Pacific Avenue || SR 7 Corridor

HIGH CAPACITY TRANSIT

FEASIBILITY STUDY

Service Alternatives Evaluation

October 12, 2017

FINAL

Prepared for:

PIERCE TRANSIT

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WSP

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Table of Contents

List of Figures

List of Tables

Blank Page

1 INTRODUCTION

Pierce Transit is studying the feasibility of high capacity transit (HCT) along the Pacific Avenue/SR 7 Corridor. The study began in February 2017 with the intent of selecting a Locally Preferred Alternative (LPA) for the Corridor by spring 2018. If a HCT mode is determined to be the final LPA, the project will move forward with environmental documentation and funding applications, and finally into design and construction, with a goal of implementing revenue service by the end of calendar year 2022.

This technical report presents the results from a service alternatives evaluation. It was created with the intent to study and assess potential service options for a new HCT line. A final score rates each service alternative based on their overall support of the goals as described in the Purpose and Need Statement.

Based on the recommendations from the Mode Evaluation Report, plus previous studies and planning efforts, it is assumed in this analysis that the HCT mode will be Bus Rapid Transit (BRT). In the unlikely event that a different HCT mode is selected for this corridor, some of this analysis will need to be redone.

2 ALTERNATIVES CONSIDERED

Four service plan alternatives were evaluated. They are differentiated by stop spacing, service frequency, and whether the new service will replace or enhance existing fixed route bus service. The four alternatives are described below:

2.1 ALTERNATIVE 1A

This alternative is BRT service operating in combination with reduced local bus service. The new BRT line runs from downtown Tacoma to 204th Street E in Spanaway, with station spacing of approximately 1/2 to 1 mile. Existing bus service (Route 1) continues to operate, but headways are reduced to 30 minutes during weekday daytimes. Service on the Route 1 outside the study corridor remains at 15-minute headways, resulting in every other trip terminating in downtown Tacoma. BRT service runs at 15-minute headways for at least 14 hours per weekday (e.g., 6:00 a.m. to 8:00 p.m.).

2.2 ALTERNATIVE 1B

Alternative 1b is the same as Alternative 1a, except that the BRT service operates at 10-minute headways during peak periods and 20-minute headways during off-peak periods. Service on the Route 1 outside the study corridor remains at 15-minute headways, resulting in every other trip terminating in downtown Tacoma. Peak periods are assumed to operate generally from 6:00 to 9:00 a.m. and from 3:00 to 6:00 p.m.

2.3 ALTERNATIVE 2A

This alternative is for BRT service that replaces the local service within the corridor. The new BRT line runs from downtown Tacoma to 204th Street E in Spanaway, with station spacing of approximately 1/3- mile. Existing bus service (Route 1) is replaced in its entirety within the corridor by the new BRT service. BRT service runs at 15-minute headways for at least 14 hours per weekday.

2.4 Alternative 2b

Alternative 2b is the same as Alternative 2a, except that the BRT service operates at 10-minute headways during peak periods and 20-minute headways during off-peak periods. Peak periods are assumed to operate generally from 6:00 to 9:00 a.m. and from 3:00 to 6:00 p.m.

3 Evaluation

3.1 Ridership Estimates

3.1.1 Methodology

Sketch-level ridership estimates were developed using the Regional Transit Ridership Forecasting Model developed by WSP for Sound Transit. The estimates developed at this phase are for comparative purposes only, in order to help differentiate between service plan alternatives. The current 2040 Puget Sound Region Incremental Transit Ridership Model used to develop the estimates assumed that the entire ST3 System Plan would be in place. This allows for the full potential of the BRT service to be reflected in terms of transfers to and from Tacoma Link light rail at Tacoma Dome Station.

3.1.2 Results

Results from the ridership estimates are shown in Figure 1 below. Operating speeds for the BRT system with fewer stops (Alternatives 1a and 1b) had a slightly faster travel times due to fewer stops. As shown in the figure, Alternatives 1a and 1b include ridership for both the new BRT service and the Route 1 service, which is assumed to continue to operate at a lower frequency than today. Alternative 1b, with BRT operating with 10-minute headways during peak periods and 20-minute headways during the off-peak, shows the highest ridership among the four alternatives. Alternative 1a shows slightly lower ridership with 15-minute headways. Ratings based on the ridership estimates are shown in Table 1. Alternatives 2A and 2B show higher ridership on the BRT service than Alternatives 1a and 1b, but lower overall ridership.

