KANSAS CITY STREETCAR RIVERFRONT EXTENSION

BENEFIT-COST ANALYSIS SUPPLEMENTARY DOCUMENTATION

FY2020 BUILD DISCRETIONARY GRANT PROGRAM

PREPARED FOR: PORT KC / KANSAS CITY STREETCAR AUTHORITY / KANSAS CITY AREA TRANSPORTATION AUTHORITY / THE CITY OF KANSAS CITY, MO

MAY 18, 2020

EXECUTIVE SUMMARY

A benefit-cost analysis (BCA) was conducted for the Kansas City Streetcar Riverfront Extension for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the BUILD 2020 program. The analysis was conducted in accordance with the benefit-cost methodology as outlined by U.S. DOT in the 2020 Benefit-Cost Analysis Guidance for Discretionary Grant Programs. The period of analysis corresponds to 30 years and includes 4 years of capital outlay and 26 years of benefits after operations begin in 2024.

The development and implementation of the initial 2.2-mile route was overseen by three partners: the Kansas City Streetcar Authority (KCSA), Kansas City Area Transportation Authority (KCATA), and the City of Kansas City, Missouri (KCMO). In 2016, the three initial project partners along with Port KC began to investigate the feasibility of extending the streetcar to the Riverfront and changing multi-modal connections and paths in the study area. In light of the proposed mixed-use development of 12 Riverfront parcels with completion dates ranging from 2020 through to 2031, this extension is intended to provide connectivity between the Riverfront and the downtown, stimulate economic activity at the Riverfront, and provide a non-vehicle travel option to access the "string" of downtown districts, as well as address parking demand and growing congestion.

COSTS

The capital cost for this Project is expected to be $18.82 million in undiscounted 2018 dollars through 2023. At a 7 percent real discount rate, these costs are $15.48 million. Operations and maintenance (O&M) costs are projected to average $492,500 (undiscounted 2018 dollars) per year in the long term. Over the entire 30-year analysis period O&M costs accumulate to $12.8 million in undiscounted 2018 dollars, or $4.4 million when discounted at 7 percent.

Table 1-1 Project Information and Cost, in Undiscounted Millions of 2018 Dollars

Variable	Undiscounted Value	Discounted Value (7% Discount Rate)
Capital Outlay Start	2020	
Capital Outlay End	2023	
Capital Outlay Duration	4 years	
Project Opening	January 2024	
Capital Cost	$18.82 M	$15.48 M
O&M Cost	$12.80 M	$4.44 M

Source: WSP/Project Team

BENEFITS

In 2018 dollars, the Project is expected to generate $24.6M in discounted benefits using a 7 percent discount rate, and increased O&M costs of $4.4M, for a project benefit of $24.6 million. These benefits are attributed to the reduction in vehicle miles travelled (VMT) and passenger hours travelled (PHT) that the streetcar will produce for new users from the Riverfront development, as well as existing users. This leads to an overall project Net Present Value (NPV) of $9.07 million and a Benefit Cost Ratio (BCR) of 1.59[1]. The overall Project impacts can be seen in Table 1-2, which shows the magnitude of change and direction of the various impact categories.

Table 1-2 - Project Impacts for the KC Streetcar Riverfront Extension, Cumulative 2020-2049

Category	Unit	Quantity	Direction
Vehicle-Miles Traveled	VMT	207,507,538	▼
Vehicle-Hours Traveled	VHT	904,592	▼
CO_2 Emissions	tons	49,729	▼
NO_X Emissions	tons	3.56	▼
PM^{10}	tons	0.47	▼
SO_X	tons	0.37	▼
VOC	tons	0.85	▼

Source: WSP

In addition to the monetized benefits presented in Table 1-2, the Project would create the following qualitative benefits:

COMMUNITY DEVELOPMENT (LAND VALUE UPLIFT) POTENTIAL

The Berkley Riverfront Development Master Planned Development (MPD) outlines two density scenarios contingent upon the construction of the streetcar extension. With the streetcar extension, the developable parcels will reduce the amount of residential parking, creating additional residential square-footage. Without the streetcar extension, the development must consider additional parking for resident commuting purposes.

SAFETY

Safety benefits are anticipated from the streetcar extension due to the reduction in VMTs that are expected. Additionally, the new pedestrian and bicycle facility allows for safer, non-vehicular journeys to and from the Riverfront.

[1] Per USDOT guidance, operations and maintenance costs are included in the numerator along with other project benefits when calculating the benefit-cost ratio.

While these benefits are not easily quantifiable, they do provide real advantages and improvements that will be experienced by individuals and businesses in the region.

The overall project benefits over the analysis period are presented in Table 1-3 below.

Table 1-3 - Project Benefits by Long-Term Outcome Category

Long-Term Outcome	Benefit (Disbenefit) Category	Monetized @ 7% Discount Rate
Quality of Life / Livability	Community Development	Qualitative Benefit
Economic Competitiveness	Travel Time Savings	$4,364,000
	Vehicle Operating Costs	$24,293,000
Safety	Reduced Incidents	Qualitative Benefit
State of Good Repair	Reduced Road Damage	$103,000
Environmental Sustainability	Reduced Emissions	$157,000
	Reduced Noise	$76,000

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1 INTRODUCTION

A benefit-cost analysis (BCA) was conducted for the Riverfront Kansas City: Connecting Our Riverfront for Everyone (KC CORE) for submission to the U.S. Department of Transportation (U.S. DOT) as a requirement of a discretionary grant application for the BUILD 2020 program. The following section describes the BCA framework, evaluation metrics, and report contents.

