and Long Term Employment Output and Income

Short term job creation is estimated based on the incremental project expenditures and forecast, short term additional station area development between 2010 and project completion in 2012. The Minnesota IMPLAN Group's input-output model is used to estimate direct, indirect and induced employment, associated output, 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 which 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). Table 5 indicates short term job creation, income and value added due to the streetcar investment. Table 6 indicates employment by sector.

Table 5: Short Term Job Creation, Income and Value Added as a Result of Project Development

Period	Employment	Total	Labor Income (\$M)	Total (\$M)	Value Added (\$M)	Total (\$M)
2010 - Q2	96	96	\$5.17	\$5.17	\$7.44	\$7.44
2010 - Q3	96	192	\$5.17	\$10.33	\$7.44	\$14.87
2010 - Q4	96	288	\$5.17	\$15.50	\$7.44	\$22.31
2011 - Q1	96	384	\$5.17	\$20.67	\$7.44	\$29.75
2011 - Q2	96	480	\$5.17	\$25.83	\$7.44	\$37.18
2011 - Q3	96	577	\$5.17	\$31.00	\$7.44	\$44.62
2011 - Q4	96	673	\$5.17	\$36.17	\$7.44	\$52.06
2012 - Q1	96	769	\$5.17	\$41.33	\$7.44	\$59.49

Table 6: Direct, Indirect, and Induced Employment by Sector and Estimated Social Benefit From Streetcar Project Development

Sectors	Total Employment	Total Benefit (\$M)
Agricultural, Forestry, Fish & Hunting	8	\$0.2
Mining	5	\$0.2
Utilities	2	\$0.0
Construction	186	\$6.6
Manufacturing	56	\$1.6
Wholesale Trade	18	\$0.9
Transportation & Warehousing	27	\$0.7

Sectors	Total Employment	Total Benefit (\$M)
Retail trade	56	\$1.2
Information	11	\$0.7
Finance & insurance	28	\$1.4
Real estate & rental	24	\$1.4
Professional- scientific & tech services	139	\$6.8
Management of companies	6	\$0.5
Administrative & waste services	53	\$1.5
Educational services	11	\$0.5
Health & social services	51	\$1.8
Arts- entertainment & recreation	12	\$0.5
Accommodation & food services	40	\$0.7
Other services	32	\$0.6
Government & non NAICs	5	\$0.2
Total	769	\$28.2²

Table 6 above presents the short term increased employment activity associated with the construction of the transit line and include direct, indirect, and induced employment opportunities. 769 cumulative job years are expected to be created from the construction of the transit line. These jobs were then monetized by the median wage of their specific sector in the Salt Lake City region. As a result, benefits resulting from employment of local workers accrue to an additional \$28 million during the construction period.

Additional short term jobs will also be created from the investment in property development along the streetcar line as documented elsewhere in this application. 3,876 jobs will be created by the end of 2012 due to \$194.4 million of investment in residential and retail developments.

Table 7: Direct, Indirect, and Induced Employment by Sector and Estimated Social Benefit from Property Development Cost Expenditures Due to Streetcar

Period	Employment	Total	Labor Income (\$M)	Total (\$M)	Value Added (\$M)	Total (\$M)
2010 - Q1	97	97	\$5.0	\$5.0	\$7.4	\$7.4
2010 - Q2	97	194	\$5.0	\$10.0	\$7.4	\$14.8
2010 - Q3	97	291	\$5.0	\$15.1	\$7.4	\$22.3
2010 - Q4	97	388	\$5.0	\$20.1	\$7.4	\$29.7
2011 - Q1	291	678	\$15.1	\$35.2	\$22.3	\$52.0
2011 - Q2	291	969	\$15.1	\$50.2	\$22.3	\$74.2
2011 - Q3	291	1,260	\$15.1	\$65.3	\$22.3	\$96.5

² Wages were selected for each specific sector, or those most similarly listed, by the Bureau of Labor Statistics for the Salt Lake City Metropolitan area.

