Final Report

Los Angeles Metro *Rapid* Demonstration Program

Metro Rapid
LOS ANGELES

Final Report

Los Angeles Metro *Rapid* Demonstration Program
March 2002

Metro Rapid was developed and is operated by the Los Angeles County Metropolitan Transportation Authority

The Metro Rapid transit priority system was developed and is operated by the Los Angeles Department of Transportation

Prime Contractor:
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Suisman Urban Design

Metro *Rapid* Program

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Metro *Rapid* Program

Executive Summary

The MTA Board of Directors, following an initial feasibility study, initiated the Metro Rapid Demonstration Program in March 1999. Staff was directed by the Board to conduct the feasibility study in response to a visit to Curitiba, Brazil by MTA and City of Los Angeles officials. The Curitiba urban design and public transportation model has been widely praised internationally for its success and has been a major force in the Federal Transit Administration creation of a national Bus Rapid Transit (BRT) initiative. The feasibility study recommended that MTA, in partnership with the City of Los Angeles, conduct a demonstration along two-to-three major arterials which have strong ridership and unique characteristics to provide broad actual experience regarding the feasibility of full-scale deployment of BRT within the MTA system. However, of the 12 key attributes associated with the successful Curitiba BRT (Curitiba does not have bus signal priority), only seven (highlighted) were deemed feasible for implementation during the expedited Phase I Demonstration Program. The remaining six attributes would be deployed in Phase II, system expansion, if the initial demonstration proved successful.

CURITIBA KEY ATTRIBUTES	Metro Rapid Phase I Demonstration	Metro Rapid Phase II Expanded System
1. Simple Route Layout	Yes	Yes
2. Frequent Service	Yes	Yes
3. Headway-based Schedules	Yes	Yes
4. Less Frequent Stops	Yes	Yes
5. Level Boarding and Alighting	Yes	Yes
6. Color-coded Buses and Stations	Yes	Yes
7. Bus Signal Priority	Yes	Yes
8. Exclusive Lanes	No	Yes
9. Higher Capacity Buses	No	Yes
10. Multiple Door Boarding & Alighting	No	Yes
11. Off-Vehicle Fare Payment	No	Yes
12. Feeder Network	No	Yes
13. Coordinated Land Use Planning	No	Yes

Phase I demonstration implementation planning was initiated in the summer of 1999 with a Spring 2000 goal for start-up of Metro Rapid. Two lines were selected for the demonstration:

- Line 720 Wilshire/Whittier (very high passenger demand urban corridor connecting through the Los Angeles Central Business District (LACBD))
- Line 750 Ventura (high passenger demand suburban corridor serving the Metro Rail Red Line)

The two Metro Rapid lines were implemented on June 24, 2000, coinciding with the opening of the extension of the Metro Red Line to the San Fernando Valley. All seven of the Phase I attributes were fully operational at start-up with the exception of the Metro Rapid Stations where temporary stops were utilized. The Stations with “next bus” displays are currently under construction, with completion of all sites expected in spring 2001.

Demonstration Has Been Successful

The Metro Rapid Demonstration Program has been a success, meeting all 7 of the program's original objects.

Objective 1: Reduce Passenger Travel Times - The Metro Rapid program introduced several attributes specifically to reduce passenger travel times, including bus signal priority, level boarding/alighting with low-floor buses, headway rather than timetable-based schedules, fewer stops, far-side intersection location of stations, and joint active management of the service operation from the Transit Operations Supervisors (TOS) in the field and the MTA Bus Operations Control Center (BOCC). Since the initial date of service, Metro Rapid operation has achieved the following improvements in operating speeds:

- Wilshire/Whittier Corridor - operating speeds increased by 29%.
- Ventura Corridor - operating speeds increased by 23%.

Objective 2: Increase Ridership - The increase in ridership has come from three principal sources: (1) 1/3 of the increase is from brand new riders (riders from households making over $50,000 per year rose to over 13% of total line ridership); (2) 1/3 are current riders riding more often (a higher percentage now ride 5 or more days a week); and (3) 1/3 are current MTA riders who changed routes (diversion).

- Wilshire/Whittier Corridor - ridership has increased by 42%.
- Ventura Corridor - ridership has increased by 27%.

Objective 3: Attract New Riders - As noted above, approximately 1/3 of the ridership increase are new riders based on a survey conducted in September 2000, prior to the work stoppage.

Objective 4: Increase Service Reliability - Metro Rapid was designed to improve service reliability by addressing bus bunching and the incidence of vehicle overcrowding. To date, service reliability has been excellent on the Ventura Metro Rapid, out-performing the time-point based local service in terms of achieving lower bus bunching and improved reliability. Service reliability has been mixed on the Wilshire/Whittier Metro Rapid, largely due to heavily loaded trips during much of the day. Scheduled service was increased in September and December 2000, and will again be increased this coming June 2001 in order to match service levels with demand. Service reliability has been improving with the increase in service and with the introduction of a new module in LADOT's bus signal priority system that helps maintain headway intervals. It is further anticipated that service reliability will continue to improve with the next round of improvements in June 2001.

Objective 5: Improve Fleet and Facility Appearance - Fleet appearance has been excellent with both Divisions 7 and 8 turning in strong ongoing performances. The improvement in fleet cleanliness was very obvious to customers as they indicated in the on-board before and after surveys. Facility appearance has not yet been measured; the Stations have been only recently constructed along Ventura and Wilshire-Whittier Boulevards.

Objective 6: Improve Service Effectiveness - Service effectiveness (passengers per revenue hour or mile) has been mixed: Wilshire/ Whittier is up, while Ventura is not. The Wilshire/ Whittier corridor shows significant improvement in effectiveness (productivity is up 17% and subsidy per passenger improved 18%) despite increased service (service hours are up 20% but resulted

in a 42% ridership gain). The Ventura corridor has showed a marked decline in service effectiveness that is the result of large increases in local service concurrent with the initiation of Metro Rapid (the local service was operating twice as often as Metro Rapid in peak periods). This increase in local service has not generated a significant change in ridership and may be addressed by Operations in the June 2001 Shake-Up. It is anticipated that the effectiveness of the Ventura corridor will improve dramatically with better matching of local service levels with local service demand.

Objective 7: Build Positive Relations with Communities - As part of the development of the Metro Rapid Station concept and design, staff worked closely with the individual communities to implement the Metro Rapid program. Staff have developed a uniform station design that meets the "image-linkage with the vehicle" requirement, while simultaneously meeting community preferences. Staff has worked with the local jurisdictions to address any concerns identified by adjacent property owners without hampering the Metro Rapid program.

Next Steps

- Build on the success of the Metro Rapid Demonstration Program with input from the Municipal Operators, cities, and County.

- Complete the Phase I attributes still in implementation, including expansion of the bus signal priority system outside the City of Los Angeles, and upgrading of Metro Rapid bollard gate stations to canopy gates stations where feasible.

- Implement the Phase II Metro Rapid System Expansion Program and remaining Phase II Metro Rapid attributes, including:

  – High capacity vehicles
  – Exclusive lanes/by-pass lanes
  – Multiple door boarding and alighting with off-vehicle fare collection
  – Feeder network

METRO RAPID PHASE II

Phase IIA	Phase IIB	Phase IIC	Phase IID
South Broadway	Central	Western	West Olympic
Vermont	Santa Monica	Beverly	Garvey/Chavez
Pico-Pico-Venice	Hawthorne	Vernon/La Cienega	Manchester
Florence	Long Beach	Atlantic	Crenshaw/Rossmore
Soto	Hollywood/Pasadena	San Fernando	Torrance/Long Beach
Van Nuys		Sepulveda	Lincoln

Metro *Rapid* Program

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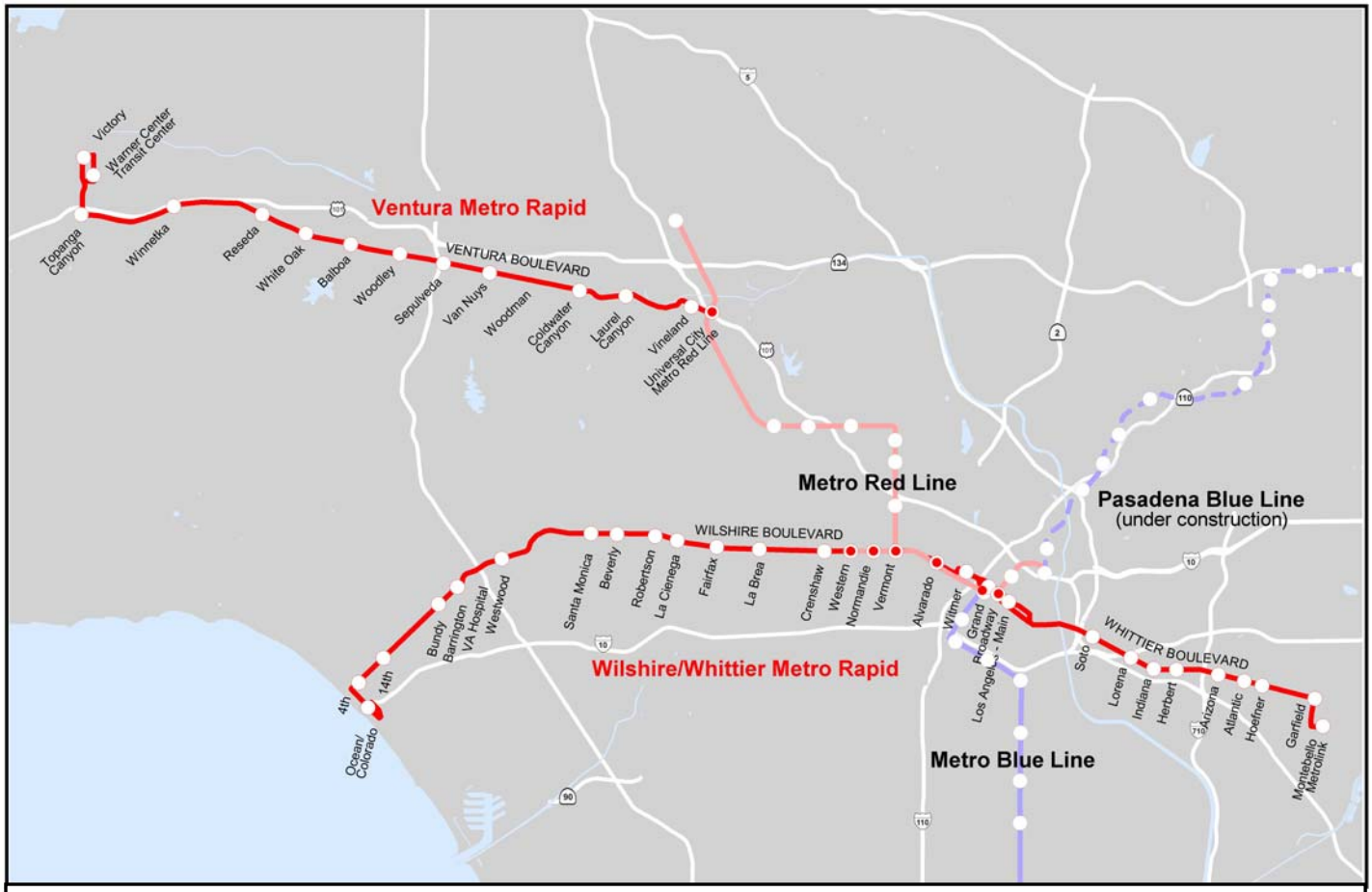

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Demonstration Lines

The Metro Rapid program has been strikingly successful, even without the completed Stations. Operating speed, service quality, ridership, and customer response have all exceeded objectives, with very little or no negative impact on the rest of the system and other travel modes.

Operating Speed, LADOT TPS, Service Quality

Pervious communications with bus riders have indicated that MTA's existing local and limited-stop bus services have been too slow and unreliable. The Metro Rapid program sought to address these shortcomings through the introduction of service that would improve operating speeds over current local service with reduced passenger wait times and load factors within Consent Decree requirements.

Operating Speed

The Metro Rapid program introduced several attributes specifically to improve service operating speeds. These included: bus signal priority, level boarding/alighting with low-floor buses, headway rather than timetable-based schedules, fewer stops, far-side intersection location of stations, and joint active management of the service operation from the Transit Operations Su-

pervisors (TOS) in the field and the MTA Bus Operations Control Center (BOCC). Since the initial date of service, the Metro Rapid operation has achieved several major improvements in operating speeds:

Operating Speeds	Wilshire/Whittier (Line 720)	Ventura (Line 750)
Overall Improvement	29%	23%
Eastbound (Range)	31% (18-40%)	20% (11-29%)
Westbound (Range)	28% (21-32%)	27% (16-34%)

The City of Los Angeles conducted independent research regarding which attributes contributed to the speed improvement and found that the bus signal priority system accounted for approximately 1/3 of the improvement and the other elements accounted for the remaining 2/3 of the benefit. In support of this finding, the running time data indicates that the segments with bus signal priority operate faster than the adjacent segments, especially when ridership loads are considered. To further increase bus speeds along the Wilshire/Whittier corridor, bus signal priority should be extended to the segments in Beverly Hills, East Los Angeles, Montebello, and Santa Monica.

