5.0 EVALUATION OF ALTERNATIVES

5.1 Introduction

This section presents an overview of the evaluation process, and presents the measures of effectiveness used to compare the study alternatives. Detailed results of the technical analysis are presented in Section 6.0.

5.1.1 Evaluation Overview

The Goals and Objectives for the Pike Transit Initiative were developed based on the needs and transportation problems identified in previous studies and goals included in regional long-range transportation plans (the 2030 Long Range Transportation Plan was used in this analysis). These goals and objectives provide a basis for the criteria and measures of effectiveness used in the evaluation of alternative transportation improvements. The results of this analysis will contribute to the data needed to recommend a Locally Preferred Alternative.

As described in Section 4, physical and operational characteristics for each alternative were defined in detail, in order to evaluate specific measures of effectiveness. Section 6 carries the analysis of several features, including potential effects on the natural and built environment, potential effects on transportation, and a discussion of estimated costs.

5.1.2 Screen 1 Considerations

The Screen 1 evaluation process yielded a set of three alternatives: Baseline/No Action, Bus Rapid Transit, and Streetcar. Subsequent evaluation led to the inclusion of an additional, smaller Modified Streetcar Alternative that assumes streetcar as the base service supplemented by peak bus service. For ease of comparison, evaluation results for this fourth alternative are shown in this Section next to the initial Build Alternatives.

5.1.3 Evaluation Criteria

The evaluation of Build Alternatives in Screen 2 is based on the evaluation criteria, from which the Measures of Effectiveness (MOEs) were developed. The criteria provide a number of ways to assess the compatibility of the proposed alternatives with the goals and objectives of the project. A short description of each criterion is provided below:

Access and Mobility

- ***Corridor Transit Travel Time*** - Evaluates the change in travel time to activity centers along the corridor using rail or bus.
- ***Accessibility*** - Evaluates the ability of the proposed transit alternatives to serve population and employment centers.
- ***Ridership*** - Evaluates the ability of the alternatives to attract riders.
- ***Traffic Conditions***- Evaluates the effect of new service on traffic along the corridor.

Community and Economic Development

- ***Support of County Revitalization Efforts*** - Evaluates the integration of proposed improvements with the goals and objectives of economic revitalization initiatives within Arlington and Fairfax counties.

Safety, Reliability and Comfort

- ***Accommodation of Transit, Auto, Pedestrian, and Bicycle Modes*** - Evaluates the extent to which proposed changes provide for the safety of people traveling by foot, bicycle, transit, or automobile.
- ***Transit Rider Visibility*** - Evaluates real and perceived passenger safety at station stops and upon entering and exiting vehicles.
- ***Ride Quality and Technical Reliability*** - Evaluates the comfort of passengers on board the vehicle, the ease of entering and exiting the vehicle, and the average frequency of vehicle breakdowns.

Regional Connections

- ***Regional Transit Travel Time*** - Evaluates the effect of improvements on the time it takes to access specified regional activity centers from points along the corridor.

Community Goals

- ***Consistency with Adopted Local Plans*** - Evaluates the extent to which proposed improvements are consistent with Arlington County and Fairfax County planning policies.
- ***Aesthetics*** - Measures the extent of visual and noise impacts on the community.

Estimated Costs

- ***Capital and Operating Costs*** - Indicate the levels of capital and yearly investment needed to construct the proposed transit line, procure vehicles and equipment, operate the new services, and maintain the systems and infrastructure.

5.2 Evaluation Measures and Results

The study goals and objectives lead to an evaluation framework by which the alternatives may be assessed and compared. The evaluation results in Table 5-1 provide a comparison of the effects that the alternatives would have within the study corridor on access and mobility; community and economic development; safety, reliability and comfort; regional connections; and community goals.

Table 5-1 summarizes the results of the analysis, showing all four of the alternatives considered. Subsequent sections discuss the evaluation measures and results in greater detail. It should be noted that the Modified Streetcar Alternative has some characteristics of both Streetcar and bus operations because a portion of the passenger trips along Columbia Pike under that scenario would be accommodated by standard buses.

Table 5-1: Evaluation Criteria and Measures of Effectiveness (DRAFT)

