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Report to Congressional Requesters

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MASS TRANSIT

Bus Rapid Transit Shows Promise

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Contents

Abbreviations

FTA	Federal Transit Administration
GAO	General Accounting Office
HOV	High-Occupancy Vehicle

GAO
Accountability * Integrity * Reliability

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Congressional Requesters

Each day millions of Americans face traffic congestion as they commute to work in automobiles. The impact from this congestion is substantial in time, resources, and pollution. For example, it is estimated that in 68 urban areas congestion cost U.S. travelers 4.5 billion hours of delay, 6.8 billion gallons of wasted fuel, and $78 billion in 1999.[1] In an attempt to present buses as a more reliable and effective high-speed transit alternative, a concept involving the improved use of buses--Bus Rapid Transit--has emerged. Bus Rapid Transit includes operating buses on exclusive bus highways, High-Occupancy Vehicle (HOV) lanes, or improving service on busier routes on city streets. Bus Rapid Transit may also include a variety of technological and street design improvements, including traffic signal prioritization for buses; exclusive lanes; better stations or bus shelters; fewer stops; faster service; and cleaner, quieter, and more attractive vehicles.

Bus Rapid Transit as a comprehensive transportation option is exemplified in Curitiba, Brazil. Curitiba's Bus Rapid Transit system is an extensive commuter bus system that includes exclusive busways and a number of other features designed to increase speed, such as traffic signal prioritization, rail-like stations with level-floor boarding, and advance fare collection. In the United States at least 17 cities are planning to incorporate aspects of Bus Rapid Transit. The Department of Transportation's Federal Transit Administration (FTA) has begun to support this concept and expand awareness of new ways to design and operate high capacity Bus Rapid Transit systems as an alternative to building Light Rail systems. Light Rail systems generally are electric trains that may operate on streets with other traffic.

[1]The 2001 Urban Mobility Report, Texas Transportation Institute, Texas A&M University System, 2001.

Figure 1: Example of Bus Rapid Transit System

Busway in Charlotte, NC

Source: Charlotte area transit system.

You asked us to (1) examine the federal role in supporting Bus Rapid Transit; (2) compare the capital costs, operating costs, and performance characteristics of Bus Rapid Transit and Light Rail systems; and (3) describe the other advantages and disadvantages of Bus Rapid Transit and Light Rail.

To address these questions, we identified where Bus Rapid Transit is being used extensively in the United States and determined how FTA supports Bus Rapid Transit projects. In addition, we visited transit agencies in Dallas, Denver, Los Angeles, Pittsburgh, San Diego, and San Jose to obtain capital and operating cost information on Bus Rapid Transit and Light Rail systems in those cities. We also interviewed FTA officials and industry experts to identify the advantages and disadvantages of Bus Rapid Transit and Light Rail systems. Appendix I provides a detailed discussion of our scope and methodology.

Results in Brief

Federal support for Bus Rapid Transit projects may come from several different sources, including FTA's New Starts, Bus Capital, and Urbanized

Area Formula Grants programs, but its use is constrained. Two Bus Rapid Transit projects have received funding commitments from the current New Starts Program, totaling about $831 million. Few additional Bus Rapid Transit projects will likely receive funding commitments under the current New Starts Program, which expires in 2003, because (1) few Bus Rapid Transit projects are ready to compete for funding, (2) there are a large number of projects eligible to compete for the approximately $462 million that is projected to remain available for fiscal year 2003, and (3) certain types of Bus Rapid Transit projects are not eligible for New Starts funding due to the requirement that projects operate on separate right-of-ways for the exclusive use of mass transit and high-occupancy vehicles. FTA also supports Bus Rapid Transit through a demonstration program that began in 1999. Under this program, $50,000 was provided to each of 10 initial grantees to improve information sharing among transit agencies about issues pertaining to Bus Rapid Transit. The demonstration program is designed to determine the extent to which Bus Rapid Transit can increase ridership, improve efficiency, and provide high-quality service. The grantees' projects include dedicated busways, bus lanes on city arterial streets, improved technology on buses, and other innovations.

The Bus Rapid Transit systems generally had lower capital costs per mile than the Light Rail systems in the cities we reviewed, although neither system had a clear advantage in operating costs. Adjusting to 2000 dollars, the capital costs for the various types of Bus Rapid Transit systems in cities that we reviewed ranged from a low of $200,000 per mile for an arterial street-based system to $55 million per mile for a dedicated busway system (see table 1). Light Rail systems had capital costs that ranged from $12.4 million to $118.8 million per mile.

Table 1: Capital Costs for Selected Bus Rapid Transit and Light Rail Projects

Project type	Number of facilities examined	Capital cost per mile	
		Cost range	Average cost
Bus Rapid Transit			
Busways	9	$7 million to $55 million	$13.5 million
HOV lanes	8	$1.8 million to $37.6 million	$9.0 million
Arterial streets	3	$200,000 to $9.6 million	$680,000
Light Rail	18	$12.4 million to $118.8 million	$34.8 million

Source: Our analysis of data supplied by FTA and local transit agencies. We did not independently verify this information. See appendix I for additional details on the methodology used.

Precise operating cost comparisons for Bus Rapid Transit and Light Rail systems within and between cities are difficult due to differences among transit agencies, transit systems, and how they account for costs. We found mixed results when we compared the operating costs for Bus Rapid Transit and Light Rail systems in the cities we reviewed that operated both types of systems. Bus systems generally had lower vehicle operating costs. However, we found no clear pattern for operating cost per trip. In some cases Light Rail had higher operating costs per trip than Bus Rapid Transit, and in other cases the reverse was true. The performance characteristics of Bus Rapid Transit and Light Rail systems also varied widely, with the largest Bus Rapid Transit system ridership about equal to the largest Light Rail ridership. Finally, Bus Rapid Transit routes showed generally higher operating speeds than the Light Rail lines in these cities.

Bus Rapid Transit and Light Rail systems offer various advantages and disadvantages. Bus Rapid Transit provides a more flexible approach than Light Rail because buses can be routed to eliminate transfers; operated on busways, HOV lanes and city arterial streets; and implemented in stages. However, transit officials repeatedly noted that buses have a poor public image. As a result, transit planners are designing Bus Rapid Transit systems that offer improved service from standard bus service. Transit officials believed that because Light Rail is permanent in a given corridor it could influence economic development over time. Such long-term changes, they said, help justify the higher capital cost of Light Rail.

Background

Bus Rapid Transit involves coordinated improvements in a transit system's infrastructure, equipment, operations, and technology that give preferential treatment to buses on urban roadways. Bus Rapid Transit is not a single type of transit system; rather it encompasses a variety of approaches, including buses using exclusive busways or HOV lanes with other vehicles, and improving bus service on city arterial streets. Busways--special roadways designed for the exclusive use of buses--can be totally separate roadways or operate within highway rights-of-way separated from other traffic by barriers. Busways currently exist in Pittsburgh, Miami, and Charlotte. Buses on HOV lanes operate on limited-access highways designed for long-distance commuters. Dallas, Denver, Houston, Los Angeles, and Seattle provide examples of extensive HOV lane use by buses.[2] Bus Rapid Transit on busways or HOV lanes is sometimes characterized by the addition of extensive park and ride facilities along with entrance and exit access for these lanes. Bus Rapid Transit systems using arterial streets may include lanes reserved for the exclusive use of buses and street enhancements that speed buses and improve service. Los Angeles recently instituted a Bus Rapid Transit type of service on two bus arterial corridors.

Bus Rapid Transit may also include any of the following features:

- Traffic signal priority. Buses receiving an early or extended green light at intersections reduce travel time–in Los Angeles, for example, by as much as 10 percent.
- Boarding and fare collection improvements. Convenient and rapid fare collection through prepaid or electronic passes and low-floor and/or wide-door boarding results in timesavings.
- Limited stops. Increasing distances between stations or shelters improves operating speeds.
- Improved stations and shelters. Bus terminals and unique stations or shelters differentiate Bus Rapid Transit service from standard bus service. (See fig. 2.)
- Intelligent Transportation System technologies. Advanced technology can maintain more consistent distances between buses and inform passengers when the next bus is arriving.

[2]Los Angeles and Houston originally built part of their systems as exclusive busways and later converted them to HOV facilities.

- Cleaner and quieter vehicles. Improved diesel buses and buses using alternative-fuels are cleaner than traditional diesel buses.
- Exclusive Lanes. Traffic lanes reserved for the exclusive use of buses help buses pass congested traffic.

Figure 2: Examples of Bus Rapid Transit Facilities in Los Angeles and San Diego

Source: Los Angeles Metropolitan Transportation Authority and San Diego Metropolitan Transit Development Board.

Light Rail transit is a metropolitan-electric railway system characterized by its ability to operate in a variety of environments such as streets, subways, or elevated structures. (See fig. 3 for an example of a Light Rail System.) Since Light Rail systems can operate on streets with other traffic, they typically use an overhead source for their electrical power and boardings take place from the street or platforms. According to a transportation consultant, because Light Rail systems operate in both exclusive and

shared right-of-way environments, they have stricter limits on their length and the frequency of service than heavy rail systems.[3]

Figure 3: Light Rail Transit in San Diego

Source: San Diego Metropolitan Transit Development Board.

Light Rail systems gained popularity as a lower-cost option to heavy rail systems, and a number of cities have constructed Light Rail projects over the past 20 years. Since 1980, Light Rail systems have opened in 13 metropolitan areas: Baltimore, Buffalo, Dallas, Denver, Northern New Jersey (Hudson and Bergen counties), Los Angeles, Pittsburgh, Portland, Sacramento, San Diego, San Jose, St. Louis, and Salt Lake City. Several other cities, including Minneapolis and Seattle, are in the process of planning Light Rail systems.

[3]Heavy rail transit systems, such as in New York City, Chicago, and Washington, D.C., are defined by their operation on a totally separated right-of-way, and use a third rail on the ground to power the trains. Heavy rail systems require platform boarding, typically have longer distances between stations, and have greater capacity than Light Rail systems.

Federal Funding Available for Bus Rapid Transit Projects, but Use Is Constrained

While there is no federal program specifically designed to fund Bus Rapid Transit, several FTA programs can be used to help fund these projects. FTA provides funding for new Bus Rapid Transit projects primarily through its New Starts Program but eligible projects face stiff competition from Light Rail, Heavy Rail, and Commuter Rail projects. Funding for additional New Starts projects of all types is constrained--FTA projects little remaining authority to make funding commitments to new projects and the Transportation Equity Act for the 21st Century (TEA-21) identified a large number of projects eligible for funding under the program. In addition to the New Starts Program, transit agencies may use other FTA funds, such as those from the Bus Capital Program and the Urbanized Area Formula Grant Program, to fund Bus Rapid Transit projects. However, the Bus Capital Program grants tend to be relatively small, thus limiting this program as a significant contributor to large projects. In addition, some Bus Rapid Transit projects may qualify for certain types of federal highway funding, notably Surface Transportation Program and Congestion Mitigation and Air Quality Improvement funds administered through the Federal Highway Administration. Since these funds are provided to state governments, local transit agencies must compete with many other state needs for these funds. In addition to providing capital funding, FTA began a demonstration program in 1999 to highlight the benefits of Bus Rapid Transit. Under this program, FTA awarded $50,000 grants to 10 transit agencies to share information and data on new Bus Rapid Transit projects. The program provides workshops and information-sharing opportunities for the transit agencies, but no capital funding. The grantees' projects include a wide variety of busways, arterial bus lanes, and bus technologies.