Metro Rapid operated faster in mixed arterial traffic than the Curitiba Express lines in exclusive lanes due to Curitiba's tighter station spacing and externally-controlled vehicle speed governors. Depending on the time-of-day and direction, Metro Rapid speeds average between 14 and 30 mph compared to Curitiba's average speed of 13.8 mph.

Several segments on both lines operated significantly more slowly due to other factors:

- Traffic congestion caused major delays for Line 750 along Ventura Boulevard between Balboa and Van Nuys (I-405 back-ups) and between Vineland and the Universal City Station; and for Line 720 through downtown Los Angeles.

- Very high ridership loads result in extended dwell times; thus, slowing operations between downtown Los Angeles and Western Avenue on Line 720. The higher capacity buses and multiple-door boarding in Phase II will reduce dwell times significantly, improving operating speeds.

In conclusion, MTA, in partnership with the City of Los Angeles Department of Transportation (LADOT), has achieved results in operating speed improvements that have been noticed and appreciated by its customers with the deployment of the Phase I Demonstration Program. A Phase II Expansion Program should build on this base and continue improving operating speeds by:

1. Complete the bus signal priority installation outside of the City of Los Angeles on demonstration Line 720 Wilshire/Whittier and establish a standard that future Metro Rapid service will be fully covered with bus signal priority.

2. Introduce exclusive bus lanes on arterials where feasible (recognizing the likelihood of future congestion); priority should be given to arterial segments with chronic, debilitating traffic congestion delay.

3. Reduce station dwell times by testing and introducing off-vehicle fare collection systems such as "proof of payment," and introducing high capacity buses to manage standees within standards and avoid gross aisle congestion delays.

4. Introduce high capacity buses to allow for operation of more capacity with less frequent service during maximum peak periods. The current westbound morning peak frequency on Wilshire/Whittier is approaching 2 minutes which allows for little traffic signal recovery between bus priority overrides and is increasing the likelihood that individual Metro Rapid buses will not receive signal priority. Discussions with LADOT indicate that 5-minute intervals are a good balance between service frequency and maximum bus signal priority availability, with 3 minutes on the lower end of desirability.

LADOT Transit Priority System

The Transit Priority System (TPS) was designed and implemented by the City of Los Angeles Department of Transportation (LADOT) to assist MTA in implementing the Metro Rapid Demonstration Program. This program has gained nationwide attention since its debut on June 24, 2000, and has significantly improved the quality of transit operations along the two Metro Rapid corridors.

The Transit Priority System was developed to provide traffic signal priority to buses operating on heavily used transit corridors, and is an enhancement to the City's Automated Traffic Surveillance and Control (ATSAC) System. This concept was embraced by the MTA and became an integral part of its Metro Rapid program. The system has been deployed at more than 211 intersections along the two Metro Rapid corridors in Los Angeles: Ventura Boulevard (16 miles) and Wilshire/Whittier Boulevards (26 miles, 14 miles in Los Angeles). During the past nine months of operation, many transportation professionals have inquired about this innovative new system, including the Federal Transit Administration (FTA) as one of the first successes in the "Bus Rapid Transit" arena.

The TPS Project also includes control of dynamic passenger information signs at selected bus shelters along the Metro Rapid routes. These highly visible Light Emitting Diode (LED) signs inform passengers of the estimated arrival times of the "next" Metro Rapid bus. The arrival time information is computed by the system based on the actual speed of the bus and is accurate to within one minute. The sophisticated algorithm which calculates the arrival time was completely developed in-house by LADOT staff.

Detailed engineering studies have been made which not only measure the effectiveness of the project, but also its impacts on general automotive traffic. The results are very promising, with total transit travel time savings of about 25% in each corridor and a reduction in delays caused by traffic signals of 33%. Overall travel speeds for the buses have increased from 11 to 14 miles-per-hour on Wilshire Boulevard and from 15 to 19 miles-per-hour on Ventura Boulevard. The impacts to cross-street traffic are minimal, typically averaging about one second of delay per vehicle. This project has clearly demonstrated that with the correct combination of technology and innovation, a creative solution to the transportation needs in Los Angeles can be met.

Service Quality

The Metro Rapid program was initiated to improve both operating speeds and service quality. The key elements of service quality that were considered important were reduction in bus bunching (headway ratios), average passenger wait times, and passenger standing loads. The two demonstration lines have differing degrees of success, largely depending upon the nature of passenger demand, with Line 750 Ventura showing excellent improvements in service quality while Line 720 Wilshire/Whittier still trying to manage the massive increase in ridership attracted to the new service.

- Line 720 Wilshire/Whittier – headway ratios show considerable bus bunching, especially during peak periods when the buses are very frequent. Average passenger wait times are typically less than 5 minutes with the only concern during PM peak periods, especially westbound, where wait times could exceed the typical headway. High daily ridership results in high average loads for much of the day. The passenger-perceived average loads were even higher due to the variability induced by the high headway ratios (bus bunching). On September 10, 2000, an additional 23 trips were added during peak periods with a resulting 10 percent increase in ridership within just three days indicating strong latent demand still remaining.

- Line 750 Ventura – headway ratios are excellent with almost no bus bunching, significantly better than the timepoint-based local service. Average passenger wait times are in the 4-to-6 minute range, which is excellent for service operating every 10-12 minutes. Average loads are below maximum seated levels, but are expected to continue to increase concurrent with ridership growth once the effects of the strike are shaken off.

- The companion local services on Wilshire/Whittier and Ventura have all shown improved service quality and performance due largely to the reduced local ridership loads, making the service operate artificially faster than previously. On Wilshire/Whittier, local service levels initially operated at the same levels as Metro Rapid, while on Ventura, local service ran twice as often during peak periods and the same as Metro Rapid during the remainder of the service day. As local service levels are adjusted to reflect actual local ridership, service performance should return more closely to normal.

In summary, Metro Rapid has had considerable success. But to avoid success being the undoing of Metro Rapid, MTA and LADOT need to move forward with refinements in operating policies and upgrades to the bus signal priority system, including:

1. Provide more capacity with less peak period frequency along Wilshire/Whittier. This will allow the TOS with help from the BOCC to better manage the service, improve the consistency of the bus signal priority system, and reduce station dwell times.

2. Introduce and monitor refined operating practices concurrent with additional training for the BOCC, TOS, and bus operators. These will balance manual intervention by MTA staff with automatic intervention by the LADOT signal system.

Ridership

MTA has estimated the ridership on the two Metro Rapid corridors using both point check data and data from automated passenger counters. While the two methods return somewhat different results, there is agreement that ridership has increased dramatically on both corridors by

approximately 25-30 percent. The increase in the Wilshire/Whittier corridor appears to result from major growth in both Metro Rapid and local ridership with the percentage of riders using Metro Rapid dropping slightly from the historic limited-stop service, possibly due to (a) the wider stop spacing for Metro Rapid, (b) the old limited-stop service was only limited-stop for a portion of the route and operated in local service for long segments of the alignment, and (c) some people are transferring between the Metro Rapid and local buses along the corridor. As well, the Wilshire/Whittier Metro Rapid appears to be capacity-constrained in the morning peak period. For instance, an additional 23 trips were introduced on September 10, 2000 to alleviate this constraint resulting in an immediate increase in ridership for the overall Metro Rapid line.

Ridership

Total Unlinked Ridership	Wilshire/Whittier Corridor		Ventura Corridor	
	Before	After	Before	After
Local	39,700	50,000	13,500	8,100
Limited	23,800			
Metro Rapid		40,300		9,000
Total Ridership	63,500	90,300	13,500	17,100
Net Increase		26,800		3,600
% Increase		42.2%		26.7%

% Corridor Ridership				
Local	63%	55%		47%
Limited/Metro Rapid	37%	45%		53%

Passenger survey data indicate that over 1/3 of this overall increase is from non-transit users (patrons who never rode transit before), with 1/3 from current riders riding more often and 1/3 from riders of other MTA transit switching to service on these corridors. Of particular significance is that a 17-to-20 percent increase in ridership came directly from new transit travel (1/3 plus 1/3).

Passenger Trip Lengths

One of the major objectives of Metro Rapid was to provide more convenient travel for longer distance transit riders. From the average trip lengths by riders on the two corridors, it is clear that longer distance travelers are using the Metro Rapid services. However, it appears that Metro Rapid is not solely used by longer distance travelers, but remains similar to the previous limited-stop services with average trip lengths of approximately twice the local service. This makes the Metro Rapid more effective from a seat turnover standpoint and is not inconsistent with expectations from a similar light rail service.

Average Passenger Trip Lengths

Wilshire/Whittier Corridor	BEFORE		AFTER	
	Eastbound (miles)	Westbound (miles)	Eastbound (miles)	Westbound (miles)
Local Line 18	2.8	3.1	2.6	2.6
Local Line 20/21	3.2	4.4	3.3	4.2
Limited-stop Line 320	5.2	7.9		
Metro Rapid Line 720			5.8	6.0

Ventura Corridor	BEFORE		AFTER	
	Eastbound (miles)	Westbound (miles)	Eastbound (miles)	Westbound (miles)
Express Line 424/522	10.6	7.8		
Express Line 425	25.2	N/A		
Local Line 150/240			N/A	N/A
Metro Rapid 750			8.4	7.5

Geographic Distribution of Ridership

The geographic distribution of boardings and the average productivity per route mile for each of the Metro Rapid lines indicates significant, but not surprising differences between lines. Ventura boardings are heavily influenced by the Metro Red Line station at Universal City with relatively even, consistent generation of riders along the remainder of the route. A key objective for the Ventura Metro Rapid was for customers to utilize it as an extension of the Metro Red Line. Service is timed for both Metro Rapid and local service to the arrival and departures of trains for Hollywood and downtown Los Angeles. Passenger surveys indicate that over 24 percent of all trips on Line 750 Ventura involve the Metro Rail system compared to just 8-to-14 percent of local trips. The 1-in-4 trips linking Metro Rapid with Metro Rail is excellent and is expected to continue to grow as new riders enter the system.

		Average Per Trip			
Line 750 Ventura		Boardings	Alightings	% of Total Boardings	Boardings Per Mile
Universal City Station	Ventura Vineland	11.1	3.9	33%	17.6
Ventura Vineland	Ventura Laurel Cyn	2.3	2.0	7%	1.5
Ventura Laurel Cyn	Ventura Van Nuys	3.5	4.1	10%	1.1
Ventura Van Nuys	Ventura Balboa	5.3	5.2	16%	1.7
Ventura Balboa	Ventura Reseda	3.9	3.4	11%	1.8
Ventura Reseda	Ventura Winnetka	1.8	1.4	5%	0.9
Ventura Winnetka	Ventura Tpga Cyn	2.6	2.2	8%	1.3
Ventura Tpga Cyn	Owensmouth Oxnard	3.6	1.6	10%	1.8
Total		34.1	23.7	100%	2.0

Line 720 Wilshire/Whittier Stations		Boardings	Alightings	% of Total Boardings	% of Total Alightings
Ocean	Colorado	1,112	1,354	3%	3%
Wilshire	4th St	1,170	1,113	3%	3%
Wilshire	14th St	534	698	1%	2%
Wilshire	Bundy Dr	740	688	2%	2%
Wilshire	Barrington	834	941	2%	2%
Wilshire	VA Hosp	441	561	1%	1%
Wilshire	Westwood	2,179	2,558	5%	6%
Wilshire	Santa Monica	951	1,134	2%	3%
Wilshire	Beverly Dr	980	1,135	2%	3%
Wilshire	Robertson	790	639	2%	2%
Wilshire	La Cienega	1,207	1,165	3%	3%
Wilshire	Fairfax	1,293	1,526	3%	4%
Wilshire	La Brea	1,275	1,203	3%	3%
Wilshire	Crenshaw	805	793	2%	2%
Wilshire	Western	3,371	2,957	8%	7%
Wilshire	Normandie	2,514	2,270	6%	6%
Wilshire	Vermont	3,891	3,065	10%	8%
Wilshire	Alvarado	2,261	2,115	6%	5%
6th St	Witmer	1,256	1,061	3%	3%
5th/6th St	Grand	1,072	1,244	3%	3%
5th/6th St	Broadway	2,915	3,127	7%	8%
5th/6th St	Main	953	965	2%	2%
Whittier	Soto	1,378	1,363	3%	3%
Whittier	Lorena	899	794	2%	2%
Whittier	Indiana	603	599	1%	1%
Whittier	Herbert	642	741	2%	2%
Whittier	Arizona	769	905	2%	2%
Whittier	Atlantic	1,313	1,061	3%	3%
Whittier	Hoeffner	977	1,194	2%	3%
Garfield	Whittier	1,025	1,103	3%	3%
Montebello	Metrolink	193	271	0%	1%
Wilshire	VA Hosp	441	561	1%	1%
Total Line 720		40,343	40,343	100%	100%

The Wilshire/Whittier Metro Rapid line is less influenced by the Metro Red Line, although the segment from Western to Alvarado has the highest ridership generation of the line. Downtown Los Angeles was the next stronger ridership generator followed by Westwood.

