



## Mode Evaluation

September 28, 2017

### INTRODUCTION

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Pierce Transit is considering potential applications of high capacity transit (HCT) along the Pacific Avenue /SR 7 Corridor. An HCT Feasibility Study for the Corridor began in February 2017, with the intent of selecting a Locally Preferred Alternative (LPA) for the Corridor by spring 2018. Should the LPA be determined to be an HCT mode, the project would proceed through environmental documentation and funding applications. At that point, a decision would be made whether the project should proceed into design and construction.

This technical memorandum presents the results of the evaluation of various transit modes considered for the corridor measured against the project goals, as listed in the Purpose and Need Statement (shown below). Each mode was evaluated based on how well it advances each goal. A final tally (shown as Figure 2 on page 12) rates each mode based on its overall support of the goals.

#### **Purpose Statement**

The purpose of the Pacific Avenue S/SR 7 HCT project is to establish a north/south HCT link in the heart of Pierce County and serving Pierce Transit's busiest transit corridor. The project will:

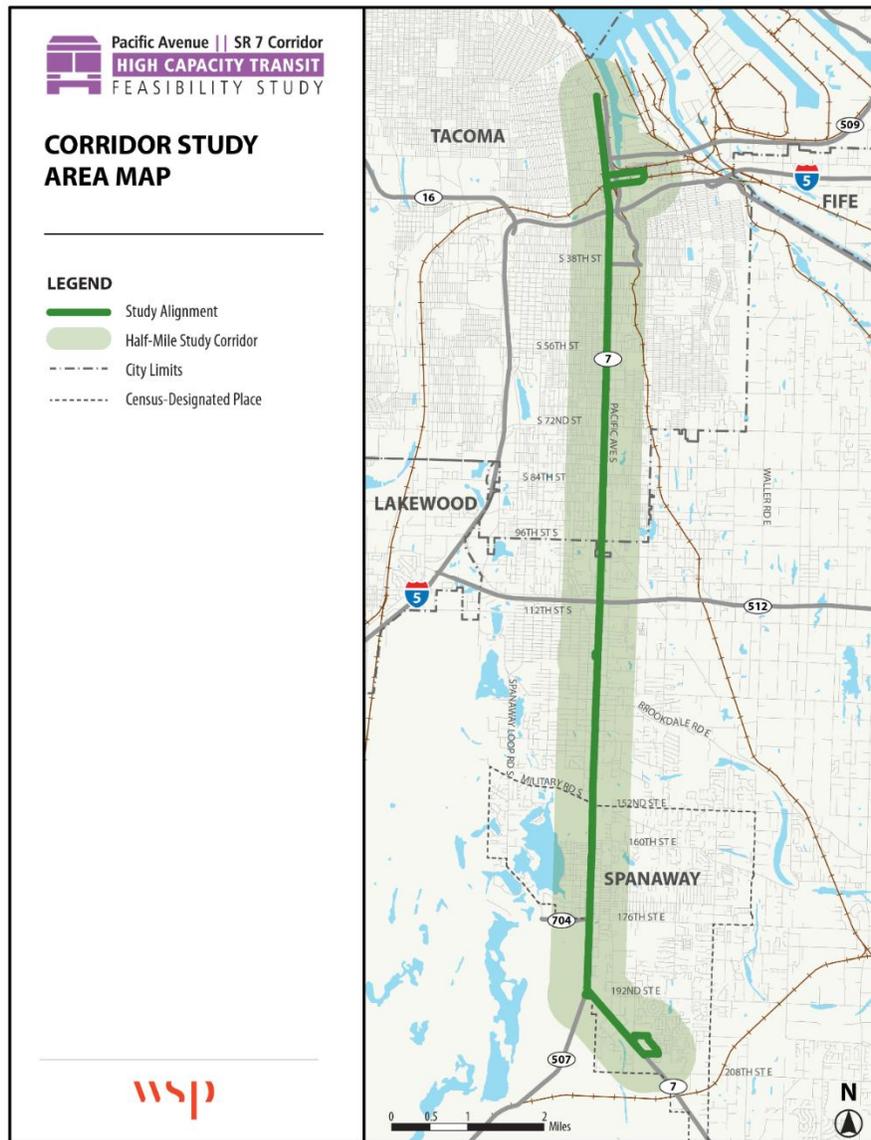
- Increase transit ridership through enhanced transit service.
- Deliver cost-effective service that provides capacity to meet future demand.
- Promote transportation equity in the corridor by ensuring that transit service is accessible to all populations.
- Improve multi-modal access and connectivity.
- Support a regional vision for the community as documented in land use and transportation plans.
- Enhance safety and security for transit patrons and public health overall.
- Support existing economic activity and be a catalyst for sustainable economic growth and corridor redevelopment.
- Promote environmental stewardship and sustainability.