New Starts Funding Provided to Few Bus Rapid Transit Projects

FTA's New Starts Program is the primary federal program to support construction of new transit systems and extensions to existing systems. Projects for bus and rail systems that operate on exclusive rights-of-way compete for FTA grants of up to 80 percent of their costs.[4] To obtain funds, a project must progress through a local or regional review of alternatives, develop preliminary engineering plans, and meet FTA approval of final design. FTA proposes New Starts projects to the Congress for funding on an annual basis based on an evaluation of their technical merits, including mobility improvements and cost effectiveness, and the stability of the local financial commitment. In making its funding proposal each year, FTA gives preference to projects with existing grant agreements. Following that, consideration is given to projects with overall ratings of "recommended" or "highly recommended" under the evaluation criteria. The Transportation Equity Act for the 21st Century authorized about $6 billion in "guaranteed" funding over 6 years for New Starts transit projects.[5]

[4]A Full Funding Grant Agreement establishes the terms and conditions for federal participation, including the maximum amount of federal funds to be made available to the project. The administration has recommended reducing the cap on new starts funding to 50 percent of a project's cost starting in 2004 to ensure that local governments play a major role in funding these transit projects. As under the current program, transit agencies could supplement New Starts funds with other federal funds for a total federal contribution of up to 80 percent.

[5]These funds are subject to a procedural mechanism designed to ensure that minimum amounts are provided each year. In addition, TEA-21 authorized FTA to make contingent commitments subject to future authorizations and appropriations. This contingent commitment authority is designed to allow FTA to execute grant agreements that extend beyond the 6-year authorization period.

Bus Rapid Transit projects compete with many other projects for New Starts funding, including Light Rail, Heavy Rail, and Commuter Railroads. In total there are over 200 projects in various stages of development. As shown in table 2, for the 26 projects with Full Funding Grant Agreements in fiscal year 2001, two projects with Bus Rapid Transit components have commitments of about $831 million in New Starts funds.[6] The total New Starts commitment for these 26 projects is about $8.3 billion, which includes $4.67 billion for Light Rail, $2.69 billion for Heavy Rail, and $111 million for Commuter Rail projects.[7]

Table 2: New Starts Program Funding for Bus Rapid Transit Fiscal Year 2001

Dollars in millions

Category of projects	Number of New Starts projects	Actual or proposed funding[a]	Number of Bus Rapid Transit projects	Actual or proposed funding[a]
Projects with Full Funding Grant Agreements	26	$8,296	2	$831
Projects pending Full Funding Grant Agreements	2	157	0	0
Projects in final design	9	1,456	1[b]	23
Projects in preliminary engineering	31	8,350	6[c]	490
Other projects authorized	137	N/A	5[d]	N/A
Total	**205**	**$18,259**	**14**	**$1,344**

Legend: N/A = Not applicable.

[a]For projects with Full Funding Grant Agreements, figures represent amounts committed while figures for other categories represent amounts being proposed by transit agencies for New Starts funding.

[b]Miami, FL, South Miami-Dade Busway Extension project.

[c]Specifically identified Bus Rapid Transit projects are in Cleveland, OH; Hartford, CT; Los Angeles, CA; Miami, FL; Stamford, CT; and Washington, D.C.

[d]The five locations that have identified projects with aspects of Bus Rapid Transit are Bridgeport, CT; Chicago, IL; Honolulu, HI; and two in Boston, MA.

[6]Houston received a commitment of $500 million in New Starts funds for systemwide bus improvements, including Bus Rapid Transit elements. It is not solely a Bus Rapid Transit project.

[7]Funding commitments for some of the projects were made under prior authorizations.

Source: GAO analysis of FTA data.

For a number of reasons, few Bus Rapid Transit projects are likely to be considered for New Starts funding in the final year of the period covered by TEA-21. First, few Bus Rapid Transit projects are ready for funding consideration. Only 1 of the 11 projects with pending grant agreements or in the final design stage is a Bus Rapid Transit project. Further, of the 31 projects in the preliminary engineering stage that have proposed about $8.3 billion in support from the New Starts program, only 6 Bus Rapid Transit projects proposing about $490 million are included. Reasons for the relatively few projects being ready for funding consideration include the newness of the Bus Rapid Transit concept and the decisions of local transit agencies, which are responsible for conducting analyses of various alternatives and proposing projects for funding. Second, FTA's authority to make new funding commitments for projects of any type will be highly limited through 2003 if FTA makes the funding commitments proposed in its fiscal year 2002 New Starts report and funding request. It projects about $462 million in remaining commitment authority for the last year of the current program. Lastly, some Bus Rapid Transit projects are not eligible for New Starts funding because projects must operate on separate rights-of-way for the exclusive use of mass transit and high-occupancy vehicles. While some Bus Rapid Transit projects, such as busways, would fit this requirement, some would not. For example, the Wilshire-Whittier Bus Rapid Transit Service in Los Angeles operates on city streets in mixed traffic; it is not, therefore, on a separate right-of-way.

Agencies Can Use Other Federal Funds for Bus Rapid Transit Projects

Local transit agencies may use other types of federal funds, in addition to New Starts funds, to build Bus Rapid Transit and other systems. For example, transit agencies can apply funds obtained through FTA's Urbanized Area Formula Grant program to Bus Rapid Transit and rail projects. This program provides capital and operating assistance to urbanized areas with populations of more than 50,000. However, areas with populations over 200,000 may only use the funds for capital improvements. For example, in fiscal year 2001, one Bus Rapid Transit project, Boston's Silver Line project, planned to use $150 million from the formula grant program, about $331 million from the New Starts Program, and $120 million in Massachusetts state bond funds. In addition, one commuter rail, one heavy rail, and six Light Rail projects planned to use about $629 million in formula grant funds, in addition to New Starts funds, as part of their overall funding.

An additional potential source for bus system improvements is the Bus Capital Program, which provides funds to states and local transit agencies for bus improvements. This program is characterized by a large number of relatively small grants. For example, for fiscal year 2001 the Congress appropriated about $574.1 million for 314 grants, ranging from $39,000 to $15.5 million; the largest amounts typically were provided for statewide bus grants. While these funds can be combined with funds from other programs, such as New Starts, they are generally not sufficient to fund a major Bus Rapid Transit project alone.

Bus Rapid Transit and other transit projects can qualify for certain types of federal highway funds administered by the Federal Highway Administration. For example, transit agencies have used Surface Transportation Program and Congestion Mitigation and Air Quality Improvement funds to help pay for transit projects.[8] Neither of the two Bus Rapid Transit projects with Full Funding Grant Agreements in fiscal year 2001 planned to use federal highway funds. Six of the Light Rail projects with Full Funding Grant Agreements plan to use about $171 million in federal highway funds. The South Miami-Dade Busway Extension project in Final Design plans to use about $39 million in these funds.

FTA Supports Bus Rapid Transit Concept Through Demonstration Program

From FTA's perspective, Bus Rapid Transit is a step toward developing public transit systems that have the performance and appeal of Light Rail transit, but at a lower capital cost. FTA contends that using technological advancements will allow buses to operate with the speed, reliability, and efficiency of Light Rail. FTA promotes the Bus Rapid Transit concept with the slogan "think rail, use buses."

[8]Among other things, Surface Transportation Program funds are provided to states to be used for the capital costs of transit projects. Congestion Mitigation and Air Quality Improvement Program funds are generally available to states for transportation projects designed to help them meet the requirements of the Clean Air Act.

In 1999, the FTA initiated a demonstration program to generate familiarity and interest in Bus Rapid Transit. The goal of the program was to promote improved bus service similar to model systems in Curitiba, Brazil; Adelaide, Australia; and Ottawa, Canada, as an alternative to more capital-intensive rail projects. The program initially provided $50,000 to 10 transit agencies to share information and data on new Bus Rapid Transit projects.[9] FTA wanted the Bus Rapid Transit program to show how using technological advancements and improving the image of buses would allow buses to increase ridership and operate with the speed, reliability, and efficiency of Light Rail. The grantees in the demonstration program may be eligible for federal capital funds such as New Starts, Bus Capital, and Urbanized Area Formula Grant funds. FTA has held workshops for consortium members focusing on developing Bus Rapid Transit's component features, such as vehicles, image, marketing, fare collection, and traffic operations. (See fig. 4.)

[9]FTA recently added Los Angeles to the Demonstration program and provided funding. The program includes six additional members of the Bus Rapid Transit consortium. These consortium members do not receive direct funding, but attend workshops and support the program goals.

Figure 4: Initial Bus Rapid Transit Demonstration Projects and Consortium Members

Source: FTA.

Some locations participating in the demonstration program have more extensive elements of a Bus Rapid Transit system than others. For example, Miami and Charlotte have busways for the exclusive use of buses, while San Jose is implementing technological and service improvements such as signal prioritization on a high-ridership HOV lane arterial corridor. In Eugene, plans are to purchase buses that will have a train-like

appearance and operate on special bus lanes (see fig. 5). In Cleveland, an extensive Bus Rapid Transit project is planned that involves the extensive reconstruction of Euclid Avenue, including signal prioritization, bus station structures, and reconstruction of the sidewalks along the corridor. Table 3 illustrates the variations in the Bus Rapid Transit concept among the 10 initial demonstration projects.

Figure 5: Artist Renderings of Planned Bus Rapid Transit System in Eugene, Oregon

Source: FTA.

Table 3: Elements of Bus Rapid Transit in the FTA Demonstration Projects

	Boston	Charlotte	Cleveland	Washington, D.C., Dulles	Eugene	Hartford	Honolulu	Miami	San Juan	San Jose
Busways		•			•	•		•		
Bus lanes	•	•	•			•		•		
Bus on HOV-Expressways		•		• [a]			•		•	
Signal priority		•	•	•	•		•			
Fare collection improvements			•	•	•					•
Limited stops	•		•	•	•		•	•		•
Improved stations & shelters		•	•	•	•	•		•		•
Intelligent transportation systems	•	•	•	•	•	•	•	•	•	•
Cleaner/quieter vehicles	•		•		•					

Note: Individual elements may change as demonstration projects evolve.

[a]Washington, D.C., includes the use of a limited-access airport road.

Source: FTA.

FTA plans to conduct evaluations of each project participating in the demonstration program after the projects are implemented. FTA also plans to evaluate Pittsburgh's Bus Rapid Transit project. Through these evaluations, FTA wants to determine the most effective Bus Rapid Transit elements so that other transit agencies can model similar systems. The Department of Transportation's Volpe Center will conduct the first evaluation on Honolulu's *CityExpress!* bus program. FTA does not plan to include all the consortium members' projects in the evaluation.

