

**A Preliminary Evaluation of the Metro Orange Line  
Bus Rapid Transit Project**

Submitted to Transportation Research Board: April 2, 2007

William Vincent  
General Counsel  
Breakthrough Technologies Institute  
1100 H Street NW, Suite 800  
Washington DC 20005  
Voice: (202) 785-4222 ext. 30  
Fax: (202) 785-4313  
E-mail: [vincent@fuelcells.org](mailto:vincent@fuelcells.org)

Lisa Callaghan  
Technology Director  
Breakthrough Technologies Institute<sup>1</sup>  
1100 H Street NW, Suite 800  
Washington DC 20005  
Voice: (202) 785-4222 ext. 16  
Fax: (202) 785-4313  
E-mail: [lisa@fuelcells.org](mailto:lisa@fuelcells.org)

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<sup>1</sup> The Breakthrough Technologies Institute (BTI) is an independent non-profit company that promotes advanced energy and environmental technologies, including bus rapid transit.

**Abstract:**

This paper provides a preliminary assessment of the Metro Orange Line, one of the first full-featured bus rapid transit (BRT) systems in the U.S. It also compares the Orange Line to two recent transit investments in Los Angeles: the Gold Line light rail and Metro Rapid, a rapid bus service with limited BRT features. Our assessment is based on existing performance, cost and operational data from the Orange Line's first year of service.

We found that the Orange Line is exceeding ridership projections, reducing travel times, easing congestion, and attracting people out of their cars. It is performing better than the Gold Line, which cost significantly more yet carries fewer riders. Metro Rapid appears to have some cost-effectiveness advantages but lack travel time consistency and a premium transit service image.

The Orange Line also offers lessons for future BRT planners. The Orange Line has suffered several collisions between buses and private vehicles, primarily because private vehicles were running red lights. Safety changes included reducing bus speeds through intersections, which contributed to higher-than-projected travel times. If safety issues are addressed, this would provide valuable lessons for future at-grade busway projects. Also, like some other recent projects, the Orange Line has pavement integrity issues. Further research would be useful in this area.

Overall, the Orange Line is providing mobility benefits and attracting new riders to an extent usually thought possible only with expensive rail systems. As the Orange Line matures, it would be valuable to conduct further performance analysis and to evaluate land development impacts.

## INTRODUCTION

Bus rapid transit (BRT) is a complete rapid transit system that can equal or exceed the performance of most rail systems but at a fraction of the cost. BRT features include exclusive bus lanes, high-capacity vehicles, increased distances between stops, more frequent service, traffic signal priority, rail-like stations, real-time passenger information, level boarding, and off-vehicle fare collection.

Opened in October 2005, the Metro Orange Line (“Orange Line”) is one of the first true BRT lines in the United States. It is operated by the Los Angeles County Metropolitan Transportation Authority (Metro) and connects the Red Line subway with the San Fernando Valley to the west. This paper reviews the development of the Orange Line and provides a preliminary evaluation based on its first year of operation, focusing upon system performance, cost effectiveness, and operational issues.

In addition, this paper compares the Orange Line’s performance with the performance of two other recent Metro transit investments: the Pasadena Gold Line light rail and the Metro Rapid bus service in the Ventura corridor.

The Gold Line light rail invites comparison with the Orange Line because it also connects with the Red Line subway, is roughly the same length as the Orange Line, and has a similar service pattern.

The Metro Rapid program is a network of arterial rapid bus routes that uses signal priority, increased spacing between stops, enhanced bus shelters, and a passenger information system to improve bus speeds. Metro plans to upgrade the system with additional BRT features such as high-capacity buses and exclusive lanes. The Metro Rapid Ventura line is used for comparison because it runs parallel to the Orange Line for roughly the same distance in the San Fernando Valley and because Orange Line opponents filed a lawsuit arguing that Metro Rapid would be a more cost-effective option for the Orange Line corridor.