1.1 BCA FRAMEWORK

A BCA is an evaluation framework to assess the economic advantages (benefits) and disadvantages (costs) of an investment alternative. Benefits and costs are broadly defined and are quantified in monetary terms to the extent possible. The overall goal of a BCA is to assess whether the expected benefits of a project justify the costs from a national perspective. A BCA framework attempts to capture the net welfare change created by a project, including cost savings and increases in welfare (benefits), as well as disbenefits where costs can be identified (e.g., project capital costs), and welfare reductions where some groups are expected to be made worse off as a result of the proposed project.

The BCA framework involves defining a Base Case or "No Build" Case, which is compared to the "Build" Case, where the grant request is awarded and the project is built as proposed. The BCA assesses the incremental difference between the Base Case and the Build Case, which represents the net change in welfare. BCAs are forward-looking exercises which seek to assess the incremental change in welfare over a project life-cycle. The importance of future welfare changes are determined through discounting, which is meant to reflect both the opportunity cost of capital as well as the societal preference for the present.

The analysis was conducted in accordance with the benefit-cost methodology as recommended by the U.S. DOT in the 2020 Benefit-Cost Analysis Guidance for Discretionary Grant Programs.[2] This methodology includes the following analytical assumptions:

- Assessing benefits with respect to each of the five long-term outcomes defined by the U.S. DOT;
- Defining existing and future conditions under a No Build base case as well as under the Build Case;
- Estimating benefits and costs during project construction and operation, including at least 20 years of operations beyond the Project completion when benefits accrue;
- Using U.S. DOT recommended monetized values for reduced fatalities, injuries, property damage, travel time savings, and emissions, while relying on best practices for monetization of other benefits;
- Presenting dollar values in real 2018 dollars. In instances where cost estimates and benefits valuations are expressed in historical dollar years, using an appropriate Consumer Price Index (CPI) to adjust the values; and
- Discounting future benefits and costs with real discount rates of 7 percent consistent with U.S. DOT guidance.

1.2 PRISM

This benefit cost analysis was done using PRISM™, a benefit cost analysis tool that uses a methodology consistent with the most recent guidelines developed by U.S. DOT. The tool determined benefits according to the following five categories: Quality of Life; Economic Competitiveness; Safety; State of Good Repair; and Environmental Sustainability.

[2] U.S. Department of Transportation. 20120 Benefit-Cost Analysis Guidance for Discretionary Grant Programs. 2020.

1.3 REPORT CONTENTS

The contents of the report are organized as follows:

- Section 1 provides an introduction.
- Section 2 of this report provides a project overview and general BCA assumptions, as well as the project costs including initial investment costs, and operating, maintenance, and other life-cycle costs.
- Section 3 describes the demand projections made for the area surrounding the proposed Riverfront streetcar stop. Section 3 also describes the project benefits, including a summary of benefits with respect to the five long-term outcome criteria set forth by the U.S. DOT, and provides details on the factors and assumptions used to derive benefits for each benefit type
- Section 4 summarizes the results of the benefit-cost analysis and sensitivity analysis to assess the impacts of changes in key assumptions.

2 PROJECT OVERVIEW

2.1 DESCRIPTION

The Kansas City Streetcar (KC Streetcar) began operation in May 2016. The existing streetcar spans a 2.2-mile route between the River Market and Union Station in downtown Kansas City, MO. This route facilitates access to Kansas City's central business district along Main Street while connecting users to other modes of transportation including the regional RideKC Bus system. The existing service has been very successful, with the streetcar celebrating its 2 millionth passenger before the end of its first year of service – this represents 74% higher ridership than the original opening-year estimate of 1.15 million trips. The total project cost was $102.5 million, of which $20 million was funded via a TIGER grant in 2013.

The development and implementation of the initial 2.2-mile route was overseen by three partners: the Kansas City Streetcar Authority (KCSA), Kansas City Area Transportation Authority (KCATA), and the City of Kansas City, Missouri (KCMO). In 2016, the project partners along with Port KC began to investigate the feasibility of extending the streetcar to the Riverfront and changing multi-modal connections and paths in the study area. In light of the proposed mixed-use development of 12 Riverfront parcels with completion dates ranging from 2020 through to 2031, this project and proposed streetcar extension is intended to provide connectivity between the Riverfront and the downtown, stimulate economic activity at the Riverfront, and provide a non-vehicle travel option to access the "string" of downtown districts, as well as address parking demand and growing congestion. The first Riverside development (Union) has been constructed and is now opened, as per the original planned development schedule.

Six alignment options were previously considered for the service extension on the basis of structural requirements, public perception and input, operational needs and limitations, cost estimates (operational and capital), as well as funding and financing. The preferred alternative involves construction of a double-track beginning at the intersection of 3rd Street and Grand Avenue which traverses north up Grand Avenue bridge, under the Heart of America Bridge, to River Front Road. Under this alternative, a central station stop will be constructed on River Front Road, close to the intersection of River Front Road and E Front Street .