# PROJECT BACKGROUND

## CORRIDOR DESCRIPTION

The Pacific Avenue /SR 7 HCT Study Corridor is a 14.4-mile segment of Pacific Avenue /SR 7 between the Commerce Street Transfer Center in Downtown Tacoma and 204<sup>th</sup> Street E in Spanaway, entirely within Pierce County (Figure 1). The Corridor is currently a segment of Route 1, which is one of Pierce Transit's four trunk routes and the highest ridership fixed route in the system. Route 1 carries almost 1.7 million passengers in 2016, which is nearly 20 percent of Pierce Transit's fixed route ridership. The segment of Route 1 in Study Corridor accounts for about two-thirds of the total Route 1 ridership. Pierce Transit's *Destination 2040 Long Range Plan*, Sound Transit's *ST3 Plan*, and Puget Sound Regional Council's (PSRC) *Transportation 2040 Long Range Plan* all identify this Corridor for potential HCT service.

Figure 1: Study Corridor and Alignment



## METHODOLOGY FOR EVALUATION

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The Purpose and Need Statement, prepared and adopted as a previous study task, identified a series of goals for the Pacific Avenue /SR 7 HCT project. A qualitative analysis was conducted to rate each mode based on how well it would achieve each goal and, thus, meet the project's purpose. This analysis used the technical expertise of the study team and their knowledge of typical applications and performance of each mode in similar corridors. They analyzed four "build" modes and a no-build ("do nothing") option, which carries forward existing Route 1 bus service into the future. Typical costs are given for each mode which represent full project costs, including vehicles. However, note that there can be outliers, both above and below the shown range, due to specific project attributes<sup>1</sup>. The "build" modes are:

- Enhanced Bus Service – improves on current service with addition of some mix of traffic signal priority, station improvements, and increased frequency. Typical capital cost per mile ranges from \$1 million to \$3 million.
- Bus Rapid Transit (BRT) – is a high-capacity bus-based transit system that generally includes some or all of the following features: unique branding, dedicated lanes, traffic signal priority, off-board fare collection, elevated platforms for level boarding, and enhanced stations (including high quality shelters, seating, real-time bus arrival information, and other passenger amenities). Typical capital cost per mile ranges from \$4 million to \$20 million.
- Streetcar – is a high-capacity fixed-rail transit system that is typically operated with single-car trains powered by overhead catenaries and more frequent stops than Light Rail Transit. Streetcar stations would be similar to BRT stations. For this analysis, Streetcar is assumed to operate in mixed-traffic or Business Access & Transit (BAT) lanes<sup>2</sup> for a large portion of the alignment. Typical capital cost per mile ranges from \$45 million to \$55 million.
- Light Rail Transit (LRT) – is a high-capacity fixed-rail transit system that typically operates in a separate right-of-way, powered by overhead catenaries, and has less frequent stops and higher travel speeds than Streetcar. LRT stations would typically be larger and more extensive than Streetcar or BRT stations and the alignment would be largely (if not entirely) separated from mixed traffic. Typical capital cost per mile ranges from \$180 million to \$200 million.