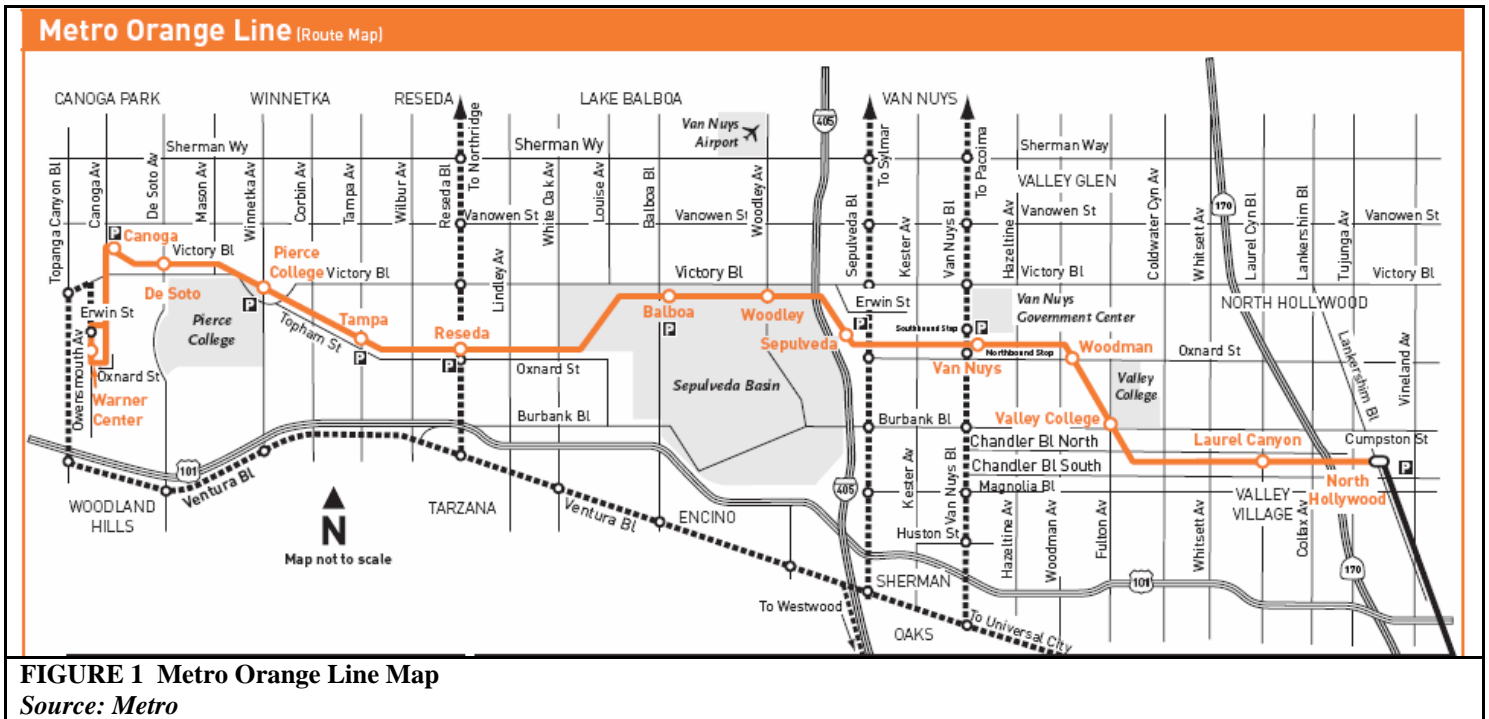
This preliminary assessment shows that Orange Line-style BRT is a viable strategy for auto-oriented cities, providing benefits usually considered possible only with rail. It also provides some lessons for future BRT projects, including the need to improve safety at busway intersections, ensure better pavement integrity, and fully consider the tradeoffs between a full BRT on a dedicated busway and an arterial rapid bus service like Metro Rapid.

## PROJECT DESCRIPTION

In 1991, Metro purchased an abandoned railroad line in the San Fernando Valley (1). The corridor runs parallel to US 101, also known as the Ventura Freeway. Initially, Metro considered building rail in the corridor, but this was deemed neither cost-effective nor politically viable (2). Following a 1998 visit to the Curitiba, Brazil BRT system, Metro proposed building a BRT line (3, 4).

