

**Jacobs**

**King County Metro – South Annex Base**  
***RAISE Grant Benefit-Cost Analysis***

**April 12, 2022**



## Table of Contents

<b>Executive Summary</b> .....	<b>4</b>
<b>1. Introduction</b> .....	<b>6</b>
<b>2. Analytical Assumptions</b> .....	<b>6</b>
<b>3. Analysis Tools</b> .....	<b>8</b>
<b>4. Overview of Benefits and Costs</b> .....	<b>8</b>
<b>5. Project Benefits</b> .....	<b>9</b>
<b>6. Economic Costs Included and Assumptions</b> .....	<b>15</b>
<b>7. Key Benefit-Cost Evaluation Measures</b> .....	<b>16</b>
<b>8. Benefit-Cost Analysis Results</b> .....	<b>16</b>
<b>9. Appendix A - Benefit-Cost Analysis Detail Tables</b> .....	<b>18</b>

## Executive Summary

A benefit-cost analysis (BCA) was conducted for the South Annex Base Project for submission to the United States Department of Transportation (USDOT) as a requirement for the 2022 RAISE discretionary grant program. The analysis was conducted in accordance with the benefit-cost analysis methodology as recommended by USDOT. The BCA covers a 24-year analysis period with four (4) years of construction, including a transition year with partial benefits, and 20 years of benefits.

South Annex Base will be located on a 13-acre property owned by King County Metro (Metro) in the City of Tukwila, located at 11911 E Marginal Way S, Tukwila, WA. The site is the current home of Metro’s South Base Training and Safety Center, South Construction Office and Metro’s South Facilities. The South Base Training and Safety Center and South Construction Office will be relocated. The South Facilities will remain on site. The remainder 13 acres of the site will be redeveloped as South Annex Base. The South Annex Base will be a self-contained maintenance and operations base that will accommodate an all-electric fleet of approximately 250 battery electric buses (BEBs).

Metro’s base facilities are at capacity while long-term demand for transit service continues to rise, particularly in the South King County area. Metro has a need to increase operational and bus base capacity and a directive through the 2020 King County Strategic Climate Action Plan (SCAP) to accomplish this increase while reducing emissions. More operational capacity is needed to efficiently support near-term service demand, to support the growth and enhancement of service envisioned in the METRO CONNECTS long-range plan, to accommodate the BEBs and charging infrastructure necessary to transition to a 100 percent zero-emission fleet, as specified in the SCAP, and to keep fleet and capital assets in a state of good repair. A new South Annex Base maintenance and operations base will enable Metro to meet projected demand by accommodating approximately 250 new coaches by 2027.

The total costs for the South Annex Base Project are provided below in Table 1. Costs include capital costs, (construction, electric bus procurement, soft costs), as well as operational and maintenance costs and repair and rehabilitation estimated for the bus facility. Vehicle maintenance and operation costs are including the benefits evaluation. An offsetting residual value is included at the end of the evaluation period and are considered a benefit for the purposes of the benefit cost ratio. Capital costs are expressed in year of expenditure dollars, operation and maintenance costs are expressed in 2020 dollars.

**Table 1: South Annex Base Project Costs**

<b>Cost Category</b>	<b>Costs (2020 \$)</b>	<b>Present Value Costs (discounted at 7% to 2020)</b>
<b>Capital Costs</b>	\$ 415,252,873	\$ 297,092,464
<b>O&amp;M Costs</b>	\$ 34,652,599	\$ 10,478,355
<b>Residual Value</b>	\$ (249,151,724)	\$ (37,472,970)
<b>Total</b>	<b>\$ 200,753,748</b>	<b>\$ 270,097,849</b>

The benefits for the South Annex Base project are shown below in Table 2. The project creates \$2.5 billion in sustainability, livability, and economic benefits, over 20 years for South King County residents. When discounted at seven percent according to the USDOT guidance, the benefit value is \$932,075,872.

**Table 2: South Annex Base Project Benefits**

<b>Benefit Category</b>	<b>Benefit Type</b>	<b>Benefit Value</b>
<b>Sustainability</b>	<i>Emission Reduction CO2*</i>	\$ 28,633,646
	<i>Emission Reduction</i>	\$ 7,033,503

	<i>Facility Infrastructure Sustainability</i>	\$	2,169,559
<b>Livability</b>	<i>Quality of Life</i>	\$	1,045,679,822
	<i>Noise Reduction</i>	\$	5,056,629
<b>Economic Competitiveness</b>	<i>Deadheading</i>	\$	179,217,394
	<i>Operational Cost Savings</i>	\$	231,833,034
	<i>Job Creation</i>	\$	1,019,899,497

\* Calculated at a 3% discount rate per US DOT BCA Guidance Materials

Table 3 below shows the results for of the benefit-cost analysis, calculated at a seven percent discount rate. The analysis yields net value of \$674,907,892 and a benefit-cost ratio of 3.5.

**Table 3: Benefit-Cost Analysis Summary Results**

<b>Benefits with 7% Discount</b>	\$	932,075,872
<b>Costs with 7% Discount</b>	\$	270,097,849
<b>Net Benefits*</b>	\$	674,907,892
<b>B/C Ratio 7% Discount Rate</b>		<b>3.5</b>

\*Includes all benefits at a 7% discount rate except CO2 emissions are included at a 3% discount rate per USDOT guidance

## 1. Introduction

A benefit-cost analysis (BCA) was conducted for the South Annex Base project for submission to the United States Department of Transportation (USDOT) as a requirement for the 2021 RAISE discretionary grant program. The analysis was conducted in accordance with the benefit-cost methodology recommended by the USDOT in the Benefit-Cost Analysis Guidance and the Notice of Funding Opportunity.