Figure 1: Relative Estimated Ridership

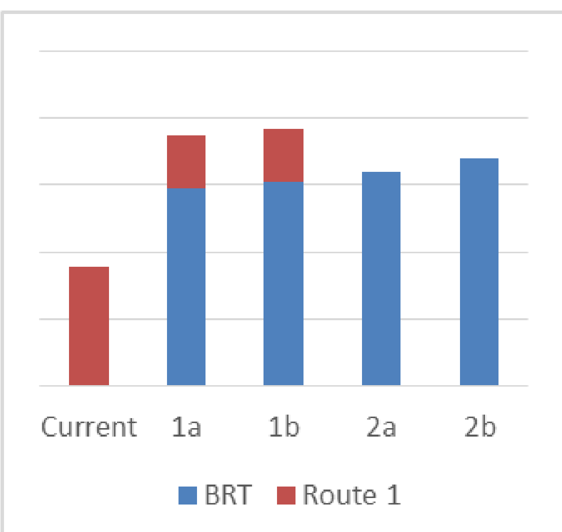


Table 1: Ratings for Ridership Estimates

Alternative	Rating
1a	4
1b	5
2a	2
2b	3

3.2 Operating Costs

3.2.1 Methodology

Estimated operating costs for the service alternatives were based to a large extent on Pierce Transit's current operating costs. It is appropriate to use per-hour cost for Pierce Transit's current fixed route service as the basis for the BRT service since the most significant cost factor, transit operators' wages, are the same for BRT as for conventional fixed route service. There are, however, some costs that are specific to BRT service that must be added to determine overall BRT operating costs. These are:

- Station cleaning, maintenance, and utility costs. While Pierce Transit has stations and shelters in its current system, the propensity of stations on the BRT line (every stop) must be taken into consideration. Costs in this category include routine cleaning of the stations (one full cleaning and one "quick clean" per week), station maintenance, and utility costs for lighting and other station amenities that require electrical power.

- Fare enforcement. Assuming that the BRT service will have an off-board fare system using ticket vending machines (TVMs) or ORCA card readers on each platform, there will be a need to have fare enforcement officers randomly check fare payment. Pierce Transit is assuming that their current security personnel will also carry out fare enforcement responsibilities, so there will be a need to add to this staff. One common standard is to have fare checking on 10 percent of revenue service hours. That would equate to approximately three fare inspectors (FTEs) for the Pacific Avenue/SR 7 HCT corridor.

- Fare collection. Another aspect of off-board fare collection is the need to periodically collect the money in the Ticket Vending Machines (TVMs) at each station platform. This is often contracted service. The cost for this assumed a biweekly fare collection.

- TVM servicing and maintenance. The TVMs require ongoing servicing and maintenance.

- Real-Time Passenger Information Maintenance. It is anticipated that the BRT platforms will have information displays indicating "real-time" arrival times for buses based on their location in the system (not based on their schedule). These displays will require ongoing maintenance and servicing.

- Articulated coaches. The BRT service would likely use articulated coaches, which are 60-foot long buses with three axles that "bend" around corners. While articulated buses are also used in conventional fixed route service, Pierce Transit does not have any articulated coaches in their current fleet (though they do maintain some Sound Transit articulated buses for regional express service). Articulated buses generally have a somewhat higher per-mile operating cost than the typical 40-foot transit bus, due to greater fuel usage and the need to maintain the articulated joint. For this analysis, it is assumed that the articulated coaches add 10 percent to the average Pierce Transit operating cost per service hour. This is based on experience from other agencies that operate both 40-foot buses and articulated buses.