A key expectation for the Wilshire/Whittier Metro Rapid line was that it would provide an important service link between the east and west sides through downtown Los Angeles. Analysis of both the Automated Passenger Counter (APC) ridership data and passenger survey data indicate that significant numbers of riders are making these trips using Metro Rapid. Some 35-40 percent of the on-board riders entering downtown continue between the east and west sides will

little variation during the day. Passenger survey responses indicated that approximately 41 percent of the Eastside riders travel to the Westside or Santa Monica with 24 percent having a downtown destination.

In conclusion, it appears that Metro Rapid has exceeded ridership expectations in terms of overall increased passenger use on both Metro Rapid and local buses, penetration of previous non-user markets, use by longer distance travelers, meeting the needs of persons traveling between the east and west sides of Los Angeles County, and serving as an extension of the Metro Red Line in the San Fernando Valley. It is also clear that ridership continues to grow, especially on the Wilshire/Whittier line, which appears to be capacity constrained during at least the peak periods. Growth will be further fostered by the completion of the Metro Rapid Stations along both corridors and the second phase of the marketing campaign. This will place a priority of providing significantly more capacity along the Wilshire/Whittier in a cost-effective fashion. Moreover, similar performance and market response to both Metro Rapid lines may be indicative of what to expect for Phase II line additions to the Metro Rapid network.

Customer Perceptions and Behavior

On-board questionnaires were distributed to bus riders “before” Metro Rapid in early June 2000 and “after” in September 2000 (prior to the strike) to assess rider perceptions, behavior, and profiles. The surveys asked riders to evaluate various elements of service as well as overall satisfaction, with the ultimate purpose of determining changes in customer perceptions of bus service after the introduction of Metro Rapid. Specific questions focused on rider behavior, including trip origins and destinations and frequency of bus use. Questions also obtained information on the ability to recognize Metro Rapid and perceptions of service quality. Finally, demographic questions provided a basis to assess changes in the demographic profile of Metro Rapid and local riders compared to the previous ridership.

Major findings include:

- An analysis of customer ratings and importance of all service attributes clearly shows that Metro Rapid riders perceive a quantum leap in service performance and quality. Changes of this magnitude in performance ratings are rare, particularly over a relatively short time frame (90 days). MTA has essentially raised the bar significantly in terms of service quality for its riders through the Metro Rapid Demonstration Program.

- Ratings for Metro Rapid service are higher for all attributes compared to the prior Limited-Stop service ratings. These improvements are statistically significant for all service attributes. The overall rating of MTA service increased by 0.35, from 3.48 among previous limited riders to 3.83 among Metro Rapid riders.

- Ratings for Metro Rapid service are higher for all attributes compared to the “after” Local service ratings, and all differences are statistically significant. The largest differentials are for cleanliness, travel time on the bus, and frequency of buses.

- Ratings have also increased on local bus service for most attributes, but many of the increases are not statistically significant.

- A surprising number of riders are coming from neighborhoods that are usually seen as low transit ridership areas, especially south of Ventura Boulevard on Route 750.

- Metro Rapid service is drawing new, non-traditional riders. Most Metro Rapid passengers were existing transit users, but 17% either did not make this trip previously or used a non-transit mode (most likely the automobile). The majority of both Metro Rapid and local bus riders report income levels below $15,000 annually. However, over 13% of Metro Rapid riders have incomes above $50,000 versus just 6 percent for local buses. Metro Rapid also has a higher percentage of male riders compared to the locals and former limited lines.

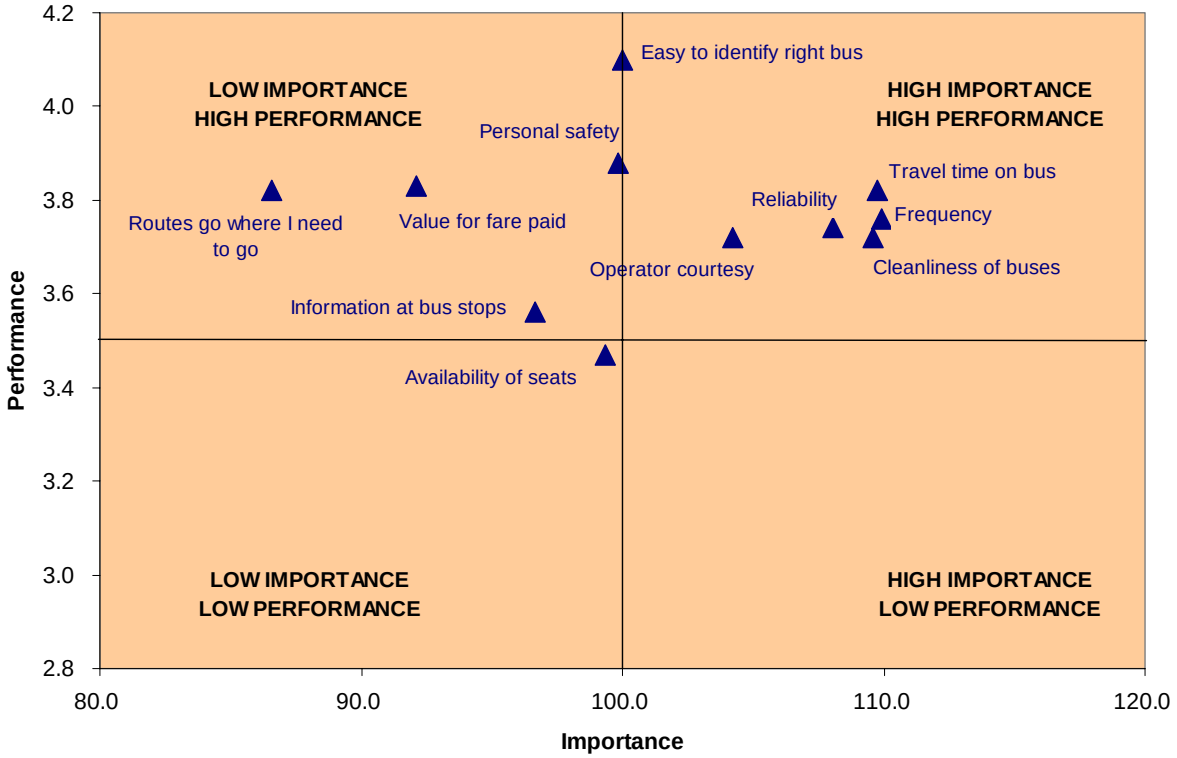
- Nearly 14% of Metro Rapid riders began using MTA services within the last three months. By comparison, only nine percent of local riders began using MTA services in this same time frame.

- Automobile availability is surprisingly similar for Metro Rapid and local bus riders. Approximately one-quarter of riders in both groups are from households with at least two cars.

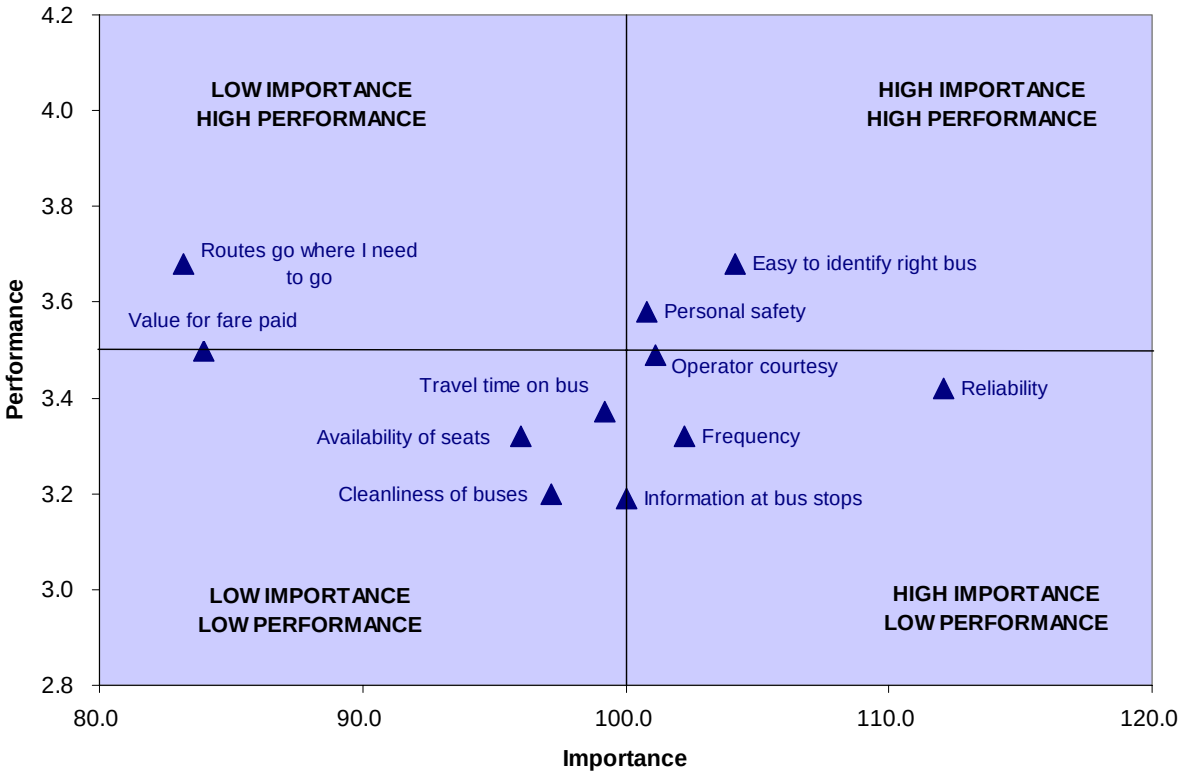
- Approximately ¼ of Line 750 Ventura riders connected to the Metro Red Line to complete their journey, indicating that the Metro Rapid is serving as an extension of the rail system in the San Fernando Valley.

- A large percentage of those originating from the Eastside, on Route 720 (Wilshire/Whittier), traveled through Downtown to the Westside on the morning trips. This supported findings in previous studies that suggested a relatively large east-to-west demand in the peak hours.

Importance vs. Performance for Service Attributes
Metro Rapid



Importance vs. Performance for Service Attributes
Local Bus After



In summary, the Metro Rapid program has demonstrated two critical elements: (1) customers perceive Metro Rapid as clearly superior to MTA's existing bus services; and (2) Metro Rapid's ability to increase transit's market share among discretionary travelers.

Service Effectiveness and Efficiency

The original operating concept for the demonstration was to provide existing and potential customers with equal amounts of local and Metro Rapid service and allow them to choose that which best met their needs. This operating plan was implemented in June 2000. From the initial week of operations it was clear that many customers were choosing the Metro Rapid ser-

Weekday Corridor Service

	Unlinked Passengers			Passenger Miles			Peak Vehicles			Revenue Hours		
Corridor	Pre-Rapid	Post-Rapid	% Change	Pre-Rapid	Post-Rapid	% Change	Pre-Rapid	Post-Rapid	% Change	Pre-Rapid	Post-Rapid	% Change
WILSHIRE-WHITTIER												
Lines 18/318	32,100			94,695			45			517		
Lines 20/21/22/320/322	31,400			162,495			77			727		
Line 18		25,000			65,000			33			397	
Lines 20/21		25,000			93,750			42			410	
Metro Rapid 720		40,300			237,770			71			705	
Combined Corridor	63,500	90,300	42.2%	257,190	396,520	54.2%	122	146	19.7%	1,244	1,511	21.5%
VENTURA												
Lines 424/425/522	13,500			124,200			37			285		
Lines 150/240		8,100			40,929			28			317	
Metro Rapid 750		9,000			71,550			21			198	
Combined	13,500	17,100	26.7%	124,200	112,479	-9.4%	37	49	32.4%	285	515	80.9%
TOTAL DEMONSTRATION	77,000	107,400	39.5%	381,390	508,999	33.5%	159	195	22.6%	1,528	2,027	32.6%

vice. This led to overloading on both Metro Rapid lines initially (only the Wilshire/Whittier line continues to have under-capacity problems) and continuing underutilization on two of the three local services (i.e., Lines 20/21 and 150/240).

Overall performance (service effectiveness and efficiency) has improved on the Wilshire/Whittier corridor with the introduction of Metro Rapid with productivity up 17 percent and subsidy per passenger and passenger mile improved 18 and 24 percent, respectively.

Weekday Corridor Performance

	Passengers Per Revenue Hour			Subsidy per Passenger Mile			Subsidy per Passenger			Subsidy per New Passenger		
Corridor	Pre-Rapid	Post-Rapid	% Change	Pre-Rapid	Post-Rapid	% Change	Pre-Rapid	Post-Rapid	% Change	Pre-Rapid	Post-Rapid	% Change
WILSHIRE-WHITTIER												
Lines 18/318	62.0			($0.17)			($0.51)					
Lines 20/21/22/320/322	43.2			($0.21)			($1.08)					
Line 18		63.0			($0.18)			($0.46)				
Lines 20/21		61.0			($0.15)			($0.58)				
Metro Rapid 720		57.2			($0.14)			($0.82)				
Combined Corridor	51.0	59.7	17.0%	($0.20)	($0.15)	-24.2%	($0.79)	($0.65)	-17.8%		($0.32)	
VENTURA												
Lines 424/425/522 [4]	47.4			($0.10)			($0.93)					
Lines 150/240 [4]		25.5			($0.42)			($2.13)				
Metro Rapid 750		45.5			($0.15)			($1.20)				
Combined	47.4	33.2	-30.0%	($0.10)	($0.25)	146.6%	($0.93)	($1.64)	76.3%		($4.30)	
TOTAL DEMONSTRATION	50.4	53.0	5.2%	($0.16)	($0.17)	3.5%	($0.82)	($0.81)	-1.0%		($0.79)	

Performance on the Ventura corridor has declined significantly despite the 27 percent increase in riders. This is principally due to the very large increase in Ventura local service which is performing at half the level of the previous express service to downtown Los Angeles. The Metro Rapid performance is tracking the previous express service that was replaced partly by the Metro Rapid and local buses and mostly by the Metro Rail Red Line extension.