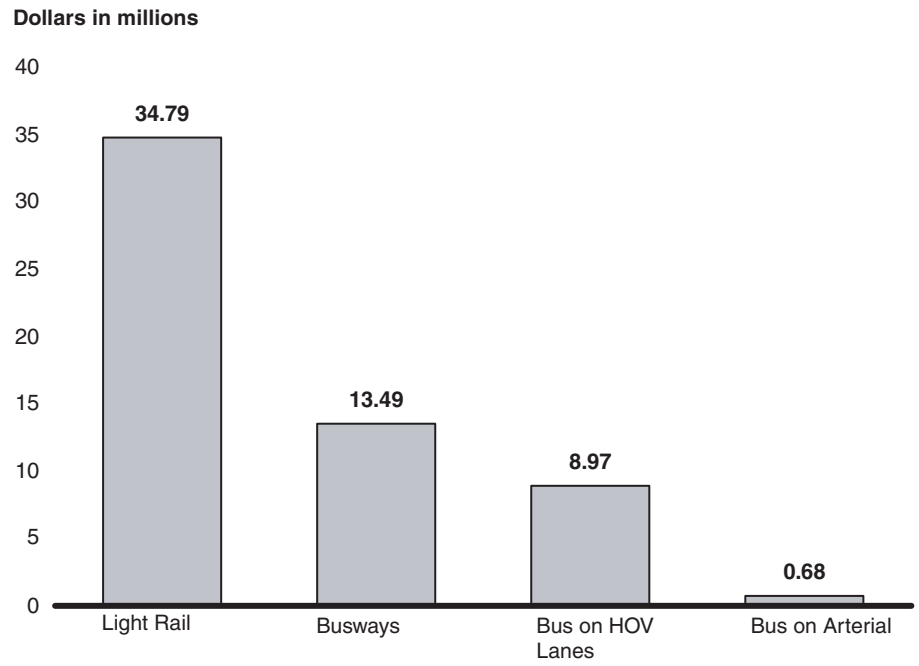
Capital Costs Appear to Favor Bus Rapid Transit, While Results Are Mixed for Operating Costs

Bus Rapid Transit capital costs were generally lower than Light Rail capital costs in the cities we reviewed, when compared on a cost-per-mile basis. We found mixed results when we compared the operating costs of Bus Rapid Transit and Light Rail systems. In examining performance characteristics, we found that the ridership and operating speeds of Bus Rapid Transit and Light Rail systems were similar in many respects.

Bus Rapid Transit Capital Costs Per Mile Generally Lower Than Light Rail

The Bus Rapid Transit projects that we reviewed cost less on average to build than the Light Rail projects, on a per-mile basis. As shown in figure 6, Bus Rapid Transit capital costs averaged about $13.5 million per mile for busways, $9.0 million per mile for buses on HOV lanes, and $680,000 per mile on city streets, when escalated to 2000 dollars.[10] For 13 cities that built Light Rail lines, since 1980, capital costs averaged about $34.8 million per mile, ranging from $12.4 million to $118.8 million per mile, when escalated to 2000 dollars. On a capital cost per-mile basis, the three different types of Bus Rapid Transit systems have average capital cost that are 39 percent, 26 percent, and 2 percent of the average cost of Light Rail systems we reviewed.

Figure 6: Capital Cost Per Mile for Light Rail and Bus Rapid Transit



Notes: Cost escalated to fiscal year 2000 dollars.

Average Light Rail capital costs are for 13 cities that built 18 Light Rail lines since 1980. Busway capital costs are for nine busways built in four cities; in two cities these facilities were subsequently

[10]Project capital costs typically include the costs to plan, design, and construct a project.

opened to private vehicles as HOV lanes. Capital costs for buses using HOV lanes are for eight HOV facilities in five cities. Capital costs for buses on arterial streets are for three lines in two cities.

Source: GAO analysis of FTA and transit agency data.

Bus Rapid Transit capital costs vary considerably, depending on the type of system built. Costs of Bus Rapid Transit projects include the cost of the roadway—busways or bus lanes, station structures, park-and-ride facilities, communications and improved traffic signal systems, and vehicles, if additional or special buses are needed for the project. Given the variety of ways in which Bus Rapid Transit may be designed, we classified the systems into three broad categories: busways, bus-HOV lanes, and Bus Rapid Transit on arterial streets. Appendixes III and IV provide information on the Bus Rapid Transit and Light Rail systems that we analyzed.

Exclusive busways, which are essentially separate highways for buses, generally had the highest capital cost per mile for those systems we analyzed, averaging $13.5 million per mile in 2000 dollars. The capital costs of nine busways in four cities ranged from $7 million to $55 million per mile.[11] The most expensive one was the Pittsburgh West Busway, which cost significantly more than other busways we analyzed. However, according to local transit agency officials, they needed to construct only 5 miles of busway to achieve their goal of rapid transit to the airport because the buses could exit the busway and use existing highways. They added that an alternative Light Rail system would have been longer, cost two to three times as much to construct and significantly more to operate and maintain, while attracting essentially no additional passengers.

Other types of Bus Rapid Transit systems had lower capital costs. For HOV facilities where buses used HOV lanes in five cities we reviewed, capital costs ranged from $1.8 million to $37.6 million per mile. For bus-HOV facilities we considered the capital cost of HOV lanes, bus stations, park-and-ride facilities, and additional vehicles. See appendix I for additional details.

Bus Rapid Transit improvements on arterial streets can have the lowest cost per mile. For example, Los Angeles completed the Wilshire Boulevard and Ventura lines at a cost of about $200,000 per mile. These two lines operate on major arterial streets, but without a dedicated right-of-way. The Bus Rapid Transit improvements included in this cost were signal

[11]Because the current bus-HOV lanes in Houston and Los Angeles were initially built as bus-only facilities, we include them as examples of busways for this analysis.

prioritization, improved stations, and real-time information systems informing riders of bus arrival times. While this type of surface street treatment was the least expensive Bus Rapid Transit option in the cities we reviewed, Bus Rapid Transit lines on arterial streets can have higher costs if they involve more extensive construction, such as building special bus lanes. In Orlando Bus Rapid Transit on arterial streets included lane construction and vehicle costs, and averaged $9.6 million per mile.

Light Rail systems we reviewed also vary considerably in their capital cost per mile. Included in capital costs are the stations, structures, signal systems, power systems, utility relocation, rights-of-way, maintenance facilities, transit vehicles, and project oversight. Again, we adjusted the historic capital cost of the projects to fiscal year 2000 dollars to provide a better basis of comparison. For the systems we reviewed the cost per mile for Light Rail averaged $34.8 million per mile, ranging from $12.4 million to $118.8 million per mile.

The higher capital costs per mile for Light Rail systems compared with Bus Rapid Transit arise from several factors. First, Light Rail systems contain elements not required in Bus Rapid Transit systems. Light Rail systems typically require train signal, communications, and electrical power systems with overhead wires to deliver power to trains. A consultant study of eight Light Rail lines in five cities (Dallas, St. Louis, Denver, Salt Lake City, and Portland) found the average costs of these elements to be $2.8 million per mile.[12] Light Rail systems also require additional materials needed for the guideway--rail, ties, and track ballast. In addition, if a Light Rail maintenance facility does not exist, one must be built and equipped. Finally, Light Rail vehicles, while having higher carrying capacity than most buses, also cost more--about $2.5 million each.[13] In contrast, according to transit industry consultants, a typical 40-foot transit bus costs about $283,000 and an articulated, higher capacity bus costs about $420,000. However, buses that incorporate newer technologies for low emissions or that run on more than one fuel can cost more than $1 million each. For

[12]Pilgrim, Richard D., "Are We Pricing Light Rail Transit Systems Out of Range? A Comparison of Cost Experiences," paper published at the 8th Joint Conference on Light Rail, Dallas, Texas, November 2000, sponsored by the Transportation Research Board and the American Public Transportation Association.

[13]Generally, the seating capacity of a single Light Rail vehicle is about 110 passengers while a 40-foot bus would seat about 50 passengers and an articulated bus can seat about 70 passengers.

example, the Boston Silver Line low-floor, articulated, compressed natural gas-hybrid electric buses will cost $1.5 million each according to FTA officials.

Another factor that can affect the cost of the systems is the amount and availability of required right-of-way. Right-of-way costs are affected by the design requirements of Bus Rapid Transit and Light Rail. Transit planners told us that a basic busway required a wider right-of-way than Light Rail. They estimated a two-lane busway required a right-of-way about 30 feet wide, compared with 24 feet wide for a double-track Light Rail system.[14] Regardless of the transportation mode---bus or rail—the basic design has a major effect on the capital costs. Specifically, projects that use tunneling or elevated structures are more expensive than those with surface level construction. For example, the Boston South Piers Transitway, a 1-mile tunnel with three stations built adjacent to the Boston Central Artery/Tunnel project, has an estimated cost of $601 million. Tunneling can be three to six times more expensive than surface construction, regardless of the type of system—bus or rail.

Operating Costs Vary for Bus Rapid Transit and Light Rail Systems

We found mixed results when we compared the operating costs for Bus Rapid Transit and Light Rail in each of the six cities that operated both types of systems.[15] We used three measures to examine operating costs: cost per vehicle revenue hour, cost per vehicle revenue mile, and cost per passenger trip.[16] We also compared these measures, correcting for vehicle capacity. Each measure resulted in somewhat different relative operating cost levels.

Part of the reason for the variation in results is that the Bus Rapid Transit systems in our example cities operate in different ways. The systems

[14]Pittsburgh officials noted that a 30-foot busway requirement was not uniform and that busways can be narrowed to Light Rail standards for short sections to fit through tunnels or accommodate obstructions. In Pittsburgh, for example, buses share a tunnel with Light Rail vehicles.

[15]The six cities with both Bus Rapid Transit and Light Rail systems in our study are Dallas, Denver, Los Angeles, Pittsburgh, San Diego, and San Jose.

[16]These three measures, while not the only possible measures of operating cost, are commonly used in transit. We also attempted to determine operating cost per passenger mile as a measure of comparison; however, we could not obtain sufficient data for such an analysis. See appendix I for details on the methodology used.

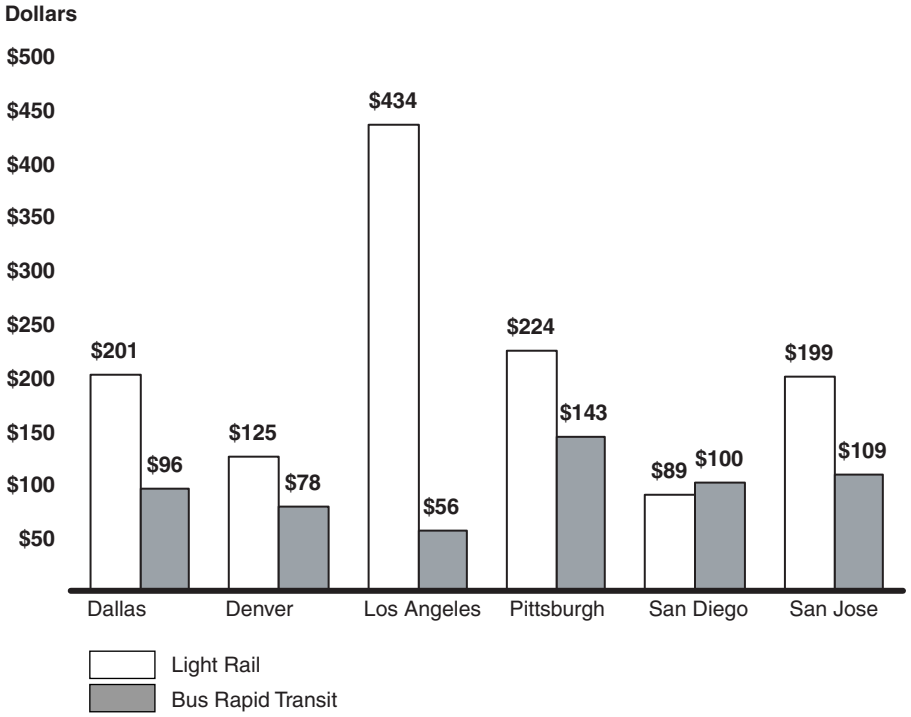
ranged from arterial bus routes in Los Angeles to freeway express buses on barrier-separated HOV lanes in Denver, Dallas, and San Diego to exclusive busways in Pittsburgh. In addition, the Light Rail systems in these cities also serve different functions in different ways. The Light Rail systems range from local distributor systems sharing downtown city streets with cars and trucks, as in Dallas and Denver, to commuter-type service along tracks separated from all other traffic, such as the Los Angeles Green Line. The route, type of service, size of vehicles, and function of the systems—long haul commuter service or downtown circulator—each have an impact on the operating cost. Greater speed can also lower operating and capital costs by permitting a bus route or rail line to be serviced with fewer vehicles.