The following modes were not included in this analysis because their cost and service profiles were deemed to not advance the project goals or fit the context of the project corridor:

- Heavy Rail – is a mode of transit service defined by the American Public Transportation Association (APTA) as an electric railway system with the capacity to handle a heavy volume of traffic. Heavy rail can also be referred to as metro, subway<sup>3</sup>, rapid transit, or

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<sup>1</sup> WSP generated cost estimates based on experience with these modes in the northwest. Enhanced Bus costs were largely based on King County METRO RapidRide; Bus Rapid Transit costs based on Community Transit Swift BRT, C-TRAN Vine BRT, and LTD EmX BRT; Streetcar on Seattle Streetcar and Tacoma Link Light Rail (which functions as a streetcar); and Light Rail Transit on Sound Transit Link Light Rail.

<sup>2</sup> A type of bus lane located on the curbside that permits traffic to use it to access driveways or cross streets but not for through travel.

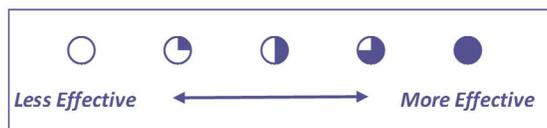
<sup>3</sup> Subway referred to an underground electric railroad.

rapid rail and is characterized by higher speed passenger rail cars that operate on fixed-rails, with separate right-of-way and high-platform boarding.

- Monorail – is an electric railway of guided transit vehicles that are suspended from, or straddle a guideway formed by a single beam.
- Personal Rapid Transit (PRT) – is a public transportation mode that features small automated vehicles operating on a network of specially built guideways.
- Electric Trolley Bus – Electric trolley buses can operate as regular fixed route service, Enhanced Bus, or BRT, with the only difference that the vehicle uses overhead wires to power electric motors. This technology has been used for many years, but more recently the preferred all-electric bus option is self-powered battery buses, especially as battery technology continues to improve. Battery propulsion is less expensive than overhead wires, and avoids the “visual clutter” created by the overhead wires.

## RESULTS OF EVALUATION

The following presents the results of the mode evaluation by each goal from the Purpose and Need Statement. Each mode is rated by how well it advances that goal. The ratings are presented using the following system:



### GOAL 1

*The project will increase transit ridership by reducing transit travel time, improving trip reliability, increasing service frequency, and enhancing transit’s comfort, convenience, and image.*

Results:

No Build (Current Service)	Enhanced Bus	Bus Rapid Transit	Streetcar	Light Rail Transit
1	3	4	4	5

Justification: LRT is a very comfortable and popular transit mode, which would improve the image of transit along this corridor.<sup>4</sup> Because of these reasons, LRT is most likely to meet this goal. Streetcar and BRT also represent large improvements over existing service, reducing transit travel time, improving trip reliability, and increasing service frequency, but not to the same degree as LRT.

<sup>4</sup> A 2009 study conducted by the United States Department of Transportation (USDOT) and the Federal Transit Administration (FTA) Office of Research, Demonstration and Innovation, “*Quantifying the Importance of Image and Perception to Bus Rapid Transit*,” found that as was expected, higher investment transit, such as LRT, was more attractive to riders than bus modes. However, BRT was seen as more attractive than traditional bus, particularly as the service is closer in profile to rail modes (including improved reliability and enhanced stations).

## GOAL 2

*The project will provide cost-effective transit service in the Study Corridor.*

Results:

No Build (Current Service)	Enhanced Bus	Bus Rapid Transit	Streetcar	Light Rail Transit
4	4	4	2	1

Justification: Typical capital costs for each HCT mode evaluated are shown in Table 1. These costs represent full project capital costs (including vehicles); however, there are cases where projects cost either more or less than what is shown here due to specific attributes of those projects. Regarding cost-effectiveness, while the rail projects (LRT and Streetcar) could result in higher ridership as compared to the bus modes, they are also disproportionately costlier than bus options in terms of capital infrastructure and potential right-of-way needs. Hence, any increased ridership from these modes in comparison to Enhanced Bus or BRT would not offset the higher costs. Because of the nature of some of the BRT upgrades, particularly at stations, there would likely be a higher cost associated with this mode than with an Enhanced or existing bus service. However, the potential for increased ridership typically makes BRT as, if not more, cost effective compared to current service.

