Chapter 4
ASSESSMENT OF PRELIMINARY CONCEPTS

This chapter assesses the performance of the preliminary concepts described in Chapter 3 in terms of performance measures, which correspond to the following project goals identified in Chapter 1:

- Enhance the customer experience
  - Reduce passenger travel times
  - Improve service reliability
- Improve service performance
  - Create a cost-effective, long-term transit solution
  - Faster average bus speeds
  - Increased ridership
- Increase person throughput for the corridor

Passenger Experience

This section assesses how the specific operational and design elements for each BRT concept would affect the passenger experience on the Vermont Corridor. Enhanced bus and station elements are a hallmark feature of a full BRT system and they contribute to an overall enhancement of the transit passenger experience. Passenger travel times relative to travel times in personal vehicles and other modes and service reliability are also key determinants of both the customer experience and utilization of the service. Ridership can reasonably be expected to benefit from transit service that meets passenger travel needs and caters to their comfort and convenience.

Enhanced Station Elements

As discussed in Chapter 2, various performance issues and physical elements have negatively affected bus passengers' perception of transit service on the Vermont Corridor. Any project that aims to improve bus service on the corridor must enhance the passenger experience holistically, by providing improvements to transit service from the beginning to the end of their journey. Existing BRT systems show that stations and buses featuring enhanced customer amenities can contribute to ridership increases.

In addition to dedicated bus lanes and other right-of-way improvements, full BRT systems feature enhanced station elements while minimizing delays and dwell times associated with traditional bus service. These enhancements improve the overall passenger experience and can attract new bus riders by providing convenience, comfort, and a sense of permanence. The best BRT stations essentially emulate the experience of using a rail transit station, which leads to an improved perception of bus service. Figure 33 illustrates some of the most common BRT station elements, including:

- Multiple door/level boarding
- Off-board fare payment
- Real-time information displays
- Enhanced seating and unique station design

Figure 33: Enhanced BRT Station Elements

The four concepts would feature these enhanced station amenities in their design, which would provide an improvement over the existing waiting environment at bus stops while making boarding and alighting more efficient – thus providing travel time improvements that would further enhance passenger convenience.

Passenger Travel Time and Average Bus Speeds

Currently, buses on the Vermont Corridor operate in mixed-flow lanes and experience the same unpredictable conditions as general traffic. In street segments with heavy traffic congestion, average bus speeds are generally slower, delays are more frequent, and dwell times at bus stops increase due to bus bunching. In combination, these factors comprise a route's end-to-end travel time. This section compares each BRT concept based on projected end-to-end travel time and average speed.

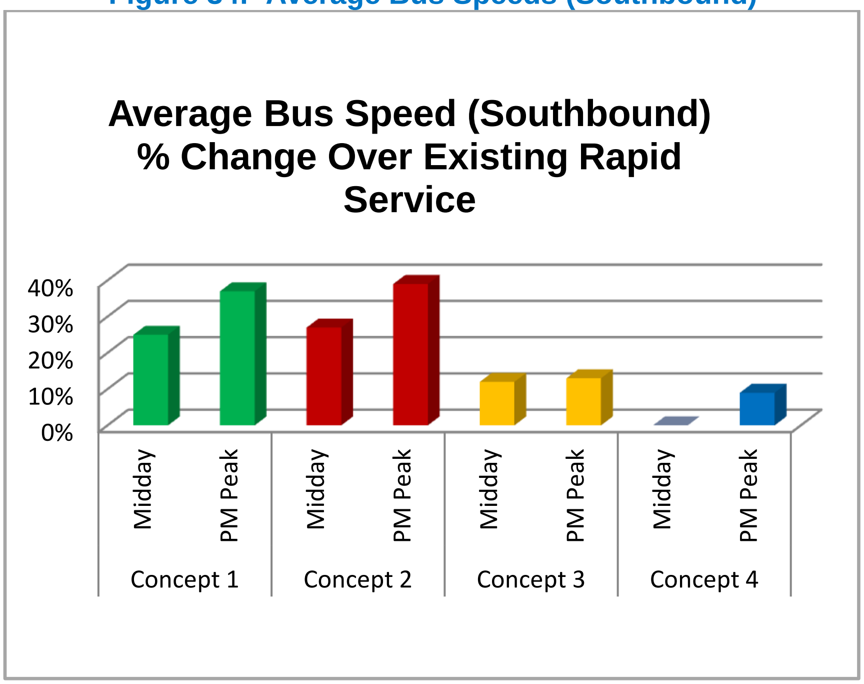
Table 8 summarizes the improvements in end-to-end travel times and Figure 34 summarizes average speeds for each of the four BRT concepts compared to actual travel times on Metro Rapid Line 754. Passenger travel time savings and average speeds are shown during the midday and afternoon peak period in the southbound direction, which are the slowest segments and direction of travel.