Operating costs for Bus Rapid Transit systems included such costs as driver's salaries, fuel, vehicle maintenance, and maintenance of the busway or HOV lane. In Dallas it also includes the cost to move 5.2 miles of road barriers twice each day to change the direction of an HOV lane that the Bus Rapid Transit system and other HOVs use as well as the cost to provide daily enforcement of lane restrictions and motorist assistance. Light Rail operating costs include driver's salaries, electricity, and maintenance of the vehicles and track system. Light Rail systems require at least one repair facility and specialized maintenance staff, while Bus Rapid Transit vehicle maintenance is often done at existing maintenance facilities by current employees whose costs can be spread over the regular bus service.

Operating Cost Per Vehicle Hour

To determine operating cost per vehicle hour, the annual operating costs are divided by the number of hours the buses or trains operate in that year. This measure shows the average cost to operate a vehicle for 1 hour, regardless of the number of passengers carried. As shown in figure 7, using this measure, Bus Rapid Transit had lower costs in five cities and Light Rail in one.

Figure 7: Operating Cost Per Vehicle Revenue Hour, 1999

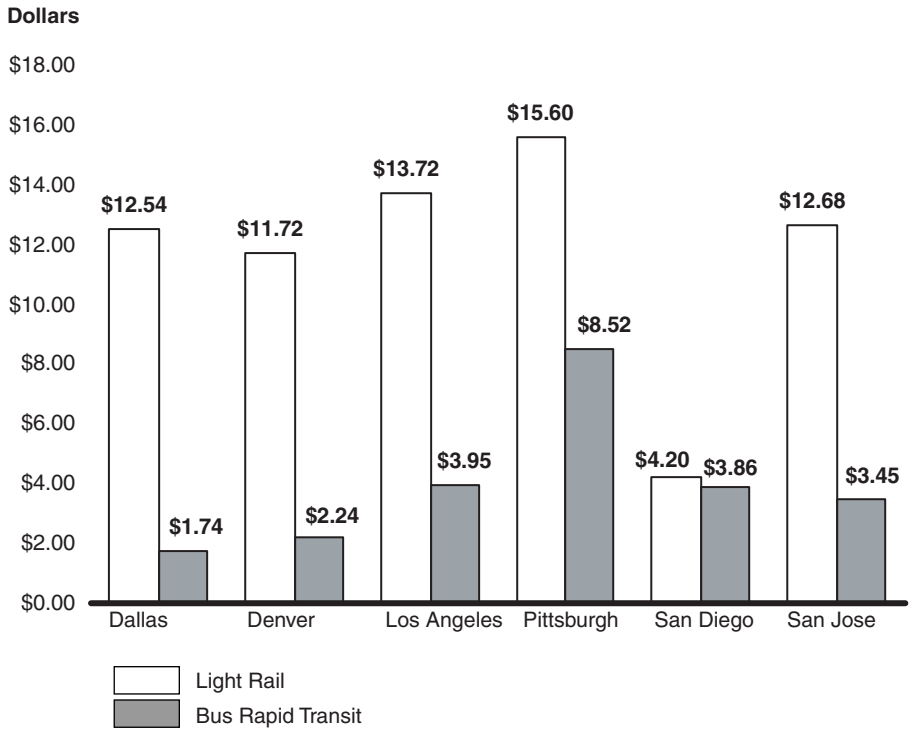


Source: National Transit Database and six transit agencies.

Operating Cost Per Revenue Mile

Operating cost per revenue mile is another way of measuring the cost of operating individual vehicles. Operating cost per revenue mile is a vehicle's annual operating cost divided by the total annual number of miles traveled while actually in passenger service. It calculates the average cost of the vehicles to travel 1 mile. As shown in figure 8, all six cities' Light Rail systems showed higher costs per vehicle mile than Bus Rapid Transit routes. According to one transit expert, Bus Rapid Transit lines often run only during the busiest rush hour periods while Light Rail systems typically offer all-day service, which may in part explain this result.

Figure 8: Operating Cost Per Vehicle Revenue Mile, 1999

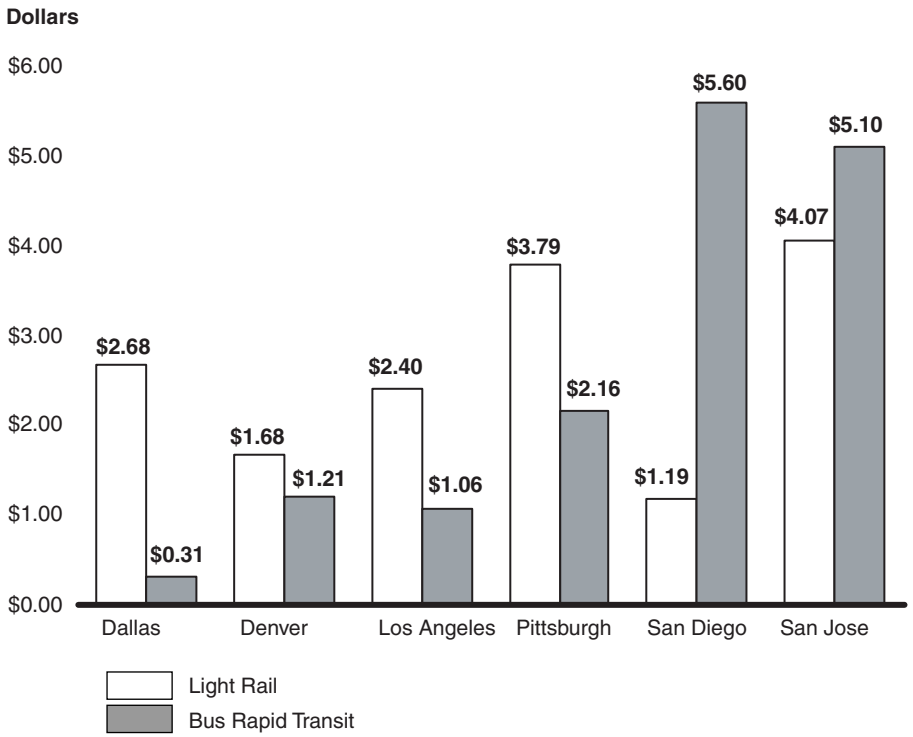


Source: National Transit Database and six transit agencies.

Operating Cost Per Passenger Trip

Transit operating costs can also be measured on a per passenger trip basis. Operating cost per passenger trip measures the total annual operating cost divided by the total annual passenger boardings, regardless of whether the passenger is transferring from a bus to a Light Rail vehicle, or vice versa. Thus, it shows how much it costs to carry a person on a trip, regardless of the length of that trip. Using this measure, four of six Bus Rapid Transit routes had lower operating costs per passenger trip than did Light Rail systems, as shown in figure 9.

Figure 9: Operating Cost Per Unlinked Passenger Trip, 1999



Source: National Transit Database and six transit agencies.

The wide disparities in operating costs and ridership levels are likely due to the variety of Bus Rapid Transit and Light Rail systems we reviewed. For example, our evaluation of Bus Rapid Transit service in Dallas included the costs to move 5.2 miles of barriers twice a day to allow Bus Rapid Transit and other HOVs to use the lanes, as well as enforcement and roadway assistance costs. In Los Angeles, the Bus Rapid Transit service on the Wilshire-Whittier line has very high ridership—about as high as the highest ridership levels achieved by Light Rail lines in the United States. High ridership generally reduces the cost per rider. In contrast, both San Diego and San Jose have lower Bus Rapid Transit ridership, which contributes to higher costs per rider. In addition, vehicle sizes and passenger capacity can vary greatly between Light Rail and bus vehicles, which can affect vehicle-based comparisons.[17] The Light Rail systems also have varied functions that can affect operating costs. For example, Denver's initial Light Rail system operated as a slower local circulator system on city streets shared with vehicular traffic, while San Diego's system is used more for longer commuting trips.[18]

Ridership and Speed of Bus Rapid Transit and Light Rail Vary Widely

Two elements of transit system performance are ridership and system speed. We found that while ridership varied considerably, the largest ridership on Bus Rapid Transit and Light Rail systems were quite similar. We also found that speed varied but that Bus Rapid Transit projects in our review were generally faster. This was likely due to the nature of the Bus Rapid Transit systems that we visited; express bus operations or operations with longer stop spacing have higher speeds.

We found that ridership on Bus Rapid Transit and Light Rail systems varies widely and depends, in part, on frequency of service, number of stops,

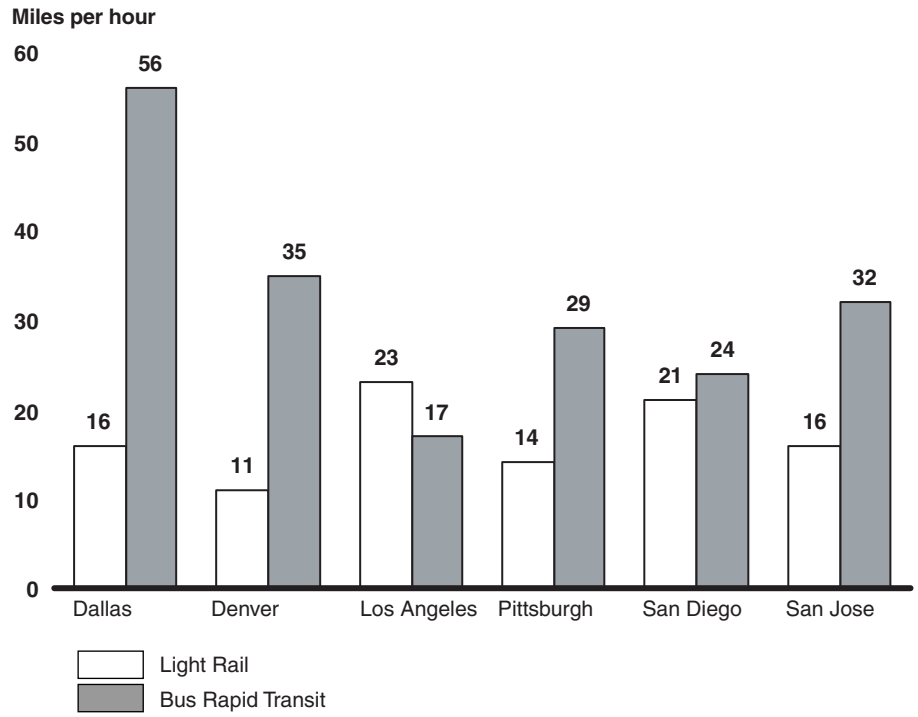
[17]Light Rail vehicles had a capacity about double that of the Bus Rapid Transit vehicles used on the routes we examined. To account for these differences, we also compared cities' operating costs per passenger space per hour and operating costs per passenger space per mile. These measures, based on the actual seating and standing spaces of the rail and bus vehicles used on the routes we examined, compared the cost of carrying enough room to carry a passenger for 1 hour and for 1 mile. The analysis again showed a mixed pattern of costs; Light Rail was less expensive in four of six cities in cost per passenger space per hour and in half the cities in terms of cost per passenger space per mile.