Evaluation Criteria	Measure of Effectiveness	Type of Measure	Baseline Alternative	BRT Alternative	Streetcar Alternative	Modified Streetcar Alternative (1)
1. Access & Mobility						
Corridor Transit Travel Time	a. Transit Travel Time to Pentagon City from Jefferson St./Columbia Pike (morning peak hour) b. Transit Travel Time to Jefferson St./Columbia Pike from Pentagon City (morning peak hour)	Quantitative Quantitative	27 min. 27 min.	19 min. 18 min.	20 min. 18 min.	19 min. 18 min.
Accessibility	c. Future Employment Near Station Stops (within ¼ mile and ½ mile for Build Alternatives, within ¼ mile for Baseline)	Quantitative	52,000	57,000 (1/4 mi.) 87,000 (1/2 mi.)	57,000 (1/4 mi.) 87,000 (1/2 mi.)	50,000 (1/4 mi.) 80,000 (1/2 mi.)
	d. Future Population Near Station Stops (within ¼ mile and ½ mile for Build Alternatives, within ¼ mile for Baseline)	Quantitative	47,000	47,000 (1/4 mi.) 79,000 (1/2 mi.)	47,000 (1/4 mi.) 79,000 (1/2 mi.)	45,000 (1/4 mi.) 76,000 (1/2 mi.)
Ridership	e. Total daily transit ridership along the corridor	Quantitative	15,670	22,490	23,080	20,670 (6 min.) 19,860 (12 min.)
	f. Transit passenger capacity per hour (peak period, peak direction)	Quantitative	1,620	2,540	3,100	2,360 (6 min.) 1,990 (12 min.)
	g. Total person through-put per hour, automobile occupants plus transit passengers (eastbound a.m. peak)	Quantitative	2,470	2,850	2,930	2,910 (6 min.) 2,810 (12 min.)
Traffic Conditions	h. Intersection Levels of Service (42 intersections)	Quantitative	4 at LOS E or worse	7 at LOS E or worse	7 at LOS E or worse	3 at LOS E or worse
	i. Automobile travel time from Jefferson St./Columbia Pike to Pentagon City (eastbound a.m. peak)	Quantitative	15 min.	15 min.	16 min.	15 min.
2. Community & Economic Development						
Support of County revitalization efforts	a. Percentage of land in Revitalization Districts within walking distance of station stops (¼ mile and ½ mile for Build Alternatives, ¼ mile for Baseline)	Quantitative	60%	64% (1/4 mi.) 86% (1/2 mi.)	64% (1/4 mi.) 86% (1/2 mi.)	55% (1/4 mi.) 75% (1/2 mi.)
	b. Potential of Alternative to serve as catalyst for development	Qualitative	low	medium	high	high
	c. Probability of private sector funding support	Qualitative	low	low	high	high
3. Safety, Reliability, and Comfort						
Accommodation of transit, auto, pedestrian, and bicycle modes	a. Average national accident rates for transit vehicles (FTA safety data by mode: bus vs. LRT, 1990 – 2002)	Qualitative	16.3 collisions per ten million psgr mi	16.3 collisions per ten million psgr mi	5 collisions per ten million psgr mi	5 to 16 collisions/ ten million psgr mi
	b. Average national accident rates for pedestrians (FTA safety data by mode: bus vs. LRT, 1990 – 2002)	Qualitative	10.2 casualties per ten million psgr mi	10.2 casualties per ten million psgr mi	8.5 casualties per ten million psgr mi	8 to 10 casualties/ ten million psgr mi
	c. Accident rates for bicycles in environments similar to project alternatives (2)	Qualitative	not reported	not reported	not reported	not reported
	d. Accident rates for automobiles in environments similar to project alternatives (3)	Qualitative	not reported	not reported	not reported	not reported
Transit Rider Visibility	e. CPTED standards incorporated into station stop concepts	Qualitative	yes	yes	yes	yes
Ride Quality and Technical Reliability	f. Passenger comfort and ride quality	Qualitative	low	medium	high	high
	g. Average frequency of vehicle breakdowns by technology type (FTA data by mode: bus vs. LRT, 1990 – 2002)	Qualitative	21 breakdowns per million psgr mi	21 breakdowns per million psgr mi	4 breakdowns per million psgr mi	4 to 21 breakdowns per million psgr mi
4. Regional Connections						
Regional Transit Travel Time	a. Improvement in Transit Travel Time to select Regional Activity Centers (as identified by MWCOG)	Quantitative	n/a	7% to Pent. City 27% to Skyline	8% to Pent. City 29% to Skyline	6% & 4% to Pent. City 22% & 19% to Skyline
	b. Regional employment accessible by transit in less than 60 minutes	Quantitative	n/a	moderate improvement	moderate improvement	moderate improvement
5. Community Goals						
Consistency with Adopted Local Plans	a. Columbia Pike revitalization recommendations incorporated	Qualitative	no	yes	yes	yes, with modification
Aesthetics	b. Potential visual impacts	Qualitative	low	low	medium	medium
	c. Potential noise impacts	Quantitative	medium	medium	low	low (6 min.) medium (12 min.)
6. Estimated Costs						
Capital Costs (2005 dollars)	a. Construction costs, including systems, facilities, and vehicle procurement; not including row or parking structures	Quantitative	$28 million	$110 to $120 million	$185 to $200 million	$110 to $120 million (6 min.) $90 to $100 million (12 min.)
Operating/Maintenance costs	b. Annual operations and maintenance costs based on assumed operating plans and fleet sizes	Quantitative	$7 million	$8 million over Baseline	$14 million over Baseline	$5 million (6 min.) $4 million (12 min.)

[1] Measures for this Alternative include data from both streetcar and bus improvements. [2] Bicycle accident data were not easily separable from accident rates reported for pedestrians. [3] Automobile accident data were not easily separable from accident rates reported for transit.

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5.2.1 Access and Mobility

Corridor Transit Travel Time Criterion

Measure1a: Transit Travel Time to Pentagon City from Jefferson Street/Columbia Pike

Measure1b: Transit Travel Time to Jefferson Street/Columbia Pike from Pentagon City

Quantitative measure of the estimated travel time on rail or bus transit—during both morning and afternoon peak periods—between Jefferson St./Columbia Pike and Pentagon City.

Data Sources:

- Forecast 2030 transit travel time between Jefferson Street/Columbia Pike and Pentagon City, based on VISSIM model.

Approach:

- Calculate 2030 travel time between Jefferson Street/Columbia Pike and Pentagon City for each Alternative.

