BROAD STREET RAPID TRANSIT STUDY: TECHNOLOGY ASSESSMENT

The purpose of this technical memorandum is to document the results of an initial screening of mode technologies for the Broad Street Rapid Transit Study based on technical attributes and order-of-magnitude costs. Several studies of the Richmond area over the past decade have analyzed the potential for transit improvements along the Broad Street Corridor. This document will review the findings of those studies with specific regard to the implications each mode would hold for the project, assess each of the technologies previously studied, and provide the basis for the decision to study in detail the implementation of BRT within the Broad Street Corridor.

1.0 BACKGROUND

The Broad Street Corridor runs through the heart of the Richmond, Virginia region. The initial phase of transit investment concerns a 7-mile portion of the corridor, connecting (from west to east) Willow Lawn in Henrico County, the museum district, Virginia Commonwealth University (VCU), the central business district (CBD), the state capitol, Main Street Station (currently intercity rail; potentially a center for high-speed rail) and the Rocketts Landing redevelopment area. The corridor also links the region's highest density residential neighborhoods and its most significant employment centers.

Broad Street itself is of considerable width, generally containing three travel lanes in each direction as well as a median. While the Richmond Area Metropolitan Planning Organization (RAMPO) does not define Broad Street as "impaired" or "congested" (where average speeds are significantly lower than posted speeds), they do use those designations for two adjacent parallel highway facilities (I-64 and I-95). All transit-related studies of the Richmond area over the last decade have identified the corridor as a priority for transit improvement. At present, the Greater Richmond Transit Company (GRTC) offers 39 fixed-route bus services, and most utilize or cross Broad Street at least once in their alignment. During the peak periods, the combined headway can average 75 seconds on some street segments in the CBD.

Though roughly a dozen of GRTC's lines run express with few or no stops between outlying areas and the CBD, the agency currently offers no premium service where transit vehicles operate in dedicated rights-of-way or receive preferential treatment on shared roadway.

2.0 ASSESSMENT OF TRANSIT TECHNOLOGIES

The initial range of alternatives includes four technologies: light rail transit, bus rapid transit, streetcar and enhanced bus service. For the purposes of this document, the term "technology" refers to the type of right-of-way (mixed traffic or exclusive), guidance (steered or guided) and propulsion (electric or internal

combustion). Each technology's combination of these attributes has major implications for its time, cost and mobility improvement potential within the Broad Street Corridor.

2.1 Light Rail Transit

Light rail transit (LRT) is the most capital-intensive alternative of those considered to date for the Broad Street Corridor. LRT operates as a single rail vehicle or a short train (two to four cars). Right-of-way can be exclusive, though it often operates with mixed traffic in CBDs. Along roadways and at intersections with high traffic volumes, the right-of-way may be grade-separated to reduce conflicts. Station spacings average ¼ of a mile to one mile depending on surrounding land uses and the desired speed of service.

Propulsion is usually drawn from overhead electric catenary lines; in rare cases onboard diesel engines are used. Overhead electric propulsion has the advantages of low noise and no local air pollution.

Several past studies have considered the implementation of LRT along the Broad Street corridor. The first report entitled Richmond Rail Transit Feasibility Study was completed for the Virginia Department of Transportation (VDOT) and RAMPO in 2003. One of their screened alternatives was a light rail line along Broad Street. (The alignment was slightly different than that currently proposed; it reached only Main Street Station to the east but extended to Short Pump in the west.) This roughly 14-mile line was estimated to cost $791M (2003 dollars). More recently, RAMPO completed the Richmond Regional Mass Transit Study (2008). This report analyzed a slightly longer route, but provided useful cost comparisons. They estimated a 17.6-mile Broad Street light rail line would cost $973M (2006 dollars).

2.2 Bus Rapid Transit

Bus Rapid Transit (BRT) shares right-of-way features with LRT, but not guidance or propulsion. BRT's service characteristics can be nearly identical to LRT. Speedy operation is achieved with dedicated right-of-way; longer stop spacing, traffic signal priority at intersections; and off-board fare collection with multiple points of entry/exit for rapid boarding. Additionally, both stations and vehicles are distinctively branded similar to rail transit services to attract greater ridership.

With respect to guidance and propulsion, BRT is similar to typical bus service. Vehicles are rubber-tired and steered by an operator. This characteristic can allow BRT to repurpose existing roadways for exclusive bus travel and forego much of the costly new infrastructure required by LRT. The lower level infrastructure investment makes BRT faster and less expensive to implement.

BRT propulsion almost always relies on the internal combustion engine. Compressed natural gas (CNG) or hybrid-electric diesel buses are often used in urban areas to help meet regional air quality goals. BRT vehicles are smaller than LRT vehicles and do not have the capability of making a train. However, BRT often uses articulated vehicles to increase line capacity.