This project would facilitate a reduction in Passenger Hours Travelled (PHTs) and Vehicle Miles Travelled (VMTs) for existing traffic as well as transportation demand from the proposed Riverfront development. The streetcar would also encourage increased travel between the Riverfront development and downtown Kansas City for work and recreational purposes. General Assumptions

2.1.1 *BASIS OF ECONOMIC BENEFITS*

The primary drivers of quantifiable project benefits for the BCA are PHT savings and VMT savings. By eliminating an average of ten million miles of vehicular travel per year, significant cost savings from reduced fuel consumption, reduced vehicle maintenance, oil imports, and emissions will be realized. Eliminating an average of 30,000 hours of person travel per year translates to substantial passenger time savings, which can be monetized.

This project would also generate significant benefits in terms of community development (land value uplift from increased investment in Riverfront development) and safety (reduced vehicle crashes due to reduced VMTs as users switch from auto to transit). Given the challenge of accurately quantifying these benefits, this BCA discusses community development and safety benefits qualitatively, noting that the true economic benefit (and Benefit-Cost Ratio) is likely higher than the value presented herein.

2.1.2 DISCOUNTING AND REAL DOLLAR VALUATIONS

Dollar figures in this analysis are expressed in constant 2018 dollars. While expressed in 2018 dollars, all Present Value cost and benefit streams are discounted to 2019. The real discount rate used for this analysis is 7.0%, consistent with U.S. DOT guidance3 and OMB Circular A-94[4].

2.1.3 EVALUATION PERIOD

The Streetcar Riverfront Extension and Multi-Modal Feasibility Study outlines the commencement of engineering work in 2020, construction beginning in 2021, and operation beginning January 2024. The complete analysis period (i.e., the period of discounting) begins with the first expenditures in 2020 and continues through to 2049, for a total of 30 years. This covers 4 years of capital outlays and 26 years of operation. Capital expenditures during this time were outlined in cost estimates provided by Burns and McDonnell.

All benefits and costs are assumed to occur at the end of each year, and benefits begin in January 2024 following a brief alignment testing period.

2.1.4 RIDERSHIP ESTIMATES AND PROJECTION SOURCES

Kansas City Streetcar extension ridership data was developed using surveys and passenger counts for the existing streetcar line, provided by Burns and McDonnell. Projections are based on current ridership for the existing line along Main Street, induced ridership from the proposed development (based on the extent of proposed development in each of the Base and Build Cases), and conservative growth rates during operational years. Capacity constraints were examined to confirm maximum line capacity (with existing vehicles) would not be exceeded within the study period under the analysis' passenger growth assumptions.

The methodology for estimating travel time savings and VMT savings is described in Section 3.2.3.

2.1.5 ANNUALIZATION FACTOR DETERMINATION

Induced daily ridership estimates were provided as inputs to the model based on the number of housing units to be included in the proposed developments on the Riverfront parcels. Induced daily ridership forecasts were annualized using an annualization factor of 420.66, derived as follows:

— $(254\ Mon - Fri\ days\ per\ week) + (52\ Sat\ per\ year\ \times Sat\ Ridership\ factor) + (52\ Sun\ per\ year\ \times Sun\ Ridership\ factor)] + (6\ statutory\ holidays\ per\ year \times Sun\ Ridership\ factor) = 421\ days$

— Current streetcar ridership is higher on weekends than Monday through Friday due to recreational attractions in downtown Kansas City that have proved to keep ridership high, including the Power and Light district, the City Market farmers market, and the Sprint Center. Saturdays have an average ridership of 2.05 times Mon-Fri ridership; and Sundays 1.605 times Mon-Fri ridership. Thus, non Mon-Fri days are assumed to generate higher ridership and were factored accordingly.

The total annualization factor was thus calculated as 421 times average weekday daily ridership projections.

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[3] U.S. Department of Transportation. 2020 Benefit-Cost Analysis Guidance for Discretionary Grant Programs. 2020.
[4] White House Office of Management and Budget, Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs (October 29, 1992). (https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/circulars/A94/a094.pdf).

2.1.6 *BENEFIT-COST EVALUATION MEASURES*

The benefit-cost analysis converts potential gains (benefits) and losses (costs/disbenefits) from the Project into monetary units and compares them. The following two common benefit-cost evaluation measures are included in this BCA.

- **Net Present Value (NPV):** NPV compares the net benefits (minus costs) after being discounted to present values using the real discount rate assumption. The NPV provides a perspective on the overall dollar magnitude of cash flows over time in today's dollar terms.
- **Benefit Cost (B/C) Ratio:** The evaluation also estimates the B/C ratio. The present value of incremental benefits minus the present value of the incremental annual operations and maintenance (O&M) costs is divided by the present value of incremental capital and rehabilitation costs to yield the B/C ratio. The B/C ratio expresses the relationship of discounted benefits to discounted costs as a measure of the extent to which a project's benefits either exceed or fall short of their associated costs, or, the expected benefits (in dollar figure) relative to each dollar of capital cost invested.

$$BCR = \frac{PV\ of\ Incremental\ Benefits - PV\ of\ Incremental\ O\&M\ Costs - PV\ of\ Incremental\ Rehabilitation\ Costs}{PV\ Capital\ Costs}$$

- **Internal Rate of Return (IRR):** The IRR is the discount rate which makes the NPV from the Project equal to zero. In other words, it is the discount rate at which the Project breaks even. Generally, the greater the IRR, the more desirable the Project.
- **Payback Period:** The payback period refers to the period of time required to recover the funds expended on a Project. When calculating the payback period, the time value of money (discounting) is not taken into account.