The subsidy per new passenger (net revenue minus net operating cost per new passenger) is very attractive for the Wilshire/Whittier Metro Rapid service at just $0.32, competing very effectively with the various rail options. At a subsidy of over $4.00 per new passenger, the Ventura Metro Rapid has been less cost-effective. However, it is expected that as services on Wilshire, Whittier, and Ventura Boulevards are adjusted to reflect actual ridership, overall and individual corridor performance should continue improve significantly.

Operating and Capital Costs

One of the principal advantages of Metro Rapid service is that the net cost, both operating and capital, is considerably lower than other transit mode choices. It balances speedy service with higher capacity and low implementation costs.

Operating Cost

Overall, the annualized (12 month) marginal operating cost of the Metro Rapid demonstration service is approximately $12.5 million with a strong likelihood that $2-3 million of this net increase will be eliminated through refinement of the local and Metro Rapid operating schedules on the two corridors. The overall annual operating cost of Metro Rapid service averages just $500,000 per mile.

Operating Cost Summary

Corridor	Annual Operating Cost			
	Pre-Rapid	Post-Rapid	Net Change	% Change
WILSHIRE-WHITTIER				
Lines 18/318	$10,563,000			
Lines 20/21/22/320/322	$14,964,000			
Line 18		$8,099,000	($2,464,000)	-23.3%
Lines 20/21		$8,574,000	($6,390,000)	-42.7%
Metro Rapid 720		$16,485,000	$16,485,000	N/A
Combined Corridor	$25,527,000	$33,158,000	$7,631,000	29.9%
VENTURA				
Lines 424/425/522	$6,954,000			
Lines 150/240		$6,922,000	($32,000)	-0.5%
Metro Rapid 750		$4,939,000	$4,939,000	N/A
Combined	$6,954,000	$11,861,000	$4,907,000	70.6%
TOTAL DEMONSTRATION	$32,481,000	$45,019,000	$12,538,000	38.6%

Capital Cost

One of the principal objectives of the Metro Rapid program is to provide high quality rail emulation service with significantly lower capital investment. The Metro Rapid capital program involved three areas: station development, bus signal priority, and vehicle acquisition. The station program was designed, fabricated and installed at a cost of approximately $100,000 per mile. The bus signal priority system cost was approximately $20,000 per intersection. Buses used to operate the Metro Rapid Program were NABI 40-foot CNG low-floor vehicles from current fleet procurement orders.

Capital Cost Summary

Capital Element	Wilshire-Whittier		Ventura	
	Units/Miles	Cost	Units/Miles	Cost
Stations	25.7 miles	$2,441,000	16.7 miles	$1,590,300
Bus Signal Priority	25.7 miles	$2,569,000	16.7 miles	$1,674,000
TOTAL DEMONSTRATION		$5,010,000		$3,264,300

Capital Element	Total		Cost Per Mile
	Units/Miles	Cost	
Stations	42.4 miles	$4,031,300	$95,000
Bus Signal Priority	42.4 miles	$4,243,000	$100,000
TOTAL DEMONSTRATION		$8,274,300	$195,000

Metro Rapid Phase II

The Metro Rapid Demonstration Program has been a clear success during its first 90 days of operations. Based on this success, a Phase II Expansion Program is proposed that involves two principal elements:

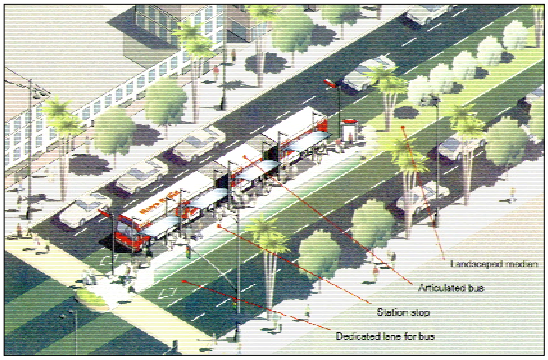
- Introduction of the remaining Curitiba model attributes (attributes 8-13).
- Expansion of the Metro Rapid network.

CURITIBA KEY ATTRIBUTES	Metro Rapid Phase I Demonstration	Metro Rapid Phase II Expanded System
1. Simple Route Layout	Yes	Yes
2. Frequent Service	Yes	Yes
3. Headway-based Schedules	Yes	Yes
4. Less Frequent Stops	Yes	Yes
5. Level Boarding and Alighting	Yes	Yes
6. Color-coded Buses and Stations	Yes	Yes
7. Bus Signal Priority	Yes	Yes
8. Exclusive Lanes	No	Yes
9. Higher Capacity Buses	No	Yes
10. Multiple Door Boarding & Alighting	No	Yes
11. Off-Vehicle Fare Payment	No	Yes
12. Feeder Network	No	Yes
13. Coordinated Land Use Planning	No	Yes

Introduce Remaining Attributes

The remaining attributes are discussed below

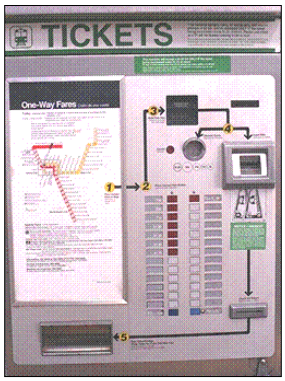
<u>Exclusive bus lanes</u> – two approaches are proposed for development of exclusive bus lanes: (1) short segments where warranted by congestion delay; and (2) full-length exclusive transitways either on arterials or in separate rights-of-way. The following is illustrative of possible arterial exclusive lane options.



Higher capacity buses – as previously discussed, the Wilshire/Whittier Metro Rapid peak hour frequency has nearly reached 2 minutes and the service is still experiencing overcrowded conditions despite several capacity increases. There are three principal options open for MTA to operate higher capacity buses:

- 45-foot vehicles (8-12 more seats than the standard bus)
- 60-foot articulated vehicles (18-20 additional seats)
- 80-foot bi-articulated vehicles (36-40 additional seats)

Multiple door boarding and fare prepayment – multiple door boarding requires off-vehicle fare collection either through controlled access or using a barrier-free proof-of-payment system. The benefits have been long established for light and heavy rail operations and are clearly applicable to high volume Metro Rapid service (the Wilshire/Whittier Metro Rapid is Los Angeles County's third heaviest transit line after the Metro Red and Blue Lines and ahead of the Metro Green Line). MTA has adopted a barrier-free system with random inspections for the rail program. Metro Rapid has very similar needs and will likely require a similar approach, especially given the limited space along the arterial rights-of-way for Curitiba-type stations.



Feeder network – MTA's basic grid network of regional and local bus services makes development of a separate feeder network for the Metro Rapid (and Metro Rail) of less importance. In Phase II, introduction of new community-based transit services (e.g., Smart Shuttles and circulators) as well as local network restructuring will be appropriate in support of the Metro Rapid network, especially where the prevailing local network is not grid-based.

Coordinated land-use – one reason for the success of both the Wilshire/Whittier and Ventura Metro Rapid lines is their operation on corridors where land-use is coordinated with transit. Streetscapes and densities are not unlike the "structural corridors" that were developed in Curitiba for the bi-articulated red express lines. The City of Los Angeles has a new project under-

way to identify transit impacts that could become part of its redevelopment warrants, i.e., Transit Oriented Design – one element could cover coordinated land-use around Metro Rapid stations.

Expansion of the Metro Rapid Network – Arterial Lines

The success of the demonstration lines has provided clear indications that the Metro Rapid program as currently implemented has met with customer approval. Together with the introduction of the additional Curitiba model attributes, expansion of the Metro Rapid network is appropriate. A multi-level selection process was developed for identifying the Phase II Metro Rapid arterial lines. The first step is based on the Tier One transit criteria and includes lines that meet the following minimum requirements:

- Serve major regional corridors
- Provide key network connections for longer distance travel
- High passenger use

The second step prioritized lines meeting the above requirements based on secondary criteria that included:

- Weekday unlinked passengers
- Average passenger trip length
- Revenue operating speed
- Annual passengers per route mile
- Weekday seat utilization
- Weekday riders retained on weekends
- Weekday passengers per bus hour
- Operating ratio

The resulting candidate lines were then checked for current frequency levels (ability to support Metro Rapid frequencies), whether the corridor currently has multiple levels of regional service (e.g., express, limited-stop, local, and community), and whether it duplicates any other comparable rapid transit (generally a one mile spacing between continuous lines). Based on these findings, lines were confirmed as Metro Rapid candidates and prioritized in three sub-Phases: IIA, IIB, and IIC. The proposed Metro Rapid candidate lines for Phase II as of February 2002 are:

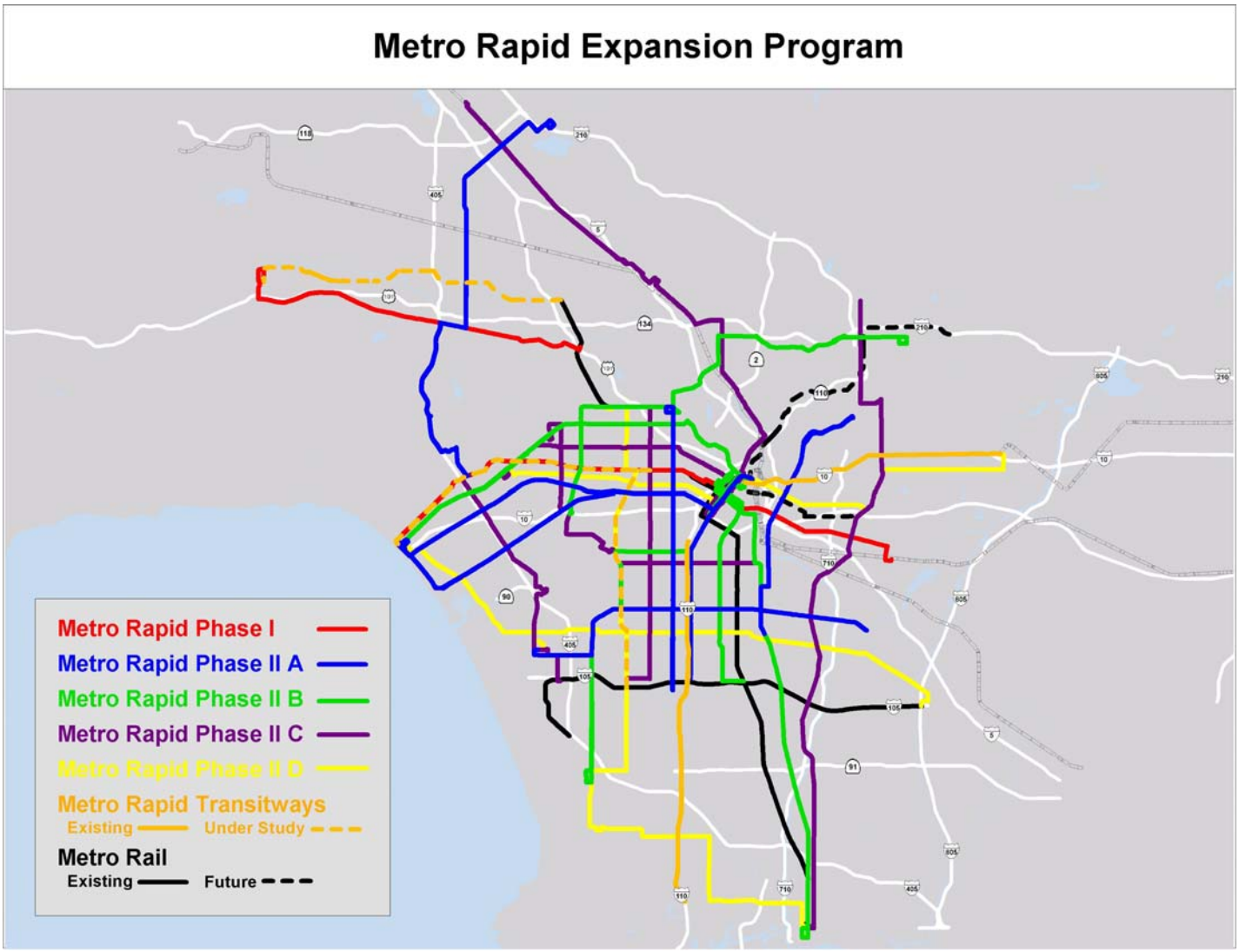
METRO RAPID PHASE II

Phase IIA	Phase IIB	Phase IIC	Phase IID
South Broadway	Central	Western	West Olympic
Vermont	Santa Monica	Beverly	Garvey/Chavez
Pico-Pico-Venice	Hawthorne	Vernon/La Cienega	Manchester
Florence	Long Beach	Atlantic	Crenshaw/Rossmore
Soto	Hollywood/Pasadena	San Fernando	Torrance/Long Beach
Van Nuys		Sepulveda	Lincoln

Colors denote sub-phasing on following map.