[18]The slower Central Corridor was the first completed section of the Denver Light Rail system. The Southwest Corridor, which opened in 2000, does not operate on city streets because it is grade-separated and runs on exclusive tracks, allowing it to achieve higher speeds.

hours of operation, and customer demand. For example, ridership on 4 busways ranged from 7,000 riders per day to about 30,000 per day and averaged about 15,600 riders per day. For 13 bus lines on HOV lanes, ridership ranged from 1,000 to about 25,000 riders per day, with an average ridership of about 8,100. In addition, the ridership on the two arterial street Bus Rapid Transit lines in Los Angeles was about 9,000 to 56,000 per day, with an average of 32,500 per day. The highest Bus Rapid Transit ridership was on Los Angeles' Wilshire-Whitter line, which runs buses about every 5 minutes and operates all day. Light Rail system ridership also varies widely. For example, ridership on 18 Light Rail lines ranged from 7,000 riders to 57,000 daily riders and averaged about 29,000 per day. The largest Light Rail ridership was also found in Los Angeles on its Blue Line.

According to a transportation consultant, system speeds generally depend on characteristics such as the distance between stops, fare-collection methods, and the degree to which the tracks or roadway are exclusive to transit vehicles or share right-of-way with cars and other vehicular traffic, as both buses and Light Rail lines typically do in downtown areas. In the cities with both Bus Rapid Transit and Light Rail, Bus Rapid Transit speeds were higher than Light Rail in five of six cities. The high-speed Bus Rapid Transit lines, as shown in figure 10, are generally commuter bus routes that run much or their entire route on highway HOV lanes.

Figure 10: Average Speed of Bus Rapid Transit and Light Rail Service, 1999



Source: National Transit Database and six transit agencies.

Bus Rapid Transit improvements to service such as exclusive bus lanes, skipped stops, dual bus lanes, and busways each may provide incremental improvements in vehicle speeds. Improvements such as bus traffic signal priority, level boarding onto low-floor buses, schedules based on time between buses rather than set schedules, fewer stops, and active management of bus spacing and traffic signal priority from a bus operations control center, can also each contribute to better service. For example, the Los Angeles Wilshire-Whitter Rapid Bus route made many of these improvements, resulting in a 29-percent improvement in average bus speeds. According to transit officials, one-third of the speed improvement along the Wilshire Avenue route was from the bus signal priority system and the rest from the other improvements.

Bus Rapid Transit and Light Rail Have a Variety of Advantages and Disadvantages

Besides cost and performance characteristics already discussed, Bus Rapid Transit and Light Rail each have a variety of advantages and disadvantages. Bus Rapid Transit generally has the advantage of (1) having more flexibility than Light Rail, (2) being able to phase in service rather than having to wait for an entire system to be built, and (3) being used as an interim system until Light Rail is built. Transit operators with experience in Bus Rapid Transit systems told us that one of the challenges faced by Bus Rapid Transit is the negative stigma potential riders attach to buses regarding their noise, pollution, and quality of ride. Light Rail has advantages, according to transit officials, associated with increased economic development and improved community image. On the negative side, building a Light Rail system can have a tendency to provide a bias toward building additional rail lines in the future.

Bus Rapid Transit Is Generally More Flexible Than Light Rail

Bus Rapid Transit systems operate more flexibly than Light Rail systems. Bus Rapid Transit can respond to changes in employment, land-use, and community patterns by increasing or decreasing capacity. Bus Rapid Transit routes can also be adjusted and rerouted over time to serve new developments and dispersed employment centers that may have resulted from urban sprawl.[19] For example, an official in San Jose noted that because of development outside the city center, there are now eight employment centers that need to be considered in its transit analysis. On the other hand, Light Rail lines are fixed and cannot easily change to adjust to new patterns of housing and employment. For example, the western portion of the Los Angeles Light Rail Green Line was built in part to provide mass transit service for workers in defense production facilities in Los Angeles. However, by the time the Green Line opened these facilities had been closed. As a result, projected ridership levels were not achieved.

Although Bus Rapid Transit sometimes uses rail-style park-and-ride lots, Bus Rapid Transit routes can also collect riders in neighborhoods and then provide rapid long-distance service by entering a busway or HOV facility. Transit agencies have considerable flexibility to provide long distance service without requiring a transfer between vehicles. This is a significant

[19]Urban sprawl is often characterized as a form of growth that is low-density, auto-dependent development that rapidly spreads on the fringes of existing communities. *Community Development: Extent of Federal Influence on "Urban Sprawl" is Unclear* (GAO/RCED-99-87, Apr. 30, 1999).

benefit, because some research has shown that transit riders view transferring to be a significant disincentive to using mass transit. In contrast, Light Rail systems frequently require a transfer of some type—either from a bus or a private automobile. When Light Rail lines are introduced, transit agencies commonly reroute their bus systems to feed the rail line. This can have the effect of making overall bus operations less efficient when the highest-ridership bus route has been replaced by Light Rail; the short feeder bus routes can be relatively costly.

Finally, bus-based systems' ability to operate both on and off a busway or bus lane provides Bus Rapid Transit the flexibility to respond to operating problems. For example, buses can pass disabled vehicles, while Light Rail trains can be delayed behind a stalled train or other vehicle on the tracks. Thus, the impact of a breakdown of a Bus Rapid Transit vehicle is limited, while a disabled Light Rail train may disrupt portions of the system.

Bus Rapid Transit Operation Can Be Phased in

Bus Rapid Transit systems differ from Light Rail systems in that they provide greater flexibility in how they can be implemented and operated. In constructing a Bus Rapid Transit system, it is not necessary to include all the final elements before beginning operations; it is possible to phase in improvements over time. Improvements such as signal prioritization and low-floor buses, which improve capacity and bus speed, can be added incrementally. These incremental changes can have significant effects. For example, one Los Angeles Bus Rapid Transit route increased its speed and cut 10 percent off its schedule time, by installing signal priority for buses to provide several additional seconds to allow buses to pass through intersections before the signal changed. Overall, the line was able to reduce travel time by 29 percent with all the improvements. In contrast, a transit expert noted that a Light Rail line segment must be fully completed and tested before starting operation and realizing benefits.

Bus Rapid Transit Can Be an Interim System

Bus Rapid Transit also has the advantage of establishing a mass transit corridor and building ridership without precluding future changes. The development of a busway secures a transit right-of-way for the future. Some cities have identified Bus Rapid Transit as a means of building transit ridership in a travel corridor to the point where investment in a rail alternative becomes a cost-effective choice. For example, one of the projects in FTA's demonstration program, the Dulles Corridor Bus Rapid Transit project in Virginia, hopes to build transit ridership in this fashion. However, converting a bus facility to Light Rail involves additional capital

costs. The idea of converting a Pittsburgh busway to rail was studied by the Port Authority of Allegheny County, and the agency concluded that the $401 million capital cost of the conversion was too high.

Bus Service's Negative Image Can Be Overcome With Equal Service Characteristics

Officials we interviewed from FTA, transit agencies, academia, and private consulting stated that a negative image exists for bus service, particularly when compared to rail service. Communities may prefer Light Rail systems to Bus Rapid Transit in part because the public sees rail as faster, quieter, and less polluting than buses, even though Bus Rapid Transit is designed to overcome those problems. While transit officials noted a public bias toward Light Rail, research has found that riders have no preference for rail over bus when service characteristics are equal.

While environmental benefits have helped justify Light Rail systems, the gap in environmental benefits between rail and buses may be narrowing. FTA and bus manufacturers have focused on improving the design of buses not just to increase their attractiveness, but also to reduce their noise levels and emissions. In December 1999, we reported that diesel buses are becoming much cleaner.[20] We noted that according to the EPA, emissions from individual buses declined substantially between 1988 and 1999. Improvements in diesel technology have resulted in heavy-duty diesel engines that are more reliable and less polluting than their predecessors. In addition, we found that newer buses can use alternative fuels, such as liquefied natural gas, fuel cells, and hybrid technologies, which may have some beneficial effect on urban air quality as they are adopted into bus fleets.

In commenting on a draft of this report, FTA officials said that the poor image of buses was probably a result of a history of slow bus service due to congested streets, slow boarding and fare collection, and traffic lights. Bus Rapid Transit is essentially designed to eliminate delays and provide faster service on better vehicles. FTA believes that the image of buses can be improved over time through bus service that incorporates Bus Rapid Transit features. This change could replicate the improved image that Light Rail systems experienced when modern Light Rail systems began to be built in the 1980's.

[20] *Mass Transit: Use of Alternative Fuels in Transit Buses* (GAO/RCED-00-18, Dec. 14, 1999).

Light Rail Seen as a Stimulus for Community Economic Development

Transit agency officials told us that Light Rail provides the opportunity for improved economic development along the rail lines. Several city transit officials and transit consultants told us that communities see Light Rail as a mark that a city is "world-class," and could help a city improve its image and ability to attract economic development. According to transit agency officials, because Light Rail systems have permanent stations and routes, developers are more likely to locate new business, residential, or retail development along a Light Rail line than along a bus route. For example, Dallas transit officials cited $800 million in commercial development along its Light Rail line. The Light Rail line itself cost $860 million to build in 1994, so these officials saw the Light Rail line as an excellent investment.[21] On the other hand, San Jose transit officials noted that while some residential development had occurred along its Light Rail line, the expectation is for changes in land use over a longer period of time, perhaps over 20 years, resulting in a more densely developed corridor.

Transit officials we interviewed disagreed on the extent that Bus Rapid Transit could spur economic development. For example, officials in Dallas said they had not experienced development near their Bus-HOV stations that they could trace to the Bus Rapid Transit service. However, the Director of the Cleveland Bus Rapid Transit project cited development already occurring in the Euclid Avenue corridor in anticipation of the Bus Rapid Transit line. Here the Bus Rapid Transit line would operate much like a Light Rail system, with the same kind of fixed route on city streets and identifiable station structures that allow for transit-oriented development on Light Rail routes.

In commenting on a draft of this report, FTA officials said that Light Rail's economic development impact comes about, in part, because of the high capital investment that gives a sense of permanence. Rail's economic development impact at stations also results from a pattern of rail service where there is excellent service to rail stations but much poorer service requiring a transfer beyond the stations. According to FTA officials, most development attributed to rail service occurs within walking distance of the rail station. In contrast, bus service that can leave the guideway and eliminate the need for a transfer places less emphasis on the stations as a

[21]Transit experts noted that it is difficult to determine how much of investment is additional investment that would not have otherwise occurred, and how much investment is redirected from somewhere else in a city to areas near the transit facility.

focus for economic development. This may diffuse the economic development impact of Bus Rapid Transit guideways and stations.

Light Rail Systems Are Usually Expanded Over Time

Most cities that built Light Rail systems did not end construction with the first rail line. Rather, the early Light Rail lines were often later extended or additional lines added. Of the 13 cities that built Light Rail systems since 1980,

- 5 cities already have more than one Light Rail line operating,
- 4 cities have already extended their initial Light Rail lines,
- 3 cities are doing initial expansions of earlier systems, and
- Buffalo is the only city of the 13 that has not expanded or is not expanding its initial Light Rail system.