2.2 BASE CASE AND BUILD CASE

The Base Case does not include construction of extension of the existing streetcar service to the Riverfront. The Berkley Riverfront Development Master Planned Development (MPD) outlines two density scenarios contingent upon the construction of the streetcar extension. The MPD low-density development scenario has been used for the purpose of the Base Case. This case assumes annualized ridership growth of 2.0% starting in 2024 to account for streetcar trips generated from the low-density development scenario. Actual annualized ridership growth from 2018 to 2019 was 5.4%, but in order to provide a conservative BCA, it was assumed that long-term annualized growth would be significantly lower at 2.0%.

The Build Case defined for this analysis follows the MPD high-density development, which assumes less required parking than is proposed in the Base Case and thus facilitates a larger residential square footage. The induced ridership forecast by Burns and McDonnell was projected based on the projected build-out year for each parcel in close proximity to the proposed Riverfront streetcar station. A linear increase in travel demand was assumed between build-out years, with a conservative estimate using the same expected annualized growth as the Base Case at 2.0% ridership growth after 2031 (the date when the final parcel is expected to finish development).

2.3 PROJECT COSTS

2.3.1 *CAPITAL COSTS*

The following capital costs were included in the BCA:

- **Guideway and Track Elements:** includes at-grade upgrades, aerial structure, ties and ballast, embedded track, and special track features such as track switches.
- **Stations, Stops, Terminals, Intermodal:** includes construction of a streetcar stop near the River Front Drive and E Front Street intersection and construction of a multi-modal transit hub at the northeast corner of 3rd St. and Grand Blvd., replacing the existing streetcar stop at 3rd St. and Walnut St.
- **Support Facilities:** includes a new yard track for additional storage, as well as administrative buildings.
- **Site Work and Special Conditions:** includes demolition and earthworks, utility allowances, site work for the right-of-way, signs and street lighting over the roads and bridges, as well as temporary facilities for the contractor.
- **Systems:** includes traffic control for traffic signals and streetcar signals, traction power substations and distribution, and communications.
- **Professional Services:** includes design costs, construction management, and owner project administration.
- **Contingency:** 15% of estimated capital costs.

Table 2-1: Project Schedule and Costs, Millions of 2018 Dollars

Variable	Undiscounted Value	Discounted Value (7% Discount Rate)
Capital Outlay Start	2020	
Capital Outlay End	2023	
Capital Outlay Duration	4 years	
Project Opening	January 2024	
Capital Cost	$18.82 M	$15.48 M
O&M Cost	$12.80 M	$4.44 M

Source: Cost Estimate, Burns and McDonnell

2.3.2 *OPERATIONS AND MAINTENANCE COSTS*

Operations and maintenance (O&M) costs are estimated to be $492,470 (2018$) per year for the streetcar extension. Over the project lifecycle, this amounts to $12.8 million (2018$) when undiscounted or $4.4 million when discounted at a 7% discount rate. The existing streetcar will require annual O&M expenditures which are not expected to change under the Build Scenario; as such, only the cost to operate and maintain the streetcar extension has been considered. O&M expenditures are shown in Table 2-1 above.

3 PROJECT BENEFITS AND ASSUMPTIONS

3.1 PROJECT BENEFITS

The KC CORE project would allow for a number of economic, environmental, quality of life, and state-of-good-repair benefits for Kansas City.

Quality of Life

- The project will enhance connectivity to the Riverfront development. The streetcar extension will allow users from the development to access 28 existing bus lines, the Downtown Transit Center, Amtrak's national network, Johnson County Transit, and future potential commuter rail service.
- The streetcar extension has the potential to reach the Isle of Capri land east of the I-29/35.

Economic Competitiveness

- The construction of the streetcar extension would enable not only a denser Riverfront development, therefore increasing the value of the land which is currently undeveloped, but will allow future residents of this development to access downtown Kansas City.
- The project will enable direct transportation access to the central business district's employment centers for new users as well as direct transportation for downtown residents to the Riverfront.
- The anticipated reduction of VMTs will translate to fuel savings, reduced oil imports, and reduced vehicle operating costs.
- The streetcar extension supports and attracts tourism to the Riverfront.
- Increased fare revenue resulting from increased ridership was treated as a transfer and therefore assumed to have no impact on net project benefit.
- The project also supports a reduction in parking spaces in downtown Kansas City. This has proven to be an increasing concern for the city as space is limited and congestion is increasing. Additionally, the reduction in parking spaces provides vacant land for future development in the downtown core.

State-of-Good-Repair

- The anticipated reduction of VMTs will result in less wear and tear on existing road infrastructure, lowering the burden on tax-payers.

Environmental Sustainability

- The anticipated reduction of VMTs will translate to fuel savings, reduced road damage, reduced wear and tear for vehicles, as well as a reduction in emissions.
- The streetcar extension would reduce the need for parking in downtown Kansas City, which has already proven to be a concerning issue.
- The reduction in vehicles also lowers the amount of noise pollution along the streetcar line.

All of the above benefits are monetizable and would begin to accrue upon completion of the streetcar extension testing in January 2024, continuing to accrue throughout the lifespan (or evaluation period) of the upgraded facility.