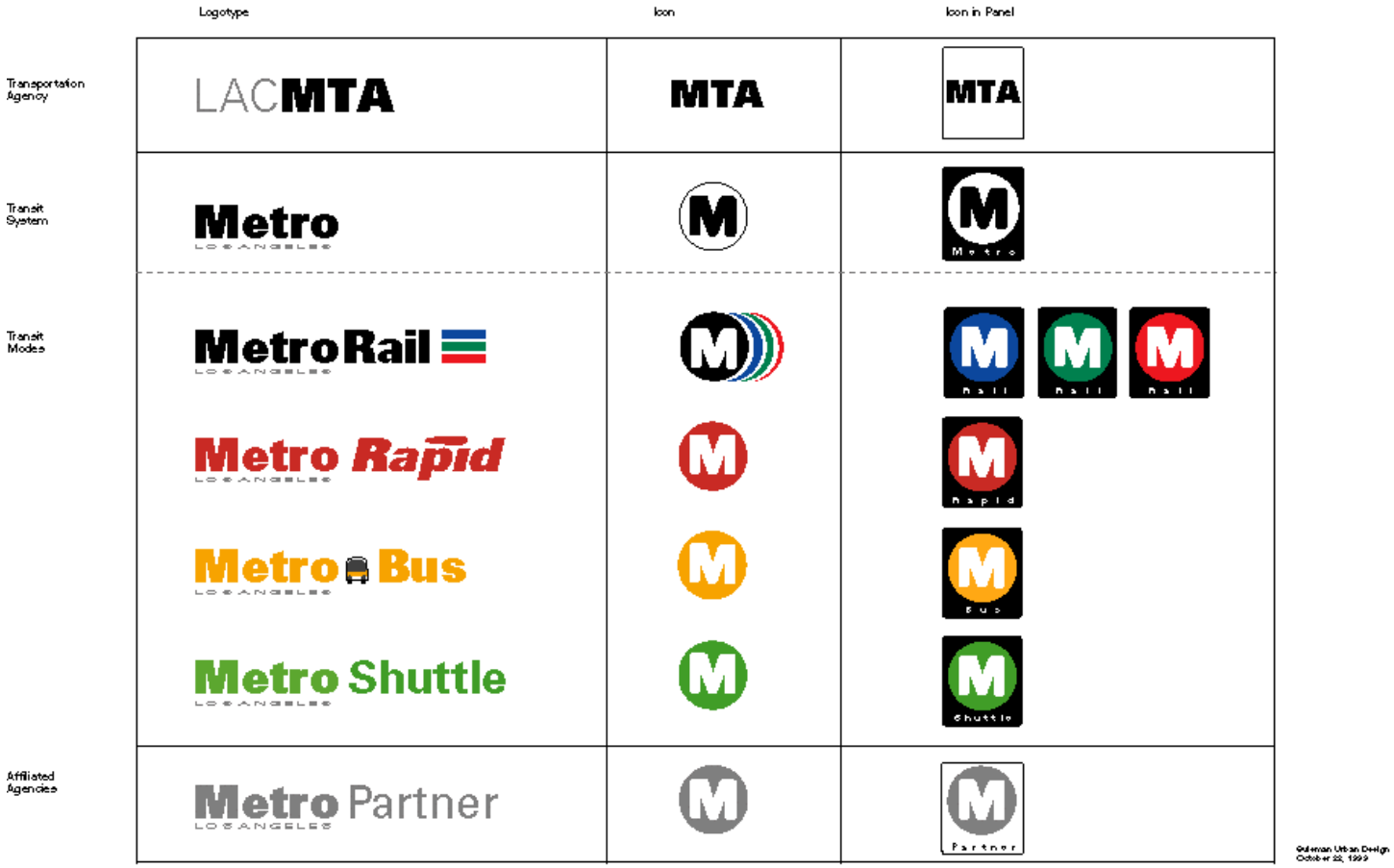
Expansion of the Metro Rapid Network – Transitways

Metro Rapid lines are also proposed for exclusive rights-of-way, augmenting the arterial Metro Rapid lines. In some cases, lines may operate partially along transitways and arterials. The overall proposed Metro Rapid network extensively covers the core high-demand portion of the County of Los Angeles, as illustrated below.

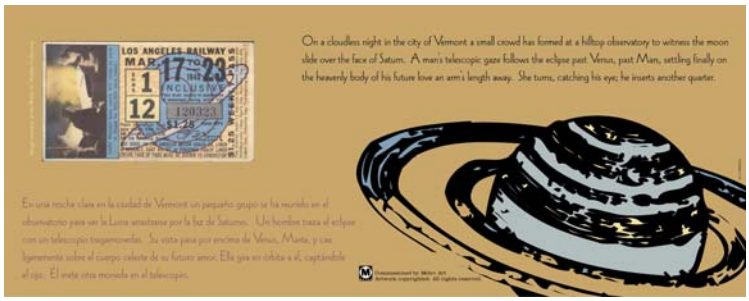


Integration of Corporate Identity

The successful "branding" of the Metro Rapid Program as a separate service with different attributes, and the development of customer loyalty, provides an opportunity for MTA to develop distinct transit services tailored to customer needs. A draft corporate identity was developed during the Metro Rapid Demonstration Program that illustrates an effective way to define and "brand" the different services.



Metro Rapid Art Program



Under the guidance of Metro Art, an artist team has created several visual enhancements to the Metro Rapid fleet interiors and select stops. These include a custom interior seat fabric and artwork for the interior spaces over the windows. The design motif is based upon symbols borrowed from historic transit passes and weaves a contemporary story played out in locations along the Metro Rapid route. The seat fabric design is visually dynamic to discourage vandalism. Concrete seating clusters with Metro Rapid "red" accents will be installed on MTA property where Metro Rapid meets Metro Rail.

Summary of Key Recommendations

- The MTA, working with the Los Angeles County Municipal Operators and cities, should build on the success of the Metro Rapid Demonstration Program.

- MTA should complete the Phase I attributes still in implementation, including the stations, “next-bus” displays, and expansion of the bus signal priority system outside the City of Los Angeles.

- A significant increase in vehicle capacity is recommended. The short-term recommendation is to increase the number of 40-foot Metro Rapid buses assigned to the two Demonstration Corridors. However, there is a limit to the number of buses that can be cost effectively added. The Wilshire/Whittier Corridor is currently operating close to this limit. The more cost-effective long-term solution is to introduce high-capacity buses.

- Implement the Phase II Metro Rapid System Expansion Program, including both new attributes and the expansion of lines.

Appendix A
Metro *Rapid* Program
Transit Priority System Evaluation Report

Introduction

The City of Los Angeles Department of Transportation (LADOT), in collaboration with the MTA, has successfully implemented an advanced Transit Priority System (TPS) project for buses along two major transit corridors in the Los Angeles Region. The TPS Project was developed by LADOT, and has received nationwide media attention. Furthermore, LADOT has received several awards for creativity and innovation from prominent organizations.

The TPS project is a critical element of the Metro Rapid Bus Demonstration Program that was jointly developed by LADOT and MTA. The initial phase of the Metro Rapid Bus was deployed on June 24, 2000, when the Metro Red Line subway was extended to the North Hollywood Stations in the San Fernando Valley. The purpose of the Metro Rapid Bus Demonstration Program is to offer rail-type frequent and high quality transit services connecting the terminus of the Red Line to major destinations in the outlining areas. The TPS project serves to improve the on-time performance of the Metro Rapid Bus by adjusting the signal timing at intersections for buses as their approach is detected. The TPS is also used to provide real-time next bus arrival information to passengers waiting at bus stations and assist bus fleet management by recording the travel time for each bus run. The Metro Rapid Bus program features limited stops and new low-floor clean-air buses.

Project Description

The TPS project involves adjusting timing of traffic signal on two of the most heavily traveled transit corridors in Los Angeles: Ventura Boulevard and Wilshire/Whittier Boulevards. The Ventura Boulevard Corridor, consisting of 88 signalized intersections and 16-miles of roadway, connects the Metro Red Line Station at Universal City to the Warner Center, a major commercial and business center in the West San Fernando Valley. The Wilshire/Whittier Boulevard Corridor, consisting of 123 signalized intersections and 14-miles of roadway, traverses through the central part of the Los Angeles Basin and connects East Los Angeles with the Central Business District, and the Cities of Beverly Hills and Santa Monica. Wilshire Boulevard is a prime business district with extensive commercial office buildings, museums and retail stores. Whittier Boulevard serves as a major east-west arterial in East Los Angeles and is fronted by a mixture of retail stores and residential area. These two streets are connected by the one-way street couplet of Fifth and Sixth Streets in the downtown Central Business District. The County of Los Angeles and the Cities of Beverly Hills and Santa Monica are not participants of this demonstration project, although the Metro Rapid Bus route extends 12 miles outside the City of Los Angeles.

The TPS Project also includes control of dynamic passenger information signs at selected bus shelters along the Metro Rapid Bus routes. These highly visible LED signs inform passengers of the estimated arrival times of the next Metro Rapid bus. The arrival time information is computed by the system based on the actual speed of the bus and is accurate to within one minute. LADOT staff also developed the sophisticated algorithm that calculates the arrival time.

Project Implementation

ATSAC and TPM System Operation

Each signalized intersection in the project area is equipped with loop detectors that serve as Automatic Vehicle Identification (AVI) sensors. These sensors embedded in the pavement receive a radio-frequency code from a small transponder installed on the underside of a vehicle. Buses equipped with unique transponders will be detected when traveling over the loop detectors. These loops are connected to a sensor unit within the traffic signal controller at each intersection, which transmits the bus identification number to the Transit Priority Manager (TPM) computer in the City's Automated Traffic Surveillance and Control (ATSAC) Center at City Hall East for tracking and schedule comparison.

Once the bus identification and location are received by the TPM, the computer makes a determination of the need for traffic signal priority. If the bus is early or ahead of the scheduled headway, no traffic signal priority treatment is provided. However, if the bus is late or beyond the scheduled headway, then the downstream traffic signal controller will provide signal priority to help the bus catch up with the scheduled headway. In addition, real-time data links from the MTA dispatch center to the ATSAC center is used to obtain the daily bus assignment for schedule comparison.

Individual Intersection Operation

Traffic signal control at each intersection is provided by Model 2070 controllers that are equipped with a state-of-the-art software program developed by the City of Los Angeles specifically for this project. Once the Model 2070 traffic signal controller receives a request from the Transit Priority Manager, it implements one of the following four types of traffic signal priority actions depending upon the point in time when the signal controller receives the commands, relative to the background cycle.

Types of Priority

- **Early Green** priority is granted when a bus is approaching a red signal. The red signal is shortened to provide a green signal sooner than normal.

- **Green Extend** priority is granted when a bus is approaching a green signal that is about to change. The green signal is extended until the bus passes through the intersection.

- **Free Hold** priority is used to hold a signal green until the bus passes through the intersection during non-coordinated (free) operation.

- **Phase Call** brings up a selected transit phase that may not normally be activated. This option is typically used for queue jumper operation, or a priority left turn phase.

Before and After Study of Bus Travel Times and Travel Speeds

A detailed evaluation of the Transit Priority System was undertaken in mid-September 2000, three months after the beginning of the Metro Rapid Bus service. This allowed time for bus operators, passengers and general automotive traffic to become aware of the system. The first part of the evaluation measures the effectiveness of the system in terms of overall travel time savings along the route and the reduction of time transit vehicles spent waiting at red traffic signals. The second part of the evaluation measures the impacts to general automotive traffic from the implementation of the Transit Priority System. Data for each evaluation was collected independently, and the results of these are presented below.

Previous Bus Delay Study

In the spring of 1998, LADOT staff conducted a manual data collection program along Wilshire and Ventura Boulevards to analyze the major causes of bus delay and operating inefficiency. The findings of that study indicated that the overall bus delays can be attributed to two major factors: buses stopped for red traffic signals, and buses delayed at bus stops loading and unloading passengers. Approximately 20% of the total bus running time was spent waiting at traffic signals, and another 25% of the total bus running time was due to bus loading delays at bus stops. These combined delays represent 45% of the total bus running time, from which the traffic signals contributed 45% of the total delays, and the bus stops 55% of the total delays.

Before and After Study Methodology

The Transit Priority System records the time and date each transponder-equipped bus passes over a loop detector in the system. This provides a complete record of each bus trip made along the Rapid Bus route. From this detailed recorded data, it is possible to determine exactly the running times of the buses. For the period September 5, 2000 through September 14, 2000, a total of 13 Rapid Buses (seven assigned to the Wilshire/Whittier Boulevard route and six assigned to the Ventura Boulevard route) were not given priority at any of the traffic signals. All of the remaining 99 Rapid Buses operated with priority. During the same time period, approximately 25 local buses, which also have transponders installed, operated over equivalent sections of the Metro Rapid Bus routes in normal revenue service. None of the local buses receive priority at any of the traffic signals along either of the routes.