Table 8: Passenger Travel Time Savings (Southbound)

		Savings Over Existing Rapid Service (minutes)	% Change Over Existing Rapid Service
Concept 1	Midday	13	20%
	PM Peak	19	27%
Concept 2	Midday	13	21%
	PM Peak	20	28%
Concept 3	Midday	7	11%
	PM Peak	8	12%
Concept 4	Midday	0	0%
	PM Peak	6	9%

Source: Metro. 2016

Figure 34: Average Bus Speeds (Southbound)



Source: Metro. 2016

Concept 1 and Concept 2 would achieve end-to-end travel times that are 27 percent and 28 percent lower, respectively, than Metro Rapid Line 754 during the PM peak period. Overall end-to-end travel time during the afternoon peak period would be 51 minutes for Concept 1 and 50 minutes for Concept 2.

With end-to-end bus lanes, Concept 2 would provide the highest average speed of the four BRT concepts, followed by Concept 1.

Concept 4 would operate mostly in mixed-flow traffic (9.7 miles) and it would result in the highest overall run time, the lowest average speed, and the highest dwell time and delay. During the midday period, Concept 4 would operate entirely in mixed-flow lanes and its end-to-end travel time and average bus speed would mirror that of the existing Metro Rapid Line 754. With 5.1 miles of mixed traffic operations, Concept 3 would fare better than Concept 4 in running time and average speed, particularly during the mid-day, but worse than Concept 1 and Concept 2.

Service Reliability

Service reliability and on-time performance are closely tied to predictable average travel speeds and the minimization of unexpected delays. Multiple-door/level boarding, enhanced BRT station elements and TSP will also help to promote both speed and reliability for each of the concepts. Dedicated lanes and reduced friction with other vehicles contribute significantly to transit predictability.

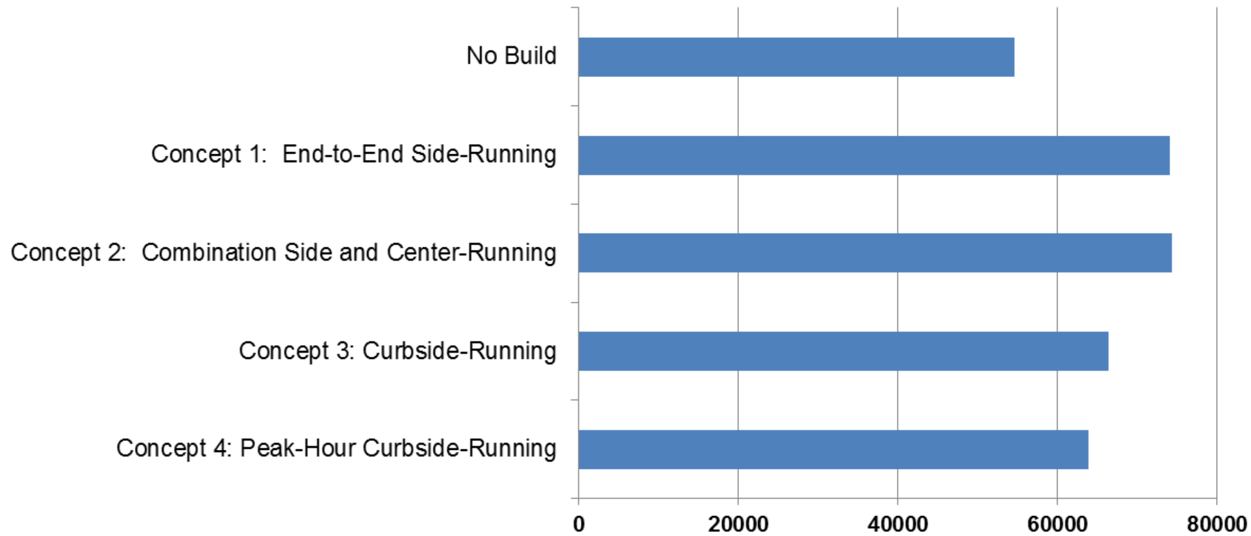
Both Concept 1 and Concept 2 provide end-to-end dedicated bus lanes. Concept 3 and Concept 4 offer 7.3 miles of curbside bus lanes and 2.7 of peak hour curbside bus lanes, respectively. Curbside bus lanes would experience more interference from right-turning vehicles at intersections than would the side-running and center-running bus lanes in Concept 1 and Concept 2. Center-running bus lanes provide the greatest reduction in friction with other vehicles. Accordingly, Concept 2, followed closely by Concept 1, would offer the greatest improvements to overall reliability due to low delay times afforded by dedicated lanes.

Ridership

Faster travel times and improved service reliability are key factors that can lead to higher transit ridership. As one of the primary north-south arterials in Los Angeles County, Vermont Avenue currently carries the second highest number of bus transit riders in the entire county. BRT implementation on the Vermont Corridor would aim to retain and attract transit riders through enhanced service and design. Figure 35 summarizes the total projected daily ridership on the Vermont Corridor in 2035 with BRT[5].

[5] Initial ridership forecasts were developed using the latest version of Metro's Transportation Analysis Model and the Southern California Association of Governments' (SCAG) 2012 model which supports the 2012-2035 Regional Transportation Plan (RTP)/Sustainable Communities Strategy (SCS). These initial ridership forecasts were used to provide a snapshot of the magnitude of ridership increase that could be expected from incremental improvements to bus travel times. The ridership model was forecasted to 2035 using a base year of 2015. The ridership forecasts were further refined with the development of the proposed operating plans.