Community Development and Safety

In addition to the above benefits, this project would also be expected to generate significant benefits in terms of community development (land-value uplift) and safety. However, given the challenge of accurately quantifying these benefits, this analysis only considers these benefits qualitatively, noting that the true economic benefit (and Benefit-Cost Ratio) is likely higher than the value presented herein.

The existing streetcar line has contributed significantly to the revitalization of downtown Kansas City; extension of the streetcar line to the Riverfront is expected to support a similar transformation of the currently underused Riverfront property. Though situated in a prime location, limited access to the Riverfront has long suppressed development of the adjacent land parcels. Extending the streetcar line is anticipated to significantly increase land value and generate increased economic activity in the community. While preliminary quantitative estimates of land value uplift have been produced, land value uplift is typically considered a reflection of all other project benefits. To avoid double-counting benefits and avoid reliance on uncertain land value uplift calculations, this benefit is considered qualitatively.

Table 3-1 below summarizes and categories each of the benefits described in this section.

Table 3-1 - Project Benefits by Long-Term Outcome Category

Long-Term Outcome	Benefit (Disbenefit) Category	Description	Value - Undiscounted	Value – Discounted at 7%
Quality of Life / Livability	Community Development	Development spurred by extension of the streetcar line will increase livability, services, and land values	Qualitative Benefit	
Economic Competitiveness	Travel Time Savings	Construction of the streetcar extension will allow the additional users from the Riverfront development to access downtown Kansas City for recreational and work commutes, reducing PHTs for all road users.	$15,016,000	$4,364,000
	Vehicle Operating Costs	Reduced VMTs associated with the Riverfront development and the streetcar extension will result in less money spent on vehicle-related O&M expenses.	$85,079,000	$24,293,000
Safety	Reduced Incidents	Reduced VMTs due to modal switch from auto to transit.	Qualitative Benefit	
State of Good Repair	Reduced Road Damage	Reduced VMTs associated commuters would result in less wear and tear on local roads, reducing maintenance costs.	$362,000	$103,000
Environmental Sustainability	Reduced Emissions	Decreased VMTs will lead to a decrease in total emissions from the vehicles of existing users and new users from the Riverfront development.	$524,000	$157,000
	Reduced Noise	Reduced VMTs will lead to a reduction in noise pollution.	$266,000	$76,000

Source: WSP

3.2 DEMAND PROJECTIONS AND ASSOCIATED SAVINGS

Build Case streetcar ridership projections were used to estimate savings of Passenger Hours Travelled (PHTs) and Vehicle Miles Travelled (VMTs), upon which quantification of benefits was based. Ridership projections were completed by Burns & McDonnell, taking into account existing ridership and projected numbers of residential units to be constructed on the land parcels adjacent to the proposed Riverfront streetcar station.

Given that ridership projections were based on the number of proposed residential units adjacent to the proposed Riverfront streetcar stop, this estimate is likely conservative in that the proposed parcel developments – which are intended to be mixed-use – will likely attract streetcar trips from individuals not living in the proposed developments; however, these trips have not been quantified for the purposes of this BCA.

3.2.1 *INDUCED STREETCAR TRIPS*

Travel Distance Estimates

Half of induced trips by residents in the proposed Riverfront developments were assumed to *board* at the proposed Riverfront streetcar station, while the other half were assumed to *alight* at the proposed station. Operating within this constraint, induced trips were assumed to follow existing streetcar user travel patterns: for southbound trips leaving the proposed station, induced trips were assumed to alight according to existing southbound stop-by-stop alighting distributions. Similarly, induced northbound trips heading to the proposed station were assumed to board according to existing northbound stop-by-stop boarding patterns. Using this logic, average in-vehicle passenger trip distances (and travel times) were estimated.

Walk distances between the proposed developments and the proposed streetcar station were calculated as an average (weighted by development gross area) of the distance between each designated land parcel and the location of the proposed stop. Walk distances at the other end of the journey for induced streetcar passenger trips were assumed to be an average of 1/8th of a mile, or 660 feet.

Residents who move into the proposed Riverfront developments were assumed to relocate from other parts of Kansas City, MO. However, lacking data on which communities these residents are expected to relocate from, relocated residents were assumed to be 'average' travellers according to census statistics. Average values for Kansas City, MO commuter travel time and modal split were used thus in calculating VHT and PHT savings.

PHT Savings Estimates

The average commuter trip in Kansas City takes 22.2 minutes[5]. PHT savings were therefore estimated based on a comparison of average travel time for induced trips on the streetcar versus the average commuter trip time of 22.2 minutes. Average travel time for induced streetcar trips was calculated as a function of average travel distance, as described above; streetcar travel speed as outlined by the Streetcar Riverfront Extension Feasibility Study by Burns & McDonnell; passenger wait time, assumed to be 2.5 minutes (25% of streetcar headway) on the assumption that passengers time their arrival with streetcar schedules; and a walk speed of 3.0 mph. Because average trip durations for non-commuting purposes were not available, the average commuter trip was used as a proxy for an average trip of any kind in Kansas City, MO. Daily estimates were annualized using the annualization factor described in Section 2.1.5.