Run time data was analyzed for over 1000 buses which made trips along the Rapid Bus routes during the A.M. and P.M. peak periods for two weeks on Tuesdays, Wednesdays and Thursdays. For the Wilshire/Whittier Boulevard route, this data was collected over three segments of the route and aggregated into a total value that represents the travel time in the City of Los Angeles only. The travel times through Beverly Hills are not examined in this analysis. The analysis of the Ventura Boulevard route included data from Topanga Canyon Boulevard to Vineland Avenue, where equivalent local bus service exists. Data was collected and analyzed for two peak periods in both directions along each route. The 7-9 A.M. morning peak and 4-6 P.M. evening peak trip start times represent the most congested times along these travel corridors, and have the most bus trips from which to analyze the data. The data collected in these time periods is summarized in Tables 1 and 2 of Attachment A.

Ventura Boulevard Travel Time Analysis

Data collected along Ventura Boulevard was used to determine the amount of time saved between local buses and Rapid Buses both with and without priority. This information shows how

much of the travel time savings is due to the Transit Priority System as compared to the Rapid Buses alone.

			Travel Time (minutes)			Time Savings					
			Local	Rapid		(minutes)		(percent)		Benefit	
Street	Direction	Time Period	Base Trip	Priority Off	Priority On	Priority Off	Priority On	Priority Off	Priority On	MTA Share	LADOT Share
Ventura Bl	E/B	7-9 am	58	48	45	10	13	17%	22%	77%	23%
Topanga Canyon	E/B	4-6 pm	54	48	44	6	10	11%	19%	60%	40%
to	W/B	7-9 am	57	47	43	10	14	18%	25%	71%	29%
Vineland	W/B	4-6 pm	53	45	40	8	13	15%	25%	62%	38%
(14 miles)	*Average*		56	47	43	9	13	15%	23%	67%	33%

The combined effects of the Rapid Bus service and the Transit Priority System have reduced the average running times along Ventura Boulevard by 23%, of which 33% is due to TPS, and 67% due to the Rapid Buses. The average travel speed for local buses was 15 miles-per-hour.

The benefits of the Transit Priority System can be calculated by comparing the traffic signal delays both with and without the priority system activated. The following analysis was used on data collected from Ventura Boulevard:

VENTURA BOULEVARD TRAVEL DELAY ANALYSIS

Length:	14	miles	Selected study area
Base running time:	56	minutes	No priority local buses
Bus stop delay:	14	minutes	25% of base running time
Traffic signal delay:	11	minutes	20% of base running time
Actual travel time:	31	minutes	27 mph running speed
Savings:			Due to project
Rapid bus:	9	minutes	16% of base running time
Signal priority:	4	minutes	7% of base running time
Total savings:	13	minutes	23% of base running time
New running time:	43	minutes	Priority buses
New bus stop delay:	5	minutes	9% of base running time
New traffic signal delay:	7	minutes	13% of base running time
Bus stop delay reduction:	9	minutes	64% of base bus stop delay
Signal delay reduction:	4	minutes	36% of base signal delay

This analysis shows that a 4-minute reduction in signal delay has been obtained from the Transit Priority System on Ventura Boulevard, which is a 36% reduction in the delays caused by traffic signals along the route. The speed for the Rapid Bus increased to 20 miles-per-hour. An alternative analysis using estimated dwell times is shown in Attachment B.

Wilshire/Whittier Boulevard Travel Time Analysis

Similar analysis based on the data collected along Wilshire/Whittier Boulevards determined the amount of time saved between local buses and Rapid buses both with and without priority, and how much of the travel time savings was due to the Transit Priority System, as compared to the Rapid Buses alone.

			Travel Time (minutes)			Time Savings					
			Local	Rapid		(minutes)		(percent)		Benefit	
Street	Direction	Time Period	Base Trip	Priority Off	Priority On	Priority Off	Priority On	Priority Off	Priority On	MTA Share	LADOT Share
Wilshire Bl	E/B	7-9 am	16	14	13	2	3	13%	19%	67%	33%
Centinela	E/B	4-6 pm	19	16	15	3	4	16%	21%	75%	25%
to	W/B	7-9 am	16	14	13	2	3	13%	19%	67%	33%
Comstock	W/B	4-6 pm	16	15	14	1	2	6%	13%	50%	50%
(3 miles)	*Average*		17	15	14	2	3	12%	18%	65%	35%
Wilshire Bl	E/B	7-9 am	29	22	19	7	10	24%	34%	70%	30%
San Vicente	E/B	4-6 pm	32	28	26	4	6	13%	19%	67%	33%
to	W/B	7-9 am	35	30	27	5	8	14%	23%	63%	38%
Valencia	W/B	4-6 pm	35	24	22	11	13	31%	37%	85%	15%
(6 miles)	*Average*		33	26	24	7	9	21%	28%	71%	29%
6th St / Whittier Bl	E/B	7-9 am	26	18	16	8	10	31%	38%	80%	20%
Valencia	E/B	4-6 pm	26	19	17	7	9	27%	35%	78%	22%
to	W/B	7-9 am	26	20	18	6	8	23%	31%	75%	25%
Indiana	W/B	4-6 pm	28	22	19	6	9	21%	32%	67%	33%
(5 miles)	*Average*		27	20	18	7	9	26%	34%	75%	25%
Wilshire / Whittier	E/B	7-9 am	71	54	48	17	23	24%	32%	74%	26%
Centinela	E/B	4-6 pm	77	63	58	14	19	18%	25%	74%	26%
to	W/B	7-9 am	77	64	58	13	19	17%	25%	68%	32%
Indiana	W/B	4-6 pm	79	61	55	18	24	23%	30%	75%	25%
(14 miles)	*Average*		76	61	55	16	21	20%	28%	73%	27%

The combined effects of the Rapid Bus service and the Transit Priority System have reduced the average running times along Wilshire/Whittier Boulevards by 28%, of which 27% is due to the signal priority system, and 73% due to the Rapid Buses. The average speed for local buses was 11 miles-per-hour.

The benefits of the Transit Priority System can be calculated by comparing the traffic signal delays both with and without the priority system activated. The following analysis was used on data collected from Wilshire/Whittier Boulevards:

WILSHIRE/WHITTIER BOULEVARD TRAVEL DELAY ANALYSIS

Length:	14	miles		Selected study area
Base running time:	76	minutes		No priority local buses
Bus stop delay:	19	minutes	25%	of base running time
Traffic signal delay:	15	minutes	20%	of base running time
Actual travel time:	42	minutes	20	mph running speed
Savings:				Due to project
Rapid bus:	16	minutes	21%	of base running time
Signal priority:	5	minutes	7%	of base running time
Total savings:	21	minutes	28%	of base running time
New running time:	55	minutes		Priority buses
New bus stop delay:	3	minutes	4%	of base running time
New traffic signal delay:	10	minutes	13%	of base running time
Bus stop delay reduction:	16	minutes	84%	of base bus stop delay
Signal delay reduction:	5	minutes	33%	of base signal delay

This analysis shows that a 5-minute reduction in signal delay has been obtained from the Transit Priority System on Wilshire/Whittier Boulevards, which is 33% reduction in the delays caused by traffic signals along the route. The average travel speeds for the Rapid Bus increased to 15 miles-per-hour. An alternative analysis using estimated dwell times is shown in Attachment B.

Summary of Findings About Travel Time Savings

The evaluation of the results show that the combined benefits of traffic signal priority and the limited stop Rapid Bus led to a net travel time saving of 28% on Wilshire/Whittier Boulevards and 23% on Ventura Boulevard. Based on further analysis, as shown in the previous tables, the following results have been determined:

- On Ventura Boulevard, 33% of the travel time savings is due to the Transit Priority System and 67% from other components of the Metro Rapid Bus Program.

- On Wilshire/Whittier Boulevards, 27% of the savings is due to the Transit Priority System and 73% from other components of the Metro Rapid Bus Program.

- The Transit Priority System reduced the delays caused by traffic signals by 36% on Ventura Boulevard.

- The Transit Priority System reduced the delays caused by traffic signals by 33% on Wilshire/Whittier Boulevards.

Mixed-Flow Traffic Impact Analysis

The second analysis involved the collection of data regarding the impacts to general automotive traffic. Data were collected at twelve selected locations along both the Ventura Boulevard and Wilshire/Whittier Boulevard routes. Using the automatic data collection capabilities of the City's ATSAC system, traffic volume, occupancy, speed, stops, queues and delay data were collected at each intersection for a two-week period. During this period, the signal priority was "enabled" and then "disabled" to effectively measure the impacts to traffic. The traffic data was collected over three two-hour periods each weekday. The data collection periods were 7-9 A.M. for the morning peak, 11 A.M. to 1 P.M. for the midday peak and 4-6 P.M. for the evening peak. Also during these times the number of cycles experiencing transit priority and the amount of green time provided was recorded.

The twelve selected locations fall into three categories of intersections. The first category is major arterial crossings, the second is secondary arterial crossings, and the third is local or collector crossings. Combinations of fully-actuated, semi-actuated and pre-timed signals were included in the study to adequately represent the typical installations along the project. A complete list of the selected intersections along with their classification and type of operation are included in Tables 2 and 4 of Attachment C.

Data for the analysis was collected over a two-week period for both the before and after conditions, providing 25 same-time-period before and after comparisons. The actual analysis was made between the two before and after days with the most similar volume data. This represents the closest traffic conditions between the before and after data. The complete data collected is shown in Tables 1 and 3 of Attachment C.

Summary of Findings for Mixed-Flow Traffic Impacts

Since each of the Metro Rapid Bus routes cross the twelve selected intersections on the eastbound and westbound approaches, the data for the northbound and southbound approaches represents the effect on cross street traffic. In general, there is only a slight impact to the cross street traffic of up to two seconds increase in delay. The average from all of the twelve locations was only one second of delay per vehicle per cycle. A decrease in delay was observed on the approaches moving concurrent with the priority phases of the same amount. Although there is some variation by location and time-of-day, the results of this analysis show that the overall impacts to cross street traffic are minimal.

Cost Benefit

The results of the evaluation analysis can be used to estimate the cost saving obtained from the Transit Priority System. The MTA indicates that the current system average cost of operating a bus is $98 per hour. With a traffic signal delay reduction of 4.5 minutes per hour, this translates into a cost saving of approximately $7.35 per hour per bus. For a bus operating along these routes for 15 hours per day, the cost saving would be approximately $110.25 per day. Assuming 100 buses per day for an average of 300 days per calendar year in the two corridors, this translates into approximately $3.3 million annual operating cost saving for the MTA. This saving does not include the added benefit of travel time saving to the Rapid Bus passengers.

The Transit Priority System cost almost $3 million to install along both Ventura Boulevard and Wilshire/Whittier Boulevards, including the cost of the software development. A total of 211 signalized intersections are outfitted with the Transit Priority System, at an average intersection

cost of $15,000 per intersection. With an anticipated project life cycle of 10 years, the relative benefits-cost ratio is more than eleven-to-one.

Conclusions

The results of the TPS Program evaluation analysis have demonstrated significant improvements to transit operations with minimal impacts to general automotive traffic. The average saving of 25% in travel time substantially improves the quality of the overall transit system. This project has shown that a Transit Priority System can be integrated into a centralized traffic control system without significant impacts to the overall traffic network while providing significant benefits to the transit user and the transit operator.

Although the average travel time savings of 4.5 minutes may appear small, the demonstrative increase in the overall ridership along the Metro Rapid Bus lines clearly shows the effectiveness of the project. The MTA has reported a 25% increase in ridership along the Ventura Boulevard and Wilshire/Whittier Boulevard corridors with the new Rapid Bus service. This ridership increase has been attributed equally to new transit ridership, existing riders on these corridors using the new service and riders from other corridors switching to these corridors.