Table 1: Typical HCT Capital Costs by Mode<sup>5</sup>

HCT Mode	Typical Cost (\$Million/Mile)
Enhanced Bus	\$1-\$3
Bus Rapid Transit	\$4-\$20
Streetcar	\$45-\$55
Light Rail	\$180-\$200

## GOAL 3

*The project will increase transit capacity to meet current and projected transit travel demand.*

Results:

No Build (Current Service)	Enhanced Bus	Bus Rapid Transit	Streetcar	Light Rail Transit
1	3	4	4	5

Justification: LRT has the highest capacity, speed and reliability of all the modes assessed.<sup>6</sup> Streetcar and BRT have similar capacities.<sup>7</sup> Maintaining just the current fixed route service would not increase capacity.

<sup>5</sup> Capital costs including vehicles.

<sup>6</sup> Washington Metropolitan Area Transit Authority (Metro) provides guidance on typical capacity and stop frequency of the various transit modes reviewed (<https://planitmetro.com/2014/05/14/how-do-different-modes-compare/>):

- Light Rail – 3,600 passengers per hour, 0.75-1.5 mile average stop spacing
- Streetcar – 1,200 passengers per hour, 0.5 mile average stop spacing
- Bus Rapid Transit – 1,900-2,100 passengers per hour, 0.5 mile average stop spacing
- Enhanced Bus – 1,200-1,400 passengers per hour, 0.25-0.5 mile average stop spacing

<sup>7</sup> Based on Washington Metro study. (<https://planitmetro.com/2014/05/14/how-do-different-modes-compare/>)

## Goal 4

*The transit service will be accessible to all populations, including minorities, people with low income levels, and those that are transit dependent.*

Results:

No Build (Current Service)	Enhanced Bus	Bus Rapid Transit	Streetcar	Light Rail Transit
5	5	4	4	3

Justification: Because of the frequent stop spacing of the existing service, as well as the Enhanced Bus option, the existing service profile is the most accessible to all populations, including those that are most transit dependent.<sup>8</sup> Streetcar and BRT rate slightly lower due to anticipated longer distances between stations, while LRT would be the least accessible due to even longer distances between stations. However, BRT, Streetcar, and LRT have improved accessibility at transit stops due to raised platforms and level boarding.

## GOAL 5

*The project will promote environmental stewardship and sustainability by reducing greenhouse gas emissions and supporting smart growth.*

Results:

No Build (Current Service)	Enhanced Bus	Bus Rapid Transit	Streetcar	Light Rail Transit
1	3	4	5	5

Justification: The two rail modes rate highest for this measure due to their electric power, as well as the potential to facilitate transit-oriented growth around stations and increase ridership, hence reducing travel by automobile. The BRT mode rates relatively high because of the potential for transit-oriented growth or infill around BRT stations, as well as the fact that electric BRT vehicles are a possibility for this route.<sup>9</sup> Enhanced Bus service has the potential to promote environmental stewardship by making transit a more attractive option, thereby reducing motor vehicle mode share from the current condition.

<sup>8</sup> Local experience as well as research from Washington Metro (<https://planitmetro.com/2014/05/14/how-do-different-modes-compare/>) provides guidance on typical stop spacing. Stop spacing was used as a proxy for how many people would be within a close distance of a transit stop. Although service might not be as frequent or reliable, closer stop spacing such as that on a standard bus provides a more accessible transit stop to a great geographic area.

<sup>9</sup> Albuquerque recently announced its plan to utilize electric buses for its ART line that opens in Fall 2017. (<https://www.cabq.gov/transit/news/albuquerque-rapid-transit-art-announces-plan-for-electric-buses>).