Figure 35: Total Daily Ridership Forecasts (2035)



Total ridership on the corridor is expected to grow to 54,600 daily riders in 2035 (No Build Scenario) in addition to increases attributed to the implementation of BRT. With BRT, ridership is expected to increase to more than 74,000 total riders on the corridor by 2035 for both Concepts 1 and 2, which is an increase of approximately 20,000 or 36 percent over the projected “No Build”' condition. Daily ridership in 2035 with Concept 1 and Concept 2 is forecast to be 74,050 and 74,380, respectively. With Concept 3 and Concept 4 the corridor is forecast to carry 66,480 and 63,850 daily transit riders respectively, an increase of 11,880 (22 percent) and 9,250 (17 percent) daily riders over the projected “No Build” condition.

> 25 percent of corridor ridership for Concept 1 and Concept 2 would be new riders shifted from other modes.

The higher ridership projections under Concept 1 and Concept 2 can largely be attributed to faster travel times. Ridership gains can also result from improved service frequencies over existing service: five minute headways during peak periods and 10 minute headways during the midday period. Of the additional 20,000 daily riders projected, about one-fourth would be new riders who have shifted from other modes (primarily private autos).

Person Throughput

One of the major goals of implementing BRT lanes along the corridor is to improve operational efficiency by maximizing the capacity to move people while minimizing delay. The ability to move people more efficiently through the Vermont Corridor, also known as person throughput, will become increasingly important over time, as travel demand (and ridership in particular) are expected to increase.

Mixed-flow lanes on Vermont Avenue can currently carry a maximum of 685 vehicles per lane per hour. With an average occupancy of 1.32 persons per car, the existing total person throughput is about 900 people per mixed-flow lane per hour.

Under the proposed operating plan for the Vermont BRT, dedicated bus lanes would carry between 13 and 15 BRT buses and approximately 5 Metro Local Line 204 buses per lane per hour. The seated capacity of articulated buses is 57 people per bus. With Metro's internal bus load factor of 1.4, the capacity of each bus is 80 people. Therefore, during the peak period, each bus lane could carry between 1,400 and 1,600 people per hour. Person throughput with dedicated bus lanes (1,400-1,600) is, therefore, higher than that of mixed-flow lanes (900) during peak hours. The highest person throughput would be expected where dedicated bus lanes are present, since they would allow buses to attract more ridership by traveling through the corridor more reliably and at higher average speeds than in mixed-flow lanes.

During peak hours, person throughput with BRT could reach up to 1,600 persons per dedicated bus lane per hour compared to 900 persons per hour in mixed-flow lanes.

A more detailed analysis of person throughput will be conducted in a future environmental phase of the Vermont Corridor BRT.

Impacts to Existing Facilities and Traffic Conditions

This section summarizes potential parking and traffic impacts resulting from the implementation of BRT service on the Vermont Corridor.

Travel Lanes

Each proposed BRT concept would reconfigure the existing Vermont Avenue right-of-way differently. Several of the concepts would require converting travel lanes to dedicated bus lanes. Table 9 presents the travel lane configuration under each BRT concept by segment on the Vermont Corridor.

Table 9: Travel Lane Configuration by Concept

Typical Segments	Right-of-Way (feet)	Travel Lanes		
		No. of Lanes (Existing) NB/SB	No. of Lanes (Concepts 1 and 2) NB/SB	No. of Lanes (Concepts 3 and 4) NB/SB
A. Hollywood Boulevard to Wilshire Boulevard	100	2/2	1/1	2/2
B. Wilshire Boulevard to Jefferson Boulevard	80–90	2/2	1/1	2/2
C. Jefferson Boulevard to Exposition Boulevard	100	2/2	1/1	2/2
D. Exposition Boulevard to Martin Luther King Jr. Boulevard	80–90	2/2	1/1	2/2
E. Martin Luther King Jr. Boulevard to Gage Avenue	80	2/2	1/1	2/2
F. Gage Avenue to Manchester Boulevard	117.5–185	3/3	2/2	3/3
G. Manchester Boulevard to I-105	180–200	3/3	2/2	3/3
H. I-105 to 120th Street	150–200	3/3	2/2	3/3

Source: LA Metro, Parsons. 2016

Concept 1 and Concept 2 would repurpose one general purpose lane in each direction. Concept 1 would convert the lane adjacent to the parking lane in each direction to a bus only dedicated lane. Concept 2 would convert the two middle lanes on Vermont Avenue (one per direction) to bus only dedicated lanes south of Gage Avenue. Under both concepts, travel lanes on Vermont Avenue north of Gage Avenue would be reduced from two travel lanes per direction to one lane per direction; south of Gage Avenue, travel lanes would be reduced from three lanes to two lanes per direction.

Concept 3 and Concept 4 would not require the conversion of any traffic lanes – the current lane configuration on the Vermont Corridor would be preserved with the implementation of either of these concepts. The following section discusses potential traffic impacts, if any, resulting from travel lane conversion.