BRT has been considered in several of the recent Richmond-area transportation studies. A 2008 Comprehensive Operations Analysis (COA) of the GRTC proposes BRT for the 7.3-mile alignment now being considered in this assessment of alternatives process. Later that same year, the Richmond Area Metropolitan Planning Organization (RAMPO) adopted the findings of the Richmond Regional Mass Transit Study which set forth a transit system plan for the Richmond Metropolitan area. This study, conducted in coordination with GRTC's COA, produced a plan of action for the development and

implantation of regional mass transit programs over the mid-range and long-range with consideration given to corridor prioritization.

As a part of this study, multiple technologies were studied for the major transportation corridors in the region, including Broad Street. As shown in the following table, this plan recommends a phased implementation approach for transit improvements in the region and the Broad Street Corridor.

RECOMMENDATIONS OF THE RICHMOND REGIONAL MASS TRANSIT STUDY

TIER	DESCRIPTION	BROAD STREET RECOMMENDATIONS
I	Corridors and modal alternatives that existing development patterns could support	BRT on Broad Street from Rocketts Landing to Willow Lawn
II	Corridors and modal alternatives that projected development patterns for 2031 could support	BRT on Broad Street from Rocketts Landing to Short Pump
III	Corridors and modal alternatives that would require significant changes to projected development patterns by 2031 to be supported	LRT on Broad Street from Rocketts Landing to Short Pump

Implementation of both BRT and LRT were studied relative to the Broad Street Corridor. However, LRT was only considered feasible after 2031 given its substantially higher capital and operating costs. For the 17.6-mile route to Short Pump, LRT was estimated to carry a $973M capital cost and BRT alternative was estimated to cost only $54.4M (2006 dollars). Using those values on a per mile basis, the 7.3-mile route envisioned for Tier I or first phase would run $404M for LRT and $23M for BRT (2006 dollars).

2.3 Streetcar

Streetcars share technical elements of both LRT and regular bus service. Like LRT, streetcars use a steel rail guideway and overhead electric propulsion. This technology can be implemented at a lower cost than LRT; however, it costs substantially more than BRT. Depending on design criteria and local conditions, streetcar tracks can sometimes be placed in existing streets for a much lower capital investment than LRT. Streetcar vehicles tend to be lower profile and lower capacity than LRT vehicles. They are most frequently used for circulation within an urban district, not as a link between multiple urban districts.

Their right-of-way and service characteristics are almost identical to local bus service. Streetcars operate in mixed traffic and make frequent stops (every 2-4 blocks), keeping average travel speeds low.
Stops may consist of a weather-protected shelter, but often do not have the amenities associated with an LRT station.

In 2004, GRTC conducted the Downtown Richmond Streetcar Study to study in more detail specifically what a streetcar network might look like in Richmond. Planners envisioned a 5-phase process, with an initial alignment on Broad Street. This first phase would run only 1.8 miles, however, at a cost of $42M (2004 dollars). Using that per mile figure along the proposed 7.3-mile route would place the full capital cost in the range of $180M (using the CPI to adjust to 2006 dollars, for comparison to LRT and BRT figures above).

3.0 Summary of Previous Studies

The chart on the following page summarizes the previous studies of transit improvements in the Richmond area.

PREVIOUS STUDIES OF TRANSIT IMPROVEMENTS IN THE BROAD STREET CORRIDOR

Study	Date	Modes Considered	Estimated Capital Cost[1, 2]	Estimated Ridership	Comments
Richmond Rail Transit Feasibility Study (VDOT and RAMPO)	June 2003	Light Rail Transit	$451M	33,700 rides/day for 13.5-mile route (Main Street Station to Short Pump)	Forecasts for cost and ridership based on sketch models derived from other light rail systems; ridership estimate exceeds the number of households identified as within ½ mile of the route by 10,400
Downtown Richmond Streetcar Study (GRTC)	Sept. 2004	Streetcar	$180M	1,000 to 3,000 rides/day for 1.8-mile route (Main Street Station to VCU)	Forecasts for cost and ridership based mostly on comparability with other streetcar systems, not on local conditions or travel demand models
Comprehensive Operations Analysis (GRTC)	March 2008	Bus Rapid Transit	No cost estimate	No specific ridership forecast, but points out that route 6 very closely follows the proposed 7.6-mile alignment with 3,600 rides/day	Route 6 ridership is a useful baseline, but given that around 20 other routes currently use some portion of Broad Street and the potential to attract new users, actual ridership would likely be higher
Richmond Regional Mass Transit Study (DRPT and RAMPO)	May 2008	Bus Rapid Transit	$23M	14,000 rides/day for 17.6-mile route (Rocketts Landing to Short Pump)	Ridership estimate is an assumed 1% mode share of total trips projected for the corridor in 2031 by RAMPO
		Light Rail Transit	$404M	Same as above	

Notes: [1] Per mile costs adjusted to fit a 7.3-mile route and given in 2006 dollars; [2] Adjusted to 2006 dollars using the Consumer Price Index (CPI).

All of the studies outlined in the chart on the previous page were performed at the feasibility scale. Each one advised further analysis before moving forward with any sort of project implementation. Ridership estimates have been particularly rough and may have overstated potential in some cases. Analysis using a regional travel demand model is now necessary to gauge the likely benefits of transit investment. More sophisticated cost estimates are also necessary. However, it is already clear that both LRT and streetcar options would involve significantly higher capital costs than BRT.