### GOAL 6

*The project will improve access to the Study Corridor transit service for pedestrians and bicyclists.*

Results:

No Build (Current Service)	Enhanced Bus	Bus Rapid Transit	Streetcar	Light Rail Transit
1	3	4	4	3

Justification: While Goal 4 refers transit service coverage, Goal 6 refers specifically to infrastructure changes that improve access for pedestrians and bicyclists. All “build” modes have the potential to include enhanced access to transit improvements near stops/stations in the corridor. Improvements are expected to be most notable for facilities directly accessing transit stations. Therefore, LRT rates slightly lower than Streetcar or BRT because it is expected that there would be fewer stations in the corridor, and Enhanced Bus rates lower because bus stops are not expected to be improved to the station level.

### GOAL 7

*The project will provide improved connections with other local or regional travel modes.*

Results:

No Build (Current Service)	Enhanced Bus	Bus Rapid Transit	Streetcar	Light Rail Transit
1	3	5	5	4

Justification: All build modes would likely serve the Tacoma Dome Station and the existing Sound Transit Commuter Rail, Regional Express Bus, and the Tacoma Link Light Rail service. Streetcar and BRT are rated the highest because of their ability to serve a large number of riders as well as improved speed and reliability from standard bus service. LRT is rated slightly lower than Streetcar and BRT because of the expected distance between stations that may make it necessary for many riders in the corridor to take local transit to access it. While Enhanced Bus will be a more attractive option to riders, speed and reliability are not expected to be as improved as with the other modes, making connections to other modes a less attractive option.

### GOAL 8

*The project will have a high likelihood of funding through identified grant programs and new funding sources.*

Results:

No Build (Current Service)	Enhanced Bus	Bus Rapid Transit	Streetcar	Light Rail Transit
1	2	4	3	2

Justification: BRT rates highest in this category because it is expected to score well on the Federal Transit Administration (FTA) Small Starts program rating criteria, particularly on the cost effectiveness rating and the local financial capacity rating. LRT and Streetcar rate lower because of their expected high capital costs and anticipated low ratings for cost-effectiveness, as well as the costs to operate and maintain them (Note: LRT rates lower than Streetcar because it is not likely to compete well for funding from the FTA New Starts program). However, the two rail modes would likely rate similarly high to BRT on the two FTA Small Starts land use measures. Enhanced Bus would not likely score well on the FTA Small Starts rating criteria because of its smaller expected benefit and the potential that, depending on its eventual design elements, would not meet the minimum qualifications for the FTA Small Starts Program.

## GOAL 9

*Enhance safety and security for transit patrons and public health overall.*

Results:

No Build (Current Service)	Enhanced Bus	Bus Rapid Transit	Streetcar	Light Rail Transit
1	3	4	4	4

Justification: All “build” modes are expected to result in increased transit ridership, which, when paired with walking or bicycling to access transit, could lead to better overall health. Improving access to transit facilities will also contribute to a safer environment for transit riders. The greatest differentiation from a safety and security standpoint can be expected at the transit stations. The two rail modes and BRT would include the most investment in stations, design elements that discourage crime through increased visibility (e.g., well lit, eliminating places to hide), and by “activating” the bus stop locations through increased usage and activity.<sup>10</sup> Therefore, they can result in more security for the transit rider as compared to the bus stops existing today. Enhanced Bus service would include some of these upgrades to stops, but not at as high of a level as these other HCT modes.

## GOAL 10

*The project will support planned local and regional growth and corridor revitalization efforts.*

Results:

No Build (Current Service)	Enhanced Bus	Bus Rapid Transit	Streetcar	Light Rail Transit
2	3	4	4	5

Justification: While all improved transit modes will support growth in the corridor, Enhanced Bus is expected to support it the least because it is not viewed as being as “permanent” as the other modes. LRT is often a strong catalyst for development and would create the most opportunities for transit-oriented

<sup>10</sup> According to the Institute of Urban and Regional Development at the University of California at Berkeley (“Bus Rapid Transit [BRT]: An Efficient and Competitive Mode of Public Transport”), there is increasing evidence that creating pedestrian friendly environments near BRT stations can lead to denser development and higher levels of “activation” nearby.