Traffic Impacts

This section discusses the impacts to traffic on the Vermont Corridor for each of the four BRT concepts. Studying project-related traffic performance along the Vermont Corridor is essential to understanding the factors that contribute to bus service performance and reliability and any impacts associated with the implementation of a BRT project. The efficiency by which traffic flows through a roadway ultimately determines the speed, severity of traffic delays, and how smoothly and reliably buses can serve passengers along a route. Level of Service (LOS) is one method for determining the efficiency of traffic flows.

LOS is a qualitative measure or assessment of the relative level of traffic flow at an intersection or roadway segment. In other words, LOS measures the amount of roadway congestion, ranging from LOS A (free flow) to LOS F (extreme congestion).

A detailed traffic study was conducted in and around the Vermont Corridor. Because the Vermont Corridor lies entirely within the City of Los Angeles, this analysis was conducted in coordination with Los Angeles Department of Transportation (LADOT) policy, which focuses on intersection level of service and change from existing or projected conditions resulting from project implementation. This analysis was prepared in addition to a previous LADOT-led traffic analysis of the same intersections. Based on LADOT policy, any significant change in traffic conditions resulting from project implementation can be interpreted as a project impact and the project sponsor would be required to provide mitigation.

Peak hour intersection turning movement volumes were counted at the following 24 intersections (also shown in Figure 36):

- Santa Monica Blvd/Western Ave
- Santa Monica Blvd/Normandie Ave
- Santa Monica Blvd/Vermont Ave
- Santa Monica Blvd/Hoover St
- US 101 NB Ramps/Vermont Ave
- Wilshire Blvd/Vermont Ave
- Olympic Blvd/Western Ave
- Olympic Blvd/Normandie Ave
- Olympic Blvd/Vermont Ave
- Olympic Blvd/Hoover St
- I-10 NB Ramps/Vermont Ave
- I-10 SB Ramps/Vermont Ave
- Jefferson Blvd/Western Ave
- Jefferson Blvd/Normandie Ave
- Jefferson Blvd/Vermont Ave
- Jefferson Blvd/Hoover St
- Jefferson Blvd/Figueroa St
- Exposition Blvd/Vermont Ave
- Martin Luther King Jr. Blvd/Vermont Ave
- Slauson Ave/Vermont Ave
- Florence Ave/Western Ave
- Florence Ave/Normandie Ave
- Florence Ave/Vermont Ave
- Florence Ave/Figueroa St

Figure 36: Traffic Count Locations

Source: Metro, Parsons. 2016

This analysis considered future traffic conditions on the Vermont Corridor at each intersection with and without a project. Intersection turning movement counts were analyzed using traffic engineering software based on the 2010 Highway Capacity Manual (HCM), which defines level of service (LOS) based on the average number of seconds of delay experienced by vehicles traveling through an intersection.

Based on this analysis, future traffic on the Vermont Corridor with BRT is forecasted to perform no better than it does today. This assessment assumes some amount of traffic diversion onto parallel north-south streets associated with the repurposing of a general purpose lane in each direction under Concept 1 and Concept 2. Based on the analysis, these parallel streets should be able to accommodate the shift in trips from Vermont Avenue with the exception of southbound during the PM peak period. A more detailed traffic analysis, to be conducted in a future environmental phase, would more thoroughly identify impacts, if any, resulting from the proposed concepts.

Vehicle Miles Traveled (VMT)

As an alternative approach to LOS analysis, vehicle miles traveled (VMT) is a method for determining project-related transportation impacts. VMT measures the expected number of miles generated from vehicle trips associated with a given project. Under State of California VMT guidelines (SB 743), transit, roadway rehabilitation, transit, bicycle, and pedestrian projects should be considered to have a less than significant transportation impact. These guidelines support the idea that reducing VMT is an important step in reducing greenhouse gas emissions, which research overwhelmingly suggests contribute to rising global temperatures and climate change.

Based on the proposed service assumptions for the BRT concepts and the average vehicle occupancy of 1.32 persons per vehicle, BRT implementation would result in an overall reduction in VMT, which would primarily be achieved through a shift in trips from private automobile to transit. The net reduction in VMT is estimated to be as high as 34,000[6]. This net VMT reduction over existing VMT would be an environmental benefit resulting from project implementation.

The reduction in VMT is closely tied to ridership and to the mode shift of private vehicles to transit. The Los Angeles County Metropolitan Transportation Authority Transportation Analysis Model (Metro Model) found that approximately 25 percent of the forecasted gains in ridership along the Vermont Corridor are new riders that would be diverted from other non-transit modes – of which private auto trips are a significant majority in the City of Los Angeles. Concept 1 and Concept 2 would result in a greater net reduction of overall VMT than Concept 3 or Concept 4 due to higher ridership and mode shift from other private vehicles.

All four concepts would provide a net reduction in overall (bus and auto) VMT. With higher mode shift to transit under Concept 1 and Concept 2, VMT reduction would be as high as 34,000.

Using this methodology, traffic diversion from Vermont Avenue resulting from the dedicated bus lanes would have less than significant or no impact. This VMT analysis provides a general depiction only. A more detailed traffic analysis, to be conducted in a future environmental phase, would more thoroughly identify impacts, if any, resulting from proposed concepts.