Period	Employment	Total	Labor Income (\$M)	Total (\$M)	Value Added (\$M)	Total (\$M)
2011 - Q4	291	1,550	\$15.1	\$80.4	\$22.3	\$118.8
2012 - Q1	581	2,132	\$30.1	\$110.5	\$44.5	\$163.3
2012 - Q2	581	2,713	\$30.1	\$140.6	\$44.5	\$207.8
2012 - Q3	581	3,295	\$30.1	\$170.8	\$44.5	\$252.4
2012 - Q4	581	3,876	\$30.1	\$200.9	\$44.5	\$296.9

In addition to the short term job creation effect, the operation and maintenance of the transit line and continuing property development produces long term jobs. Unlike construction, these jobs are permanent and exist throughout the life expectancy of the transit line. These jobs are not considered incremental benefits of the project. The analysis assumes that full or near full employment will be reached by 2013. Therefore these job creation estimates are not monetized and are not used in the benefit-cost calculation.

Table 8 below presents long term job creation resulting from operation of the streetcar, continuing induced property development and the monetary trip cost savings estimated to accrue to users, i.e. the portion of VOC savings that is re-spent by users. Estimates of trip cost savings are described in a subsequent section.

Table 8: Long Term Job Creation

	Value	Direct & Indirect Jobs per Year	Induced Jobs per Year	Total Jobs per Year	Life Cycle Jobs Created
Annual O&M Expenditures	\$1.6 M	25	20	45	900
Annual Incremental Property Development*	\$57.2 M	689	452	1,141	24,418
Average Annual Monetary Savings to Trip Makers	\$1.3 M	11	5	16	319
Total³	\$60.1	725	477	1,202	25,637

* Forecast jobs resulting for the additional development attracted to the station area due to the presence of the streetcar, above expected development levels in the no-build condition.

2.2.2 Economic Development

A majority of benefits from the transit line result from economic development of the community and appreciation of land values to nearby properties. Economic development

³ Total Long Term Job Creation is calculated by multiplying the number of jobs created by Annual O&M by the 20 years of operation and then adding the jobs created by monetary savings from VOC and induced property development.

benefits are estimated as a short-term, extra, or premium rate of property appreciation above and beyond the general rate of appreciation, which in this case is assumed to be the inflation rate. The premium rate for incremental additional property value to proximity to the streetcar in the build scenario was assumed to be 4 percent realized in the year of property construction completion. The premium is applied to new construction properties property values only. As documented elsewhere in this application, estimates were also made for no-build construction rates and values. This analysis assumes that the difference between the no-build and build construction rates represents incremental development induced by the construction of the streetcar.

To avoid the possibility of double-counting benefits, the economic development benefits are reported net of all travel time saving effects. This ensures that any property value appreciation effects resulting from the desire to live or work near transit *in order to enjoy improved travel conditions* is not counted twice in the analysis. Studies of other systems have reported premiums as low as 2 percent, but most are much higher (some as high as 1,000 percent). This analysis relies on a relatively low premium after accounting for travel benefits to ensure the analysis is not affected by overly optimistic expectations of development impacts and to avoid the possibility of accounting for travel benefits twice – in the travel impacts analysis and in the economic development forecast.

Only forecasted newly constructed properties are considered in the analysis; no estimate is made of the effect of construction on the value of existing, non-redeveloped properties. This is a conservative approach, as existing research indicates that it is highly likely these properties will experience incremental appreciation in the build scenario. The baseline and build (with streetcar) construction and value forecasts were used to estimate an incremental induced development estimate. It is estimated elsewhere in this application that 100 percent of all new properties are due to the incremental effect of streetcar. The development forecast indicates at least 550 new residential units will be built by 2012 in the study area adjacent to the streetcar and over 400 thousand square feet of office and retail space will be developed. In 2030, the entire projected development around the streetcar route will include 4,000 new residential units and over 2.12 million square feet of new office and retail space.

A premium value estimate due to streetcar proximity was estimated for the incremental development and this premium rate was applied to determine the gross economic development benefit value. From this, total system travel time savings were netted out to assure that value increases due to travel benefits, accounted for elsewhere in this analysis, were not double-counted under this benefit category. The residual value appreciation effect, after travel benefits represents the agglomeration benefit (amenity value, productivity effect, commercial activity effect, productivity effect, etc.) conferred by the streetcar on those

[properties in proximity to it largely achieved through the level of densification encouraged by the presence of a transit facility \(Transit Oriented development\).⁴](#)

Table 9: Per-Property and Community Appreciation

Economic Development	2012 (Current \$2009)	2030 (Current \$2009)
Cumulative Incremental Development		
Housing (units)	550	4,000
Office/Retail (sq ft)	420,000	2,120,000
Per-Property Appreciation in Year of Construction above Baseline		
Housing (per unit)	\$7,321	\$7,321
Office/Retail (per sq ft)	\$7.32	\$7.32
Incremental Appreciation	\$7,774,400	\$48,974,400

Table 9 above, illustrates the cumulative effect of economic development. Incremental appreciation throughout the study period is summed across all years and discounted and total system travel time savings are netted out to calculate total economic development benefits. On a discounted basis, the proposed streetcar is estimated to provide over \$210 million in monetized economic development benefits.