[5] https://datausa.io/profile/geo/kansas-city-mo-ks-metro-area/

VMT Savings Estimates

As described above, the average commuter trip in Kansas City, MO takes 22.2 minutes. The US Census Bureau's American Community Survey states that commuters who do not work from home have an auto mode share of 85.3% in Kansas City. Assuming an average travel speed of 26.25 mph (75% of the typical posted speed limit of 35mph), VMT savings were calculated as a function of the number of reduced auto trips (assumed to be 95% of induced streetcar trips); average travel time and speed; and average vehicle occupancy for Kansas City, MO.[6] Daily estimates were annualized using the annualization factor described in Section 2.1.5.

Table 3-2 summarizes the assumptions and inputs used for these calculations.

Table 3-2 - PHT and VMT Assumptions and Inputs (Induced Trips)

Variable	Unit	Value	Source/Calculation
No Build Ridership Growth Rate (after 2023)	%	2.0%	Assumption
Base Daily Ridership (Mon-Fri)	Trips per day	5,154	Average Historical Weekday Ridership in 2018 and 2019 provided by Burns & McDonnell
Build Case Incremental Ridership (2020 to 2031)	Trips per day	410 to 4,557	The ridership data was provided for years 2020 through 2031 by Burns & McDonnell. Growth was assumed to be linear between years.
Build Case Ridership Growth (after 2031)	%	2.0%	Equal to No Build growth rate
Mode Splits	% Transit	5.25%	US Census Bureau – American Community Survey – Commuting Characteristics by Sex
	% Bicycle	0.54%	
	% Walking	2.79%	
	% Auto	94.1%	
Average Walk Speed	Miles/hour	3.20	Based on US DOT Federal Highway Administration specified range of 4 to 8 feet/second.
Average Auto Speed	Miles/hour	26.25	Assumed to be ¾ of typical posted speed limit (35mph)
Average Bike Speed	Miles/hour	10.50	The average bicycle speed was determined from the US DOT Federal Highway Administration.
Average Work Commute	Minutes	22.2	Data USA[7]
Average Vehicle Occupancy	Pssngrs/ vehicle	1.67	U.S. DOT Guidance
Percent of Existing Users Travelling for Recreation	%	75.92%	Based on the trip purpose survey conducted by KC Streetcar, it was determined that 75.92% of trips for the existing streetcar were for recreational purposes.
Reduction in VMT for non-commuting trips	%	75%	A conservative assumption was used to estimate the reduction of VMTs for non-commuting versus commuting trips.

Based on the KC Streetcar Passenger Count for three months of ridership from July to September 2016, the distribution of passengers boarding and alighting at the various stops is as follows:

[6] https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_1YR_S0801&prodType=table
[7] https://datausa.io/profile/geo/kansas-city-mo-ks-metro-area/

Table 3-3: Boarding and Alighting Distribution, Total for Three Months (July-September 2016)

Stop	% Alighting	% Boarding
River Market North on 3rd Street at Grand WB	17.0%	
River Market West on Delaware at 4th Street SB	9.9%	
North Loop on Main at 7th Street SB	1.9%	
Library on Main at 9th Street SB	7.6%	
Metro Center on Main at 12th Street SB	14.9%	
Power and Light on Main at 14th Street SB	12.2%	
Kauffman Center on Main at 16th Street SB	8.2%	
Crossroads on Main at 19th Street SB	16.5%	
Union Station on Main at Pershing SB	11.8%	
Crossroads on Main at 19th Street NB		44.9%
Kauffman Center on Main at 16th Street NB		7.2%
Power and Light on Main at 14th Street NB		8.1%
Metro Center on Main at 12th Street NS		8.9%
Library on Main at 9th Street NB		4.2%
North Loop on Main at 7th Street NB		1.4%
City Market on Walnut at 5th Street EB		18.0%

3.2.2 *EXISTING STREETCAR TRIPS*

Existing streetcar users are assumed to experience no VMT savings or penalties under the Base or Build Cases. In reality, there may be a small VMT savings for existing streetcar users in the Build Case as there may be a small number of users who currently drive (or are driven) between the proposed Riverfront streetcar station and the existing streetcar line who may cease to drive under the Build Case; however, the benefits associated with this are expected to be small and therefore have not been quantified.

PHT savings are anticipated for users who currently access the Riverfront using the existing streetcar line. These users are assumed to walk from the existing terminal station to the Riverfront, approximately 1.15 miles away. The number of current users assumed to be accessing the Riverfront by foot is estimated as 5% of existing users who travel for recreational purposes to or from the northern terminal stop of the streetcar line.

Table 3-4: PHT and VMT Assumptions and Inputs (Existing Trips)

Variable	Unit	Value	Source/Calculation
Base Daily Ridership (Mon-Fri)	Trips per day	5,154	Average Historical Weekday Ridership in 2018 and 2019 provided by Burns & McDonnell
Users Travelling for Recreation	%	75.9%	This value was determined based on KC Streetcar survey results provided by Burns & McDonnell. It was assumed that new users will follow the same travel patterns as existing.
Users Walking from River Market to Riverfront Development for Recreational Purposes	%	5%	A conservative estimate was used to model the number of users travelling for recreational purposes through the extension. As indicated by Burns and McDonnell, this estimate was assumed to be 5% as parking is limited and passengers likely would not have access to a vehicle after alighting.
Average Walk Speed	Miles/hour	3.00	Based on US DOT Federal Highway Administration specified range of 4 to 8 feet/second.
Walk Distance	Miles	1.15	Distance between existing northern terminal stop and proposed Riverfront streetcar stop.