In addition, of the 13 cities,

- 9 cities have current Full Funding Grant Agreements amounting to over $2.6 billion and have construction under way on 10 projects to expand existing Light Rail systems. Overall, the cost estimates for these projects range from $19.5 million per mile to $238.3 million per mile with an average cost of about $54 million to construct a mile of Light Rail line.
- 10 cities have proposed 15 additional New Starts Light Rail projects that are in various levels of design or development.

Two transportation experts told us that Light Rail systems, once installed, tend to expand because of the ease of making rail to rail connections, as opposed to bus to rail connections. In addition, they said that expansion also occurs because once a system has incurred the initial costs of building rail maintenance and repair facilities and training a new labor force of drivers and specialized maintenance workers, the initial costs can be spread over a larger system.

Conclusions

A number of transit options are available to communities to help address growing traffic congestion. One such option is Bus Rapid Transit. Bus Rapid Transit is an emerging approach to using buses as an improved high-speed transit system. By employing innovative technologies such as signal prioritization, better stations or shelters, fewer stops, and faster service on more attractive vehicles, Bus Rapid Transit shows promise in meeting a

variety of transit needs. In addition, in many communities Bus Rapid Transit systems can have lower capital costs than Light Rail systems yet can often provide similar performance. Further, Bus Rapid Transit's flexibility may be a potentially valuable feature for many communities with sprawling patterns of development, where public transportation needs can be more complex and difficult to address than focusing on a single central business district.

While Bus Rapid Transit shows promise, the primary federal program to support new and expanded transit systems, the New Starts Program, will provide little capital funding for Bus Rapid Transit over the next 2 years. First, the New Starts Program is stretched to its capacity to respond to the growing number of eligible projects and few projects of any kind will receive funding for the remainder of the current program. In addition, some of the Bus Rapid Transit projects do not fit the exclusive right-of-way requirements of the New Starts Program and thus would not be eligible for funding consideration. Further, since Bus Rapid Transit is a relatively new concept, some of the projects have not reached the point of being ready for funding consideration and there are many other rail projects further along in development with which they will ultimately have to compete.

FTA is encouraging Bus Rapid Transit through a Demonstration Program. This program does not provide funding for construction but rather focuses on obtaining and sharing information on projects being pursued by local transit agencies. The evaluations of the Bus Rapid Transit projects, which are under way and planned, will hopefully provide additional needed information on the effectiveness of this transit option.

The future of Bus Rapid Transit in the United States largely rests with the willingness of communities to consider it as they explore transit options to address their specific situations. Such decisions are difficult and made on a case-by-case basis considering a variety of factors including cost, ridership, environmental impacts, and community needs and attitudes. No one transit option is right for all situations. However, given the merits of Bus Rapid Transit and its potential cost advantages, we believe that it should be given serious consideration as options are explored and evaluated.

Agency Comments and Our Evaluation

We provided a draft of this report to the Department of Transportation for review and comment. Officials from the Department generally agreed with the report. Officials from FTA's Office of Research, Demonstration, and

Innovation; Office of Planning; and Office of the Chief Counsel provided observations on the public's poor image of bus service and the economic development impact of rail and bus service, which we included in the report. These officials also provided technical comments, which we incorporated into the report as appropriate.

As arranged with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies of this report to the Secretary of Transportation and the Administrator of the Federal Transit Administration. We will also make copies available to others upon request.

If you or your staff have questions about this report, please call me at (202) 512-2834 or write to heckerj@gao.gov. Key contributors to this report were Samer Abbas, Robert Ciszewski, David Ehrlich, and Glen Trochelman.

JayEtta Z. Hecker
Director, Physical Infrastructure Issues

List of Congressional Requesters

The Honorable Tom DeLay
Majority Whip
The Honorable Don Young
Chairman, Committee on Transportation and Infrastructure
The Honorable Thomas Petri
Chairman, Subcommittee on Highways and Transit
Committee on Transportation and Infrastructure
The Honorable Tom Tancredo
House of Representatives

Scope and Methodology

To identify the status of federal funding for Bus Rapid Transit and Light Rail systems, we reviewed FTA budget and program data, reports on New Starts projects, and prior GAO reports. To analyze support being provided to Bus Rapid Transit and Light Rail, we used the most recent report on the New Starts Program *Annual Report on New Starts*, *Proposed Allocation of Funds for Fiscal Year 2002*, Department of Transportation, Federal Transportation Administration, May 25, 2001. To describe FTA's Bus Rapid Transit Demonstration Program, we interviewed officials from FTA, reviewed program documents, and contacted the demonstration project sponsors for additional information.

To determine the capital costs of Bus Rapid Transit and Light Rail projects, we obtained cost data from FTA and transit agencies for selected cities. For Bus Rapid Transit systems, we initially selected the cities of Dallas, Denver, Los Angeles, Pittsburgh, San Diego, and San Jose because they had both Bus Rapid Transit and Light Rail systems. We added Houston and Seattle because they have extensive Bus Rapid Transit type systems and are in advanced stages of planning to build Light Rail systems. We also added Miami and Charlotte because they are operating dedicated busways. Lastly, we added Orlando because it is operating a Bus Rapid Transit type system on arterial streets. For Light Rail, we identified 13 cities that built systems between 1980 and 2000. We limited systems to this timeframe due to concerns about the availability of data from earlier dates. To obtain the capital costs for the Bus Rapid Transit systems, we used prior reports, if available, or contacted the local transit agency. For the Light Rail projects, FTA and transit agency officials provided total capital expenditures.

We calculated capital costs based on the cost to complete the transit line, escalated to 2000 dollars. To escalate project costs, we used the Gross Domestic Product Implicit Price Deflator applied to the lump-sum capital cost at the year of completion. The only exception to this method was for the San Diego Light Rail system. Due to the way in which this system was built over time, escalating from the final lump-sum cost of the projects was not appropriate. However, the transit agency provided us annual capital expenditures, and we escalated each of these annual costs to 2000 dollars to determine the capital cost of this system.

The capital cost analysis we conducted focused on capital cost per mile that was derived by dividing the total escalated costs by the number of miles of the various systems. We used cost per mile as our measure because it presents comparable information on a common basis. While other measures might have been attempted, such as annualized costs or

cost per passenger, sufficient data were not available to do so. However, in our view, cost per mile presents a reasonable representation of the magnitude of the cost differences.

In determining operating costs, we selected cites that had both significant Bus Rapid Transit and Light Rail systems—Dallas, Denver, Los Angeles, Pittsburgh, San Diego, and San Jose. We believed it important to use cities with both types of systems so that accounting of costs would be more consistent. Local transit agencies did not collect or maintain operating costs for Bus Rapid Transit systems or their individual lines. As a result, transit authorities had to calculate or estimate the operating costs associated with their operations. Because of the difficulty of this, we were able to analyze a limited number of Bus Rapid Transit lines in the cities. Based on discussions with the transit agencies, we judgmentally selected routes that had the most Bus Rapid Transit elements. The following identifies the Bus Rapid Transit type line in each city and the source of that data. For Light Rail operating costs, data were obtained from the 1999 National Transit Database.

- Dallas: We examined express bus routes on two Dallas area barrier-separated HOV lanes: I-35 East (Stemmons), and I-30 (Thornton). The Dallas Area Rapid Transit agency calculated the operating costs for buses using the HOV lanes. The reported operating costs are actual operating costs, not estimates, and are "fully loaded" to include direct, indirect, and general and administrative allocations. This includes the cost to move 5.2 miles of barriers twice a day to provide an extra HOV lane during rush hours.
- Denver: At the suggestion of local transit officials, we used the 120X Express Bus Route as an example of Bus Rapid Transit in Denver, since it includes all-day service and a substantial portion of the route runs on a freeway HOV lane. Operating costs were estimated according to average operating cost per vehicle hour for regular bus service. A Regional Transportation District official told us that he believed that the operating costs for the 120X route would be similar to regular bus operating costs, and that the same buses and drivers are used for both the 120X and regular buses.
- Los Angeles: We examined two Bus Rapid Transit routes: one runs along Wilshire-Whittier Boulevard and the other along Ventura Boulevard. Los Angeles officials provided an estimate of the operating costs for these lines. These lines operate all-day on routes that run concurrently with local buses, but with fewer stops and higher

ridership. The buses travel on streets with other traffic and do not run on HOV lanes or bus lanes.

- Pittsburgh: Two Bus Rapid Transit busways were examined in Pittsburgh: the East Busway and the South Busway. The West Busway was not included because it was not open in 1999. Pittsburgh officials provided actual ridership figures and estimated the operating costs, vehicle hours, and vehicle miles for all routes using each busway from the outer end of the busway and including the downtown loop circulator portion where buses pick up and drop off passengers. Operating costs included all busway expenses for the two busways, including salaries and wages for operators, maintenance, and administration; diesel fuel; maintenance of facilities; materials and supplies; utilities; and purchased services.
- San Diego: We examined several express commuter bus routes in San Diego: the 810, 820, 850, 860, and 870. All travel at least part of their route on barrier-separated HOV lanes. San Diego officials provided estimates for the operating cost for these lines.
- San Jose: On the recommendation of local transit officials, we examined one Bus Rapid Transit route of the Santa Clara Valley Transit Authority, Route 102, from South San Jose to Stanford Research Park. Route 102 is a 32-mile long express commuter bus route that is 70 percent on HOV lanes--the highest HOV level of any Valley Transit bus route. Operating costs were estimated according to average operating cost per vehicle hour for regular bus service.

In analyzing operating cost we used three measures: cost per vehicle revenue hour, cost per vehicle revenue mile, and cost per passenger trip. These are commonly used comparisons in this industry. To arrive at the results, the operating cost for 1999 was divided by the number of hours the vehicles operated in service that year, the number of miles the vehicles traveled when in service that year, or the number of passenger trips on each route that year. We also tried to calculate cost per passenger mile, but sufficient information was not widely available on where and how many passengers were getting on and off vehicles along their routes.

To obtain information on the ridership and performance of Bus Rapid Transit and Light Rail systems, we relied on information obtained from transit agencies, supplemented with information from the National Transit Database, and interviewed FTA and transit agency officials, academic researchers, and private consultants.

To determine other advantages and disadvantages of Bus Rapid Transit and Light Rail systems, we reviewed FTA documents, academic and private consultants' reports, and interviewed FTA officials and study authors. We also interviewed transit agency officials to determine what additional factors they considered when they made choices to develop bus or rail systems, and what they had observed in the actual construction and operation of the systems.

Certain limitations apply to the data presented in this report. First, the report primarily focuses on the cost of transit projects; we have not attempted to quantify all the possible benefits of these projects. Therefore, our review is not a comprehensive cost-benefit analysis. Second, because of differences among transit agencies in how they report operational information, analyses in this report generally are restricted to operating cost comparisons between bus and Light Rail within a given transit agency. Conclusions on the relative operating efficiency of one transit agency versus another should not be drawn from this report. In addition, not all the transit agencies we reviewed were able to totally segregate Bus Rapid Transit costs from their overall bus operating costs, which limited our analysis to overall operating cost rather than the various elements that contribute to it. Finally, transit agencies collect ridership information in a variety of ways, ranging from actual farebox counts to periodic ridership surveys. Because transit agencies are the only available source for such information, we relied on ridership data they provided.