2.3 Livability

2.3.1 Savings in Vehicle Operating Costs

Trip cost reductions accrue to users who divert from personal automobiles to the new transit service. As with all other benefit categories, the Vehicle Operating Cost (VOC) savings benefit compares forecast VMT and trips in the no-build to build forecasts. Monetized benefits are separated into five categories; fuel, oil, tire, maintenance, parking, and depreciation. The costs in transit fares for passengers diverted from auto are subtracted from these reductions in vehicle costs to reach a net savings estimate. Table 10 presents savings due to reduced VMT and trips in 2012 and for the lifecycle.

Table 10: VOC Savings in 2012 and Lifecycle

Vehicle Operating Cost Savings	2012 (Discounted \$2009)	Lifecycle (Discounted \$2009)
Fuel	\$165,348	\$2,130,287
Oil	\$12,483	\$161,150

⁴ See recent evidence on the scale and applicability of agglomeration benefits over-and-above capitalized travel time savings in P.C. Melo, *et al*, "A Meta-Analysis of Estimates of Urban Agglomeration Economies," *Regional Science and Urban Economics* 39, 2009 and Graham, Daniel J., "Agglomeration, Productivity, and Transport Investment," *Journal of Transport Economics and Policy*, Volume 41, Part 3, September 2007

Vehicle Operating Cost Savings	2012 (Discounted \$2009)	Lifecycle (Discounted \$2009)
Tires	\$4,228	\$53,806
Maintenance	\$104,058	\$1,316,349
Depreciation	\$172,991	\$2,280,285
Parking	\$1,361,736	\$17,554,476
Streetcar Fares	(\$291,801)	(\$3,761,673)
Total VOC Savings	\$1,529,044	\$19,734,679

2.3.2 Travel Time Savings

Travel time savings accrue to both diverted auto trips and diverted bus trips. Though the primary purpose of the streetcar is to enhance mobility and not reduce travel times, per se, the streetcar is expected to have a moderate positive effect on door-to-door travel times. This is a result of auto users with origins or destinations in the study area who experience a minor speed improvement for remaining roadway users as car trips are diverted to transit. However, the majority of travel time savings accrue from pedestrians. The travel time savings for vehicle drivers are presented in Table 11. The difference in average time savings is assumed for all diverted users and remaining drivers on the local arterials from reduced congestion. In the opening year, a total time savings of approximately \$1.7 million for vehicle drivers and pedestrians is calculated. Throughout the study period, the time savings accrues to over \$24 million.

Table 11: Time Savings by Previous Mode of Transport: Autos

	2012	2022	2031
Auto (total hours for all AADT)	25,511	45,287	75,906

The benefit enjoyed by induced users is represented by the blue triangle in Figure 1. Over the period of analysis, it is forecasted that there are 31,610 induced trips. These trips on the streetcar are made up of diverted trips from the previous lower cost alternative and from new trips on the streetcar due to the transit oriented development in the study area. The benefits from induced demand are calculated at approximately \$1.3 million throughout the study period.

2.3.3 Budgetary Savings to Low-Income Users

Benefits to low income populations are derived from the proportion of transit users assumed to be low income (those estimated to be below the poverty line). It is assumed that the proportion of transit users who are low income is 12 percent. These low income riders experience both time savings and trip cost reductions. The low income proportion of trip cost and time savings is

estimated to be \$1.03 million for these riders. These benefits are discussed here for informational purposes, but are aggregated with all travel benefits in the benefit-cost analysis to avoid double-counting.

In addition to time savings, the construction of the streetcar line will increase employment in sectors of business that staff many low-income employees. Table 12 indicates the short-term employment in key industries that employ low income workers estimated to be generated by the streetcar investment. The second column of the table refers to the numbers of job created in the respective sector annually during the construction period. The third column provides labor income (in millions of dollars) which represent not only salaries but all benefits.