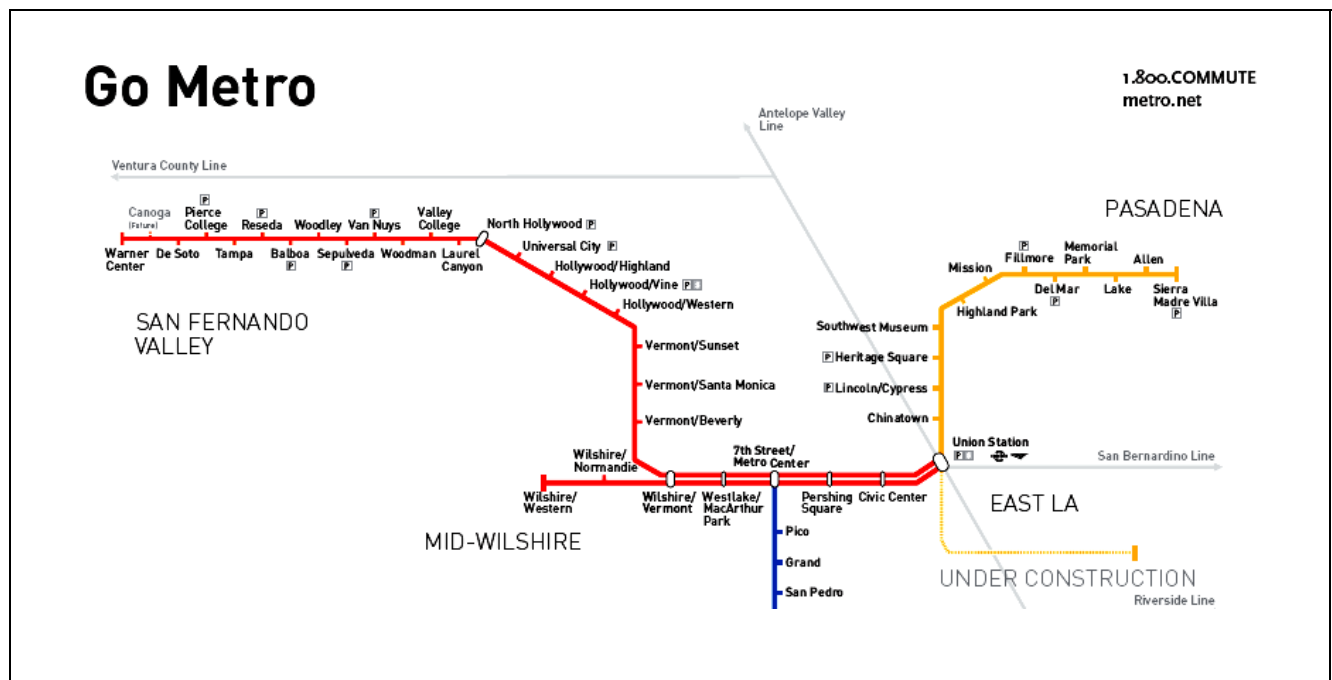
The Orange Line corridor is mainly residential, with single-family housing and some three- to four-story multi-family housing. Most of the corridor’s commercial activity is focused around the Warner Center, the third largest employment center in Los Angeles County, and the North Hollywood area, where the Red Line subway’s western terminus is located (2,5,6). By contrast, the Ventura Metro Rapid Line, which runs 1.5 miles to the south of the Orange Line, is located in the Valley’s main commercial corridor.

Figure 1 provides a detailed map of the Orange Line Corridor. Figure 2 is a portion of Metro’s rail system map, showing the Orange Line connection to the Red Line subway at North Hollywood, and the Gold Line connection to the Red Line at Union Station.



**FIGURE 1 Metro Orange Line Map**

Source: Metro



**FIGURE 2 Metro Rail Map Showing the Red, Orange, and Gold Lines**

Source: Metro

**Busway**

The Orange Line is a two-lane, 14-mile, dedicated busway. It crosses 34 streets and five mid-block pedestrian crosswalks, with loop detectors installed at each of the signalized intersections to give Orange Line vehicles traffic signal priority (7). It uses rubberized asphalt and sound walls on portions of the busway to reduce noise impacts on adjacent neighborhoods. Metro also

built eight miles of bicycle and pedestrian paths adjacent to the busway, with designated on-street bike lanes for the remaining six miles. The corridor features an irrigation system to maintain extensive landscaping.

### **Stations**

The Orange Line has 14 stations spaced roughly one mile apart and primarily located near major residential areas, activity centers and major north/south arterials. Stations feature variable message signs and real-time bus arrival information. They are decorated with terrazzo paving and enameled art panels. Each station also offers bicycle racks and lockers, covered seating, telephones, lighting, and security cameras. Six stations have park-and-ride lots, supplying a total of 3,800 free parking spaces (8). Planners projected that 80 percent of passengers would arrive by bus, subway, bike or on foot (9).

### **Fare Policy**

Passengers purchase one-way tickets and day passes at automated ticket machines located in stations. Ticket prices are the same as for other Metro services: one-way tickets cost \$1.25 and day passes cost \$3.00. Monthly discounted passes are also available. Passengers are required to carry proof-of-payment, which may be verified by fare inspectors (9). Future plans include the implementation of smart cards.

### **Vehicles**

The Orange Line uses a fleet of 60-foot, articulated vehicles powered by compressed natural gas. Known as "Metro Liners," the buses were custom-built by North American Bus Industries. The agency ordered 200 for their total bus fleet, with 30 initially assigned to the Orange Line.

Each vehicle seats 57 passengers. Passengers may board through any of three, 36-inch-wide doors. The buses have low floors to allow level boarding at stations and wheelchair ramps.

The buses feature aerodynamic-styling, large windows, wide aisles and improved lighting. On-board video monitors were recently installed, but plans to introduce wireless internet have been postponed (conversation with Dave Sotero, Metro press office, July 28, 2006).