## 2. Analytical Assumptions

### Discount Rates

For both project costs and benefits, the monetary values in this analysis are expressed in constant year end 2020 dollars. The real discount rate used for this analysis was seven percent<sup>1</sup> (7.0%), consistent with USDOT guidance for Discretionary Grant Programs

### Evaluation Period

The period of analysis for this benefit-cost analysis is approximately 28 years-- four years of design, four years of construction, and 20 years of benefits. This analysis period represents a conservative approach that captures major costs related to capital development, including pre-construction costs (engineering and design), construction, operations and maintenance (O&M) for the useful life of the facility and annualized rehabilitation and repair costs.

Design of South Annex Base began in 2020 and is expected to last until construction begins in 2024. Construction of South Annex Base is expected to last approximately four years. Partial service is anticipated to begin in the third quarter of 2027 with full battery electric bus service beginning in 2028. The 20-year benefit evaluation period will conclude in 2047.

### Project Region & Description

Metro has a need to increase operational and bus base capacity and implement a directive in the 2020 SCAP to increase capacity while reducing emissions. More operational capacity is needed to efficiently support near-term service demand, to support the growth and enhancement of service envisioned in the METRO CONNECTS long-range plan, to accommodate the battery-electric buses and charging infrastructure necessary to transition to a 100 percent zero-emission fleet by 2035 as specified in the SCAP, and to keep fleet and capital assets in a state of good repair.

Metro's South Base is currently operating beyond optimal capacity, risking higher costs, deteriorating service quality, and increased safety risks. Metro is unable to add new service at South Base due to lack of bus parking space and lack of maintenance capacity, challenging Metro's ability to meet growing ridership and expanded service envisioned in METRO CONNECTS. To meet a projected demand for service increases of 70 percent by 2040, Metro must increase its vehicle fleet by more than 22 percent (a total of 1,930 buses by 2050, or more than 430 buses over the 2021 fleet) and increase its service capacity by the equivalent of two to three additional maintenance and operations bases.

Metro is proposing to redevelop a Metro-owned site that is part of Metro's South Campus in the City of Tukwila. The site address is 11911 E Marginal Way S, Tukwila, Washington, (parcel no. 1023049066). The site is the current home of Metro's South Base Training and Safety Center, South Construction Office and Metro's South Facilities. The South Base Training and Safety Center and South Construction Office will be relocated. The South Facilities will remain on site. The remainder of the site will be redeveloped as South Annex Base. The South

---

<sup>1</sup> CO2 emissions are evaluated with a 3.0 % discount rate consistent with USDOT guidance

Annex Base will be a self-contained maintenance and operations base that will accommodate an all-electric fleet of approximately 250 battery electric buses (BEBs).

The project will meet the purpose and need described below:

- Metro's base facilities are at capacity while long-term demand for transit service continues to rise, particularly in the south King County area. The South Annex Base maintenance and operations base will enable Metro to meet projected demand by accommodating approximately 250 new coaches by 2027.
- Increased capacity in the system with South Annex Base will allow Metro to convert existing facilities to all electric service. It is not possible to build all-electric infrastructure on existing facilities without curtailing transit service during construction, even if demand for expansion were zero. The new base will incorporate electric charging infrastructure and allow seamless future conversion to an all-electric fleet by allowing for temporary relocation of service to South Annex Base during renovations to other bases.
- King County goals, policies, and plans prioritize the reduction of greenhouse gas emissions (e.g., Strategic Climate Action Plan) and the redress of inequities and social injustice within our communities. The South Annex Base will meet the needs expressed in the County's climate goals by building, maintaining, and operating with the highest green building and sustainable development practices consistent with King County's Green Building Ordinance (ord. no. 17709). The design goal is to achieve LEEDv4 Platinum certification or other equivalent third-party certifications. The South Annex Base will meet the needs embodied by equity and social justice by creating construction and transit jobs in south King County, by creating opportunities for the adjacent community to participate in apprenticeship programs, and by supporting increased service and access to transit. Daylighting of two branches of Riverton Creek will also enhance the natural environment for the adjacent neighborhood and contribute to Tukwila's goals for the Duwamish River.

The South Annex Base preliminary concept plan includes up to 22 bus bays for maintenance, washing and steaming, inspection,; electric charging infrastructure to support an all-electric fleet; 8,400 square feet of maintenance and administration office spaces; 7,500 square feet of parts storage; 16,500 square feet of operator spaces (break areas, locker rooms, restroom, dispatch center, and chief and superintendent offices); and miscellaneous other business functions required for base operations (safety, health and wellness, etc.). The largest occupied structure will be the new maintenance and operations building with the bus bays able to accommodate double-height vehicles, office space potentially on a second story, outdoor storage, and a basement maintenance area for access to the underside of buses.