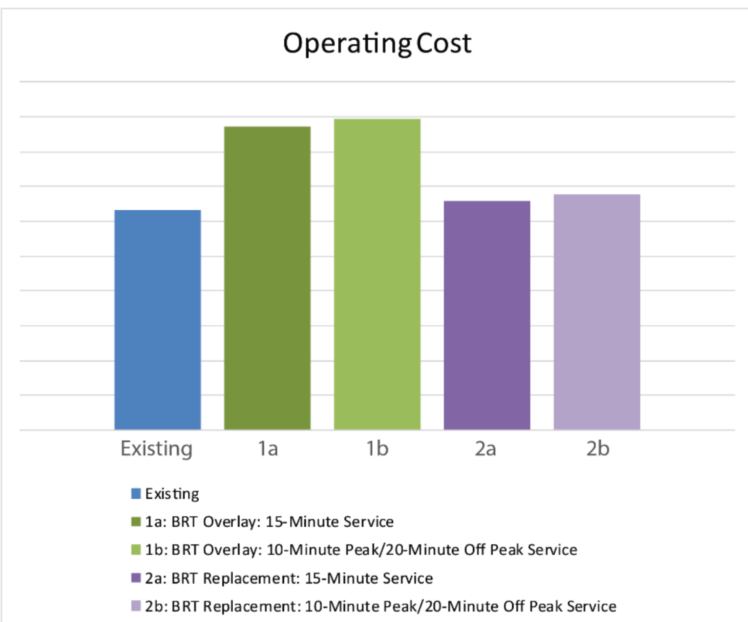
Estimates for the BRT-specific costs are based on typical costs from current BRT systems in the northwest, including Lane Transit District's EmX, C-TRAN's The Vine, and Community Transit's Swift.

Data for the current service are based on actual hours provided by Pierce Transit. Estimates of revenue service hours for the service options are generated by the Regional Transit Ridership Forecasting Model. Since a high-level model is being used at this point, the service hours output by the model need to be considered preliminary. While the absolute numbers may change, the relative differences between the service options should be reasonably accurate. Caution should be used in comparing the service options to current service since the current service is based on actual service hours and not a model estimate.

Revenue hours from the model were adjusted to service hours (which includes non-revenue time spent for items such as layovers and travel to and from the garage or base) based on the ratio of revenue hours to service hours of the current Route 1. The operating cost was calculated by multiplying the service hours by the per service hour cost for each service type and then adding the additional costs for non-service BRT costs, as itemized above.

3.2.2 Results

Figure 2: Relative Estimated Operating Costs for Service Options



The BRT overlay options (Alternatives 1a and 1b), which include continued local service, are, as expected, more expensive to operate than the BRT replacement options, which do not have underlying local service. There is little difference in operating cost between the BRT options that provide 15-minute weekday service operating 14 hours per weekday from those that provide 10-minute peak (six hours per weekday) and 20-minute off-peak service.

Based on this preliminary analysis, it appears that the BRT replacement options have similar operating costs to the existing service. This would indicate that the additional BRT non-service costs (e.g., station maintenance, fare collection and enforcement, etc.) are largely offset by the shorter BRT travel times which allow a given level of service to be operated with fewer buses and drivers. BRT overlay options would result in additional operating cost compared to existing fixed route service.

Based on this information, the following ratings have been assigned:

Table 2: Ratings for Operating Cost

Alternative	Rating
1a	2
1b	2
2a	4
2b	4

3.3 Access

3.3.1 Methodology

Access was determined by several factors: the total number of stations that would be constructed with a new BRT line, the estimated spacing between the new BRT stations, and the potential for bicycle and pedestrian connections and improvements to those stops. The following assumptions were used to create this methodology:

1. A new BRT line combined with existing local bus service (Route 1) would have BRT stations spaced farther apart (up to one mile apart, comparted to 1/3-mile BRT station spacing for the replacement options), but would retain current local bus stops. This option, called a BRT overlay, would result in more transit stops than there are currently along the corridor. Fewer BRT stations, however, would also lead to fewer bicycle and pedestrian improvements.
2. A new BRT line that completely replaces the existing local bus service (Route 1) would have more HCT stations spaced closer together than the BRT overlay option described above. All existing local bus stops, however, would be removed, which means that there would be fewer total transit stops along the corridor. More BRT stations can also lead to the possibility of additional bicycle and pedestrian amenities. For example, the Central Loop Bus Rapid Transit project in Chicago took the opportunity to develop bus island shelters for each BRT station with a protected bicycle lane running behind it. Other BRT projects such as Albuquerque's ART bus rapid transit project brought sidewalk improvements along the entire corridor giving pedestrians more space to walk.
3. A single headway at 15 minutes all day provides better and more stable access for transit dependent and low income riders than does a variable peak/off-peak head way of 10 – 20 minutes.

To quantify some of these data points, a map was created to highlight the effect of removing existing local bus stop access, as would occur under Alternatives 2a and 2b (Figure 3). Along the route corridor from downtown Tacoma to Spanaway, hypothetical stations were placed every 1/3-mile and given a 500-foot buffer around each to account for some variability in station placement. Using existing northbound and southbound Route 1 average boarding data, an estimate of how many current local bus stops were captured within each 1/3-mile buffered HCT station. A similar map was not created for alternatives that continued local existing service as that access potential would not be affected.