### **Service Plan and Connections**

The Orange Line provides all-stop service only, although Metro is considering implementing express service. Vehicles operate solely on the dedicated busway and do not leave the busway to serve arterial streets. Vehicles do briefly enter mixed traffic in order to serve the Warner Center transit hub at the route's western terminus.

The service operates 22 hours per day, seven days a week. Vehicles depart every five to six minutes during the morning and evening peaks; every 10 minutes mid-day; and every 15 - 20 minutes in the very early morning and the late evening. Weekend headways are 10 - 20 minutes.

Schedules are coordinated with the Red Line subway to facilitate transfers (10). The Orange Line also connects to the Metro Rapid Ventura Line and numerous local bus lines. Metro rerouted several bus lines in the Valley to bring them closer to the Orange Line and added buses to several north-south lines connecting to the busway. The city of Los Angeles introduced a new, all-day shuttle service to carry Orange Line passengers from the final stop at the Warner Center to their workplaces in the complex (10).

**Branding**

The Orange Line is branded like Metro's rail lines in order to highlight it as a premium service and visually distinguish it from bus service. For example, as shown in Figure 2, the agency shows the Orange Line transitway on its rail system map to emphasize its integration into, and similarity to, rail service. The Metro Liners are painted in the silver and gray colors of Metro rail vehicles. Although they have individual artwork, all stations are of an identical basic design and construction, ensuring a recognizable branding identity. The Orange Line has an interactive website that explains system operations and emphasizes its similarity to rail.

**PROJECT OBJECTIVES AND PLANNING**

Metro's main goals for the Orange Line included:

- improving mobility for Valley residents;
- minimizing travel times;
- connecting the Warner Center to the North Hollywood subway station, thereby providing a high-capacity rapid transit route from the Valley into downtown L.A.;
- relieving congestion on US 101 and local streets; and
- promoting transit-oriented development (TOD) along corridors targeted by the city's long-term planning policies (6).

Initially, Metro faced opposition from Citizens Organized for Smart Transit (COST), which argued for additional Metro Rapid lines instead of the Orange Line. COST filed a lawsuit alleging that Metro overestimated the Orange Line's potential travel time benefits and that Metro Rapid service would provide comparable time savings at significantly lower cost. The Orange Line was put on hold for one month to enable the courts to hear the complaint (7).

Metro was required to evaluate several rapid bus alternatives, and it issued a revised Final Environmental Impact Report (FEIR) in October 2004. The FEIR concluded that the Orange Line would meet project goals more effectively than additional Metro Rapid lines. Among other things, it found that:

- end-to-end travel time would be in the range of 28.8 to 40 minutes and would be faster than the proposed Metro Rapid alternatives;
- the Orange Line would result in greater and more consistent travel time savings, because Metro Rapid lines operate in mixed traffic, not on a dedicated busway;
- full BRT would attract more riders, and most importantly, more new transit customers, than Metro Rapid;
- full BRT would be more cost-effective;
- full BRT would better support local land use policies by placing high-capacity service near activity centers targeted by the city for TOD (6).
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**PRELIMINARY EVALUATION**

Early results show that the Orange Line is exceeding expectations for ridership, reducing travel times for the majority of users, and achieving a significant mode shift from cars to transit. This section examines ridership, travel patterns of Orange Line riders, mode shift, congestion relief,

travel time savings, operational challenges, and cost effectiveness. To the extent data was available, it compares the Orange Line's performance to the Gold Line and Metro Rapid. This section also briefly discusses potential land use impacts.

## System Performance

### *Ridership*

Metro projected 5,000 to 7,500 average weekday boardings for the first year of Orange Line service and 22,000 average weekday boardings by 2020 (11). By May 2006, only seven months after opening, the Orange Line had achieved its 2020 goal, attracting 21,828 average weekday boardings. While Metro ridership on all modes has increased, the Orange Line has experienced more than twice the increase of rail and almost three times the increase of buses (12).

Total Orange Line ridership is higher than that of the Gold Line, a 13.7-mile light rail service starting at the Red Line's Union Station and running northeast into Pasadena. Opened in 2003, this 13-station route is the first section of a proposed 37-mile line serving east Los Angeles (13). The Pasadena line operates on 10-minute peak headways with additional express service during peak hours. Planners had predicted the service would have 30,000 weekday boardings, and that the ridership would double by 2023 (14). In the three years since the line opened, ridership has fallen well short of expectations.

As shown in Table 1, the Orange Line has outperformed the Gold Line during most months since the Orange Line was launched (15).