The project also includes daylighting the west and east branches of Riverton Creek and installing three fish-passable culverts to improve fish passage and habitat. Resident cutthroat trout and coho salmon are known to occur in Riverton Creek. The two branches of Riverton Creek are currently piped underneath the site and discharge into a wetland/stream complex on the northern property boundary. Approximately 940 linear feet of Riverton Creek may be daylighted, comprising 328 linear feet of the West Branch and 612 linear feet of the East Branch. The West Branch is planned to be restored in its current alignment, and the East Branch will be realigned east of its current underground location which will add approximately 63 linear feet of stream habitat. The stream sections will be restored within confined corridors sized to allow a naturalized channel. The confined corridors are necessary to allow sufficient room for this relatively small site to fully function as a long-term bus maintenance and operations base. Approximately half an acre of riparian vegetation will be restored in addition to the stream channel restoration. The daylighting is expected to create a small net reduction in pollution-generating impervious surface, but these benefits are not quantified

### **Future Years Population and Employment Growth**

The Puget Sound Regional Council (PSRC) Planned Population Growth rate through 2050 is 1.1 percent per year and employment growth is expected to increase at 1.3 percent per year through 2050. Between 2020 and 2040 the forecasted increase in population in the Puget Sound Region is anticipated to be 26 percent resulting in a total of 5.3 million residents and the increase in employment is forecasted to be 30 percent to a total of 3.0 million jobs.

### 3. Analysis Tools

This benefit-cost analysis is supported by a detailed Microsoft Excel-based benefit-cost analysis worksheet which uses methodologies consistent with the most recent guidance provided by USDOT. The worksheet determines benefits according to three categories, Sustainability, Livability, and Economic Competitiveness

### 4. Overview of Benefits and Costs

The South Annex Base project realizes a wide range of benefits in sustainability, livability, and economic competitiveness during construction and operation. Most benefits will occur because the base will be an energy efficient maintenance and operations facility, designed to LEEDv4 Platinum-or other third-party certification standards, supporting an all-electric bus fleet. Benefits include reduced building and vehicle emissions, reduced noise, environmental enhancement, job creation, operational cost savings, and others as described below. Benefits also occur because without a new base there would be additional costs incurred to maintain an expanded diesel-hybrid bus fleet at an existing facility. Many of the benefits that occur with South Annex Base have been assigned a value and included in the benefit-cost ratio calculation. Some benefits of the new base, such as equity and environmental enhancements, have not been assigned a value and are included as non-monetized benefits of the new facility. These cost and benefits are shown below in Figure 1.

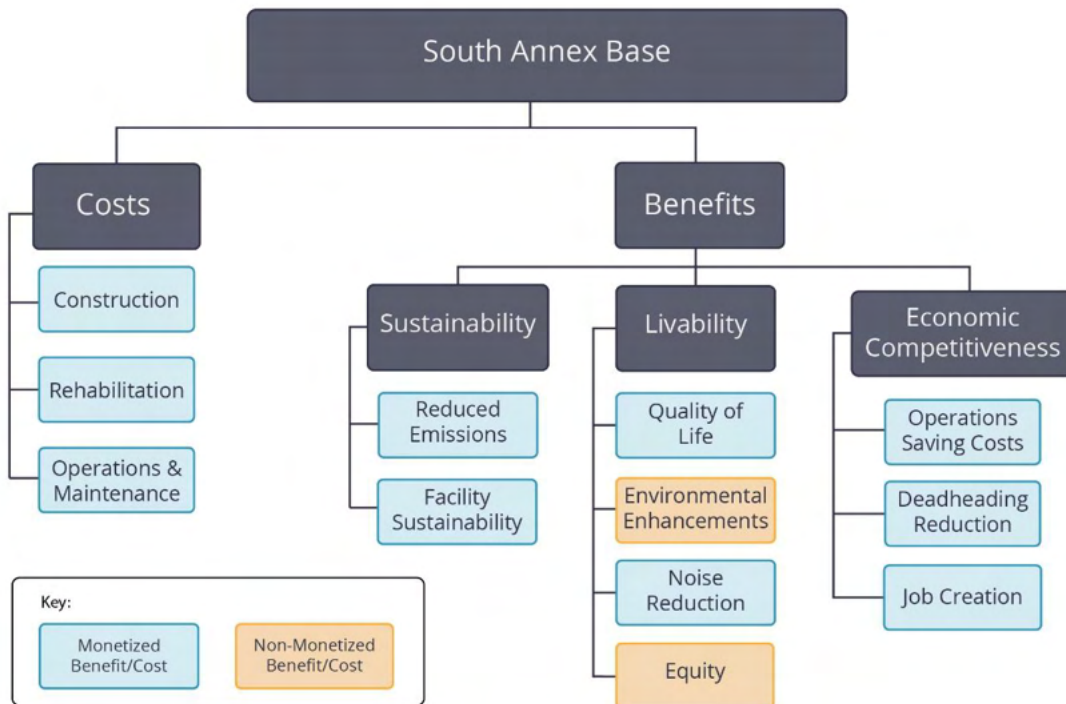


Figure 1: South Annex Base Project Benefits and Costs



## 5. Project Benefits

### Sustainability

#### Reduced Emissions

The evaluated project will operate with an all-electric bus fleet which will contribute minimal greenhouse gas (GHG) emissions from transit operations and will result in a significant decrease in GHG emissions when compared to a hybrid bus facility of similar size. A no-build scenario would result in no decrease in emissions and a likely increase to GHG emissions due to the need to run existing diesel hybrid buses more frequently to meet increasing demand, and because it would delay Metro's ability to electrify the remainder of their fleet.

Emissions are linked to increased public health risks and contributions to global climate change, among other impacts.<sup>2</sup> Reduction in emissions would translate to increased quality of life for people living in the region due to the improvement of air quality.