3.2.3 *TOTAL PHT AND VMT SAVINGS*

Using the assumptions outlined in Table 3-2 and Table 3-4, VMT and PHT savings were calculated for both the Build and Base Cases. The results are presented in Table 3-5 and were used as inputs to quantify the project benefits.

Table 3-5: PHT and VMT Savings

Variable	First Year of Benefits (2024)	Final Year of Benefits (2049)
Reduced Car Trips	264,000 trips	1,180,000 trips
Reduced Vehicle Miles Travelled	2,565,000 VMT	11,456,000 VMT
Reduced Travel Time	13,100 PHT	48,700 PHT
Reduced Passenger Hours Travelled – Auto	9,400 PHT	41,900 PHT
Reduced Passenger Hours Travelled – Bus	3,400 PHT	5,300 PHT
Reduced Passenger Hours Travelled – Bicycle + Walk	300 PHT	1,500 PHT

Source: WSP

3.3 STREETCAR CAPACITY CONSTRAINTS

Calculations were performed to confirm that the capacity of the streetcar line will not be exceeded as a result of project annual ridership growth under the Base and Build Cases. Though the Build case will result in a longer travel distance and thus a slower round-trip travel time for streetcar vehicles, the purchase of an additional vehicle is intended to maintain the existing headway, and thus the existing capacity, of the streetcar line. Because higher ridership is projected under the Build case, streetcar line capacity was compared to the projected Build case ridership in the last year of project operation to confirm that existing capacity will be sufficient for the duration of the project.

Streetcar capacity was calculated as follows:

- Given headway of 10 minutes:

$$Frequency = \left(\frac{60\ min/hour}{10\ min}\right) = 6.0\ vehicles/hour$$

- Given per-vehicle capacity of 150 passengers

$$Total\ line\ capacity = (150\ passengers) \times (10\ vehicle/hour) = 1{,}500\ passengers/hour$$

- Given Approx. 18 operating hours per day during weekdays, when peak ridership is anticipated

$$Daily\ capacity = (18\ hours) \times (1{,}500\ passengers) = 27{,}000\ passengers/day$$

Maximum anticipated Monday-Thursday daily ridership was estimated to be 6,639, or roughly 3,319 per direction (Build case in 2050). Even when multiplied by a weekday to Saturday conversion factor of 2.05 as discussed in Section 2.1.5, the total potential one-way ridership of 13,610 is lower than the capacity of the streetcar line (27,000 passengers/day). Thus, ridership growth is not expected to be limited by the capacity of the streetcar line.

3.4 ECONOMIC COMPETITIVENESS

This project would contribute to increasing the economic competitiveness of the nation through improvements in the mobility of people in the study area. Two types of societal benefits are measured in the assessment of economic competitiveness: travel time savings and vehicle operating savings (which include fuel savings) that will be realized by users of the streetcar extension in the Riverfront development.

Table 3-6: Economic Competitiveness Estimation of Benefits, 2018 Dollars

Benefit	First Year of Operation (2024)		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Travel Time Savings	$218,000	$155,000	$15,016,000	$4,364,000
Vehicle Operating Cost Savings (including Fuel Savings)	$1,051,000	$750,000	$85,078,000	$24,293,000

Source: WSP

3.4.1 TRAVEL TIME SAVINGS

Travel time savings includes in-vehicle travel time savings for auto drivers and passengers. Travel time is considered a cost to users, and its value depends on the disutility that travelers attribute to time spent traveling. A reduction in travel time translates into more time available for work, leisure, or other activities. The assumptions used in the estimation of travel time savings are presented in the following table.

Table 3-7: Travel Time Savings Assumptions and Sources

Variable	Unit	Value	Source
Average Vehicle Occupancy – Passenger Vehicles	Passengers /vehicle	1.67	U.S. DOT BCA Guidance – January 2020
Value of Travel Time	2018$ per person-hour	16.60	U.S. DOT BCA Guidance – January 2020

Source: WSP

3.4.2 OPERATING COST SAVINGS

Vehicle operating cost savings includes the cost of fuel, as well as maintenance and repair, replacement of tires, and the depreciation of the vehicle over time. Consumption rates per vehicle mile travelled (VMT) are used to calculate the vehicle operating cost savings. Estimates of VMT and unit costs for each component of vehicle operating cost are applied to the consumption rates to calculate the total vehicle operating cost. The assumptions used in the estimation of vehicle operating costs are presented in the following table.

Table 3-8: Operating Cost Savings Assumptions and Sources

Variable	Unit	Value	Source
Vehicle Operating Cost Savings, including Fuel Costs	2018$/VMT	0.41	U.S. DOT BCA Guidance – January 2020

Source: AAA, WSP.

3.5 SAFETY

The safety benefits assessed in this analysis include a reduction in fatalities and injuries, as well as a reduction in other property damage crash costs resulting directly from the project. Safety benefits for this project have been acknowledged qualitatively, however, not assessed quantitatively, due to the difficulty of estimating where VMT reductions will occur throughout the city. Safety benefits are anticipated as a reduction in journeys is expected to lead to a commensurate reduction in the number of crashes.