Month	Orange Line	Gold Line
Nov. 2005	16,360	16,910
Dec. 2005	15,492	14,417
Jan. 2006	16,100	16,318
Feb. 2006	17,636	15,325
March 2006	18,242	15,769
April 2006	18,700	15,587
May 2006	21,828	18,078
June 2006	20,844	18,771
July 2006	20,760	20,329
Aug. 2006	19,531	18,874
Sept. 2006	21,005	20,972
Oct. 2006	20,217	18,035
Nov. 2006	20,659	17,768
Dec. 2006	19,004	17,956
Jan. 2007	19,048	17,638

*Source: Metro and The Transit Coalition*

In total, Metro estimates that the Orange Line logged about 6 million boardings in its first 12 months (16), while the Gold Line had approximately 5.4 million boardings in this same time period (15). From July through September 2006, the Gold Line averaged 85 boardings per train revenue hour and 5.5 boardings per train revenue mile, while the Orange Line averaged 76 boardings per vehicle revenue hour and 4.7 boardings per vehicle revenue mile (email from

David Sotero, Metro, November 10, 2006). As discussed below, however, the Gold Line cost roughly twice as much as the Orange Line per boarding and per passenger mile, indicating that it is not as economically efficient as the Orange Line in providing mobility services.

Orange Line ridership also compares favorably to Metro Rapid's Ventura and Wilshire-Whittier lines which were launched in 2000. The Wilshire-Whittier and Ventura corridors have experienced ridership increases of 47% and 45% respectively over the previous local bus service (17). However, the Ventura line, which runs roughly parallel to the Orange Line for 16.4 miles with 16 stops, averages 9,216 daily weekday boardings, less than half that of the Orange Line (conversation with Scott Page, Metro, July 28, 2006). This is likely in part because the Metro Rapid line does not use high-capacity vehicles, runs fewer hours, and has longer headways at certain times of the day. It should be noted that the service has met Metro's goals, which were to increase ridership, reduce travel times and improve service image quickly and at low cost. Metro has recently begun placing 60-ft articulated vehicles into some Metro Rapid lines, so it would be valuable to track how ridership is affected and make further comparisons with Orange Line ridership.

To meet the high passenger demand, Metro began running more buses during peak hours in January 2007. The agency also plans to test 65-ft buses, which can accommodate 14 additional passengers, in summer 2007 (18).

#### *Travel Patterns*

In January 2006, Metro conducted a survey of Orange Line riders, collecting information about trip purpose, previous travel mode, boarding and alighting patterns, service perceptions and passenger demographics (19). The survey showed that, during the morning peak:

- 86 percent of eastbound passengers and 91 percent of westbound passengers indicated that their trip began from home; and
- 65 percent of eastbound passengers and 73 percent of westbound passengers indicated that their final destination was work.

During the evening peak:

- 42 percent of eastbound passengers and 41 percent of the westbound passengers indicated that their trip began from work; and
- 44 percent of eastbound passengers and 36 percent of westbound passengers indicated that their final destination was home.

Overall, out of those riders who indicated their trip purpose, about 41 percent were heading between home and work, while 31 percent were heading to other destinations like shopping, medical appointments, or school. This indicates that the Orange Line is not just a commuting service, but is also being integrated into other community activities.

The survey also showed that 79 percent of all riders arrived at the station via transit, bike, or walking, while only 13 percent drove. This is consistent with the original project goal of 80 percent access by means other than a personal vehicle. Similarly, upon reaching their final station, most Orange Line riders either walked (28%) or transferred to bus (28%) or rail (26%) service to reach their ultimate destination. Only five percent of passengers drove to their final destination from an Orange Line station.

The Orange Line also seems to be fulfilling expectations that it act as an extension to the Red Line via the North Hollywood station. Fifty-two percent of riders boarding at the North Hollywood station were transferring from the Red Line, while 59 percent of passengers who debarked at this station said they would be connecting to the subway.

#### *Mode Shift and Reduced Congestion*

In December 2005, the California Center for Innovative Transportation (CCIT) analyzed the impact of the Orange Line on US 101 peak hour commutes (20). CCIT found that, since the opening of the Orange Line, southbound traffic flow during the morning peak had improved roughly seven percent, while total time spent stuck in congestion had dropped by about 14 percent (21). CCIT also found that the congestion started about 11 minutes later in the morning since the Orange Line opened, and that northbound traffic flow in the evening rush hour improved by six percent.

This study did not look at overall traffic patterns, and therefore did not determine conclusively that the Orange Line was responsible for the lower congestion levels. However, the findings are corroborated by the Metro ridership survey. Although 62 percent of those surveyed previously rode bus (52%) or rail (10%), 18 percent previously drove, either alone (14%) or in a carpool (4%). About 79 percent of riders who formerly drove said they had used the US 101 freeway.