Emission reduction benefits were calculated by comparing the cost of emissions for a hybrid electric bus to the cost of emissions for a battery electric bus per mile driven. Battery electric buses are assumed to have brake emissions but no tailpipe emissions or upstream<sup>3</sup> emissions.<sup>4</sup> Only tailpipe emissions are calculated in the analysis. Additionally, electricity for the South Annex Base is provided by Seattle City Light. Seattle City Light has maintained a carbon neutral energy status every year since 2005;<sup>5</sup> there are, therefore, no emissions associated with electricity generation for this project.

#### Value of Reduced Emissions

Emissions reductions were calculated based on emission damage costs provided by USDOT<sup>6</sup>. Emissions data<sup>7</sup> was converted from grams per Vehicle Miles Traveled (VMT), to metric tons per VMT and then multiplied by the costs per metric ton provided by USDOT to establish a cost per VMT. The analysis multiplied that cost by an average VMT per transit bus, and then by the assumed number of buses operating out of South Annex Base. Emissions were calculated separately for each type of emission as well as for both 40-foot buses and 60-foot buses.

The Emissions Reduction benefit begins in 2028 when Metro will start running a full fleet of battery electric buses out of the South Annex Base. The emissions savings of electric buses will be over \$35 million over the 20-year analysis period.

#### Emissions and Equity

A move to a zero-emission fleet also creates an opportunity to further advance equity consistent with the King County Equity and Social Justice Strategic Plan goals. A 2017 study<sup>8</sup> showed how Metro can prioritize the deployment of zero-emission buses in areas that have both poor air quality and populations with a relatively high prevalence of respiratory and cardiac health issues who are generally less able to move or to receive treatment for these conditions.

---

<sup>2</sup> [https://www.niehs.nih.gov/research/programs/geh/climatechange/health\\_impacts/index.cfm](https://www.niehs.nih.gov/research/programs/geh/climatechange/health_impacts/index.cfm)

<sup>3</sup> Upstream emissions are defined as all GHG emissions from production and processing operations <https://www.wri.org/data/upstream-emissions-percentage-overall-lifecycle-emissions>

<sup>4</sup> King County, (2020). *King County in the Zero-Emission Battery Bus Preliminary Implementation Plan*

<sup>5</sup> <https://www.seattle.gov/city-light/energy-and-environment/environment/climate-change-and-energy>

<sup>6</sup> Appendix A: Table A-6 Damage Costs for Emissions per Metric Ton <https://www.transportation.gov/sites/dot.gov/files/2021-02/Benefit%20Cost%20Analysis%20Guidance%202021.pdf>

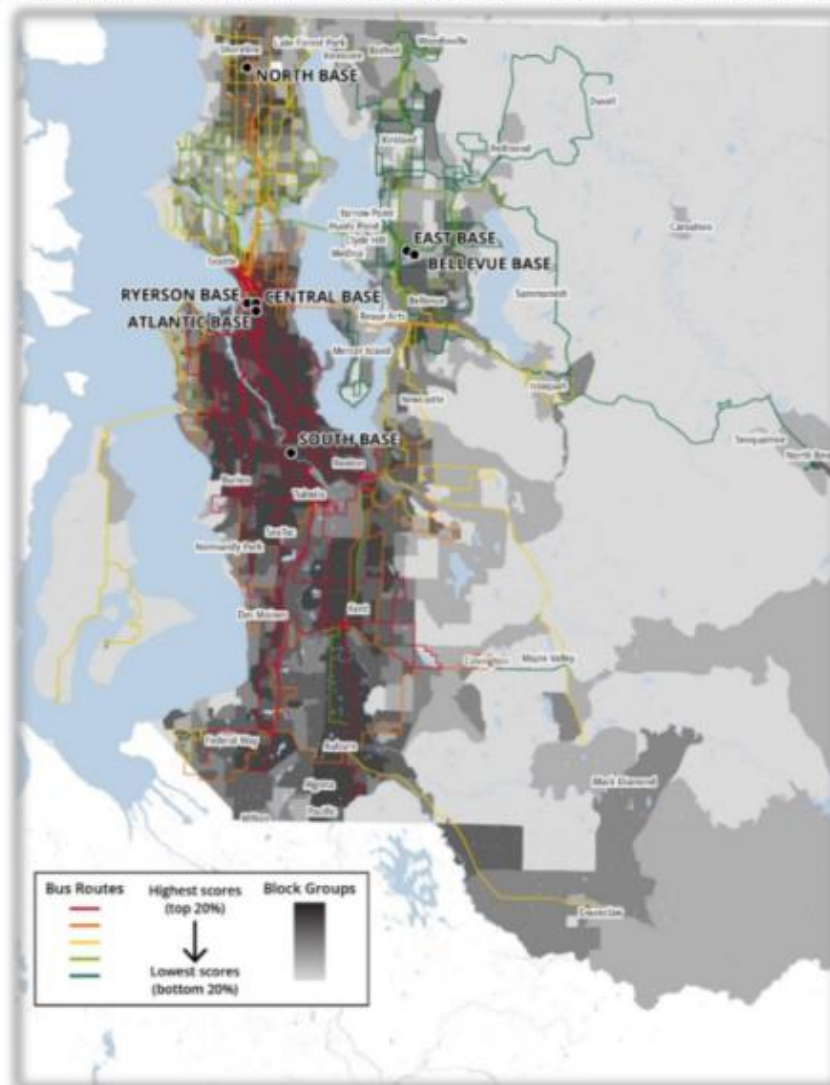
<sup>7</sup> King County, (2020). *King County in the Zero-Emission Battery Bus Preliminary Implementation Plan, Appendix F*