Results:

Transit travel time in the morning peak hour between Pentagon City and the intersection of Jefferson Street and Columbia Pike should decrease from approximately 27 minutes in the Baseline Alternative to between 18 and 20 minutes for all Build Alternatives. This decrease in travel time is due in large part to the reduction in the number of station stops and the placement of most station stops at the far side of the intersection, enabling more benefit from signal priority.

Accessibility Criterion

Measure 1c: Future Employment near Station Stops (within ¼ mile and ½ mile for Build Alternatives, within ¼ mile for Baseline/No Action Alternative)

Quantitative measure of forecast number of jobs within ¼ mile and ½ mile of transit station stops.

Data Sources:

- MWCOG round 6.4a forecast data on employment by TAZ for year 2030.
- List and map of proposed station stops for each Alternative.

Approach:

- Identify and map station stops.
- Establish ¼ mile and ½ mile radii around station stops.
- Determine forecast number of jobs within ¼ mile of station stops for Baseline/No Action Alternative and within ½ mile of station stops for Build Alternatives.
- Where the entire TAZ falls within the ¼ or ½ mile radius, 100% of the projected employment will be counted. Where smaller portions of TAZs fall within the radius, employment density will be assumed uniform and the affected area of the TAZ will be rounded to the nearest one-quarter. In other words, 75%, 50%, 25% or 0% of that zone's employment will be counted.

Results:

Because the station stops for the BRT Alternative and Streetcar Alternative are the same, the projected number of employees within ½ mile and ¼ mile of station stops in 2030 is the same for both alternatives. The BRT Alternative and Streetcar Alternative are projected to have more employees within ¼ mile of station stops than the Baseline Alternative. This is due to the fact that the alignment for the Build Alternatives provides direct access to the office buildings at Skyline.

This measure defines walking distance for the Build Alternatives as up to ½ mile, as opposed to the ¼ mile distance for the Baseline Alternative. This is based on research and industry experience which indicates that riders are willing to walk longer distances to access premium service (O'Sullivan and Morrall, 1996). When the projected employment within ½ mile of Build Alternative station stops is compared to the projected employment within ¼ mile of Baseline Alternative station stops, the number of employees within walking distance of Build Alternative station stops is significantly higher.

Measure 1d: Future Population near Station Stops (within ¼ and ½ mile for Build Alternatives, within ¼ mile for Baseline/No Action Alternative)

Quantitative measure of forecast number of residents within ¼ mile and ½ mile of transit station stops.

Data Sources:

- MWCOG round 6.4a forecast data on population by TAZ for year 2030.
- List and map of proposed station stops for each Alternative.

Approach:

- Identify and map station stops.
- Establish ¼ mile and ½ mile radii around station stops.
- Determine forecast number of residents within ¼ mile of station stops for Baseline/No Action Alternative and within ½ mile of station stops for Build Alternatives.
- Where the entire TAZ falls within the ¼ or ½ mile radius, 100% of the projected population will be counted. Where smaller portions of TAZs fall within the radius, population density will be assumed uniform and the affected area of the TAZ will be rounded to the nearest one-quarter. In other words, 75%, 50%, 25% or 0% of that zone's population will be counted.

Results:

Because the station stops for the BRT Alternative and Streetcar Alternative are the same, the projected population within ½ mile and ¼ mile of station stops in 2030 is the same for both alternatives. There is also no difference between the projected population within walking distance of the Build Alternatives and the Baseline Alternative station stops for the ¼ mile radius.

This measure defines walking distance for the Build Alternatives as up to ½ mile, as opposed to the ¼ mile distance for the Baseline Alternative. This is based on research and industry experience which indicates that riders are willing to walk longer distances to access premium service (O'Sullivan and Morrall, 1996). When the projected population within ½ mile of Build Alternative station stops is compared to the projected population within ¼ mile of Baseline Alternative station stops, the number of residents within walking distance of Build Alternative station stops is significantly higher.

Ridership Criterion

Measure 1e: Estimated Transit Ridership

Quantitative measure of the estimated number of corridor trips taken using transit, compared across alternatives.

Data Sources:

- Corridor transit trips for the year 2030 from the MWCOG regional travel demand model.

Approach:

- Compare the total number of daily transit trips within the study area for the Baseline versus Build Alternatives

Results:

Of the many ways to compare estimated transit patronage within the corridor, one of the most useful is to compare the total number of transit trips within the study area for the Baseline versus Build Alternatives. Given the dense network of bus and rail service within the region, not all of these trips would be accommodated by the service (either Baseline or Build) running directly along Columbia Pike. More detail regarding projected boardings at individual station stops, locations of peak passenger loads, and demand levels with different alignments and station stop locations is presented in Section 6 of this report.

In general, where frequent high-quality transit service is available, daily ridership increases. The BRT and Streetcar Alternatives show significant improvement—44 percent and 47 percent, respectively—over the Baseline Alternative. The Modified Streetcar Alternative provides less premium transit service but attempts to minimize the need for passengers to transfer from one mode to another, especially during peak periods.

Measure 1f: Transit Passenger Capacity

Quantitative measure of the number of transit riders that can be accommodated in the corridor with each Build Alternative, compared with the Baseline/No Action Alternative.

Data Sources:

- Vehicle capacity specifications.
- Operating plans for each Alternative including the number of transit vehicles passing through the corridor per hour (frequency).