The results of the analysis show that the BRT replacement options with stations every $^{1}/_{3}$ mile would capture 56 percent of all current local bus stops. It would capture 58 percent of stops with an average of 30 people per boarding and 67 percent of stops with an average of 100 people per boarding. Analysis showed that the new HCT line could capture more stations with an average of 30 or more people per boarding by concentrating stations in the downtown Tacoma area.

It is important to note that while this analysis does show that there will be some local bus stops (Route 1) that are not captured by the new HCT stations. It also is not accounting for whether riders would be willing to walk the extra distance to their nearest HCT station. Research does show that riders are generally willing to walk anywhere from 1/4 to 1/3 of a mile to their nearest bus stop. Longer distances for higher quality transit modes and for commute versus non-commute trip types. In addition, the stop placement used in this analysis is very preliminary. A walkshed analysis would look more deeply into this issue. Actual bus stop placement would look closely at specific activity centers and the current stop usage along the corridor.

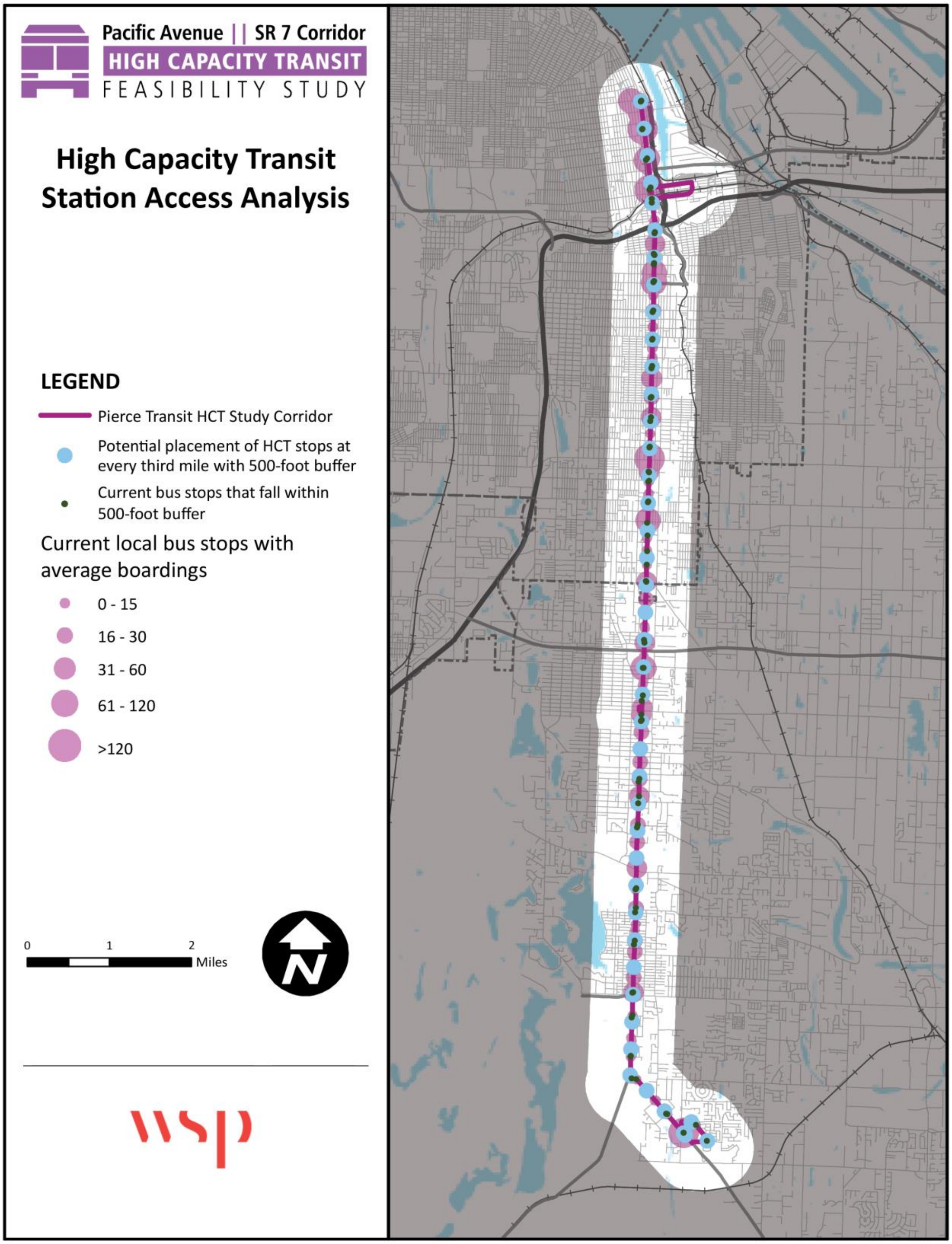
3.3.2 Results

Given that Alternatives 1a and 1b keep their existing local bus service (Route 1) and add the new BRT stations, they have a high level of access to transit. This is somewhat offset by the fact that there are not as many BRT stations, so there would be fewer improvements to station area pedestrian and bicycle access.

Table 3: Ratings for Access

Alternative	Rating
1a	4
1b	4
2a	2
2b	2

Figure 3: Potential BRT Stops with Current Local Bus Service Stops



3.4 Service Complexity

3.4.1 Methodology

Service complexity can be based on two factors: complexity for the transit operators and complexity for the transit passengers. Complexity concerns for operators would likely be minimal between the service options since there are unlikely to be drastic changes in design and function of the system between the service alternatives (though, of course, as a new transit mode, the BRT service will require advanced operator training). For the riders on the corridor, there will be some difference in complexity between the service alternatives.

The following assumptions were made when assessing the service complexity:

1. A single line is easier to understand than multiple lines running along the same route.
2. A single headway is easier to understand and deal with than a variable headway based on peak/off-peak travel times.
3. Given that the new HCT line (downtown Tacoma to Spanaway at 14.4 miles) is not proposed to run the same length as the existing local bus service line (full Route 1 at 18.6 miles), there is an assumption that complexity will increase across all service alternatives as passengers must adapt if their trip begins or ends on the portion of Route 1 not covered by the proposed BRT service.
4. Differences in running speeds between local and BRT service would potentially result in bus bunching or other operational issues.

3.4.2 Results

Alternatives 2a and 2b are more straightforward and would be easier for riders to understand. With these alternatives, riders will not have to figure out which stop serves which line, and which service would get them closest to their destination. It is also more complex to determine which combination of local and rapid service will reduce their overall travel time.