As planners projected, the Orange Line is attracting riders who are new to transit. According to the ridership survey, 17 percent of all riders were new to Metro, and 14 percent had been using Metro for less than one year. More than one-third of the riders had a car available for the trip.

By comparison, Metro Rapid is also attracting new transit customers, but at a lower rate than the Orange Line. According to Metro, one-third of the ridership increases along the Ventura and Wilshire-Whittier lines were new riders, which translates to approximately 10.7 percent of all riders on these lines.

#### *Travel Time*

According to the rider survey, approximately two-thirds of the riders who previously drove on the US 101 said their travel time had been reduced by the Orange Line. Of respondents who made the same trip by any mode prior to the opening of the Orange Line, 85 percent reported a reduction in travel time by switching to the Orange Line.

Although the Orange Line appears to be providing good travel time benefits, these benefits are not as great as originally predicted. Metro estimated that end-to-end travel time would take between 28.8 and 40 minutes (6). As shown in Table 2, actual average travel times are 41 minutes eastbound and roughly 50 minutes westbound, which is comparable to the Metro Rapid Ventura Line. The failure to achieve projected travel times is due partly to the failure to provide the Orange Line with traffic signal preemption and partly to intersection safety

**TABLE 2 End-to-End Travel Time and Average Speed Comparison  
Between the Ventura Metro Rapid Line and the Orange Line**

	Ventura Metro Rapid (16.4 miles in length)		Metro Orange Line (14 miles in length)	
	Total Time	Average Speed	Total Time	Average Speed
A.M. Westbound	44 minutes	22.4 mph	50 minutes	16.8 mph
A.M. Eastbound	45 minutes	21.9 mph	41 minutes	20.5 mph
P.M. Westbound	50 minutes	19.7 mph	51 minutes	16.5 mph
P.M. Eastbound	59 minutes	16.7 mph	41 minutes	20.5 mph

*Source: Gephart, Rex, Metro Rapid Program Manager, presentation dated April 2006*

problems, which are discussed below.

The similarity between Orange Line and Metro Rapid travel times is significant, because, while the Ventura Line parallels the Orange Line, it is 2.4 miles longer and operates in mixed traffic. Like the Orange Line, Metro Rapid has signal priority and stations spaced roughly one mile apart. These features have reduced travel times for riders in this corridor. However, because the Orange Line has its own right-of-way, travel times are more consistent than with Metro Rapid, as Metro Rapid travel times can be significantly affected by traffic conditions on arterial streets. In addition, the Orange Line is accommodating twice as many daily boardings as the Ventura Line, using off-board fare collection and multiple-door entry to speed passenger loading.

## Operational Challenges

### *Safety Issues*

Soon after the busway opened, there were several collisions with transit vehicles, caused mainly by cars running red lights. In response, Metro reduced bus speeds through intersections from 25 mph to 10 mph. This has lowered average speeds and affected travel time savings achieved with this service.

Other safety modifications have been or are being implemented to reduce the risk of red light running, including:

- installing 36-inch bus crossing signs at intersections (Figure 3);
- changing traffic signal timing to give buses more time to clear intersections;
- changing conventional round green light signals to an “up” arrow signal to emphasize the prohibition on “turning right on red”;
- lowering the flashing “bus coming sign” to be immediately adjacent to “no right turn on red” signs (Figure 3);
- installing 24-inch “Look Both Ways” pedestrian warning signs;
- adding “Keep Clear” pavement markings at intersections;
- testing strobe lights on a few buses to increase their visibility; and
- installing photo enforcement cameras to deter red-light runners (7).



The safety modifications appear to be working and, as of June 2006, the 2006 accident rate for the Orange Line was lower than that of other Metro services (email from Dave Sotero, Metro, August 1, 2006). The agency continues to work with the community to increase

awareness of busway safety. Among other things, it distributed an interactive DVD on Orange Line safety to more than 30,000 San Fernando Valley residents (22).

Metro officials have indicated they will consider increasing intersection bus speeds if the safety improvements keep the accident rate down (7). Metro also has discussed installing railroad-style gates, but noted that similar gates had not prevented auto collisions with Gold Line trains (23). According to Metro, these intersection safety concerns have also prevented the Gold Line from meeting its projected travel times (email from Kathleen Sanchez, Metro, Aug. 1, 2006), demonstrating that the tradeoff between speed and safety is not unique to the Orange Line.

#### *Noise Complaints*

As noted above, Metro used rubberized asphalt and soundwalls on some portions of the busway to reduce noise impacts. Nevertheless, some residents have complained about noise. To address these complaints, Metro modified the buses' exhaust pipes to vent away from residential areas and continues to work with the community on a case-by-case basis to address sound issues (24, 25, conversation with Dave Sotero, Metro, July 28, 2006).