6 Calculated by the SCAG trip assignment model using 2016 numbers

Parking

This section evaluates potential on-street parking impacts resulting from BRT implementation. Parking on the Vermont Corridor is a valuable asset to residents, businesses, and institutions that rely on the availability and convenience of the local on-street parking supply. Any impacts to the on-street parking supply may lead to impacts on these groups.

Table 10 presents the existing on-street parking supply along the Vermont Corridor by segment. Table 11 summarizes the net parking changes associated with the four BRT concepts. The Vermont Corridor includes a supply of approximately 2,005 on-street parking spaces between Hollywood Boulevard and 120th Street. Parking spaces along Segment A and Segment B (Hollywood Boulevard to Adams Boulevard) are peak-hour restricted, while 492 spaces on Segment E through Segment G (south of Gage Avenue to 89th Street) are located within frontage roads rather than along the immediate curb lanes. Due to existing peak hour parking restrictions between Hollywood and Adams Boulevard, actual parking supply during the peak periods is reduced to 1,451 spaces.

Table 10: On-Street Parking Space Supply (All-day)

Typical Segments	Miles	Supply
A. Hollywood Boulevard to Wilshire Boulevard	2.7	328
B. Wilshire Boulevard to Jefferson Boulevard	2.6	295
C. Jefferson Boulevard to Exposition Boulevard	0.5	111
D. Exposition Boulevard to Martin Luther King Jr. Boulevard	0.5	0
E. Martin Luther King Jr. Boulevard to Gage Avenue	2.0	352
F. Gage Avenue to Manchester Boulevard	1.5	442
G. Manchester Boulevard to I-105	2.2	413
H. I-105 to 120th Street	0.4	64
Total/Average	**12.4**	**2,005**

Source: LA Metro, Parsons. 2016

Table 11: Summary of On-Street Parking Space Impact

	Existing	Concept 1	Concept 2	Concept 3	Concept 4
Total Supply	**2,005**	1,559	1,541	905	1,922
Net Change	**--**	**-446**	**-464**	**-1,100**	**-83**
% Net Change	--	-22%	-23%	-55%	-4%

Source: LA Metro, Parsons. 2016

Concept 3 would result in the largest impact to on street parking with a loss of approximately 1,100 all-day parking spaces (55 percent of the existing supply). This concept differs from the others in that it would operate in the curbside lane (where on-street parking is located) to accommodate dedicated BRT lanes instead of removing a travel lane, as with Concept 1 and Concept 2.

Concept 4 would result in the lowest reduction (83 spaces or 5 percent) of all-day street parking spaces, largely due to operating in mixed-flow traffic for most of the day. Concept 2 would reduce the number of all-day parking spaces by 464 spaces (23 percent of the existing supply), while Concept 1 would result in a similar but slightly lower reduction (446 spaces or 22 percent).

Based on the parking usage rates along the corridor, sufficient remaining on-street parking would be available under Concept 1 and Concept 2 to meet current demand with a possible exception in the segment from Jefferson to Exposition Boulevards, adjacent to USC. Parking occupancy is near capacity (95 percent) in that four-block (0.5-mile) segment.

Any project impacts to the parking supply will be more fully identified and explored in a future environmental phase.

Capital and Operating and Maintenance Costs

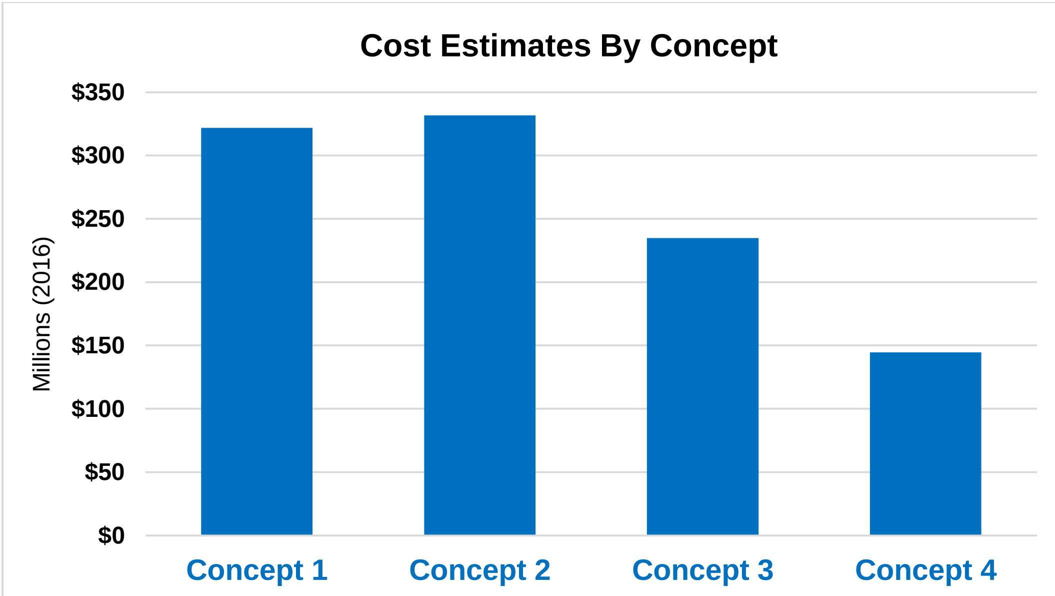
This section presents estimated Capital and annual Operating and Maintenance (O&M) costs for the four BRT concepts. Preliminary cost estimates, based on a 5 percent level of engineering sufficient enough to allow the preparation of capital costs and an operating plan, were developed for each of the four concepts. Understanding these costs can help to assess the financial needs of each of the four concepts and can also help to weigh costs versus benefits resulting from BRT implementation. These preliminary costs also serve as the basis for future detailed design work.