Approach:

- Determine capacity of transit vehicles for each Alternative.
- From the operations planning exercise, determine transit vehicle frequency for each Alternative.
- Multiply number of transit vehicles per hour (frequency) by the appropriate vehicle capacity for each Alternative to obtain transit capacity.
- Compare Build Alternatives against Baseline Alternatives.

Results:

The comparison was done assuming transit vehicle frequencies in a typical peak hour along Columbia Pike at George Mason Drive. This “screen line” location was chosen because this portion of the Pike has the most frequent bus service. The alternatives were compared for their maximum passenger capacity in the peak direction during a typical peak hour. Due to vehicle size, and the high frequency of service, the Streetcar Alternative shows the greatest passenger capacities. The Modified Streetcar Alternative shows a somewhat reduced capacity compared to the other Build Alternatives, but still accommodates the projected 2030 passenger demand.

BRT vehicles, Streetcars, and standard buses were assumed to be configured as shown in Table 5-2. For the Modified Streetcar Alternative, approximately half of the vehicles in the peak hour would be the same as for the Streetcar Alternative. The other half of the vehicles in the peak hour would be standard WMATA buses with a seating capacity of 40 people and 20 standees. See Table 6-6 for a full description of the capacities assumed for each vehicle and transit route.

Table 5-2: Assumed Vehicle Capacity

	Standard Bus	BRT Vehicle	Streetcar
Seated Passengers	40	46	44
Standees	20	60	90
Total Passengers	60	106	134

Measure 1g: Total Person Through-Put

Quantitative measure of the number of person trips the corridor is expected to accommodate for each Build Alternative compared with the Baseline/No Action Alternative.

Data Sources:

- Operating plans for each alternative including the number of transit vehicles passing through the corridor per hour (frequency).
- Any changes in roadway volume as a result of each Build Alternative.
- Output from the regional travel demand model.
- Output from the VISSIM traffic simulation model.

Approach:

- Use estimates of passenger demand for each Alternative.
- Model potential impacts to roadway volume for each Alternative.
- Use average auto occupancy to determine impacts to person trip volume.

Results:

This measure compared the predicted magnitude of transit passenger demand plus automobile travelers in the peak direction during a typical peak hour. As expected, the total estimated through-put varies in proportion to the forecasted ridership. The number of automobile trips expected along the Pike also varies somewhat by Alternative, with the Build Alternatives attracting a marginally higher number of automobile trips. However, the largest differences between the Baseline and Build Alternatives may be traced to the greater ridership that is attracted by the Build Alternatives. Total person through-put is expected to be greater for the Build Alternatives than for the Baseline Alternative.

The comparison was done assuming a “screen line” location along Columbia Pike at George Mason Drive. Average automobile occupancy was assumed to be 1.1 persons.

Traffic Conditions Criterion

<u>Measure 1h</u>: Intersection Levels of Service (LOS)

Quantitative measure of the estimated levels of service (LOS) for intersections along the corridor for each Build Alternative, compared with the Baseline/No Action Alternative.

Data Sources:

- Details of transit service changes.
- Details of Build Alternative characteristics.
- Output from the regional travel demand model.
- Output from the VISSIM traffic simulation model.

Approach:

- Determine future intersection LOS for each Alternative.

Results:

Intersection Level of Service (LOS) indicates the amount of traffic delay an intersection experiences. Levels of service are identified with a single letter, A through F. Intersections operating at LOS A have very low delay and excellent operating conditions. Intersections operating at LOS F have very poor conditions that result in significant delays to motorists. LOS ratings are computed according to the *Highway Capacity Manual*. Delays in certain ranges are assigned the corresponding LOS ratings A through F.

Most intersections experience little change in delay between alternatives, particularly those that are outside the proposed transitway corridor. However, the BRT Alternative and Streetcar Alternative experience almost twice the number of intersections operating at LOS E or F as the Baseline. Fewer intersections operate at LOS E or F in the Modified Streetcar Alternative than in the Baseline Alternative. A more detailed description of this analysis can be found in Section 6.3.4.

This increase primarily occurs at intersections where the transit vehicle is turning left, resulting in a halt to all other vehicular movements across the intersection.

<u>Measure 1i:</u> Automobile Travel Time between Jefferson Street/Columbia Pike and Pentagon City

Quantitative measure of the calculated travel time along the length of the Build Alternatives.

Data Sources:

- Details of transit service changes.
- Details of Build Alternative characteristics.
- Output from the regional travel demand model.
- Output from the VISSIM traffic simulation model.

Approach

- Determine the estimated travel times for different traffic conditions and times of day.
- Verify using new field tests or other collected travel time data.

Results:

Travel time along a corridor is a more intuitive measure of the level of congestion than delay measures. Since travel time is measured in minutes, roadway users can relate to the magnitude of changes in travel time between alternatives. This analysis shows very little change in automobile travel time among the alternatives. Eastbound (morning peak direction) travel times are three to four minutes longer than off-peak westbound travel times in all alternatives, but no alternative shows more than a minute of difference from any other alternative in one direction (see Tables 6-14 and 6-15).

5.2.2 Community and Economic Development

Support of County Revitalization Efforts Criterion

Measure 2a: Percentage of Revitalization Districts within Walking Distance of Station Stops (½ mile for Build Alternatives, ¼ mile for Baseline/No Action Alternative)

Quantitative measure of the percentage of Arlington and Fairfax County revitalization districts within ¼ mile of station stops for the Baseline/No Action Alternative and within ½ mile of station stops for the Build Alternatives.