4.0 SCREENING ANALYSIS

A synthesized evaluation of the technology alternatives is presented below.

BRT would be a cost-effective means of meeting near- and long-term transit needs.

At reasonable capital cost, BRT would provide the region with its first premium transit service. The *Richmond Regional Mass Transit Study* devised a three-tiered implementation approach for improving transit (see table in section 2.2). The study placed a Willow Lawn-Rocketts Landing BRT project on Tier I, defined as a service for which current land development and travel patterns indicate there is sufficient demand. An LRT option was placed on Tier III, indicating significant risk it would not be an effective investment without substantial changes to the growth patterns projected for the region.

These findings would not preclude planners from envisioning alternative higher-density growth patterns. However, until it becomes clear that growth patterns are indeed changing, BRT can provide a practical near-term solution under the Small Starts program while opening the door to various long-term alternatives.

BRT would support plans for expanding and enhancing transit services in the region.

Organizations including the DRPT, RAMPO and GRTC have all expressed interest in introducing premium transit service in Richmond. The most recent studies undertaken by those agencies (*Comprehensive Operations Analysis* and *Richmond Regional Mass Transit Study*) both identified BRT as the appropriate mode technology for initial investment in the Broad Street Corridor. Likewise, preliminary engineering for BRT is included in RAMPO's 2009-2012 Transportation Improvement Program (TIP) and full BRT construction is included in RAMPO's 2031 Long-Range Transportation Plan.

The proposed alignment would support other regional transportation plans. The GRTC *Comprehensive Operations Analysis* calls for five new transit centers, three of which are on the 7.3-mile proposed route. These locations would be the transfer hubs of a rationalized route system for all GRTC buses. A transit center in downtown could serve as a major intermodal connection for the region. The City, GRTC and Amtrak are working to integrate buses, airport shuttles, taxis, intercity trains and, possibly, high-speed trains at this location. BRT on Broad Street and at Main Street Station would provide visitors and travelers with a high quality transit connection to many of Richmond's major destinations.

BRT would comply with regional plans and support local development plans.

The City of Richmond has a future land use agenda that prioritizes transit supportive development. Its draft *Richmond Downtown Plan* calls for a density and mix of land uses compatible with increased transit use. The *Plan* specifically endorses the BRT project recommended in the GRTC *Comprehensive Operations Analysis* with an eye toward possible future conversion to a rail mode.

Henrico County also has transit supportive land use plans. Its Urban Mixed Use zoning designation could provide the right framework for transit-oriented districts at route terminals in Rockett's Landing and Willow Lawn.

Because light rail or streetcar would follow the same alignment as BRT, they would offer very little in terms of cost savings and would introduce additional impacts.

Guided modes of transportation require great infrastructure investment. While all modes would involve the purchase of vehicles, LRT and streetcar would have the added capital expense of track and overhead catenary. A streetcar might provide some cost savings by foregoing the construction of stations and physically separated right-of-way, but those cost savings would not compare to the added costs of track and electrical systems. Given the generous width of Broad Street, exclusive right-of-way would not require much additional land acquisition, making it a negligible cost consideration. Since neither a BRT nor an LRT project proposes significant grade separation, travel times along the corridor between the two would be comparable.

Rail modes have lower noise and no local air pollution impact, but it is important to remember that a BRT trunk line on Broad Street with feeder service to transfer stations would also result in a net decrease in bus traffic, reducing existing inputs to local noise and air pollution.

Current forecasts of population and employment growth indicate that the increased capital and operating costs of light rail and streetcar would not be offset by commensurate increases in ridership benefits.

LRT does provide the opportunity for greater line capacity, and rail modes can prove more effective at attracting choice riders. However, current forecasts for population and employment do not indicate there will be sufficient growth along the Broad Street corridor to produce the kind of immediate demand necessary to justify the additional infrastructure costs. Should future trends shift substantially enough to warrant reconsideration, BRT investment in exclusive right-of-way, stations, traffic signal priority and off-board fare collection can serve as a preliminary investment in higher capacity services.

The additional capital requirements and costs associated with light rail and streetcar would make them uncompetitive candidates for Small Starts funding.

Local officials have expressed interest in applying for a grant through the FTA's Small Starts Program for this project. A stipulation of that program limits FTA grants to $75M and limits total project cost to $250M. Such restrictions would likely make the full 7.3-mile route ineligible for Small Starts funding with LRT as the selected mode. Streetcar might also push the limits of Small Starts funding. With low prospects for significantly higher ridership in the near and medium terms, the almost tenfold higher capital cost for streetcar would make it less competitive in an FTA grant application.

5.0 CONCLUSION

The above evaluation indicates BRT would be the most cost-effective investment for the Broad Street Corridor at the present time. Its technical attributes would allow it to address local transportation needs, support economic development plans and achieve environmental objectives, all within difficult fiscal constraints. Most importantly, the lower capital costs of BRT would make it a more competitive candidate for Small Starts funding, while offering the opportunity to phase in rail alternatives once ridership and land use in the study area warrant further investment.