ATTACHMENT A

Table 1

Summary of all run time data collected for the travel time analysis along Ventura Boulevard

			Local Buses		Metro Rapid Buses			
			Priority Off		Priority Off		Priority On	
Street	Direction of Travel	Time Period	Number of Samples	Travel Time (minutes)	Number of Samples	Travel Time (minutes)	Number of Samples	Travel Time (minutes)
Ventura Bl	E/B	7-9 am	38	58	19	48	76	45
Topanga Canyon	E/B	4-6 pm	46	54	23	48	109	44
to	W/B	7-9 am	29	57	34	47	124	43
Vineland	W/B	4-6 pm	45	53	20	45	91	40
(14 miles)	*Total / Average*		158	56	96	47	400	43

Table 2

Summary of all run time data collected for the travel time analysis along Wilshire/Whittier Boulevards

			Local Buses		Metro Rapid Buses			
			Priority Off		Priority Off		Priority On	
Street	Direction of Travel	Time Period	Number of Samples	Travel Time (minutes)	Number of Samples	Travel Time (minutes)	Number of Samples	Travel Time (minutes)
Wilshire Bl	E/B	7-9 am	11	16	12	14	134	13
Centinela	E/B	4-6 pm	6	19	18	16	190	15
to	W/B	7-9 am	13	16	32	14	321	13
Comstock	W/B	4-6 pm	5	16	11	15	143	14
(3 miles)	*Total / Average*		35	17	73	15	788	14
Wilshire Bl	E/B	7-9 am	11	29	10	22	135	19
San Vicente	E/B	4-6 pm	18	32	28	28	260	26
to	W/B	7-9 am	17	35	24	30	249	27
Valencia	W/B	4-6 pm	9	35	11	24	138	22
(6 miles)	*Total / Average*		55	33	73	26	782	24
6th St / Whittier Bl	E/B	7-9 am	20	26	8	18	136	16
Valencia	E/B	4-6 pm	22	26	23	19	258	17
to	W/B	7-9 am	19	26	14	20	151	18
Indiana	W/B	4-6 pm	11	28	9	22	114	19
(5 miles)	*Total / Average*		72	27	54	20	659	18
Wilshire / Whittier	E/B	7-9 am	*Combined*	71	*Combined*	54	*Combined*	48
Centinela	E/B	4-6 pm	*data from*	77	*data from*	63	*data from*	58
to	W/B	7-9 am	*segments*	77	*segments*	64	*segments*	58
Indiana	W/B	4-6 pm	*shown*	79	*shown*	61	*shown*	55
(14 miles)	*Total / Average*		*above*	76	*above*	61	*above*	55

ATTACHMENT B

VENTURA BOULEVARD TRAVEL DELAY ANALYSIS

Length:	14	miles		Selected study area
Number of bus stops:	12			
Bus stop dwell time:	20	seconds		
Total bus stop time:	4	minutes		
Rapid bus stop savings:	9	minutes		
Base bus stop delay:	13	minutes		
Base running time:	56	minutes		
Minimum travel time:	31	minutes	27	mph average speed
Base bus stop delay:	13	minutes	23%	of base running time
Traffic signal delay:	12	minutes	21%	of base running time
Bus stop delay reduction:	9	minutes	69%	of base bus stop delay
Signal delay reduction:	4	minutes	34%	of base signal delay

The results shown above were calculated using an alternative methodology which calculates the actual delay percentages from the field measured data with an average bus stop dwell time. The results of this analysis are within 2% of the results shown in the report.

WILSHIRE/WHITTIER BOULEVARD TRAVEL DELAY ANALYSIS

Length:	14	miles		Selected study area
Number of bus stops:	16			
Bus stop dwell time:	20	seconds		
Total bus stop time:	5	minutes		
Rapid bus stop savings:	16	minutes		
Base bus stop delay:	21	minutes		
Base running time:	76	minutes		
Minimum travel time:	42	minutes	20	mph average speed
Base bus stop delay:	21	minutes	28%	of base run time
Traffic signal delay:	13	minutes	17%	of base run time
Bus stop delay reduction:	16	minutes	75%	of base bus stop delay
Signal delay reduction:	5	minutes	39%	of base signal delay

The results shown above were calculated using an alternative methodology which calculates the actual delay percentages from the field measured data with an average bus stop dwell time. The results of this analysis are within 6% of the results shown in the report.

ATTACHMENT C

Table 1

Average delay values for two days on Ventura Boulevard for all vehicles on the indicated approach in seconds per vehicle per cycle for both the before and after conditions

	Measured Delay (seconds)											
	Northbound			Southbound			Eastbound			Westbound		
Location	Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change
Reseda Bl	38	39	+1	29	32	+3	16	15	-1	29	26	-3
and	38	38	+1	31	32	+2	18	17	-1	24	23	-1
Ventura Bl	38	39	+1	31	31	-1	22	21	-1	29	23	-7
Sepulveda Bl	22	26	+4	50	52	+2	30	28	-2	49	48	-1
and	31	28	-3	33	33	0	32	31	-1	22	22	+1
Ventura Bl	47	49	+2	33	33	0	42	42	0	30	27	-3
Van Nuys Bl	28	29	+1	35	37	+2	23	22	-1	33	29	-4
and	32	34	+2	42	40	-2	19	19	0	27	24	-3
Ventura Bl	47	43	-4	43	45	+2	23	23	-1	29	22	-7
Laurel Canyon Bl	33	33	+1	39	39	0	25	22	-3	36	35	-1
and	35	35	+1	35	37	+3	27	26	-1	31	31	+1
Ventura Bl	42	46	+4	33	36	+3	43	38	-6	41	39	-2
Tujunga Bl	0	0	0	35	35	0	10	10	+1	11	11	0
and	0	0	0	34	39	+5	8	10	+2	10	12	+2
Ventura Bl	0	0	0	38	36	-2	9	9	0	10	11	+1
Corbin Av	31	35	+4	34	34	-1	11	11	0	16	14	-2
and	33	35	+2	35	35	0	16	14	-2	14	13	-1
Ventura Bl	32	38	+7	32	31	-1	18	19	+1	13	13	+1
Average Change			+1			+1			-1			-2

The three sets of numbers for each location represent the morning, midday and evening peaks.

Table 2

Locations where the traffic impact analysis data was collected

Ventura Corridor Intersections	Classification	Type of Operation
Reseda Boulevard & Ventura Boulevard	Major	Semi-actuated
Sepulveda Boulevard & Ventura Boulevard	Major	Fully-actuated
Van Nuys Boulevard & Ventura Boulevard	Secondary	Pre-timed
Laurel Canyon Boulevard & Ventura Boulevard	Major	Fully-actuated
Tujunga Boulevard & Ventura Boulevard	Local	Semi-actuated
Corbin Avenue & Ventura Boulevard	Secondary	Semi-actuated

Note: Classification refers to the cross streets only. Ventura Boulevard is a Major Highway.

Table 3

Average delay values for two days on Wilshire/Whittier Boulevards for all vehicles on the indicated approach in seconds per vehicle per cycle for both the before and after conditions

	Measured Delay (seconds)											
	Northbound			Southbound			Eastbound			Westbound		
Location	Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change
Veteran Av	52	53	+1	56	58	+2	41	37	-4	34	26	-8
and	53	52	-1	57	56	-1	43	41	-2	28	29	+1
Wilshire Bl	52	56	+4	77	74	-3	46	45	-1	26	26	0
La Brea Av	21	22	+1	22	22	-1	11	11	+1	23	20	-3
and	22	22	0	24	24	+1	27	26	-1	17	16	-1
Wilshire Bl	25	28	+3	22	22	0	32	30	-2	20	19	-2
Soto St	14	14	0	11	11	0	12	11	-1	12	12	0
and	12	12	0	6	6	0	11	11	-1	9	9	0
Whittier Bl	16	18	+2	8	8	0	13	12	-1	13	12	-1
Alvarado St	21	22	+1	28	32	+4	11	11	0	16	14	-2
and	24	24	0	26	27	+1	15	15	0	15	15	+1
Wilshire Bl	24	25	+1	25	29	+4	22	21	-2	13	13	-1
Rampart Av	28	31	+3	29	32	+3	8	6	-2	16	16	0
and	30	32	+2	31	30	-1	14	14	0	6	7	+1
Wilshire Bl	33	34	+1	28	28	0	22	22	0	8	8	-1
6th St	35	35	0	33	33	-1	6	7	+1	10	10	0
and	39	39	+1	30	31	+2	11	10	-2	11	11	0
Witmer Av	40	39	-1	27	29	+2	14	14	0	6	6	0
Average Change			+1			+1			-1			-1

The three sets of numbers for each location represent the morning, midday and evening peaks.

Table 4

Locations where the traffic impact analysis data was collected

Wilshire/Whittier Corridor Intersections	Classification	Type of Operation
Veteran Avenue & Wilshire Boulevard	Secondary	Semi-actuated
La Brea Avenue & Wilshire Boulevard	Major	Pre-timed
Soto Street & Whittier Boulevard	Major	Pre-timed
Alvarado Street & Wilshire Boulevard	Major	Pre-timed
Rampart Avenue & Wilshire Boulevard	Secondary	Semi-actuated
Sixth Street & Witmer Avenue	Local	Semi-actuated

Note: Classification refers to the cross streets only. Wilshire Boulevard is a Major Highway. Fifth Street, Sixth Street and Whittier Boulevard are Secondary Highways.

Appendix B
Metro *Rapid* Program
Service Quality Analysis

Introduction

A fundamental objective of introducing Metro Rapid service was to improve service quality, both from a customer perception and actual measurable performance standpoint. Effective service quality can be measured by vehicle headway maintenance or spacing (delivery performance), passenger waiting times (customer experience), and overcrowding of vehicles (from both average delivery performance and customer experience).

There is a significant interrelationship between these measures and with the scheduled service. For instance, the average customer wait times will be a function of both the scheduled intervals and the effective delivery of those intervals, as well as the vehicle loading (which will greatly affect bus bunching and pass-ups). In assessing the service, these relationships will be noted.

The field data was collected by MTA in August and September 2000 during a series of point checks at strategic locations. The use of timepoint data (as opposed to onboard ride check data) is appropriate as the aim is to ascertain a snapshot of the service at particular locations. The data was at various time intervals, as headways/frequencies are different during the day. The timepoints used were Whittier/Soto, Wilshire/Western, and Wilshire La Brea on the Line 720 Wilshire-Whittier corridor; and Ventura/Reseda for the Line 750 Ventura corridor.

It is important to reiterate that the data was from August 2000 prior to the MTA strike and was just 8-10 weeks after the start of a completely new operating strategy[1]. More recent field checks have indicated that the Metro Rapid division line staff together with ongoing improvement in the operating schedules have continued to improve the quality of service and that the loads have continued to grow on Metro Rapid.

Headway Ratio. This ratio is a simple way to measure the variability of headways at a given timepoint, which measures the evenness of vehicle spacing. A headway ratio of 1.0 indicates that vehicles arrived at a stop perfectly spaced, whereas a headway ratio of 2.0 suggests that, on average, vehicles arrived in bunched pairs. In effect, the headway ratio is a measure of the extent of bunching of vehicles. Depending upon the frequency of service, bunching may have a negative effect on the effective level of service delivered to passengers. It results in an actual level of service below that scheduled and may cause overcrowding and unacceptably long passenger waits.[2]

[1] The unique Metro Rapid operating protocols involved the first time use of traffic signal priority for buses, elimination of timepoints and use of a headway interval spacing to manage vehicles, and separate station stops from local buses.

[2] Even spacing is very important under most service frequency conditions. However, under extremely frequent service conditions (headways well below 5 minutes), the need to delivery evenly spaced service is unnecessary from a customer wait experience standpoint. The more important objectives under these conditions are to avoid service gaps beyond 4-5 minutes and to provide adequate capacity so that there are no pass-ups.

The results on *Ventura Boulevard* indicate low levels of bunching at Reseda Boulevard[3], and this generally effective service delivery. The only bunching problems appear to be on the local services, and more so on the westbound local services. The spacing of the Metro Rapid service appears to be very consistent, indicating good headway maintenance success.

On *Wilshire Boulevard*, the results are mixed. During the midday periods in both directions, headway intervals are adequate but need improvement on both Metro Rapid and local. The average midday passenger waits are consistently less on the Metro Rapid despite operation of the same headway on both Metro Rapid and local. During the peak periods, when the Metro Rapid is operating every 2-to-2½ minutes, many times vehicles are arriving almost in pairs. The problem time and direction for Metro Rapid is westbound during the PM peak where average waits are around 8-minutes with average arrivals in more than pairs[4]. The local service is also experiencing similar problems, but with a shorter route the problems are less acute. While the Metro Rapid service performance looks to be on-par or slightly better during regular demand periods, there is a need to closely monitor spacing during the peak periods with the objective of keeping average wait times below 5-minutes and the measured average load and passenger average load close to one and other.

On *Whittier Boulevard*, the Metro Rapid and local services are performing similarly with both services delivering similar headway ratios. The exception is eastbound Metro Rapid where interval performance is not satisfactory during the midday with average waits of nearly 8 minutes (ideally they should be 5 minutes) and during the PM peak where almost 2½ buses are arriving together. At Soto Street, the Metro Rapid buses are already some 75 minutes into the eastbound trip; however, the line staff will need to determine why service is bunching significantly after departing the Western Station eastbound with low bunching.

There are two major impacts of higher headway ratios (or higher bunching levels). The first is significantly increased average passenger waiting times over scheduled levels. The second is loading variability, causing overcrowding and poor utilization of available capacity. These impacts are discussed further below.

Average Wait Times. For high-frequency transit service, average wait time would normally be half the scheduled headway, assuming passengers arrive at stops in a random manner (i.e., random walk theory). For example, on a 10-minute frequency, a passenger arriving randomly at a stop could be expected to wait, on average, for five minutes.

However, where service becomes less reliable (due to bunching), average wait times increase. This can be measured as expected average wait time, assuming random arrivals at stops by passengers. This performance measure is, in effect, one of the most powerful and descriptive measures of how effectively the service is being delivered and a good indicator of customer out-of-vehicle wait times. This is because this simply measures how long passengers have to wait for vehicles, as compared to what the schedule suggests. Average wait time is closely tied to the headway ratio – where headway ratios increase, so too will passengers' average wait times.

Another way to look at average wait time is to use it to calculate the affective level of service being delivered. Simply multiply the average wait time by two, and you have the true level of

[3] Note that this stop is west of the traffic congestion around the I-405 San Diego Freeway interchange – eastbound services will have not yet encountered this point.

[4] These conditions were present even with the lowest measured average loads of the day for Metro Rapid, but worse from a customer standpoint due to very uneven loading.

service that a passenger waiting at that stop would have seen. This can then be compared to the scheduled level of service to measure how effectively the service is being delivered.