In addition, for some of the Light Rail analyses in this report we relied on information contained in FTA's 1999 National Transit Database, the most recent at the time of our analysis. While we did not perform a comprehensive data reliability assessment of this information, we did determine that FTA has procedures in place to monitor data quality. We performed our review from July 2000 through August 2001 in accordance with generally accepted government auditing standards.

Bus Rapid Transit Demonstration Projects

For each of the 10 Bus Rapid Transit demonstration projects supported by the Federal Transit Administration, the following provides a project description, construction cost estimates, a summary of the comparative analysis used to choose Bus Rapid Transit, and status of the project. The projects are:

- Boston, MA – Silver Line
- Charlotte, NC – Independence Corridor
- Cleveland, OH – Euclid Corridor Transportation Project
- Dulles Corridor, VA – Dulles Corridor Bus Rapid Transit
- Eugene, OR – Pilot East-West Corridor
- Hartford, CT -- Hartford-New Britain Busway
- Honolulu, HI – CityExpress!
- Miami, FL – South Miami-Dade Busway
- San Jose, CA – Line 22 Rapid Transit Corridor
- San Juan, PR – Rio Hondo Connector Bus Rapid Transit

Boston, MA – Silver Line

Project Description

The Massachusetts Bay Transportation Authority is constructing a two-phased Silver Line project, which will run from Dudley Square to Logan Airport, via downtown and the South Boston Waterfront. As of January 2001, funding has been secured for one of the project's two phases. The project calls for the buses to operate on exclusive lanes on surface streets and in an exclusive busway-tunnel. Vehicles are expected to feature low-floors and real-time information. Some buses will use alternative-fuels to reduce emissions. When it begins operations, the Silver Line is expected to make 17 trips per hour with a round-trip running time of 48 minutes. Once completed, the Silver Line expects to serve 60,000 riders daily.

Cost Estimates

According to a Massachusetts Bay Transportation Authority official, the estimated cost for developing the two phases of the Silver Line is $1.34 billion, of which $641 million has been secured. The Authority is seeking an additional $700 million from federal, state, and local sources.

Estimated Time Savings

The Massachusetts Bay Transportation Authority estimates a 3 to 5 minute time savings from Washington Street to downtown. Time savings for the completed Silver Line and the service from South Station to the Piers area and Logan Airport are not possible to calculate because this is a new service.

Comparative Analysis

The Massachusetts Bay Transportation Authority decided that Bus Rapid Transit could attract similar ridership as a Light Rail system. In addition, according to the Project Manager, the Bus Rapid Transit project could be built at a much lower cost than Light Rail. Further, a busway would create fewer disturbances to Boston's infrastructure than Light Rail. However, the construction of the Bus Rapid Transit system allows for possible construction of a future Light Rail system.

Status

According to the Project Manager, as of January 2001, the project was 35 percent to 40 percent complete. The Massachusetts Bay Transportation Authority plans to provide a fully integrated Silver Line service by 2008.

Charlotte, NC – Independence Corridor

Project Description

Charlotte's project involves extending the existing busway on Independence Boulevard, adding intelligent transportation systems on its buses, and adding new stations. In 1998, the Charlotte Area Transit System opened a 2.6-mile two-way express busway (without stations) in an unused HOV lane that, according to the Project Manager, cannot open to carpools until 2006, when the next phase of the Independence freeway project is completed. The project allows buses to bypass congestion. Under the current Bus Express Lane system, the Charlotte Area Transit System estimates that the monthly total ridership for January 2000 on the busway was about 15,700 —an increase of 55 percent from the previous year. The express bus routes make 32 trips during the morning period and 29 trips during the afternoon. The plan consists of retrofitting 3.6 miles of Independence Boulevard into a busway facility with five new stations and adding intelligent transportation systems technology such as automated vehicle locators and automatic passenger counters. The long-range goal is to extend the busway 13.5 miles, according to the Project Manager. The Metropolitan Transit Commission began a Major Investment Study that will cover the entire corridor and involve an evaluation of various forms of transit, including Bus Rapid Transit, Light Rail, and Commuter Rail. The Commission expects to complete the study in late 2001.

Cost Estimates

According to the Project Manger, the Major Investment Study will determine the cost of the next phase. Federal, state, and local funding is planned for the project with the local share coming from a sales tax approved in a countywide referendum in 1998. The Charlotte Area Transit

System plans to dedicate this revenue source to public transportation expenditures. The Charlotte Area Transit System estimated that the sales tax would generate over $50 million annually for transit in the Charlotte area.

Estimated Time Savings

The Charlotte Area Transit System estimates that the current Bus Rapid Transit system saves 10 to 15 minutes in the afternoon rush hour trips and 2 to 4 minutes in the morning. According to the Project Manager, the Major Investment Study will estimate time savings for the next phase.

Comparative Analysis

The Major Investment Study will compare various forms of transit, including Bus Rapid Transit, Light Rail, and Commuter Railroad, according to the Project Manager.

Status

The 2.6-mile express busway has been in use since 1998. In January 2000, it carried over 15,000 passengers. The Major Investment Study is under way to analyze the remaining phase of this project. It is expected to be complete in late 2001.

Cleveland, OH – Euclid Corridor Transportation Project

Project Description

The Euclid Corridor Transportation Project, located in the cities of Cleveland and East Cleveland, will connect the region's two largest employment centers—downtown/central business district and University Circle. The project calls for bus stations to be located over 7 miles on a landscaped center median, on the city's major arterial street. The exclusive bus lane would be located along the median, with the curb lane available for other vehicle traffic. The last 2.5 miles of the route will have buses operating at the curb lane in mixed traffic. According to the Project Director, the vehicles are expected to be 60 foot, articulated, low-floor, diesel/electric buses. The system features an exclusive busway, intelligent transportation systems technologies, traffic signal preemption, and faster boarding and alighting due to off-board fare collection.

Cost Estimates

The Euclid Corridor Transportation Project estimates the capital cost for the program at $220 million.

Estimated Time Savings

The Greater Cleveland Regional Transit Authority estimates a travel time reduction of 30 to 40 minutes along the route.

Comparative Analysis

In December 1995, Greater Cleveland Regional Transit Authority's management planning organization, the Northeast Ohio Area Wide Coordinating Agency, selected the Bus Rapid Transit project. Prior to this selection, rail options were evaluated against the Bus Rapid Transit approach. The Authority's decision was heavily influenced by the costs as compared with the expected benefits of the options. The Authority selected the Bus Rapid Transit option because it was estimated to cost about one-half of the best rail option, yet would achieve many of the transit benefits.

Status

The FTA New Starts Program has given the project a "recommended" rating. Greater Cleveland Regional Transit Authority is currently working on design completion. It expects to begin limited service by 2005 and complete service in 2007, according to the Project Director.

Dulles Corridor, VA – Dulles Corridor Bus Rapid Transit

Project Description

The Dulles Corridor Bus Rapid Transit project is part of a multiyear, four-phased effort to bring rail service to the rapidly growing Dulles Corridor in the Washington, D.C., metropolitan area. The Virginia Department of Rail and Public Transportation's goal is to build a 23.5-mile rail transit system in the area that will serve as an extension to the 103-mile Metrorail service. The Bus Rapid Transit segment of the project is to serve as an interim step to rail. The plan calls for vehicles in the Bus Rapid Transit project to operate between an existing Metrorail stop and Dulles International Airport and beyond to Loudon County. Most of the route to the airport would be on the existing limited access road. A total of four stations would be constructed. Consideration is being given to buses that would feature intelligent transportation systems technology such as real-time and parking information and automated vehicle location. The plan calls for buses to run every 10 to 20 minutes in peak hours and every 20 to 60 minutes during the off-peak and weekend hours. The Virginia Department of Rail and Public Transportation estimates an average weekday ridership of 23,000 for the fully operating Bus Rapid Transit system. It plans to start operations in 2003 and begin conversion to rail by 2006. The Virginia Department of Rail and Public Transportation plans full implementation of rail by 2010.

Cost Estimates

The Virginia Department of Rail and Public Transportation estimates a total cost of $287.3 million for the Bus Rapid Transit portion of the project and $2.2 billion for the entire project including rail service.

Estimated Time Savings

The Virginia Department of Rail and Public Transportation Project Manager estimates that for the Bus Rapid Transit portion of the project, average rush hour time savings will be about 18 minutes.

Comparative Analysis

In 1997, a Major Investment Study on the Dulles Corridor recommended a "seamless" extension of the Metrorail system. The Virginia Department of Rail and Public Transportation evaluated Light Rail as an alternative, but it did not offer any cost savings or operational advantages. A 1999 supplement to the Major Investment Study concluded that Bus Rapid Transit could provide interim mobility improvements in the corridor but, due to operating constraints in the Tysons Corner area and projected future demand, a rail line was the most appropriate long-term solution. Current analysis will determine the most effective alignment for the future Metrorail extension.

Status

According to the Project Manger, in 2000, FTA approved advancing the Bus Rapid Transit portion of the project into preliminary engineering, and the entire Bus Rapid Transit-to-rail project into the National Environmental Policy Act process. The Bus Rapid Transit portion of the project received a "recommended" rating from FTA.

Eugene, OR – Pilot East-West Corridor

Project Description

Eugene's Lane Transit District is directing a two-phased, 10-mile Pilot East-West Corridor Bus Rapid Transit project that will connect east Springfield to west Eugene. The Lane Transit District's goal is to provide fast "rail-like" transit service along major corridors with smaller buses providing access from neighborhoods to the Bus Rapid Transit Lines, nearby shopping, and employment. The project calls for the system to use exclusive busways, traffic signal priority, prepaid fares, real-time information, and fewer stops. At implementation, the pilot corridor will operate at 10-minute intervals during weekdays and 20-minute intervals during evenings and weekends.

Cost Estimates	The Lane Transit District estimates a total cost of $44 million to construct the project.
Estimated Time Savings	The Lane Transit District estimates that the Bus Rapid Transit system would decrease travel time by 20 percent compared to regular bus service in the year it begins operation. It also estimates that this may grow to 40 percent by 2015.
Comparative Analysis	According to the Project Manager, the Lane Transit District conducted a Major Investment Study that determined that Bus Rapid Transit is the preferred approach to Eugene's transportation needs. The evaluation concluded that Eugene currently does not have the population density to support a rail system.
Status	The Bus Rapid Transit project is in preliminary engineering and environmental assessment. According to the Project Manager, the Lane Transit District developed a public input process to educate residents and business owners about the Bus Rapid Transit project and to gather input on corridor issues such as engineering solutions and system image and character. The Project Manager stated that the goal is to complete Phase I by 2003 and Phase II by 2005. Once Phase I is completed, 4 miles of the project would be operational. The completion of Phase II would complete the 10-mile project and allow for full Bus Rapid Transit operation.

Hartford, CT – Hartford New Britain Busway

Project Description	The Hartford-New Britain Busway project consists of a two-way, 9-mile exclusive busway linking downtown New Britain with Hartford's Union Station. The plan calls for buses to use intelligent transportation systems technologies, possibly including signal priority, automatic vehicle location, real-time information, and a smart signal system for grade crossing control. The Connecticut Department of Transportation estimates that daily ridership will increase by almost 11,500 new riders to 28,500 riders in the selected busway system, according to the Planning Manager.
Cost Estimates	The Connecticut Department of Transportation estimates a total project cost of $100 million, according to the Planning Manager.