Alternatives 1b and 2b have different headways during weekdays, requiring passengers to know when the headway changes. This level of complexity makes it more difficult for passengers to simply memorize clock headways and not headways that change midday.

Another issue all service alternatives create is that the BRT service will not operate the entire length of the current Route 1, as noted previously. For an overlay service, this means that passengers must choose service lines based on speed and potential for transfers should they need to head west once reaching downtown Tacoma. For a replacement service, passengers who now can ride a single bus to or from the current west end of Route 1 at Tacoma Community College, will now be forced to transfer. However, transfer time penalties would likely be reduced in scenarios with 10-minute frequencies instead of 15, assuming timed transfers are impractical. No matter which service alternative is selected, this issue creates added complexity.

Table 4: Ratings for Service Complexity

Alternative	Rating
1a	2
1b	1
2a	3
2b	4

3.5 Capital Costs

3.5.1 Methodology

Since no conceptual design work has been completed for the project to date, it is impossible to develop capital cost estimates for the project. However, it is possible to estimate the differences in capital costs resulting from the various service options analyzed. The differences are in two areas:

- **Station Construction**. Stations represent a significant cost item for BRT projects. Based on other regional BRT projects, station costs, including all amenities and systems such as real-time information displays, ORCA card readers, and ticket vending machines, are estimated to be $300,000 per platform. This represents the cost for a high-quality station with significant amenities, similar to the EmX stations in Eugene, Oregon, or The Vine stations in Vancouver, Washington. The BRT overlay service options (Alternatives 1a and 1b) are assumed to have stations every $^{3}/_{4}$ mile, while the BRT replacement service options (Alternatives 2a and 2b) are assumed to have stations every $^{1}/_{3}$ mile. Thus, the BRT replacement options would have a higher capital cost due to the need to construct more stations.
- **Vehicles**. Project vehicle needs are determined by the travel time and the peak frequency of the service. The options with 10-minute peak frequency (Alternatives 1b and 2b) will require more buses than the service options with a maximum frequency of 15 minutes (Alternatives 1a and 2a). In addition, the BRT options that have underlying local service (Alternatives 1a and 1b) would have fewer stops and, thus, faster travel times. This would allow the service to be operated with fewer buses than the replacement service options (Alternatives 2a and 2b) that stop more frequently. Estimated peak BRT vehicle needs for revenue service assumed that the service would be 20 percent faster than the current service for the replacement options, and 25 percent faster than current service for the overlay options. This is a rough estimate based on a typical BRT travel time improvements. The BRT vehicle needs for peak revenue service are increased by 20 percent to account for layover time and include a 20 percent spare ratio to arrive at total fleet needs. The per vehicle cost assumes articulated buses and is estimated at $1.2 million per vehicle.