Data Sources:

- List and map of proposed station stops for each alternative.
- List and map of Arlington County revitalization districts.
- List and map of Fairfax County revitalization districts.

Approach:

- Determine percentage of Arlington and Fairfax County revitalization districts within ¼ mile of station stops for the Baseline/No Action Alternative and within ½ mile of proposed station stops for the Build Alternatives.

Results:

Table 5-3 shows the percentage of land within county-designated revitalization districts that is within ¼ mile and ½ mile of the proposed station stops for each alternative. Because the proposed station stops for both Build Alternatives are the same, the percentage of land in revitalization districts within walking distance of station stops is the same for the BRT Alternative and the Streetcar Alternative. In Arlington County, percentages are roughly the same for the No Build and Build Alternatives. In Fairfax County, a significantly higher percentage of land in revitalization districts would be within walking distance of station stops under the Build Alternatives than under the No Build Alternative. This results from the new alignment on Jefferson Street and through Skyline.

Table 5-3: Percentage of Land in Revitalization Districts within Walking Distance of Station Stops

	Baseline		**Build**	
	¼ mile	**½ mile**	**¼ mile**	**½ mile**
Arlington County	97.7	100	97.6	100
Fairfax County	46.5	69.3	50.8	80.2
Combined Total	60.8	77.8	63.9	85.7

Measure 2b: Potential for Alternatives to Serve as Catalyst for Development

Qualitative measure of the likelihood that an alternative will make the corridor more attractive to developers.

Data Sources:

- Tri-County Metropolitan Transportation District of Oregon, "Portland Streetcar Fact Sheet," September 2003. http://www.trimet.org/inside/publications/pdf/railfactsheetstreetcar.pdf.
- Federal Transit Administration, Characteristics of Bus Rapid Transit for Decision-Making, August 2004. http://www.fta.dot.gov/documents/CBRT.pdf.
- American Public Transportation Association, "MBTA Opens First Leg of Silver Line BRT," http://www.apta.com/passenger_transport/thisweek/0729-2.cfm.
- Main Street Coalition, Independent Overview of the Economic Impact of Light Rail vs. Enhanced Bus – Main Street Corridor, Houston, Texas, August 1999.
- Dallas Area Rapid Transit, The Initial Impacts of the DART LRT System, Dallas, Texas, July 1998.
- Initial reaction from individuals and agencies involved in Columbia Pike revitalization efforts.

Approach:

- Discuss highlights of relevant studies from peer cities and transit operators

Results:

The Baseline Alternative has low potential to serve as a catalyst for development, the BRT Alternative has medium potential to serve as a catalyst for development, and the Streetcar Alternatives have high potential to serve as a catalyst for development.

These ratings are based on the experience of transit systems in the United States, and on surveys of the development community. In the United States there are more examples of fixed-rail systems such as light rail or streetcar lines spurring development than there are of BRT lines doing the same. Surveys of the development community also indicate that developers believe that investment along a streetcar line would yield a higher return than would investment along a BRT line. Both BRT and streetcar would have a greater development impact because of improved service and visibility. Rail systems are perceived to have a greater impact than BRT in part because of the higher visibility of rail and because rail is seen as a more permanent public investment. Because BRT is by definition a rubber tired bus, BRT vehicles can be diverted to other corridors. Streetcar vehicles, however, can only run in corridors where the investment in rails has been made.

<u>Measure 2c</u>: Probability of Private Sector Funding Support

Qualitative measure of the likelihood that an alternative will be supported financially by business owners and others along the study corridor.

Data Sources:

- Initial reaction from individuals and agencies involved in the public outreach portion of the Pike Transit Initiative.

Approach:

- List highlights of relevant studies from peer cities and transit operators.

Results:

The Baseline Alternative and the BRT Alternative have low probability of private sector funding support. The Streetcar Alternatives have a higher probability of private sector funding support.

The Columbia Pike Revitalization Organization (CPRO) has expressed interest in forming a special assessment district for the purpose of funding a Streetcar Alternative. This would be similar to the special assessment district which was formed in Portland, Oregon to help finance the construction of the Portland Streetcar.

5.2.3 Safety, Reliability, and Comfort

Accommodation of Transit, Auto, Pedestrian, and Bicycle Modes Criterion

Measure 3a: Accident rates for transit vehicles in environments similar to the project alternatives.

Measure 3b: Accident rates for pedestrians in environments similar to the project alternatives.

Measure 3c: Accident rates for bicycles in environments similar to the project alternatives.

Measure 3d: Accident rates for automobiles in environments similar to the project alternatives.

Qualitative measures of the safety of different modes.

Data Sources:

- Federal Transit Administration, Transit Safety and Security Statistics Annual Report, website, http://transit-safety.volpe.dot.gov/Data/Samis.asp.

Approach:

- Using information from the above data source, assess comparative safety of the Build Alternatives and the Baseline/No Action Alternative.

Results:

Analysis of accident rates for transit vehicles, pedestrians, bicycles, and automobiles was constrained by the available data. Available national transit safety data does not provide information on these accident rates separately. As a result, for this analysis two measures were used to determine the level to which the BRT Alternative and the Streetcar Alternatives would conflict with other demands for road space.