#### *Pavement Deterioration*

Portions of the busway surface have begun to fail, with some crumbling occurring even before the Orange Line's debut. In December 2006, Metro rebuilt one mile of pavement and is attempting to determine the cause of the failures. Metro believes the rubberized asphalt may not have been built to specifications or that the soil under the asphalt was not properly packed. The contractor believes that the asphalt met specifications (26).

### **Capital and Operating Costs and Efficiencies**

#### *Capital Cost Efficiency*

According to Metro, the Orange Line cost roughly \$349.6 million to build, or \$25 million per mile. A rough breakdown, based on the contractor's schedule, is shown in Table 3 below.

<b>TABLE 3 Approximate Breakdown of Orange Line Capital Costs (millions)</b>	
Guideways	144.1
Yards and Shops	1.4
System Equipment	8.8
Stations and Park and Ride Lots	31.1
Bicycle Path	10.6
Vehicles	15.7
Right of Way	17.3
Special Conditions	36.4
Professional Services	48.2
Contingency	10.0
<b>TOTAL</b>	<b>323.6*</b>
<i>Source: Patel, Hitesh, Metro Orange Line – Design and Construction, presentation dated</i>	

April 20, 2006.  
 \* Total does not include \$26 m. for construction of the 14<sup>th</sup> station, opened in Dec. 2006.

In capital cost efficiency, the Orange Line compares quite favorably with the Gold Line. Metro spent approximately \$859 million to build the Gold Line, or \$62.7 million per mile (27). Table 4 shows that after just seven months in service, the Orange Line was outperforming the much more expensive light rail service, with capital costs per weekday boarding about one-third of the Gold Line's costs.

<b>TABLE 4 Comparison of Capital Cost Effectiveness</b>			
	<b>Orange Line BRT (a)</b>	<b>Gold Line Light Rail (a)</b>	<b>Metro Rapid Ventura Line (b)</b>
Length (miles)	14	13.7	16.4
Number of Stations	13	13	16
Number of Vehicles	30	24	24
Average Weekday Boardings (June 2006)	20,844	18,771	9,216 (March '06)
Average Saturday Boardings (June 2006)	12,437	7,314	5,675 (March '06)
Average Sunday Boardings (June 2006)	9,951	7,544	3,968 (March '06)
Capital Costs	\$349,600,000	\$859,000,000	\$11,680,000 (c)
Capital Costs Per Mile	\$24,757,142	\$62,700,729	\$712,195
Capital Costs Per Average Weekday Boarding	\$16,772	\$45,762	\$1,267
<p>(a) Data from Los Angeles Metro website's Facts at a Glance, <a href="http://www.mta.net/press/pressroom/facts.htm">http://www.mta.net/press/pressroom/facts.htm</a>, accessed July 27, 2006</p> <p>(b) Boarding figures from Rex Gephart, Metro Rapid Program Manager (July 27, 2006)</p> <p>(c) Capital costs from Rex Gephart, Metro Rapid Program Manager (Aug. 1, 2006) and Jan. 27, 2000 Los Angeles Metro Board Meeting Minutes</p> <p>Note: Costs are not normalized for inflation; however, there are fewer than five years separating the three projects.</p>			

Comparisons between the Orange Line and Metro Rapid are more difficult, in part because Metro does not publish performance and budget data specific to Metro Rapid. Agency officials report that Metro Rapid capital costs include two elements:

- Stations, at a cost of \$100,000 per mile
- Bus signal priority, at a cost of \$20,000 per intersection

Therefore, according to Metro, total capital cost for the Ventura line was \$3.28 million. However, since the Orange Line capital costs include the vehicles, it is fair to add vehicle cost to

the Ventura Line's total. According to Metro, the 24 buses that serve the Ventura Line cost roughly \$350,000 per unit, for a total of \$8.4 million. Adding the two, we derived a rough approximation of the total capital costs for the Ventura Line of \$11.68 million, or \$712,195 per mile.

The Metro Rapid Ventura Line's capital costs per mile were much lower than the Orange Line's, indicating that Metro Rapid is a cost effective way to reduce travel times and add riders.

### *Operating Cost Efficiency*

In Table 5, we compare Metro's fiscal year 2007 operating cost budget for the Orange Line, the Gold Line, and bus service. Unfortunately, the Metro budget does not separate Metro Rapid and local bus costs. However, according to the Metro Rapid program manager, the operating costs per hour for Metro Rapid and local bus service are the same (email from Rex Gephardt, July 31, 2006). Therefore, as a surrogate for Metro Rapid, we compared the Orange Line and the Gold Line operating costs with all bus services in the San Fernando Valley, which includes the Ventura Line.