Service Alternative 1a, which has underlying local service and 15-minute maximum service frequency, requires fewer stations and buses and has the lowest capital costs of the four service plan alternatives. Since total project capital costs cannot be estimated at this time, this analysis uses Alternative 1a as the “base” and shows the estimated additional capital cost required for the other options.

3.5.2 Results

Table 5: Ratings for Capital Costs

Alternative	Capital Cost Difference	Rating
1a: BRT Overlay: 15-Minute Service	Base	5
1b: BRT Overlay: 10-Minute Peak/20-Minute Off Peak Service	+$3.5 million	4
2a: BRT Replacement: 15-Minute Service	+$15.5 million	2
2b: BRT Replacement: 10-Minute Peak/20-Minute Off Peak Service	+$19 million	1

The data indicate that the two overlay options (Alternatives 1a and 1b), which have significantly fewer stations, cost less than the two replacement options (Alternatives 2a and 2b), which have station every 1/3-mile. The additional buses required to operate 10-minute peak frequency add approximately $3.5 million to the cost compared to the options that have 15-minute maximum frequency.

It is expected that this BRT project could have an overall cost of between $150 and $175 million. Thus, the difference in capital costs resulting from the service plan that is chosen could be up to 12 percent of the total project costs.

3.6 Cost Effectiveness

3.6.1 Methodology

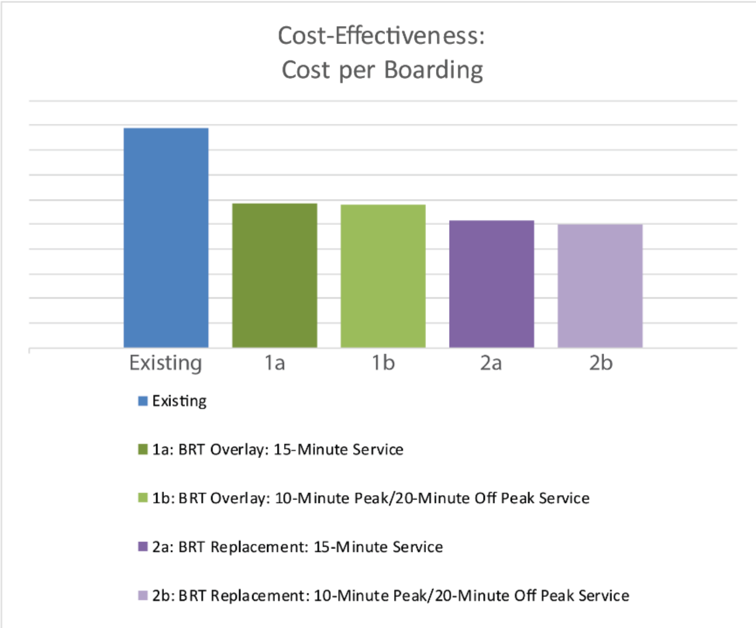
Transit agencies often determine the cost-effectiveness of service using the measure of operating cost per boarding. This performance measure incorporates the primary goal for transit agencies, which is to transport people, and the greatest constraint that they typically face, which is the operating budget. A low cost per boarding means that more people can be served within a given budget.

Ridership data for the service options were generated through the Regional Transit Ridership Forecasting Model. As noted previously, this is a very high level ridership analysis, so actual ridership numbers are only rough estimates. However, the relative ridership between the service alternatives is more accurate. The operating cost for the alternatives was based on service hour output from the model and comes with the same caveats. Data for existing service are from Pierce Transit's ridership counts and service hour tabulation, so comparisons between existing service and the service plan alternatives, which use high-level estimates, should be considered as a very rough comparison only.