<sup>8</sup> King County, (2017). *Feasibility of Achieving a Carbon-Neutral or Zero Emission Fleet*

The results of this study found that deploying zero-emission buses to South Base would have the greatest positive impact on equity compared to improvements at any other base. See Figure 2, below. South Base is located at Metro's South Campus, where South Annex Base will be located. The study found the following to be true about South Base:

- South Base routes have the most daily mileage in the high priority areas identified by this analysis; 62 percent of the highest scoring route mileage originates at Metro's existing South Base, which is adjacent to the future South Annex Base site and will pickup/serve routes in the same geographic area.
- South Base routes also travel through more of the high priority areas than any other base; 31 percent of the census blocks that South Base routes travel through are considered the most vulnerable to poor air quality and other emissions related health issues.

*Darker shaded areas are more vulnerable to air pollution than the lighter shaded areas. Red bus routes are in the highest priority quintile to be served by zero-emission buses, green routes the lowest.*



**Figure 2. Highest and Lowest Scored Areas in King County by Air Pollution Vulnerability and Scored Bus Routes**

The electrification of South Annex Base will further King County's efforts to ensure Equity and Social Justice in transit planning.

### **Facility Sustainability**

The evaluated project will significantly increase the facility's sustainability compared to conventional facility designs or no-build scenarios. The South Annex Base will be built to LEEDv4 Platinum standards or other similar third-party standards, which will decrease the impact of the building on its environment compared to a conventional facility and a no-build scenario. The building will have fewer impacts associated with construction and operations compared to a conventional facility, including construction waste diversion, high efficiency building envelope and HVAC to reduce building emissions, no/low fossil fuels used for building operation, and similar measures.

The design goal to achieve LEEDv4 Platinum or other third-party certification would result in significantly reduced building emissions compared to a conventional building not built to LEED standards. Reduction in emissions would meet the needs expressed in the County's climate goals by building, maintaining, and operating with the highest green building and sustainable development practices consistent with King County's Green Building Ordinance (ord. no. 17709). Methodologies for calculating this benefit include evaluating building energy savings through improved building performance and use of on-site photovoltaic energy generation which reduces energy use from the grid.

### **Value of Facility Cost Savings**

Facility sustainability cost savings are calculated by comparing the energy usage of a conventionally built facility to the energy usage of a LEEDv4 Platinum or other similarly energy efficient facility. A baseline assumption of 3,800,000 kWh per year<sup>9</sup> for a base of this size was compared to the energy costs of a facility using photovoltaic energy generation. The cost per kWh was provided in 2020 dollars and escalated based on the commercial energy costs estimates calculated by the US Energy Information Administration (EIA). The total energy cost savings over the 20-year analysis period is over \$2 million.

### **Economic Competitiveness**

#### **Vehicle Operating Cost Savings**

The evaluated project will reduce the operating cost of the South Annex Base bus fleet due to a reduction of fuel use in comparison to current fleet operations and a reduction in vehicle maintenance costs. South Annex Base will be built to support an all-electric fleet of buses and, will be operating an all-electric fleet beginning in 2028. The project will realize immediate savings from the all battery-electric vehicles operating from South Annex Base. The methodologies used to calculate the benefit include both comparing the cost of gas needed to operate hybrid diesel buses to the cost of running battery-electric buses and comparing the average cost of vehicle maintenance for battery-electric vehicles to the average vehicle maintenance cost for a hybrid bus.

#### **Value of Operating Cost Savings**

Operational cost savings are calculated by comparing the average vehicle maintenance cost and average fuel costs/charging costs for both a hybrid bus and a battery-electric bus and subtracting the difference.

Vehicle maintenance costs for both diesel hybrid buses and battery-electric buses are provided in 2020 dollars per mile.<sup>10</sup> The average annual vehicle miles traveled<sup>11</sup> for a transit bus in the United States is provided to calculate the annual cost of vehicle operation. To account for the different costs of operating both 40-foot-long buses and 60-foot-long buses, the cost of operations are calculated separately for each type of bus and then added together to provide the full cost savings. The annual maintenance costs were then escalated with an

---

<sup>9</sup> Based on the annual energy usage for South Base, a similar sized base to South Annex Base

<sup>10</sup> King County Metro, Zero Emission Battery Electric Bus Preliminary Implementation Plan (2020), Appendix F

<sup>11</sup> Average VMT per transit bus is 43,674, US Department of Energy <https://afdc.energy.gov/data/widgets/10309>

estimated annual inflation rate based on data provided by the U.S. Bureau of Labor Statistics.<sup>12</sup> The total cost savings for vehicle maintenance is \$231 million over the 20-year time period.

Fuel and costs for the diesel hybrid buses are estimated by multiplying the cost of fueling<sup>13</sup> by the average miles per gallon<sup>14</sup> of a diesel hybrid bus. This was again multiplied by the assumed annual vehicles miles traveled to calculate the estimated annual cost. Diesel fuel costs are escalated using rates provided by the EIA.

Charging costs for the BEB are calculated by multiplying the estimated dollar per kWh<sup>15</sup> by the average kWh used per mile by a BEB to estimate the cost per mile. This was multiplied by the assumed annual vehicle miles traveled to calculate the annual cost. Charging costs are escalated using rates provided by the EIA.<sup>16</sup> The total savings in fuel costs by using BEB is over \$525,000 over the 20-year time period.