Estimated Time Savings	The Connecticut Department of Transportation estimates a 40.5 percent time savings using the busway from Hartford to New Britain.
Comparative Analysis	The Connecticut Department of Transportation recommended the busway project after considering six alternatives. The agency selected the busway project as the preferred option based on transit-related, highway, and arterial-roadway performance measures and cost.
Status	FTA approved the project into preliminary engineering with a "recommended" New Starts project rating. The Connecticut Department of Transportation expects to begin design in 2001. The plan calls for the Bus Rapid Transit system to begin operating in 2003.

Honolulu, HI – CityExpress!

Project Description	The City and County of Honolulu plans to expand its current bus system and implement Bus Rapid Transit in the primary urban corridor. Honolulu began a limited-stop express bus service in 1999 in the corridor as a precursor to Bus Rapid Transit. Known as "CityExpress!" the system operates between Kalihi Transit Center and the University of Hawaii. During the first 6 months of operation, CityExpress! experienced a 50-percent increase in ridership. Honolulu plans to implement the Bus Rapid Transit system in the same corridor by providing exclusive lanes where heavy traffic congestion impedes the transit operation. According to the Public Transit Chief, the plan calls for Bus Rapid Transit to include transit centers, signal prioritization, and traveler information systems. A fully constructed Bus Rapid Transit system would produce an estimated 46,000 additional daily riders on mass transit in 2025.
Cost Estimates	Total capital cost is estimated at $1.06 billion over 25 years.
Estimated Time Savings	Bus Rapid Transit would result in estimated time savings of approximately 35 percent.
Comparative Analysis	The Major Investment Study/Draft Environmental Impact Statement recommended Bus Rapid Transit over Light Rail. Furthermore, it stated that the Bus Rapid Transit alternative forecasts the highest level of transit usage compared with other alternatives. The study deleted the rail option through a collaborative process after the analyses indicated that Bus Rapid

Transit would provide an equal level of service and performance with less cost and impacts.

Status

The Honolulu City Council selected Bus Rapid Transit as the Locally Preferred Alternative in November 2000. According to the Public Transit Chief, it expects to complete the Final Environmental Impact Study in 2001. Upon competition of the study, the Chief said that Honolulu plans on seeking New Starts funding assistance from FTA.

Miami, FL – South Miami-Dade Busway

Project Description

The South Miami-Dade Busway project is an 11.5-mile expansion of the existing busway south to the cities of Homestead and Florida City. In 1997, the Miami-Dade Transit Agency implemented the original 8.5-mile busway. According to a transit agency official, this was to facilitate increased economic development to the region in the aftermath of Hurricane Andrew. The system features exclusive lanes, signal priority, low-floor buses, and automated vehicle location and real-time announcements. The original busways resulted in significant growth in transit use, with ridership rising by 40 percent, according to the Management Chief.

Cost Estimates

The Miami-Dade Transit Agency states that the total estimated cost for the extension is $85.5 million, according to the Management Chief.

Estimated Time Savings

Currently, the Miami-Dade Transit Agency states that the scheduled time savings is less than 10 percent. The agency states that the time savings is minimal because buses operate at-grade and are interrupted at intersections located at half-mile intervals. Thus, service is not much faster than when the buses operate on U.S. Highway 1.

Comparative Analysis

The Management Chief stated that the Miami-Dade Transit Agency evaluated various modes of transit before building the South Miami-Dade Busway. It found other options too expensive: Heavy Rail would have cost 10 times as much to build, while Light Rail would cost 4 times as much in comparison with a busway. In addition to the cost disparities, the agency concluded that Light Rail would be too disruptive to existing surface traffic.

Status	Construction is scheduled to begin in November or December 2001, with completion of the extension by 2003. The U.S. Department of Transportation is working with the Miami-Dade Transit Agency to coordinate the construction of the extension with its repair project of U.S. Highway 1 to reduce disruptions, according to the Management Chief.

San Jose, CA – Line 22 Rapid Transit Corridor

Project Description	The Santa Clara Valley Transportation Authority plans to expand the "backbone" of its bus system—the 27-mile Line 22 corridor–into a Bus Rapid Transit project. The plan calls for enhanced station areas, fare prepayment, low-floor buses, and intelligent transportation systems technology such as automatic vehicle location and signal prioritization. Line 22 runs every 10 minutes during peak hours and operates near capacity with 28,000 average daily riders (18 percent of total system ridership). Based on projections for one segment of the project, the Santa Clara Valley Transportation Authority estimates that ridership could increase by over 9 percent.
Cost Estimates	Consultants for the Santa Clara Valley Transportation Authority estimated a total cost of $38 million.
Estimated Time Savings	After developing Line 22 into a Bus Rapid Transit line, the Santa Clara Valley Transportation Authority expects to experience time savings in the range of 25 percent to 40 percent over current travel times.
Comparative Analysis	According to a Santa Clara Valley Transportation Authority official, Line 22's proximity to Caltrain—the Bay Area's commuter railroad—served as a disincentive in considering a Light Rail transit project for this corridor.
Status	The Santa Clara Valley Transportation Authority has begun the preliminary engineering needed to complete elements of the line. The agency expects a fully operational Bus Rapid Transit system by late summer or fall 2002 using federal highway and FTA Bus Capital funds, in addition to state and local funds.

San Juan, PR – Rio Hondo Connector Bus Rapid Transit

Project Description	The Rio Hondo Connector Bus Rapid Transit project is to provide high-speed bus shuttle service between the Tren Urbano rapid transit line now under construction and intermodal transfer facilities. The plan calls for the the construction of a plaza and park-and-ride lot at the end of the connector, and a 2.5-mile length of limited-access HOV lanes in each direction. The project will feature intelligent transportation system technology, including automated vehicle location, computer-aided dispatching systems, traffic signal priority, and vehicle monitoring systems.
Cost Estimates	The Puerto Rico Highway and Transportation Authority estimates a total cost of approximately $66 million for the entire project, including construction of HOV lanes and stations. The agency estimates $7 million to $8 million for the Bus Rapid Transit portion of the project.
Estimated Time Savings	The Puerto Rico Highway and Transportation Authority expects a 10-minute travel time savings on the Bus Rapid Transit route.
Comparative Analysis	The Puerto Rico Highway and Transportation Authority did not conduct an alternative analysis for this project.
Status	The Puerto Rico Highway and Transportation Authority is advancing its work on the highway element and expects to implement its Bus Rapid Transit system by 2003.

Capital Costs of Light Rail Systems

Dollars in millions

Location or system	Total cost (year of expenditure)	Year system opened	Escalated total cost (year 2000 dollars)	System length (miles)	Cost per mile (year 2000 dollars)
Baltimore, MD					
Central Line	364.00	1992	424.54	22.6	18.78
Three extensions	106.30	1997	111.82	6.8	16.44
Buffalo, NY	510.60	1984	760.50	6.4	118.83
Dallas, TX					
S&W Oak Cliff	280.70	1996	300.21	9.6	31.27
Park Lane	579.30	1997	609.40	10.4	58.60
Denver, CO					
Central Corridor	116.00	1994	129.05	5.3	24.35
Southwest Extension	176.30	2000	176.30	8.7	20.26
Los Angeles, CA					
Blue Line	775.00	1990	954.55	22.0	43.39
Green Line	900.00	1995	980.29	20.0	49.01
N.E. New Jersey					
Hudson Bergen	992.10	2000	992.1	10.0	99.21
Pittsburgh, PA	540.00	1985	780.01	25.2	30.95
Portland, OR					
Banfield	282.00	1986	398.64	15.0	26.58
Westside/Hillsboro	963.50	1998	1,001.77	17.7	56.60
Sacramento, CA					
Original line	165.00	1987	226.71	18.3	12.39
Mather Field Road Extension	34.00	1998	35.35	2.3	15.37

Dollars in millions

Location or system	Total cost (year of expenditure)	Year system opened	Escalated total cost (year 2000 dollars)	System length (miles)	Cost per mile (year 2000 dollars)
Salt Lake City, UT					
South Light Rail Line	312.50	1999	320.22	15.0	21.35
San Diego, CA					
Blue Line	473.93	1981	788.52	25.2	31.29
Orange Line	302.46	1986	506.69	21.6	23.46
San Jose, CA					
Guadalupe	400.00	1987	549.60	21.0	26.17
Tasman West	325.00	1999	333.03	7.6	43.82
St. Louis, MO					
Metrolink	348.00	1993	395.27	19.0	20.80
Total	**$8,946.69**		**$10,774.58**	**309.7**	**34.79**

Source: FTA and transit agencies.

Capital Costs of Bus Rapid Transit Systems

Table 4: Capital Costs of Bus Rapid Transit Busways

Dollars in millions

Location or system	Total cost (year of expenditure)	Year system opened	Escalated total cost (year 2000 dollars)	System length (miles)	Cost per mile (year 2000 dollars)
Houston, TX					
Katy (I-10)	103.50	1984	154.16	15.3	10.08
North (I-45S)	138.90	1984	206.88	19.9	10.40
Northwest (US 290)	113.50	1988	150.87	13.5	11.18
Gulf (I-45)	98.90	1988	131.46	15.5	8.48
Los Angeles, CA					
El Monte Busway	58.00	1973	127.25	11.0	11.57
Miami, FL	60.00	1997	63.12	8.5	7.43
Pittsburgh, PA					
South Busway	27.00	1977	63.34	4.3	14.73
East Busway	113.00	1983	174.54	6.8	25.67
West Busway	275.00	2000	275.00	5.0	55.00
Total	**$987.80**		**$1,346.62**	**99.8**	**$13.49**

Note: In Houston and Los Angeles these systems were originally built as busways. However, they were subsequently converted to HOV lanes carrying buses and other vehicles.

Source: FTA and transit agencies.

Table 5: Capital Costs of Bus Rapid Transit Using HOV Lanes

Dollars in millions

Location or system	Total cost (year of expenditure)	Year system opened	Escalated total cost (year 2000 dollars)	System length (miles)	Cost per mile (year 2000 dollars)
Dallas, TX					
I-30	18.90	1991	26.75	5.2	3.64
I-35E	11.60	1996	13.96	6.6	1.76
Denver, CO					
I-25	228.00	1995	248.34	6.6	37.63
Houston, TX					
Southwest (US 59)	129.60	1993	147.21	14.3	10.29
Eastex (US 59)	146.80	1999	150.43	20.2	7.45
Seattle, WA					
I-5	7.60	1985	10.98	6.0	1.83
I-405	10.20	1986	14.42	6.0	2.40
San Diego, CA					
I-15	31.40	1988	41.74	8.0	5.22
Total	**$584.12**		**$653.82**	**72.9**	**$8.97**

Source: FTA and transit agencies.

Table 6: Capital Costs of Bus Rapid Transit on Arterial Streets

Dollars in millions

Location or system	Total cost (year of expenditure)	Year system opened	Escalated total cost (year 2000 dollars)	System length (miles)	Cost per mile (year 2000 dollars)
Los Angeles, CA					
Wilshire-Whittier	5.01	2000	5.01	25.7	0.19
Ventura	3.26	2000	3.26	16.7	0.20
Orlando, FL					
Lymmo	21.00	1997	22.09	2.3	9.60
Total	**$29.27**		**$30.36**	**44.7**	**$0.68**

Source: FTA and transit agencies.

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