3.6.2 Results

The data show that the BRT options that replace existing service (Alternatives 2a and 2b) have a lower cost per boarding than the BRT overlay options which retain local fixed route service (Alternatives 1a and 1b) as shown in Figure 4. Although the overlay options have higher ridership, the increased operating cost associated with the continuation of local fixed route service is proportionally greater than the ridership increase.

Figure 4: Estimated Cost per Boarding for the Service Options



All the BRT options show a significant improvement in cost per boarding compared to existing service. This has been true for most of the BRT systems that have been implemented so far, nationwide.

Based on this information, the following ratings have been assigned.

Table 6: Ratings for Operating Costs

Alternative	Rating
1a	2
1b	2
2a	4
2b	4

3.7 Support for Redevelopment

3.7.1 Methodology

Recent research has indicated that, if done in the right manner, BRT can influence real estate decisions and even attract jobs.[i] [ii] For the purposes of this analysis, support for redevelopment was assessed based on a combination of the number of and expected activity level at stations, as well the as frequency of BRT corridor service (i.e., the potential for a positive impact on redevelopment increases with an increased number of stations, increased activity at each station, and higher frequency of service).

3.7.2 Results

The results, shown in the table below, indicate that all options have the potential to positively affect redevelopment in the corridor. For the two replacement service options, Alternative 2b is rated higher than Alternative 2a due to the higher frequency of service during the peak periods. In comparing the overlay alternatives with the replacement alternatives, the overlay options have fewer stations, but they are expected to attract more ridership and the associated potential for more economic activity, including jobs and housing, which would tend to offset the effect of having fewer stations overall. Therefore, the overlay alternatives are rated similarly to the replacement alternatives for this measure

Table 7: Ratings for Support for Redevelopment

Alternative	Rating
1a	4
1b	5
2a	4
2b	5

3.8 Summary Results

Table 8 shows a summary of the overall evaluation results.

Table 8: Summary Ratings

Alternative	Ridership Estimates	Operating Cost	Access	Service Complexity	Capital Costs	Cost-Effectiveness	Support for Redevelopment	Overall
1a	4	2	4	2	5	2	4	3.3
1b	5	2	4	1	4	2	5	3.3
2a	2	4	2	3	2	4	4	3.0
2b	3	4	2	4	1	4	5	3.3

4 Recommendation

The analysis of service alternatives did not show major differences between the four service options considered (Alternatives 1a, 1b, 2a, and 2b), as they all have comparable overall ratings. Based on this analysis, and input received at a workshop reviewing these results (held July 27, 2017), it is recommended that this assessment be used primarily to indicate the relative advantages and disadvantages of the four service options, and that the eventual decision will be based on prioritizing the most important criteria as well as feedback from the community on the basic question of whether local service should continue to be operated on the corridor if BRT service were to be added. Following this approach, the following two options were recommended to be carried further into alternatives analysis:

- Service Alternative 1a: BRT with 15-minute frequency combined with local service with 30-minute frequency (which provides an average combined headway of 10 minutes).
- Service Alternative 2b: BRT with 10-minute peak and 20-minute off-peak frequency without underlying local service (if local service is removed, then the replacement service would need to demonstrate an advantage over the previous service, so 10-minute peak headways are proposed).

It is further recommended that additional analysis be conducted to determine the most advantageous peak service period given the corridor ridership characteristics. Currently, ridership does not conform to the traditional morning and afternoon peaks.

5 APPENDIX: SUMMARY RESULTS

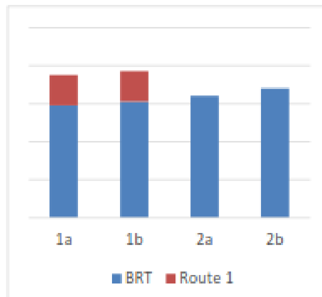
Pacific Ave/SR 7 HCT Service Plan Evaluation Matrix

Service Plan Alternative Definitions (same span of service as current service)

Alternative	Description
1a	HCT overlay with reduced local service / HCT headway: 15-minute for 14 hours per day/Local headway: 30 minutes
1b	HCT overlay with reduced local service / HCT headway: 10-minute peak (4 hours), 20-minute off-peak/Local headway: 30 minutes
2a	HCT replacement service / HCT headway: 15-minute for 14 hours per day
2b	HCT replacement service / HCT headway: 10-minute peak (4 hours), 20-minute off-peak