Capital Costs

Capital costs incorporate the major components of the BRT project including running way and station construction, sitework improvements, BRT system elements (e.g. TSP), vehicles, right-of-way, professional services, and contingencies.

Capital cost assumptions were based on: a 12.4 mile alignment with 12-foot to 14-foot wide lanes; 42 proposed stations (21 two-sided platforms) and related amenities; 32 new 60-foot BRT vehicles; 25 percent of the total for professional services (design, legal, permits, management, etc.); and a 30 percent contingency fee. Although no ROW acquisition was anticipated at this level of conceptual engineering, a minimal amount of $10 million was included. Capital cost estimates were developed using unit costs derived from Metro's own cost estimates, FTA's standard cost estimates, and recent BRT corridor development and construction experience both locally and throughout the U.S. Figure 37 shows the worst case high end cost estimates for each concept in 2016 dollars.

Figure 37: Estimated Worst Case Capital Costs (in 2016 dollars)



As Figure 37 shows, the capital costs for the dedicated BRT lanes along the entirety of the corridor in Concept 1 and Concept 2 ($321,738,000 and $331,830,000, respectively) are significantly higher than for Concepts 3 and 4 ($234,779,000 and $144,505,000, respectively) due to the reconstruction of existing general purpose lanes.

Operating and Maintenance (O&M) Costs

O&M costs are the day-to-day, ongoing costs associated with operating and maintaining bus service. BRT O&M costs are anticipated to be similar to typical Metro bus O&M costs, but BRT also includes components that are not a part of the existing bus service. Therefore, the BRT cost model uses many of the line item unit costs in the standard bus O&M cost model but incorporates additional items including curbside station platform maintenance, center station platform maintenance, fare enforcement, fare equipment maintenance (i.e., fare validator machines), ITS equipment/signage maintenance, exclusive lane mile routine maintenance (new pavement), and exclusive route mile routine maintenance (streetscape/landscape).

Costs associated with these expenses are approximately 5.4 percent higher than O&M costs for standard bus service. The estimated O&M cost estimates are shown in Table 12, which include the following service assumptions:

- BRT service would replace the existing Metro Rapid Line 754 with dedicated lanes and other BRT attributes.
- The span of service on the BRT would be extended from 9:00 PM to 10:00 PM for a total of 17 hours of service on weekdays. The span of service on weekends would include 16 hours on Saturdays and 14 hours on Sundays.

- BRT service would operate with headways of every 5 minutes during peak periods, every 10 minutes mid-day, and every 15 minutes in the evenings, coupled with Metro Local Line 204 operating every 10 minutes (currently every 7 to 15 minutes) in the peak periods and every 15 minutes mid-day (no change).
- Metro Local Line 204 would continue to operate 24 hours per day, 7 days per week.

Table 12: Summary of Operating Statistics and O&M Cost Estimates

Mode Key Supply Variable	Unit Cost (in $2016)	Concept 1	Concept 2	Concept 3	Concept 4
STANDARD BUS					
Annual Revenue Bus-Hours	$54.50	(66,270)	(66,270)	(66,270)	(66,270)
Annual Revenue Bus-Miles	$3.97	(642,700)	(642,700)	(642,700)	(642,700)
Peak Buses	$109,116	(29)	(29)	(29)	(29)
Garages	$11,967,091				
Total Incremental Standard Bus Cost		**($9,329,000)**	**($9,329,000)**	**($9,329,000)**	**($9,329,000)**
BUS RAPID TRANSIT					
BRT Annual Revenue Bus-Hours (Service)	$54.50	90,570	90,570	93,880	95,930
BRT Annual Revenue Bus-Miles	$3.97	1,064,600	1,064,600	1,064,600	1,064,600
BRT Peak Buses	$109,116	26	26	28	29
BRT Garage Expansion	$11,967,091				
Curb Platforms (Split)	$2,000	42	32	42	42
Center Street Platforms (Split)	$2,000	0	10	0	0
Fare Enforcement (BRT revenue hours)	$4.88	90,570	90,570	93,880	95,930
Fare Equipment - TVMs	$6,000	12	12	12	12
Fare Equipment - Validators	$168	52	52	56	58
ITS Signs	$3,000	42	42	42	42
Exclusive Lane Miles (New Pavement)	$31,400	0	0	0	0
Route Miles (Streetscape/Landscape)	$5,000	0	0	0	0
Total BRT Cost		**$12,734,300**	**$12,734,300**	**$13,149,700**	**$13,380,900**
TOTAL ADDITIONAL ANNUAL O&M COST		***$3,405,300***	***$3,405,300***	***$3,820,700***	***$4,051,900***

BRT service under all four concepts would cost between $12.7 and $13.4 million per year to operate and maintain. As BRT service would replace Metro Rapid Line 754 and some adjustments would be made to the remaining Metro Local Line 204, the net annual increase in Operating and Maintenance costs is estimated to range from $3.4 and $4.1 million. With slower end-to-end travel times and average speeds, Concept 3 and Concept 4 would result in slightly higher annual O&M costs than would Concept 1 and Concept 2.