Table 12: Short Term Employment Key Industries Employing Low-Income People from Streetcar Project Expenditures

Key Industries Employing Low-Income People	Job Years	Labor Income (\$ Million)
Agriculture, forestry, fishing and hunting	8	\$0.2
Construction	186	\$9.8
Retail trade	56	\$1.7
Truck transportation	9	\$0.4
Administrative and support and waste management and remediation services	53	\$1.6
Nursing and residential care facilities, home health care services	26	\$0.8
Accommodation and food services	40	\$0.9
Personal and laundry services	6	\$0.1
Total	383	\$15.5

2.4 Sustainability - Reduction in Environmental Emissions

Similar to the variable costs in VOC, emissions costs are dependant on the reduction of vehicle-miles diverted by the construction of the streetcar. The consumption values were produced using Mobile 6 and take into account future regulations and trends. Per-unit costs were then applied to the consumption rates in the base case and then multiplied by the reduction in VMT caused by the diversion from auto to the streetcar. There are five types of emissions being measured; Nitrous oxide (NOx), sulfur dioxide (SO2), carbon monoxide and carbon dioxide (CO2), particulate matter (PM), and volatile organic compounds (VOC). The carbon dioxide produced from the streetcar is subtracted from the sum of vehicle emission cost savings to deliver the net emission savings. Table 13 and Table 14 indicate the monetized values for 2012

and 2030 forecast emissions reductions, respectively. Total lifecycle emissions reductions savings accrue to \$842,607.

Table 13: Emissions Reductions Savings, 2012

Pollutant	Daily Saved Emission (grams)	Annual Saved Emissions (g)	Total Annual Saved (\$)
SO2	24	7,053	\$104
Diesel_PM	100	29,125	\$4,527
PM2.5	169	49,272	\$7,658
PM10	183	53,500	\$8,316
Nox	6,274	1,831,941	\$6,780
CO2	2,500,782	730,228,373	\$22,295
CO	34,637	10,114,119	\$4,679
Total	2,543,769	742,780,692	\$54,358

Table 14: Emissions Reduction Savings, 2030

Pollutant	Daily Saved Emission (grams)	Annual Saved Emissions (g)	Total Annual Saved (\$)
SO2	49	14,346	\$63
Diesel_PM	203	59,241	\$2,724
PM2.5	343	100,219	\$4,609
PM10	373	108,819	\$5,004
Nox	12,761	3,726,198	\$4,080
CO2	5,086,632	1,485,296,422	\$13,417
CO	70,453	20,572,284	\$2,816
Total	5,174,069	1,510,828,043	\$32,712

2.5 Safety - Reduced Accident Costs

The reduction of accident costs, like other variable costs, is dependant on the reduction of vehicle-miles traveled. The reduction in vehicles on the road is combined with a multiplier or per-unit of cost accident. This multiplier is a weighted average of fatal, injury, property damage only (PDO) accidents. In the analysis, the opening year savings in accident costs were calculated at approximately \$25,975 and the net accident savings throughout the study period at \$334,853.

3. Findings

Excluding economic development benefits, the estimated rate of return is 14 percent. At a 7 percent discount rate, a \$50 million lifecycle cost results in over \$72 million net benefits and with benefit to cost ratio of about 1.4. If the discount rate is reduced to 3 percent, a \$60.5 million cost results in over \$100 million in net benefits and a benefit-cost ratio of about 1.7.

Including economic development benefits, at a 7 percent discount rate, a \$50 million lifecycle cost results in over \$283 million net benefits and with benefit to cost ratio of about 5.6. If the discount rate is reduced to 3 percent, a \$60.5 million cost results in over \$453 million in net benefits and a benefit-cost ratio of about 7.5.

The table below summarizes the BCA findings.

Overall Results of the Benefit-Cost Analysis (BCA)

Summary of Primary Selection Criteria - Long Term Outcomes	7% Discount Rate	3% Discount Rate
State of Good Repair		
Pavement Maintenance Savings (\$ millions)	\$0.04	\$0.06
Economic Competitiveness		
Additional Short-Term Employment (No. of New Jobs)	769	
Direct Employment	280	
Indirect Employment	175	
Induced Employment	314	
Benefits of Short-Term Employment (\$ millions)	\$26.51	\$28.32
Economic Development (\$ millions)	\$210.97	\$352.58
Livability		
VOC Savings (\$ millions)	\$19.73	\$30.55
Travel Time Savings (\$ millions)	\$24.70	\$38.69
Low-Income Mobility (\$ millions)	\$1.03	\$1.59
Sustainability		
Gallons of Gasoline Avoided (From the reduction in VMT)	1,134,573	
Reduced Emissions (tons), from the reduction in VMT		
TOG_exh	15.38	
SO2	0.23	
Diesel_PM	0.96	
PM2.5	1.62	
PM10	1.76	
Nox	60.28	
CO2	24,027.67	
CO	332.80	
Emissions Savings (\$ millions)		
TOG_exh	No estimate	No estimate
SO2	\$0.002	\$0.00
Diesel_PM	\$0.07	\$0.12
PM2.5	\$0.13	\$0.20
PM10	\$0.14	\$0.22
Nox	\$0.11	\$0.18
CO2	\$0.37	\$0.59
CO	\$0.08	\$0.12