development around stations.<sup>11</sup> However, LRT construction and right-of-way requirements could also disrupt businesses. The Streetcar mode has similar issues in terms of disruption during construction, and stations do not generally invite the level of development that LRT stations do. Similar to Streetcar, BRT stations and service do not generally support the same level of redevelopment and growth as LRT stations; because, unlike fixed-guideway transit, a bus can more easily be rerouted in the future. Investing more significantly in the BRT stations can demonstrate a permanent commitment to the corridor and might therefore invite more development. Enhanced Bus would support some level of growth and revitalization by improving mobility in the corridor, but would not be seen as a permanent transit option and therefore would generate less interest in transit-oriented development.<sup>12</sup>

## GOAL 11

*The project will be consistent with adopted local and regional transportation plans.*

Results:

No Build (Current Service)	Enhanced Bus	Bus Rapid Transit	Streetcar	Light Rail Transit
1	4	5	1	1

Justification: The Sound Transit ST3 System Plan calls for "Bus capital improvements for speed, reliability and convenience" in this corridor, while the PSRC Long Range Plan (Transportation 2040) calls for "BRT and transit supportive infrastructure," and all scenarios considered in the Pierce Transit Long Range Plan (Destination 2040) assume enhanced bus or BRT along Pacific Avenue/SR 7. The BRT mode is consistent with all of these plans, while the Enhanced Bus mode is consistent with most. The other modes are not consistent with these plans and therefore have the lowest rating.

## GOAL 12

*The project will minimize adverse impacts to other travel modes and adjacent property.*

Results:

No Build (Current Service)	Enhanced Bus	Bus Rapid Transit	Streetcar	Light Rail Transit
5	5	3	2	2

Justification: Rail projects will cause traffic conflicts (if in road) or major right-of-way issues (if in separate right-of-way). BRT may have some right-of-way impacts and possible traffic impacts if stopping in-lane.<sup>13</sup> Enhanced Bus and Current Service have minimal impact to other travel modes and adjacent properties.

<sup>11</sup> In a study on from the University of Minnesota, they found that the new Green Line being built through Minneapolis spurred the number of building permits by 30 percent when full funding was awarded (<http://www.cts.umn.edu/Publications/catalyst/2014/july/lrt>).

<sup>12</sup> In a white paper on the issues of Bus Rapid Transit, the FTA suggests that while an enhanced bus service is acceptable, for economic development purposes, BRT system will likely bring more development due to a variety of permanent infrastructure improvements (<https://www.transit.dot.gov/sites/fta.dot.gov/files/issues.pdf>).

<sup>13</sup> NACTO recommends some right of way improvements, such as queue jumping lanes, but there is not a strict requirement for fully dedicated right-of-way, such as exists with light rail ([https://nacto.org/docs/usdg/service\\_design\\_guidelines\\_vta.pdf](https://nacto.org/docs/usdg/service_design_guidelines_vta.pdf)).

## PARTNER AGENCY AND PUBLIC COMMENT

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A project Technical Advisory Committee (TAC) composed of partnering agency staff from the City of Tacoma, Pierce County, Pierce Transit, Puget Sound Regional Council, Sound Transit, and the Washington Department of Transportation, discussed the mode evaluation at a meeting on August 23, 2017, and supported BRT as the mode that best meets the project goals.

The mode options were presented at a series of four open houses held at various locations along the Pacific Avenue/SR 7 corridor in mid-September, 2017. The public was provided cost and operational information about each mode, and asked which mode best met the project goals.

A total of 34 people “voted” on this issues, and the percentage of their votes was as follows:

No-Build	0%
Enhanced Bus	19%
BRT	72%
Streetcar	9%
Light Rail	0%

## RECOMMENDATION

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A summary of the mode evaluation ratings is contained in LRT scored lower in the ratings due to larger stop spacing, greater property impacts, and very high capital costs. Streetcar has a higher capital cost than BRT while offering similar benefits in speed and reliability. The No-Build (Current Service) option will be carried forward through to the selection of a Locally Preferred Alternative. No-Build provides a baseline from which other options can be compared.