Cost Per Passenger

Using the annualized Capital and Operating and Maintenance cost estimates, projected ridership and revenue hours, the following Table 13 shows the cost per boarding for each of the four Concepts.

Table 13: Cost Per Passenger Estimates (2035)

Vermont BRT	Concept 1	Concept 2	Concept 3	Concept 4
Upfront Capital Cost (2016)	$321,737,750	$331,830,375	$234,778,563	$144,504,688
Annualized Capital Cost*	$16,086,888	$16,591,519	$11,738,928	$7,225,234
Total Annual BRT O&M Cost (2016)	$12,734,300	$12,734,300	$13,149,700	$13,380,900
Total Annual BRT O&M Cost (2035)**	$20,357,691	$20,357,691	$21,021,770	$21,391,378
Total Annualized Cost (2035)	$36,444,579	$36,949,210	$32,760,698	$28,616,613
Average Weekday BRT Boardings (2035)	49,690	50,050	43,020	40,690
Total Annual Boardings***	12,670,950	12,762,750	10,970,100	10,375,950
Cost per Boarding	**$2.88**	**$2.90**	**$2.99**	**$2.76**

* assumes 20 year useful life
** assumes 2.5% inflation per year
***assumes typical annualization factor of 255 weekdays per year

With capital costs annualized over a 20 year period, the cost per boarding would range from $2.76 to $2.99 in 2035, a portion of which would be recovered through passenger fares.

Summary

This section summarizes how each preliminary BRT concept performs, with a focus on the balance between project benefits, impacts and costs for each.

Concept 1 – End-to-End Side-Running BRT

Concept 1, which maximizes the benefits of dedicated bus lanes by implementing them along the entire 12.4 mile corridor, provides the second highest improvement (27 percent reduction) in travel time savings of up to 19 minutes during the PM peak period. Average travel speeds under Concept 1 also increase 37 percent from an average of 11.9 mph during the PM peak period to 15.1 mph, due to the segregation of buses from congested, mixed flow travel times. The overall improvement in passenger travel times and average bus speeds contribute to ridership of 74,050 average daily boardings (2035), a 36 percent increase over the projected 'No Build' condition. Room for the bus lanes would be made available by converting the general purpose lane (one in each direction) adjacent to the curbside parking lanes to a transit only bus lane. By keeping the buses out of unpredictable traffic conditions, the analysis also shows that headways and bus loads would be more even, thereby improving schedule reliability and lessening overcrowding.

The advantage of Concept 1 is that it maintains most of the on-street parking, but there would be a loss of approximately 446 (of total 2,005) parking spaces, due to localized ROW constraints and station needs as discussed in Chapter 3. Based on preliminary VMT analysis, the impact to traffic resulting from the implementation of Concept 1 is estimated to be less than significant. More traffic analysis will be needed in a subsequent phase of work to verify this finding. The estimated capital cost to implement Concept 1 is $322 million. Operating and maintenance costs result in a net annual increase of $3.4 million.

Concept 2 – Combination Side and Center-Running BRT

Concept 2, which also maximizes the benefits of dedicated bus lanes by implementing them along the entire 12.4 mile corridor, provides a marginally higher improvement (28 percent reduction) in travel time savings of up to 20 minutes during the PM peak period than Concept 1. Average travel speeds under Concept 2 also increase 39 percent during the PM peak period to 15.3 mph, due to the segregation of buses from congested, mixed flow travel times. The overall improvement in passenger travel times and average bus speeds contribute to ridership of 74,380 average daily boardings, a 36 percent increase over the projected 'No Build' condition. Room for the bus lanes would be made available by converting the general purpose lane (one in each direction) adjacent to the curbside parking lanes to a transit only bus lane north of Gage Avenue. South of Gage Avenue, room for the bus lanes would be made available by converting the two middle general travel lanes (one in each direction) to dedicated bus only lanes. By keeping the buses out of unpredictable traffic conditions, the analysis also shows that headways and bus loads would be more even, thereby improving schedule reliability and lessening overcrowding.

The advantage of Concept 2 is that it also maintains most of the on-street parking, but there would be a loss of approximately 464 (of total 2,005 spaces) parking spaces, due to localized ROW constraints and station needs as discussed in Chapter 3. Based on preliminary VMT analysis, the impact to traffic resulting from the implementation of Concept 2 is estimated to be less than significant. More traffic analysis will be needed in a subsequent phase of work to verify this finding. The estimated capital cost to implement Concept 2 is $332 million. Operating and maintenance costs result in a net annual increase of $3.4 million.