The vehicle operations savings benefit begins in 2028 when Metro will start running a full fleet of battery electric buses out of the South Annex Base. The total vehicle operating cost savings for operating BEB is approximately \$232 million over the 20-year analysis period

### Job Creation

The evaluated project will increase the number of well-paying jobs in the area, in the short term with construction-based jobs and in the long term for the maintenance and operation of the expanded fleet. An increase in family-wage jobs will benefit the local economy. As the base reaches full capacity in 2028, approximately 200 new full-time employees will need to be hired to staff South Annex Base.

In addition to the jobs created for the direct operation and maintenance of South Annex Base, this study also anticipates the impact of construction and capital improvement spending on the wider economy. The Council of Economic Advisors (CEA) within the Executive Office of the President released the most recent official estimate of the impacts of infrastructure investment on employment in 2011. This report estimated that every \$1 billion in spending would support 13,000 jobs for one year,<sup>17</sup> the equivalent of one job-year per \$76,923 spent in capital funds. These jobs include direct, indirect, and induced jobs impacted by capital spending.

- A **direct job** is the job created by the actual government expenditure and the wages are paid for from the funds for the project.
- An **indirect job** is the job created by the expenditures the suppliers make to produce the materials used for the project. The cost of this would be included in the cost of the materials.
- An **induced job** is the job created elsewhere in the economy as increases in income from the direct government spending lead to additional increases in spending by workers and firms.

The value of the jobs created by infrastructure investment was calculated by dividing the estimated cost of construction for the new base (\$284 million) by the estimated value of one job-year.

---

<sup>12</sup> 1.7% conservative estimate of average annual inflation rate based on data from US Bureau of Labor Statistics  
<https://data.bls.gov/pdq/SurveyOutputServlet>

<sup>13</sup> \$3.50 per gallon in 2024 <https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2018&region=1-0&cases=ref2018&start=2016&end=2050&f=A&linechart=~ref2018-d121317a.30-3-AEO2018.1-0~ref2018-d121317a.33-3-AEO2018.1-0&map=ref2018-d121317a.4-3-AEO2018.1-0&ctype=linechart&sourcekey=0>

<sup>14</sup> 4.00 mpg <https://www.nytimes.com/2009/10/22/automobiles/autospecial2/22BUS.html>

<sup>15</sup> \$0.10 per kWh in 2024

<sup>16</sup> .6% fuel escalation rate from EIA

<sup>17</sup> <https://www.fhwa.dot.gov/policy/otps/pubs/impacts/>

### **Value of Job Creation**

To estimate the value of the jobs created by this project, the average annual wage for King County employees<sup>18</sup> was multiplied by the number of new jobs generated by the facility to calculate the estimated annual value of the operation and maintenance jobs. This number was escalated using a 0.3 percent annual increase to represent Washington State's Office of Financial Management's (OFM's) estimated average wage increase.

To estimate the value of capital spending, the 2011 CEA value for job-years created by capital spending was adjusted to 2020 dollars using the USDOT Gross Domestic Product deflator provided in Appendix A of the USDOT BCA Guidance. The capital cost of construction was divided by this number to estimate the number of jobs created by the capital spending. These job years were multiplied by the King County average annual wage to calculate the value of jobs created.

The final benefit value for job creation is a combination of the jobs created by the increased operations and the value of jobs created by infrastructure spending, with a total value of over \$1.0 billion.

### **Deadheading**

The evaluated project will decrease the distances for deadheading as Metro expands their fleet. A 2016 study<sup>19</sup> determined that when left unconstrained, South Campus (including South Annex Base) is the closest facility to serve future routes proposed for south King County. Expanding capacity at South Campus has the impact of reducing deadheading costs for service expansion.

### **Value of Deadheading**

To calculate the deadheading savings, an estimated daily deadheading cost was calculated based on previous route modeling. The daily deadheading costs for an expansion of all existing bases, including South Base, was estimated to be \$1.12 to \$1.36 million for the whole fleet or \$587 to \$712 per bus in 2015 dollars. The median cost of daily deadheading was calculated to be \$650 per bus multiplied by 365 to calculate the annual median deadheading cost. This estimate was adjusted to 2020 dollars using the US DOT GDP deflator provided in Appendix A of the BCA Guidance. This number was multiplied by the number of buses at South Annex Base to calculate the annual median deadheading cost for 250 buses. The value of deadheading was calculated using an assumed savings rate of 10 percent, and then escalated using a conservative inflation rate of 1.7 percent with a total cost savings of over \$179 million over the 20-year horizon of the analysis.

## **Livability**

### **Quality of Life**

The proposed project will increase the quality of life in King County by increasing and expanding high quality transit availability. The Victoria Transportation Policy Institute has calculated that a high-quality transit has a benefit of \$1,575 per capita in 2015.<sup>20</sup> This calculation includes often overlooked impacts of transit on the general public such as parking cost savings, a reduction in vehicle ownership and maintenance costs, and the cost of congestion on city streets.