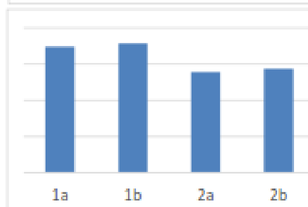
Measure Results: Ridership Estimates

Alternative	Rating
1a	4
1b	5
2a	2
2b	3



Measure Results: Operating Costs

Alternative	Rating
1a	2
1b	2
2a	4
2b	4



Measure Results: Access

Alternative	Rating	Data/Comments
1a	4	Stop spacing 1/2-mile with local service stops every 1/5-mile. Consistent headways for both commute and non-commute (low income/transit dependent riders).
1b	4	Stop spacing 1/2-mile with local service stops every 1/5-mile. Inconsistent headways tend to impact low income/transit dependent riders disproportionately.
2a	2	Stop spacing every 1/3-mile. Quantitative analysis shows this line would only capture 56% of the current local stop boardings. 58% of the local stop boardings of over 30 people and 67% of the local bus stops over 100 people. A 500-foot buffer was used to capture this data.
2b	2	Stop spacing every 1/3-mile. Quantitative analysis shows this line would only capture 56% of the current local stop boardings. 58% of the local stop boardings of over 30 people and 67% of the local bus stops over 100 people. A 500-foot buffer was used to capture this data. Inconsistent headways impact low income/transit dependent riders disproportionately.

Measure Results: Service Complexity

Alternative	Rating	Data/Comments
1a	2	New HCT service with local service increases complexity to riders. New line doesn't go as far as the local bus service (i.e., extending west to Tacoma Community College). New headways for local service will need to be explained.
1b	1	This option suffers from all the same problems as the above, but with the added confusion of having two different headways at different times of the day for the HCT.
2a	3	Less complex with new service replacement and a consistent headway throughout the day.
2b	4	Simpler due to there being only a single line. The variable headway option can still be confusing for riders.

Measure Results: Capital Costs

Alternative	Rating	Data/Comments
1a	5	Lowest Capital Cost option
1b	4	Approximately $3-4 million more expensive
2a	2	Approximately $15 million more expensive
2b	1	Approximately $19 million more expensive

Measure Results: Cost-Effectiveness

Alternative	Rating	Data/Comments
1a	2	Higher cost per boarding than BRT replacement options
1b	2	Higher cost per boarding than BRT replacement options
2a	4	Lower cost per boarding than BRT overlay options
2b	4	Lower cost per boarding than BRT overlay options

Measure Results: Support for Redevelopment

Alternative	Rating	Data/Comments
1a	4	Fewer stations, but higher activity at each
1b	5	Same as 1a, but with more frequent peak service
2a	4	More BRT stations, but lower level of use at each
2b	5	Same as 2a, but with more frequent peak service

Rating Basis	5 = Best ridership 4 = Good ridership 3 = Moderate moderate 2 = Fair ridership 1 = Poorest ridership	5 = Lowest cost 4 = Low cost 3 = Moderate cost 2 = Higher cost 1 = Highest cost	5 = Best access 4 = Good access 3 = Moderate access 2 = Fair access 1 = Poorest access	5 = Least complex 4 = Low complexity 3 = Moderate complexity 2 = Greater complexity 1 = Greatest complexity	5 = Lowest cost 4 = Low cost 3 = Moderate cost 2 = Higher cost 1 = Highest cost	5 = Lowest cost per boarding 4 = Low cost per boarding 3 = Moderate cost per boarding 2 = Higher cost per boarding 1 = Highest cost per boarding	5 = Best support 4 = Good support 3 = Moderate support 2 = Less support 1 = Least support

Alignment	Ridership Estimates	Operating Cost	Access	Service Complexity	Capital Costs	Cost-Effectiveness	Support for Redevelopment	Overall
1a	**4**	**2**	**4**	**2**	**5**	**2**	**4**	**3.3**
1b	**5**	**2**	**4**	**1**	**4**	**2**	**5**	**3.3**
2a	**2**	**4**	**2**	**3**	**2**	**4**	**4**	**3.0**
2b	**3**	**4**	**2**	**4**	**1**	**4**	**5**	**3.3**

FINAL October 12, 2017

[i] http://t4america.org/2016/01/12/new-study-finds-positive-economic-development-benefits-associated-with-bus-rapid-transit-projects/

[ii] NATIONAL STUDY OF BRT DEVELOPMENT OUTCOMES Final Report NITC-UU-14-650, Arthur C. Nelson, Joanna Ganning, November 2015