Concept 3 – Curbside-Running BRT

Concept 3 features dedicated BRT lanes next to the curb. Concept 3 provides an improvement (12 percent reduction) in travel time savings of up to 8 minutes during the PM peak period. Average travel speeds under Concept 3 also increase 13 percent during the PM peak period to 13.3 mph, due to the some segregation of buses from congested, mixed flow travel times. The overall improvement in passenger travel times and average bus speeds contribute to ridership of 66,480 average daily boardings, a 22 percent increase over the projected 'No Build' condition. Room for the bus lanes would made available by converting the curbside parking lanes (one in each direction) to transit only bus lanes (north of Gage Avenue). South of Gage Avenue, room for the bus lanes would be made available by converting one of the three general purpose lanes (the lane closest to the curb) to bus lanes. Most of the on-street parking south of Gage Avenue (between Gage Avenue and Manchester Boulevard) is along frontage roads rather than curbside.

Concept 3 requires the removal of 1,100 on-street parking spaces including the removal of all on-street spaces in Segments A through E (north of Gage Avenue). Due to localized ROW constraints and parking lanes that are too narrow for a bus lane, only 7.3 miles of dedicated bus lanes could be achieved. The remaining 5.1 miles would operate in mixed flow. Based on preliminary VMT analysis, the impact to traffic resulting from the implementation of Concept 3 is estimated to be less than significant. More traffic analysis will be needed in a subsequent phase of work to verify this finding. The estimated capital cost to implement Concept 3 is $235 million. Operating and maintenance costs result in a net annual increase of $3.8 million.

Concept 4 – Peak Period Curbside-Running BRT

Concept 4 features dedicated BRT lanes next to the curb during peak hours only (7:00 to 9:00 AM and 4:00 PM to 7:00 PM). Concept 4 provides an improvement (9 percent reduction) in travel time savings of up to 6 minutes during the PM peak period. Average travel speeds under Concept 3 also increase 9 percent during the PM peak period to 12.8 mph, due to some segregation of buses from congested, mixed flow travel times. However, these savings are realized in the peak periods only. No savings are achieved during any other period of the day. The overall improvement in passenger travel times and average bus speeds contribute to ridership of 63,850 average daily boardings, a 17 percent increase over the projected "No Build" condition. Room for the bus lanes would made available by converting the peak hour only curbside parking lanes between Hollywood Boulevard and Adams Boulevard, where wide enough, to bus only lanes.

Concept 4 attempts to minimize traffic impacts during peak hours. However, due to existing ROW constraints and a lack of peak hour restricted parking, the BRT would have to operate in mixed-flow for approximately 9.7 miles or implement additional peak hour parking restrictions on the corridor. Concept

4 would remove 83 all-day parking spaces with additional parking loss during the peak periods. Based on preliminary VMT analysis, the impact to traffic resulting from the implementation of Concept 4 is estimated to be less than significant. More traffic analysis will be needed in the subsequent phase of work to verify this finding. The estimated capital cost to implement Concept 4 is $134 million. Operating and maintenance costs result in a net annual increase of $4.1 million.

Table 14 summarizes the average end-to-end travel time, average speed, corridor ridership, and costs for each concept. Table 15 shows the impacts to existing travel lanes, throughput capacity, and parking supply.

Table 14: Performance Summary for ach Concept

Concepts	Average Travel Time (PM Peak, SB, in Minutes)			Average Speed (mph)			Total Corridor Ridership (weekday)			Capital Cost (in Millions)	Increase in Annual O&M Cost (in Millions)
	Current Metro Rapid Line 754	Post Project	% Change	Current Metro Rapid Line 754	Post Project	% Change	No Build (2035)	Build (2035)	% Change	Post Project (2016$)	Post Project (2016$)
Concept 1	70	51	**27%**	11	15.1	**37%**	54,600	74,050	**36%**	322	**3.4**
Concept 2		50	**28%**		15.3	**39%**		74,380	**36%**	332	**3.4**
Concept 3		62	**12%**		12.4	**13%**		66,480	**22%**	235	**3.8**
Concept 4		64	**9%**		12	**9%**		63,850	**17%**	145	**4.1**

Table 15: Summary of Impacts to Existing Transportation Infrastructure

Concepts	Travel Lane Impacts (by direction)		Person Throughput (per lane)			Parking Impacts (reduction)		
	Current	Post Project	Current	Post Project	% Change	Current	Post Project	% Change
Concept 1	2-3	**1-2**	900	1,400-1,600	**56% - 78%**	2,005	-446	**-22%**
Concept 2		**1-2**					-464	**-23%**
Concept 3		**2-3**					-1,100	**-55%**
Concept 4		**2-3**					-83	**-4%**

Assessment of Preliminary Concepts

All four concepts increase both transit ridership and overall person throughput on the Vermont Corridor and enhance passengers' experience and comfort. However, Concept 1 and Concept 2 outperform Concepts 3 and 4 in providing benefits such as passenger travel time savings, average bus speed, and induced ridership. Based on the high level assessment and review of this technical study, both Concept 1 and Concept 2 appear feasible and are most promising. The potential impacts to existing facilities including vehicular travel lanes and on-street parking would be further analyzed in future study.