### **Value of Quality of Life**

To calculate the quality-of-life benefit of transit, cost per capita (\$1,575) was adjusted to 2020 dollars using the US DOT GDP deflator provided in Appendix A of the BCA Guidance. This number was multiplied by the US Census estimate for number of households in King County. A 1.1 percent growth rate was used to project the population estimate to 2047 based on population growth assumptions made in PSRC VISION 2050<sup>21</sup>. For the purposes of this analysis, high quality transit is defined as 'frequent transit'. Frequent transit is defined by Metro

---

<sup>18</sup> \$83,932 is the average annual wage for King County Employees, 2019 <https://openpayrolls.com/county/king-county-wa/2019>

<sup>19</sup> King County Metro, (2016). Countywide Bus Base Siting Analysis Memorandum

<sup>20</sup> Transit Benefits per Capita <https://www.vtqi.org/raisetaxes.pdf>

<sup>21</sup> [https://www.psrc.org/sites/default/files/2050\\_macro\\_forecast\\_web.pdf](https://www.psrc.org/sites/default/files/2050_macro_forecast_web.pdf)



as service that comes every 10 to 15 minutes and is faster and more reliable than other service types due to features such as dedicated bus lanes. A 2017 report<sup>22</sup> done by Metro found that approximately 50 percent of county residents live within a half mile radius of frequent bus service. By 2040 Metro estimates that 68 percent of its transit service will be frequent service. To estimate the number of households that might benefit the most from additional high-quality transit, the total household population was multiplied by 50 percent and then again by 68 percent. Since the South Annex Base project will represent a ten percent increase to the overall Metro Bus fleet, the quality-of-life benefit is multiplied again by ten percent to calculate the benefit of building the South Annex Base. The total benefit per capita for the 20-year span of the project is over \$1 billion.

## **Noise Reduction**

The construction of the proposed South Annex Base for all-electric fleet will reduce the noise impacts on the base and the potential noise impacts from the buses en route compared to hybrid buses. Noise from the South Annex Base bus fleet is expected to blend into background noise associated with existing roadways, and the use of battery-electric vehicles will reduce noise in neighborhoods served by bus routes compared to the use of hybrid diesel-electric vehicles. Reducing noise impacts will benefit neighborhood livability as noise has been demonstrated to increase stress levels and negatively affect quality of life.

## **Value of Noise Reduction**

To calculate the value of noise reduction, the costs per mile from noise impacts<sup>23</sup> were assigned to both a diesel hybrid bus and a BEB. The average hybrid bus emits \$.07 per VMT while the average BEB emits \$0.05 per VMT. This value was multiplied by the average VMT for a transit bus. The estimated cost of each bus type was escalated based on a conservative inflation rate of 1.7 percent. The total benefit value was calculated by subtracting the cost of the BEB from the cost of the hybrid bus. The benefit for noise reduction starts in 2028 when South Annex Base begins operating with a full electric fleet, leaving a total cost savings over the 20-year analysis period of \$5 million.

## **Environmental Enhancement Benefits**

The proposed project will significantly improve water quality in Riverton Creek and directly benefit the Duwamish River and salmonid habitat. Approximately 940 linear feet of creek will be daylighted and restored, along with approximately half an acre of riparian habitat. Environmental enhancement would improve livability and quality for local habitat as well as local residents of life by improving stream temperature through riparian habitat plant selection, stream channel design, and floodplain connectivity; increasing dissolved oxygen for the benefit of fish and stream macroinvertebrates through natural aeration processes by creating varied in-stream habitat features (riffles, pools, and similar); and decreasing pollutant loading downstream through nutrient uptake and filtration from increased interspersed with vegetated riparian buffers on site. The proposed project will also act as a catalyst for future daylighting of Riverton Creek upstream of the South Annex Base site as future land use applications are received by the City of Tukwila. The daylighting of Riverton creek was identified by the community as a high priority outcome of the development of South Annex Base during the initial public outreach phase. Environmental enhancement benefits are a recognized benefit of the project but are not monetized.

## **Equity**

The South Annex Base project will support existing service based at South Campus as well as the expanded service envisioned in METRO CONNECTS. This service directly contributes to equity and social justice goals for the South Campus service area. As discussed in the Environmental Justice Analysis<sup>24</sup>, the area immediately surrounding the project and areas of south King County in general have seen increased population diversity,

---

<sup>22</sup> <https://kingcounty.gov/~media/depts/transportation/metro/accountability/reports/2017/metro-2017-strategic-plan-progress-report.pdf>

<sup>23</sup> King County Metro, Zero Emission Battery Electric Bus Preliminary Implementation Plan (2020), Appendix F

<sup>24</sup> OTAK, (2020) South Annex Base Environmental Justice Analysis

especially of low- and middle-income populations, families of racial and ethnic minorities, and foreign-born [non-English-speaking?] residents (collectively referred to as environmental justice populations under federal Executive Order 12898--Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations).

The project will support access to new opportunities for environmental justice populations that have been underserved, including direct employment of bus operators, maintenance workers, and supervisory staff at South Annex Base, and indirectly through improved connectivity to professional, educational, and other community opportunities.

Low-income commuters disproportionately rely on public transit to get to work compared to other populations because of the high cost of car ownership; transportation costs compete against food and housing expenses in tight domestic budgets. The completion of the South Annex Base project is a critical capital improvement needed to provide expanded transit service that will support transit accessibility.

## 6. Economic Costs Included and Assumptions

### Initial Project Investment Costs

The capital costs for the South Annex Base are \$415,252,873 over the seven years of design and construction.<sup>25</sup> Capital costs are expressed in 2020 dollars. This estimate includes both construction and soft costs such as planning and design. Costs include the price to design and build the base, as well as the cost of buying 250 Battery Electric Buses.