Table 5 shows that, based upon available metrics, the Gold Line light rail is far more expensive to operate than the Orange Line BRT. On the other hand, with the exception of cost per passenger mile, the Orange Line appears to have higher operating costs than Metro Rapid. Additional research into this issue would be valuable, using real Metro Rapid operating costs to verify whether its operating costs are significantly lower than the Orange Line's and to understand why.

<b>TABLE 5 Comparison of Operating Efficiencies</b>			
Operating Cost Efficiencies	Orange Line BRT	Gold Line Light Rail	San Fernando Valley Bus
Cost Per Revenue Service Hour	\$243.18	\$552.54	\$96.71
Cost Per Revenue Service Mile	\$14.53	\$24.56	\$9.57
Cost Per Passenger Mile	\$0.54	\$1.08	\$0.63
Cost Per Boarding	\$3.79	\$7.54	\$2.17
<i>Source: Los Angeles Metro FY'07 Proposed Budget, <a href="http://www.mta.net/other_info/budget_online/images/Budget_Proposed_FY07.pdf">http://www.mta.net/other_info/budget_online/images/Budget_Proposed_FY07.pdf</a></i>			

### **Transit Oriented Development Impacts**

Land use was a major factor in the selection of the Orange Line BRT over alternatives like Metro Rapid. Los Angeles' long-term development plan calls for high-capacity transit along certain major activity centers in order to encourage TOD. At this point, it is too early to assess the Orange Line's impact on development in the corridor. However, large multi-unit developers have already expressed interest, and Metro is reviewing joint development contracts to construct over two million square feet of mixed-use development at several stations (28, 16). These developments would integrate park and ride, residential and commercial facilities with ground floor retail and office space (conversation with Kathleen Sanchez, Metro, 07/25/06). Metro has also committed to a \$3.6 million renovation project in a historic district near the North Hollywood station (16).

It is important to note that other forces are also attracting development to the corridor. For example, the North Hollywood terminus was already a major transit hub. Future studies should carefully examine and isolate the land use impact of the Orange Line.

## **CONCLUSION**

Currently, many believe that light rail offers benefits that are superior to any BRT system. The early experience with the Orange Line shows that this is not the case. The Orange Line demonstrates that, for agencies looking to implement a premium transit service, BRT can equal or exceed the performance of comparable light rail systems, but at significantly lower capital and operating costs. It also demonstrates that BRT can attract people out of their cars and have an impact on local traffic congestion.

Some Orange Line critics claim that the unexpectedly high ridership indicates Metro should have built light rail instead of BRT to meet the corridor's potential passenger demand. Metro officials contend that the Orange Line can accommodate 40,000 or more weekday boardings and is nowhere near capacity (12).

Moreover, as shown by the very high cost per boarding and per passenger mile of the Gold Line, as well as the much higher capital costs, it is not clear that light rail would offer benefits beyond what can be achieved by adding bus capacity to the Orange Line.

As a result of the Orange Line's success, the Metro Board approved a feasibility study to extend the Orange Line six miles north to the Chatsworth Metrolink Station and are considering further extensions (29). Metro projects that the Chatsworth extension would increase boardings by 4,000 per year and would cost \$135 million.

The Orange Line also provides important lessons for BRT planners. For example, the Orange Line shows that care must be taken when designing at-grade busways that intersect with busy arterial streets. Planners should anticipate that car drivers will illegally enter the busway, and steps should be taken to ensure safety. Planners also should anticipate that safety issues could result in travel time increases. Thus grade separation, at least at the busiest intersections, should be considered.

It is also important for BRT planners to understand pavement durability issues and develop appropriate specifications to ensure long-term pavement integrity.

Finally, planners should carefully consider the tradeoffs between BRT on a dedicated right-of-way and arterial rapid bus services. The Metro Rapid system increases bus speeds and attracts new passengers at low cost. The Orange Line system provides a premium quality service that provides rail-like performance and amenities at a much lower cost than rail. Communities need to establish clear goals and choose the system that will best achieve those goals.

As the Orange Line matures, it would be valuable to further analyze system performance and benefits using independently collected data and ridership surveys. It also would be interesting to study those Metro Rapid lines that are beginning to deploy 60-ft articulated buses and make further comparisons to the Orange Line. Also, although there appears to be some land use impact of the Orange Line, it is too early to reach any definitive conclusions, so additional research and analysis on this issue will be very important.

## **ACKNOWLEDGEMENTS**

The authors would like to thank BTI intern Nicholas Balistreri for his help with research and editing. We would also like to thank Dave Sotero, Rex Gephart, Scott Page, and Kathleen Sanchez of Metro, as well as Tom Rubin and Diana Lipari, for their guidance and assistance.

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