The number of collisions per ten million passenger miles measures incidents involving other vehicles, objects, or people. This number was used as a surrogate for the accident rates for transit vehicles in environments similar to the project alternatives.

The number of casualties per ten million passenger miles measures incidents in which people were hurt, but not as the result of collisions, derailments, or fires. This number was used as a surrogate for the accident rates for pedestrians in environments similar to the project alternatives.

No data was found which could serve as a surrogate for bicycle or automobile accident rates in environments similar to the project alternatives.

Transit Rider Visibility Criterion

Measure 3e: Crime Prevention through Environmental Design (CPTED) Standards Incorporated into Station Stop Concepts

Qualitative measure of the extent to which CPTED standards have been incorporated into station stop design concepts.

Data Sources:

- Transit Cooperative Research Program, Improving Transit Security, Washington, DC: 1997.
- Transit Cooperative Research Program, Emergency Preparedness for Transit Terrorism, Washington, DC: 1997.
- CPTED standards.
- Drawings and description of Baseline station stop concepts.

Approach:

- Compare drawings and description of station stop concepts with CPTED standards, and determine consistency of station stop concepts with standards.

Results:

Crime Prevention through Environmental Design (CPTED) standards aim to reduce opportunity for crime through the design of structures. For transit systems, this often means incorporating design elements that increase visibility to and from stops and station stops (riders can see what is going on around them, and passers-by can see riders) and maintaining cleanliness to improve the perception of safety. Strategies include better lighting, the use of transparent rather than opaque design and building materials, and the use of graffiti-resistant materials.

CPTED standards will be incorporated into the design of the Super Stops currently planned for Columbia Pike, which are part of the Baseline Alternative. CPTED standards will be used for all station stops in the Build Alternatives.

Ride Quality and Technical Reliability Criterion

Measure 3f: Passenger Comfort and Ride Quality

Qualitative measure of the comfort level of passengers on board the transit vehicle, including the smoothness of the ride and noise levels inside the vehicle, and the ease of entering and exiting the vehicle.

Data Sources:

- Industry experience relating to the ride quality of different modes

Approach:

- Determine the difference, if any, in ride quality for the Build Alternatives and the Baseline/No Action Alternative, based on relevant studies.

Typically, transit modes running on steel rails are judged superior in terms of ride quality. Embedded track is constructed to close tolerances, and vehicles are guided by the closely controlled wheel/rail interface.

Rubber-tired transit modes are typically operated along roadways designed for automobiles. Though the geometric standards are tightly controlled, construction tolerances tend to be less stringent. Maintenance does not by necessity bring the wheel/pavement interface back to an optimal level, as it does with steel-wheeled modes.

The disadvantage of BRT in terms of ride quality may be partially mitigated through reconstruction of the transit guideway. This analysis assumes such reconstruction and a “rail-like ride quality” as far as practicable. However, the quality of ride for the Streetcar Alternatives is still deemed superior.

Measure 3g: Average Frequency of Vehicle Breakdowns by Technology Type

Quantitative measure of the frequency with which different technologies break down.

Data Sources:

- National Transit Database

Approach:

- Determine the frequency of vehicle breakdowns for technologies proposed for use in the Build Alternatives and in the Baseline/No Action Alternative.
- Rank alternatives based on frequency of vehicle breakdowns.

Results:

The National Transit Database does not distinguish between standard bus and BRT vehicles, or between light rail and streetcar vehicles. Therefore, data on the frequency of vehicle breakdowns for bus and light rail vehicles was used. Although BRT vehicles have a number of features which distinguish them from standard buses, the basic technology (including form of propulsion and running way) is the same, and therefore it can be assumed that the frequency of breakdowns would be similar. Light rail and streetcar vehicles also share fundamental features which make it safe to assume that breakdown rates would be similar.

Based on this data, buses break down far more frequently than do light rail vehicles (approximately five times as often). Therefore, the Streetcar Alternatives are rated higher than the BRT Alternative.

5.2.4 Regional Connections

Regional Transit Travel Time Criterion

Measure 4a: Change in Transit Travel Time to Select Regional Activity Centers

Quantitative measure of the change in travel time on bus or rail transit between locations along the corridor and select regional activity centers.

Data Sources:

- Activity centers from the existing conditions report.
- Forecast 2030 transit travel time between TAZs on the corridor and regional activity centers.

Approach:

- For each Build Alternative, estimate transit travel time between corridor TAZs and the following regional activity centers: the Pentagon, the Skyline office complex, Old Town Alexandria, Tysons Corner, and Ballston.
- Establish change in transit travel time between corridor TAZs and regional activity centers based on comparison to the Baseline/No Action Alternative.

Results:

In general, transit travel times to regional activity centers from locations within the study area would be improved or unaffected by the Build Alternatives, as shown in Table 5-4. As expected, travel to the activity centers located within the study area—the Pentagon, Pentagon City, and Skyline—would be most affected by corridor transit improvements. With savings of between 0 and 11 percent, the Build Alternatives would bring minor improvements in travel times to the Pentagon and Pentagon City. Transit travel times to Skyline, on the other hand, would be improved by 18 to 27 percent with the improvements proposed in the Build Alternatives. Travel from the study corridor to the other activity centers—Alexandria, Tysons, and Ballston—would not be affected.