3.6 STATE OF GOOD REPAIR

The state of good repair benefits assessed in this analysis include maintenance and repair savings, deferral of replacement cost savings, as well as reduced VMT which leads to less road and pavement damage.

Given that the facilities anticipated to experience reduced VMTs are publicly owned and paid for, the benefits of reduced state-of-good-repair expenditures are expected to accrue to taxpayers (society) as a whole. However, the magnitude of state-of-good-repair benefits is expected to be minimal in comparison to monetized VMT and PHT savings.

Table 3-9: State of Good Repair Estimation of Benefits, 2018 Dollars

Benefit	First Year of Operation (2024)		Project Lifecycle	
	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Reduced Road Damage	$4,500	$3,200	$362,000	$103,000

Source: WSP

The assumptions used in the estimation of state of good repair benefits are presented in the following table.

Table 3-10: State of Good Repair Benefits Assumptions and Sources

Variable	Unit	Value	Source
Auto Average Pavement Cost	2018$/VMT	0.002	FHWA 2000

Source: WSP

3.7 ENVIRONMENTAL SUSTAINABILITY

This project will create environmental and sustainability benefits relating to reduction in air pollution associated with decreased automobile travel as an increased number of commuters shift to using the streetcar. Five forms of emissions were identified, measured and monetized, including: nitrous oxide, particulate matter, sulfur dioxide, volatile organic compounds, and carbon dioxide.

A reduction in emissions was calculated based on rate quotes in the Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator together with vehicle miles travelled (VMT) savings. The total emissions reduction was then monetized using the social cost of carbon values referenced in the U.S. DOT 2020 BCA Guide.

Table 3-11: Environmental Sustainability Estimation of Benefits, 2018 Dollars

	First Year of Operation (2024)		Project Lifecycle	
Benefit	Undiscounted	Discounted (7%)	Undiscounted	Discounted (7%)
Reduced CO_2 Emissions	$800	$600	$84,300	$22,200
Reduced NO_x Emissions	$1,400	$1,000	$30,600	$10,900
Reduced PM	$7,400	$5,300	$388,500	$118,100
Reduced SO_x Emissions	$300	$200	$18,300	$5,400
Reduced VOCs	$100	$40	$1,800	$600

Source: WSP

The assumptions used in the estimation of environmental sustainability benefits are presented in the following table.

Table 3-12: Environmental Sustainability Benefits Assumptions and Sources

Variable	Unit	Value	Source
CO_2 cost savings	2018$/metric ton	$1 until 2034, $2 thereafter	FASTLANE Guide 2016
NO_X cost savings	2018$/short ton	8,600	U.S. DOT BCA Guidance 2020
PM_{10} cost savings	2018$/short ton	387,300	U.S. DOT BCA Guidance 2020
SO_X cost savings	2018$/short ton	50,100	U.S. DOT BCA Guidance 2020
VOCs cost savings	2018$/short ton	2,100	U.S. DOT BCA Guidance 2020

4 SUMMARY OF RESULTS

4.1 BCA RESULTS

The table below presents the evaluation results for the project. Results are presented in undiscounted 2018 dollars, and 2018 dollars discounted at 7 percent as prescribed by the U.S. DOT. All benefits and costs were estimated over an evaluation period extending 30 years beyond construction completion in December 2023.

Table 4-1: Benefit Cost Analysis Results, Millions of 2018 Dollars

BCA Metric	Project Lifecycle	
	Undiscounted	Discounted (7%)
Total Benefits	$88.44	$24.55
Total Costs	$18.82	$15.48
Net Present Value (NPV)	$69.62	$9.07
Benefit Cost Ratio (BCR)	4.70	1.59
Payback Period	25.5 years	
Internal Rate of Return (IRR)	11%	

Source: WSP

The benefits over the project lifecycle are presented in the table below by U.S. DOT long-term outcome category.

Table 4-2: Benefits by Long-Term Outcome, Millions of 2018 Dollars

Long-Term Outcome	Project Lifecycle	
	Undiscounted	Discounted (7%)
Quality of Life / Livability	(Qualitative)	
Economic Competitiveness	$100.09	$28.66
Safety	(Qualitative)	
State of Good Repair	$0.36	$0.10
Environmental Sustainability	$0.52	$0.16
O&M Savings	($12.8)	($4.4)

Source: WSP

4.2 SENSITIVITY TESTING

A sensitivity analysis is used to help identify which variables have the greatest impact on the BCA results. This analysis can be used to estimate how changes to key variables from their preferred value affect the final results and how sensitive the final results are to these changes. This allows for the assessment of the strength of the BCA, including whether the results reached using the preferred set of input variables are significantly different by reasonable departures from those values. The table below summarizes the key variables which have been tested for sensitivity and the results of this analysis, using a 7 percent discount rate.

Table 4-3: Benefit Cost Analysis Sensitivity Analysis, Millions of 2018 Dollars

Sensitivity Variable	Sensitivity Factor	New BCR	New NPV
PHT Savings	Low Value (0.8)	1.53	$8.19
	High Value (1.2)	1.64	$9.94
VMT Savings	Low Value (0.8)	1.27	$4.14
	High Value (1.2)	1.90	$13.99
Capital Cost	Low Value (0.8)	1.98	$12.16
	High Value (1.2)	1.32	$5.97
O&M Cost	Low Value (0.8)	1.64	$9.95
	High Value (1.2)	1.53	$8.18

Source: WSP