*Figure 2* on the following page. Based on this analysis, as well as the partnering agency and public or stakeholder input, the project team recommends BRT as the high capacity transit mode that best meets the project goals. The BRT mode rated either a “5” or “4” for 11 out of the 12 goals.

Using the numeric results of the analysis (i.e., converting the moon symbols to numbers (where “5” = “5” and “1” = “1”), the BRT mode has a total score of 49 and an average score of 4.1, which was significantly higher than the next closest modes (3.5 for Streetcar and 3.4 Enhanced Bus). It should be noted that this average score assumes that all the criteria carry the same weight or importance, which is unlikely to be the case.

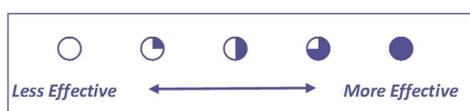
BRT has been previously assumed to be the best mode for this corridor and this analysis supports that assumption. BRT is the most appropriate mode given the current and expected level of ridership and best meets the nexus of existing land use and population distribution with the goals for improved transit speed and reliability and future investment along the corridor. Enhanced stations will improve the passenger experience with transit in this corridor, and increased stop spacing and other corridor upgrades will improve transit speed and reliability as compared to the existing service. Additionally, while stop spacing will be increased from the existing service, BRT still offers an access profile that fits the context of the existing land use and population distribution.

Enhanced Bus scored a “5”, “4”, or “3” for 11 out of the 12 goals, which indicates that the mode generally supports the project goals. There are relatively minor differences between a simplified BRT line that operates in mixed traffic and an Enhanced Bus option. Given the relatively good rating of Enhanced Bus, the recommendation is to consider a simplified, mixed traffic BRT in developing the design options. This would, in essence, carry forward an Enhanced Bus option, but defines that mode option in a manner that makes it eligible for FTA Small Starts funding. Advancing a mixed-traffic BRT option will provide a lower cost “build” alternative to compare to some higher cost, more comprehensive BRT options.

LRT scored lower in the ratings due to larger stop spacing, greater property impacts, and very high capital costs. Streetcar has a higher capital cost than BRT while offering similar benefits in speed and reliability. The No-Build (Current Service) option will be carried forward through to the selection of a Locally Preferred Alternative. No-Build provides a baseline from which other options can be compared.

Figure 2: Results of Modal Evaluation

Purpose and Need Goals		No Build (Current Service)	Enhanced Bus	Bus Rapid Transit	Streetcar	Light Rail Transit
1	The project will increase transit ridership by reducing transit travel time, improving trip reliability, increasing service frequency, and enhancing transit’s comfort, convenience and image.	1	3	4	4	5
2	The project will provide cost-effective transit service in the Study Corridor.	4	4	4	2	1
3	The project will increase transit capacity to meet current and projected transit travel demand.	1	3	4	4	5
4	The transit service will be accessible to all populations, including minorities, people with low income levels, and those that are transit dependent.	5	5	4	4	3
5	The project will promote environmental stewardship and sustainability by reducing greenhouse gas emissions and supporting smart growth.	1	3	4	5	5
6	The project will improve access to the Study Corridor transit service for pedestrians and bicyclists.	1	3	4	4	3
7	The project will provide improved connections with other local or regional travel modes.	1	3	5	5	4
8	The project will have a high likelihood of funding through identified grant programs and new funding sources.	1	2	4	3	2
9	Enhance safety and security for transit patrons and public health overall.	1	3	4	4	4
10	The project will support planned local and regional growth and corridor revitalization efforts	2	3	4	4	5
11	The project will be consistent with adopted local and regional transportation plans.	1	4	5	1	1
12	The project will minimize adverse impacts to other travel modes and adjacent property.	5	5	3	2	2
Total Score:		24	41	49	42	40
Average Score by Goal:		2.1	3.4	4.1	3.5	3.3



Note: Average score calculated by assigning numerical values as follows: 1 = 1 point; 2 = 2 points; 3 = 3 points; 4 = 4 points; 5 = 5 points.