When the analysis of access to activity centers is extended to a regional level—not limited to trips originating within the study area—the Build Alternative improvements have measureable effects on travel to each of the five activity centers, as shown in Table 5-5. Travel time to Skyline would improve by 20 to 30 percent and travel time to Pentagon City would improve by between 4 and 8 percent, depending on the alternative.

Table 5-4: Percentage Savings over Baseline in Peak Period Person Transit Travel Time from Columbia Pike to Regional Activity Centers

Alternative	Activity Centers					
	Pentagon	Ballston	Alexandria	Tyson's Corner	Skyline	Pentagon City
BRT	1%	0%	1%	0%	29%	10%
Streetcar	2%	0%	1%	0%	30%	11%
Modified Streetcar (6 minute)	0%	0%	1%	0%	25%	8%
Modified Streetcar (12 minute)	0%	0%	1%	0%	17%	3%

Table 5-5: Percentage Savings over Baseline in Peak Period Person Transit Travel Time from Analysis Area to Regional Activity Centers

Alternative	Activity Centers					
	Pentagon	Ballston	Alexandria	Tyson's Corner	Skyline	Pentagon City
BRT	2%	7%	5%	1%	27%	7%
Streetcar	2%	7%	5%	1%	29%	8%
Modified Streetcar (6 minute)	1%	7%	5%	1%	22%	6%
Modified Streetcar (12 minute)	0%	7%	5%	1%	19%	4%

Measure 4b: Percentage of regional employment accessible by transit

Quantitative measure of the effect of each alternative on access to regional employment from the study corridor via transit

Data Sources:

- MWCOG data on 2030 transit travel times

Approach:

- Estimate percentage of 2030 regional employment accessible by transit from the study corridor in less than 60 minutes for each alternative.

Results:

This measure seeks to quantify the effects of the alternatives on regional transit connectivity. As shown in Table 5-6, each of the Build Alternatives has a small but positive effect on the number of jobs that become accessible through a one-hour transit trip.

Table 5-6: Number of TAZs Providing Access to Regional Employment within 60 minutes

Percentage of Regional Employment Accessible within 60 Minutes	Alternative				
	Baseline	BRT	Streetcar	Modified Streetcar (6 minute)	Modified Streetcar (12 minute)
Greater than 90%	0	6	6	5	5
Between 75% and 90%	183	201	202	191	189
Less than 75%	207	183	182	194	196

5.2.5 Community Goals

Consistency with Adopted Local Plans Criterion

Measure 5a: Columbia Pike Revitalization Recommendations Incorporated.

Qualitative measure of the extent to which the recommendations of various planning initiatives for the revitalization of Columbia Pike and Bailey's Crossroads have been incorporated into proposed transit improvements.

Data Sources:

- Columbia Pike Initiative: a Revitalization Plan (Arlington County)
- Arlington County Street Space Planning Task Force Final Report.
- Bailey's Crossroads Revitalization Plan (Fairfax County)
- Plans for physical alterations to the corridor for each of the Build Alternatives.

Approach:

- Determine degree to which proposed physical alterations to the corridor are consistent with planning initiative recommendations.

Results:

Arlington County Street Space Planning Task Force recommendations have been used to inform the Baseline and Build Alternatives throughout the Pike Transit Initiative. The three major goals of the Task Force--1) reduce speeds along the Pike, 2) minimize pedestrian crossing distances, and 3) increase sidewalk space—are all accommodated within the alternatives. However, the investment required to accomplish the goals is included to varying degrees in the alternatives: not enough funding is programmed or included in the Baseline Alternative to construct many of the recommended improvements. The BRT Alternative includes curb-to-curb street reconstruction and would therefore satisfy many of the Task Force recommendations. The level of construction assumed was similar to recent projects completed as part of Bailey's Crossroads revitalization. The Streetcar Alternatives as defined include less street reconstruction than the BRT Alternative, but would require more than the Baseline.

Aesthetics Criterion

Measure 5b: Potential visual impacts

Qualitative measure of the extent to which the improvements associated with each alternative affect visual perception of the environment along the study corridor.

Data Sources:

- Input from the public involvement process
- Published visual preference surveys

Approach:

- Present results of public involvement process and literature survey.

Results:

Both the Streetcar and BRT Alternatives have the potential to enhance, or detract from, the visual appeal and aesthetic experience of the overall streetscape. The potential variations of impacts created by the two alternatives are discussed below.

The type of vehicle propulsion technology to be used for the new transit service would have varying visual and noise effects along the corridor. To accommodate a Streetcar Alternative powered by electricity, new poles would be installed to support overhead wires. The overhead wires and connecting poles and substations could have a visual impact along the alignment and in areas of economic development initiatives. It is not anticipated that implementating BRT service would create any visual impacts beyond the existing conditions.

Measure 5c: Potential noise impacts

Qualitative measure of the extent to which the improvements associated with each alternative affect noise levels along the study corridor.