Safety		
Accident Cost Savings (\$ millions)	\$0.33	\$0.52
Benefit Cost Analysis Results		
Without Incremental Economic Development		
Total Discounted Benefits (\$ millions)	\$72.79	\$100.43
Total Discounted Cost (\$ millions)	\$50.46	\$60.52
Benefit - Cost Ratio	1.4	1.7
Net Present Value (\$ millions)	\$22.33	\$39.91
Internal Rate of Return	14%	
With Incremental Economic Development		
Total Discounted Benefits (\$ millions)	\$283.76	\$453.01
Total Discounted Costs (\$ millions)	\$50.46	\$60.52
Benefit - Cost Ratio	5.6	7.5
Net Present Value (\$ millions)	\$233.30	\$392
Internal Rate of Return	N/A	

Values for Use in Economic Analysis in TIGER Grant Application

PARAMETER	Metric	MODE				
		Highway	Urban Transit	Passenger Rail	Freight Rail	Ports
BASE CASE		Improvements that would occur in the absence of the grant				
TRAVEL TIME						
Local Travel						
All Purposes ^b	2009 U.S. \$/ person-hour	14.1 ^a				
VEHICLE OPERATING COSTS						
Fuel Prices (average retail gasoline price per gallon, 2011-30)	2007 U.S.\$	3.33 ^c			3.48 ^f	
Rebound Effect (VMT Elasticity)		-0.15 ^c				
PARAMETER	Metric	MODE				
		Highway	Urban Transit	Passenger Rail	Freight Rail	Ports
ENVIRONMENTAL EMISSIONS						
Volatile Organic Compounds (\$/ton)	2007 U.S.\$/ton	1,700 ^d				
Nitrogen Oxides (\$/ton)	2007 U.S.\$/ton	4,000 ^d				
Particulate Matter (\$/ton)	2007 U.S.\$/ton	168,000 ^d				
Sulfur Dioxide (\$/ton)	2007 U.S.\$/ton	16,000 ^d				
Carbon (U.S. domestic value)	2007 U.S.\$/ metric ton	33				
OTHER EXTERNALITIES						
External Costs from Additional Automobile Use Due to "Rebound" Effect						
Accidents	2007 U.S./ vehicle-mile	0.023 ^e				

Notes:

- All combinations of in-vehicle and other transit time. A common value of local travel time is given for automobile drivers and passengers, public transit passengers, pedestrians, and bicyclists (A separate value is stated for truck drivers). Walk access, waiting, and transfer time should be valued at \$21.10 per hour for personal and \$21.20 per hour for business travel when actions affect only those elements of transit time. Source: U.S. Department of Transportation, Revised Departmental Guidance: Valuation of Travel Time in Economic Analysis, February 11, 2003. <http://ostpxweb.dot.gov/policy/reports.htm>. See also U.S. Department of Transportation, Departmental Guidance for the Valuation of Travel Time in Economic Analysis, April 9, 1997, at 11. Updated with guidance from <http://www.dot.gov/recovery/ost/responses090828.htm>
- Weighted averages, using distributions of travel by trip purpose on various modes. See *id.*
- See Final Regulatory Impact Analysis of the National Highway Traffic Safety Administration's rulemaking on Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks.

<http://www.nhtsa.dot.gov/portal/site/nhtsa/menuitem.d0b5a45b55bfbe582f57529cdba046a0/>

- d. These estimates, expressed as dollars per ton, are based on the benefits associated with recently-adopted regulations that limit emissions of air pollutants from mobile sources, a category that includes passenger cars, light trucks, and other highway vehicle. See *id.* at VIII-47 and VIII-58
- e. See *id.* at VIII-57 for more information
- f. <http://www.eia.doe.gov/oiaf/aeo/supplement/index.html>