**Table 4: Capital Costs**

<b>Project Phase</b>	<b>Cost</b>	
<b>Implementation</b>	\$	356,139,931
<b>Planning</b>	\$	1,637,783
<b>Preliminary Design</b>	\$	11,715,197
<b>Final Design</b>	\$	44,759,962
<b>Closeout</b>	\$	1,000,000
<b>Total Capital Cost (2020 \$)</b>	<b>\$</b>	<b>415,252,873</b>

### Annual Operating and Maintenance Costs

Annual operating and maintenance costs for the facility are included in the cost side of the analysis. Operating costs and maintenance costs are assumed to begin in 2028 when the base opens to full capacity. The operating and maintenance costs for vehicles are included in the benefit side of the analysis. Operation and maintenance costs estimated based on an average of the annual maintenance costs of existing Metro bases. Maintenance costs are provided below in Table 5. The total annual maintenance cost is \$850,300. Maintenance costs are escalated over the analysis period with an escalation rate of 4%. Total maintenance costs over the 20-year analysis period is \$10,478,355.

<sup>25</sup> PRODIMS Draft Cost Estimate June 3, 2021

**Table 5: Operating and Maintenance Costs**

<b>Base</b>	<b>Preventative (Maintenance)</b>	
<b>East Base</b>	\$	869,362
<b>North Base</b>	\$	926,883
<b>South Base</b>	\$	755,657
<b>Average</b>	\$	<b>850,300</b>

### **Residual Value**

South Annex Base is assumed to have a 50-year life span, after which the facility will be in need of major repairs or replacement. Year 50 of the facility operation is 2077. The analysis assumes a 20-year evaluation period ending in 2047, after which there will be approximately 30 more years of operation. This operation will produce additional benefits that are captured in the residual value calculation.

The residual value calculation is calculated by determining the percentage of useful life remaining beyond the analysis period and multiplying that percentage by the construction cost for that facility. Since this is a 20-year analysis and South Annex Base has a 50-year operational life, the residual value is 60 percent of the total cost using the straight-line depreciation method. The remaining capital value is viewed as a cost offset, or negative costs, and is applied to the last year of the analysis period as a negative value. This residual value expressed in 2020 dollars is \$249,151,724 prior to discounting.

## **7. Key Benefit-Cost Evaluation Measures**

The benefit-cost analysis converts potential gains (benefits) and losses (costs) from the project into monetary units and compares them. The following benefit-cost evaluation measure is included in this BCA.

**Benefit-Cost (B/C) Ratio:** The benefit-cost ratio calculates the discounted present value of incremental benefits divided by the discounted present value of incremental capital and R&R costs to yield the benefit-cost ratio. The B/C ratio expresses the relation of discounted benefits to discounted costs as the factor by which a project's benefits either exceed or fall short of their associated costs.

## **8. Benefit-Cost Analysis Results**

### **Results in Brief**

The results of the Benefit-Cost Analysis assume a seven percent discount rate for all benefits with the exception of the CO<sub>2</sub> benefits, which are calculated at a three percent discount rate consistent with the USDOT Guidance. It is estimated that the South Annex Base project investment yields a benefit-cost ratio of 3.5. All benefits and costs were estimated in constant 2020 dollars over an eight-year design and construction period and a 20-year evaluation period ending in 2047.

### **Benefits by Category**

Over the course of the analysis period the South Annex Base project shows a significant reduction in greenhouse gas emissions and vehicle operation costs and a significant increase in the quality of life and the economic benefit of job creation. These benefits are shown below in Table 7.



**Table 7: South Annex Base Project Benefits**

<b>Benefit Category</b>	<b>Benefit Type</b>	<b>Benefit Value</b>
<b>Sustainability</b>	<i>Emission Reduction CO2*</i>	\$ 28,633,646
	<i>Emission Reduction</i>	\$ 7,033,503
	<i>Facility Infrastructure Sustainability</i>	\$ 2,169,559
<b>Livability</b>	<i>Quality of Life</i>	\$ 1,045,679,822
	<i>Noise Reduction</i>	\$ 5,056,629
<b>Economic Competitiveness</b>	<i>Deadheading</i>	\$ 179,217,394
	<i>Operational Cost Savings</i>	\$ 231,833,034
	<i>Job Creation</i>	\$ 1,019,899,497
<b>Total Benefits</b>		<b>\$ 2,519,523,085</b>
<b>Total Benefit with 7 % discount</b>		<b>\$ 932,075,872</b>

\* Calculated at a 3% discount rate per US DOT BCA Guidance Materials

Over the 20-year analysis period there are \$2,519,523,085 in benefits assigned to this project in 2020 dollars which is discounted to \$932,075,872 with a 7 percent discount rate.

### Costs over Time

The capital construction costs for the South Annex Base are \$415,252,873 spread out over the eight years of design and construction. Capital costs are expressed in 2020 dollars and discounted at seven percent to \$297,092,464.

Operation and Maintenance dollars are expressed in 2020 dollars. The average annual maintenance cost is \$850,300. Maintenance costs are escalated over the analysis period with an escalation rate of 4%. Total maintenance costs over the 20-year analysis period is \$10,478,355.

### Residual Value

The remaining capital value of the South Annex Base facility is \$249,151,724 before applying a 7 percent discount rate. Discounted to present value terms, the residual value is \$37,472,970.

### Cumulative Benefits and Costs

The value of the project benefits exceeds the cost of the project. The project benefit exceeds the cost of the project by nearly \$675 million with a benefit-cost ratio of 3.5.

## **9. Appendix A - Benefit-Cost Analysis Detail Tables**