Data Sources:

- Published studies on the relative noise emissions of transit vehicles under each alternative
- FTA guidance on noise impact assessment

Approach:

- Present results of the literature survey
- Conduct a simplified noise modeling exercise

Results:

Similar to the potential visual impacts of two alternatives, the noise and vibration resulting from the construction and ongoing operation of the selected transit improvement may produce some short-term and/or long-term impacts on the community. Existing sources that contribute to the ambient background levels of noise and vibration include motor vehicles, buses, trucks and other ongoing construction activities located in the corridor. It is anticipated that both the construction and ongoing operation of the selected transit system, either BRT or Streetcar, will contribute to these existing noise levels. Two sources containing criteria relevant for detailed evaluation of noise impacts and related mitigation measures during future analysis include the following:

1. The Federal Transit Administration's (FTA) *Transit Noise and Vibration Impact Assessment* guidance manual (DOT-95-16, April 1995). In accordance with FTA

guidelines, vibration impacts would be assessed based on the level of new proposed vibration sources created by the proposed transit improvement.

2. WMATA noise criteria for both vehicles and facilities.

The specific type of noise impact caused by operation of the transit system will largely depend on whether a BRT or a Streetcar Alternative is selected. BRT systems typically use rubber-tired vehicles, such as the current WMATA buses operating along Columbia Pike, and would likely have overall noise effects similar to the existing transit service. Streetcar vehicles, powered by electricity, generally create less propulsion-related noise than do large buses using conventional engines, and could potentially provide a lower level of propulsion-related noise than under existing conditions and transit service. However, Streetcar vehicles operating on steel wheels on tracks may have some potential for noise impacts that are different in character from existing transit service. It is expected that any potential noise-related effects would likely occur at or near service and maintenance yards. Depending on the propulsion methodology selected, a BRT Alternative could present the potential for increased bus noise along with increased emissions and exhaust if the vehicles are powered by CNG or diesel fuel, as opposed to the Streetcar Alternatives which are powered by electricity.

Streetcars have the potential to create ground-borne vibration associated with vehicle movements, which is usually the result of uneven interactions between the wheel and the rail surfaces. Utilization of dampening materials for the Streetcar Alternatives or devices under switches and crossovers could reduce potential vibration impacts.

Noise levels from construction activities, although temporary, could create a nuisance to nearby community resources. Project construction activities could include street reconstruction, station stops and maintenance/storage facilities, and parking garages.

5.2.6 Capital and Operating Costs

Capital Costs Criterion

Measure 6a: Quantitative estimate of the scale of construction and related costs for each alternative. Includes systems, facilities, and vehicle procurement; does not include right-of-way acquisition or parking structure construction.

Data Sources:

- Fairfax County Columbia Pike reconstruction project
- Las Vegas BRT project
- Portland Streetcar engineer's construction estimates
- Tampa Streetcar contractor's bid
- Plans for physical alterations to the corridor for each of the Build Alternatives

Approach:

- Use representative costs from peer projects to develop estimates of project costs for each Build Alternative.
- Costs for line and facilities construction and vehicle procurement were included in the analysis, along with project planning/design and design contingencies.

Results:

Several features were consistent across all of the alternatives. Passenger station stops, for example, were assumed the same for all of the Build scenarios, including platforms, shelters, lighting, and off-vehicle fare collection. Utilities costs, traffic signal work, and general requirements were also assumed to be similar.

The Streetcar Alternative is significantly more expensive than the BRT Alternative because the combined costs of track construction, electrification, and more expensive streetcars outweigh the corresponding costs of street reconstruction and less expensive BRT vehicles. The BRT Alternative would cost between $110 million and $120 million to construct, and the Streetcar Alternative would cost between $185 million and $200 million to construct.

The shorter Modified Streetcar Alternative provides savings in terms of line and facilities construction, but the largest savings are due to the smaller fleet with an alignment that is shorter in length. The Streetcar Alternative would require some 27 vehicles, the Modified Streetcar Alternative would require 11 and 5 vehicles respectively for the 6- and 12-minute operating scenarios. The Modified Streetcar Alternative (6-minute operating scenario) would cost between $110 million and $120 million to construct.

Operating/Maintenance Costs Criterion

Measure 6b: Annual operations and maintenance costs based on assumed service levels, operating plans, and fleet sizes.

Data Sources:

- WMATA Metrobus operating statistics
- National Transit Database
- Columbus, Ohio streetcar cost model
- Portland, Oregon Streetcar

Approach:

- Use representative costs from peer projects to develop accurate estimates of project costs for each Build Alternative.
- The analysis considered the impacts on overall annual costs for several operational factors: peak vehicle requirements, revenue vehicle-miles, revenue vehicle-hours, number of passenger station stops, total route lengths, number and locations of maintenance facilities, and required administrative infrastructure.

Results:

The BRT Alternative would be less expensive to operate than the Streetcar Alternative, largely because BRT system operations are similar to the existing regional bus network. Operation of the Streetcar Alternative, on the other hand, assumes substantial new investment in personnel. In addition, a rail system typically assumes maintenance-of-way activities that would not be included in a bus or BRT operation. For this analysis it is assumed that the local jurisdictions would assume the costs of maintaining the guideway. However, additional roadway maintenance would be required in order to maintain a high “rail like” quality ride.

For the Streetcar and Modified Streetcar scenarios, estimated costs reflect the fact that for different levels of operating intensity, different levels of administrative and maintenance support would be required.

Operating and maintenance costs for current or Baseline bus service in the corridor total sine $7 million annually. The operating and maintenance costs for the Build Alternatives reflect reductions in corridor bus service. Using unit costs for WMATA bus operations, these reductions range from about $3.7 million for the initial BRT and Streetcar Alternatives, to about $2.2 million for the 12-minute operating condition for Modified Streetcar Alternative.