On *Ventura Boulevard*, the average waiting times are in line with the headway ratio. They tend not to be significantly greater than scheduled average waiting times. The only exception is on the local service, westbound in the AM Peak, where average wait time is 4.3 minutes, suggesting the actual level of service delivered is 8.6 minutes, which is well below the scheduled level of service of 5-minutes.

On *Wilshire Boulevard*, the actual level of service delivered varies (sometimes significantly) from the scheduled level of service. An example is the local service on Wilshire at La Brea, eastbound in the PM Peak. The scheduled level of service is around 7 minutes. Therefore the average wait for a passenger randomly arriving at a stop should be 3.5 minutes. But instead, the average wait was over 5 minutes. The implication is that while the resources expended equal a 7-minute service, from the passengers' perspective, only an 11-12 minute service is being delivered.

Average wait times on *Wilshire Boulevard* on the Metro Rapid are also, at times, well in excess of scheduled levels. As the headway ratio suggests, the main issues appear to be PM Peak and early evening westbound, where average wait times are over eight minutes, indicating an affective service level of over 16 minutes, again well below scheduled frequencies, and midday eastbound where average waits are around 7 minutes (the scheduled wait is 5-minutes). Overall, however, it appears that the Metro Rapid service is being delivered on-par or slightly better than the local service (i.e., lower headway ratios and lower deviation from the scheduled average wait time), especially when the very high peak direction frequencies are considered.

On *Whittier Boulevard*, average wait times are much higher than scheduled eastbound, in the off-peak and PM Peak. During the off-peak on the Metro Rapid, the average wait time is nearly eight minutes, suggesting an effective level of service of 15 minutes, while the scheduled level of service is 10 minutes. In the PM Peak (again eastbound), average wait times are 4.6 minutes, indicating an effective actual service level of over nine minutes, which is nearly three times the scheduled service level.

Patron Perceived and Measured Average Loads. This is a measure of the variability of load distribution. Usually, where bunching occurs, some vehicles will be heavily loaded, while some will be relatively empty (particularly close-trailing vehicles). This measure weights the loads according to the actual average customer experience.

In an extreme example, where two buses operate, the first with 60 passengers, and the second with none. The average load is 30, suggesting no capacity issues. However, all passengers saw a load of 60, and therefore the passenger perception is that all buses are overcrowded. In short, this measure considers how many passengers actually experience vehicle crowding. This is also a good measure of loading variability. Loading variability is a measure of service effectiveness, as high loading variability usually means that additional resources are required to provide the necessary capacity. Patron average load experience needs to be measured against the measured average load to measure loading variability.

On *Ventura Boulevard* there is some sporadic loading variability. However, neither the true average load or patron-perceived average load are close to capacity levels, indicating, if anything, excess capacity on both the local and Metro Rapid services.

On *Wilshire Boulevard* there are examples of sufficient capacity, but variability of loading causing overcrowding problems. A good example is on the Wilshire Metro Rapid at La Brea, westbound in the PM peak. The average load is 39, indicating no real capacity issues. However, the patron-perceived average load is nearly 52. Therefore, while no average capacity problems exist, there would be a perception of significant overcrowding problems from the passengers themselves. This indicates that there is high loading variability during this time period and during the early evening in the same direction, with some very-heavily loaded buses, and some half-empty buses (almost present on the local service at the same time and direction). The likely outcome would be additional resources, yet there is clearly enough capacity on average.

On *Whittier Boulevard*, the most significant incidence of loading variability is eastbound in the PM Peak. However, the average load is 27, and the patron-perceived average load is 32 with neither a problem from a customer perception standpoint. The rest of the day, on both the local and Metro Rapid services, there do not appear to be either capacity or overcrowding issues.

Loading Summary In summary, it appears that there are capacity issues on the *Wilshire Metro Rapid* westbound throughout the day with significant problems in the AM Peak and midday periods. Eastbound capacity shortfalls are only during the PM Peak and early evening periods. The eastbound loads are evenly distributed between locals and Metro Rapid services at Western, but the Metro Rapid loads are higher at La Brea. Westbound, the Metro Rapid loads are consistently much higher than the local services.

On *Whittier Boulevard*, the only capacity issue is westbound in the AM Peak, where the average load is 46 passengers. As with the Wilshire corridor, locals and Metro Rapids are similarly loaded eastbound, but the Metro Rapids are averaging somewhat higher loads westbound.

On *Ventura Boulevard*, the Metro Rapid loads are higher than the locals, except during the afternoons westbound. Overall average loads suggest no capacity issues.

Recommendations:

1. Given the frequency levels and loads on Metro Rapid, continue with plans to introduce higher capacity vehicles on the corridor.

2. Continue to adjust scheduled frequencies and running times to reflect current conditions based on more recent point checks and TOS input.

3. Continue to campaign the bus bunching problems through the deployment of additional capacity where needed, Metro Rapid point checks and ride checks to identify delay issues, strengthen the support of the BOCC to the line TOS in early notice of bunching, and introduce the bunching assistance routines in the LADOT bus signal priority system in a test mode to ascertain the impact of reducing bus bunching on operating speed and resource requirements.[5]

[5] The issue is whether to improve out-of-vehicle wait times (bus bunching) at the expense of in-vehicle travel times (operating speed). This is not an either/or situation; the conventional wisdom is that once the average waits fall well under 5-minutes there is little customer-perceived benefit in further reductions. Thus, bus bunching actions should aim at keeping average waits well below 5-minutes, but recognize that average waits of under 3-minutes have little value in attracting additional customers or retaining current riders.

4. As detailed stop level data becomes available, consider the possibility of a short line east of downtown Los Angeles at or before Soto Street. This will add complexity to a simple line and likely strand significant numbers of patrons at the short line terminal[6]. Thus, it should be approached cautiously and have initial and on-going customer notification involved on a real-time basis.

5. The upcoming introduction of the "next-bus" displays will provide early notice to customers and possibly effect customer choice of local versus Metro Rapid. Customer reaction should be monitored for impact on service schedules and delivered performance.

[6] MTA Headquarters Operations and Scheduling introduced a weekend shortline at the 6th/Los Angeles station that Division 7 TOS report strand up to 15 customers per trip on Saturdays and Sundays.

Appendix C
Metro *Rapid* Program
Before and After Passenger Surveys

Summary

The MTA and City of Los Angeles Department of Transportation (LADOT) implemented the Metro Rapid Bus Demonstration Program on June 24, 2000 in the Whittier-Wilshire and Ventura corridors.

On-board questionnaires were distributed to bus riders "before" Metro Rapid in early June 2000 and "after" in September 2000 (prior to the strike) to assess rider perceptions, behavior, and profiles. The surveys asked riders to evaluate various elements of service as well as overall satisfaction, with the ultimate purpose of determining changes in customer perceptions of bus service after the introduction of Metro Rapid. Specific questions focused on rider behavior, including trip origins and destinations and frequency of bus use. Questions also obtained information on the ability to recognize Metro Rapid and perceptions of service quality. Finally, demographic questions provided a basis to assess changes in the demographic profile of Metro Rapid and local riders compared to the previous ridership.

Major findings include:

- Ratings for Metro Rapid service are higher for <u>all</u> attributes compared to the prior limited-stop service ratings. These improvements are statistically significant for all service attributes. The overall rating of MTA service increased by 0.35, from 3.48 among previous limited riders to 3.83 among Metro Rapid riders. In particular, the differential between Metro Rapid and local service is much greater than the limited-stop service which was little distinguished from the local services.

- Ratings have increased on local bus service for most attributes, but many of the increases are not statistically significant.

- Ratings for Metro Rapid service are higher for <u>all</u> attributes compared to the "after" Local service ratings, and all differences are statistically significant. The largest differentials are for cleanliness, travel time on the bus, and frequency of buses.

- An analysis of customer ratings and importance of all service attributes clearly shows that Metro Rapid riders perceive a quantum leap in service performance and quality. Changes of this magnitude in performance ratings are rare, particularly over a relatively short time frame (90 days). MTA has essentially raised the bar significantly in terms of service quality for its riders through the Metro Rapid demonstration program.

- A large percentage of those originating from the Eastside, on Route 720 (Wilshire/Whittier), traveled through Downtown to the Westside on the morning trips. This supported findings in previous studies that suggested a relatively large east-to-west demand in the peak hours.

- A surprising number of riders are coming from neighborhoods that are usually seen as low transit ridership areas, especially south of Ventura Boulevard on Route 750.

- Some 24 percent of Line 750 Ventura riders connected to the Metro Red Line to complete their journey, indicating that the Metro Rapid is serving as an extension of the rail system in the San Fernando Valley.

- Metro Rapid service is drawing new, non-traditional riders. Most Metro Rapid passengers were existing transit users, but 20 percent either did not make this trip previously or used a non-transit mode (most likely the automobile). The majority of both Metro Rapid and local bus riders report Income levels below $15,000 annually. However, over 13 percent of Metro Rapid riders have incomes above $50,000 (twice as many when compared to local service). Metro Rapid also has a higher percentage of male riders compared to the locals and former limited lines. As well, over 50 percent of Metro Rapid riders report using transit in order to avoid traffic or because it is more convenient, significantly more than current local riders.

- Nearly 14 percent of Metro Rapid riders began using MTA services within the last three months. By comparison, only nine percent of local riders began using MTA services in this same time frame.

- Vehicle availability is surprisingly similar for Metro Rapid and local bus riders. Approximately one-quarter of riders in both groups are from households with at least two cars.

Metro *Rapid* Program
Before and After Passenger Surveys

Introduction

The Los Angeles County Metropolitan Transportation Authority (MTA) and the City of Los Angeles Department of Transportation (LADOT) implemented the Metro Rapid Bus Demonstration Program on June 24, 2000. The purpose of Metro Rapid Bus is to address the need for faster travel choices for bus riders, especially the transit-dependent. The initial Demonstration Program encompassed the Whittier-Wilshire and Ventura corridors.

Evaluation of the various components of Metro Rapid is a critical part of the demonstration process. On-board questionnaires were distributed to bus riders "before" Metro Rapid in early June 2000 and "after" in September 2000 (prior to the strike) to assess rider perceptions, behavior, and profiles. The surveys asked riders to evaluate various elements of service as well as overall satisfaction, with the ultimate purpose of determining changes in customer perceptions of bus service after the introduction of Metro Rapid. Specific questions focused on rider behavior, including trip origins and destinations and frequency of bus use. Questions also obtained information on the ability to recognize Metro Rapid and perceptions of bus cleanliness. Finally, demographic questions provided a basis to assess changes in the demographic profile of Metro Rapid and local riders compared to today's riders.

The sampling plan called for the collection of 400 completed "before" surveys on limited-stop routes and 400 completed surveys on local routes in the two Metro Rapid corridors by placing surveyors on randomly selected bus runs. In the "after" phase, 400 completed surveys were collected on Metro Rapid and 400 surveys on local routes in the two corridors. For both surveys, the sample was drawn primarily from morning bus runs of at least seven hours in length, to maximize surveyors' time; a smaller sample of afternoon/evening runs was drawn to ensure that no bias was introduced by this method. This more intensive sampling allows comparisons between Metro Rapid and local service as well as before and after comparisons. The number of surveys was selected to ensure an accuracy of $\pm$5 percent at the 95 percent confidence level.

On-Board Survey Results

The "before" survey was conducted in June 2000, immediately prior to the Metro Rapid implementation. The "after" survey was conducted in September 2000, after the service had been in operation for a few months. For the first survey on June 13th and 14th, surveyors handed out surveys to riders as they boarded the buses. Both limited and local bus routes along the corridors where Rapid would be implemented were surveyed, and a total of 288 limited and 871 local usable questionnaires were returned. Beginning on September 12th and continuing until September 14th, surveyors handed out surveys on both Rapid lines as well as the local routes that serve the same corridors as the Rapid. The number of usable questionnaires returned for the "after" survey was 719 on Metro Rapid, and 676 on local routes. Thus, a grand total of 2,554 surveys were received and tabulated for the two survey periods.

Origin-Destination

Riders were asked to give the nearest street intersection of their origins and destinations (the start of their trip, not where they boarded the bus).

- A large percentage of those originating from the Eastside, on Route 720 (Wilshire/Whittier), traveled through Downtown to the Westside on the morning trips. This supported findings in previous studies that suggested a relatively large east-to-west demand in the morning peak hours.

- A surprising number of riders are coming from neighborhoods that are usually seen as low transit ridership areas, especially south of Ventura Boulevard on Route 750.

Satisfaction With Service

Respondents were asked to rate their perception of MTA's performance for various service attributes on a scale of 1 to 5, where 1 is "very poor" and 5 is "excellent." Attributes and results are presented in Tables 1 through 4 below. Differences in ratings for each attribute were tested for significance using a statistical procedure known as a T-test of independent samples. A single asterisk in the right-hand column indicates that there is a 95 percent probability that there is a statistically significant difference in the rating, while a double asterisk notes a 99 percent probability of a significant difference.

Comparisons Between Metro Rapid and Former Limited Service (Table 1)

- Ratings for Metro Rapid bus are higher for <u>all</u> elements of service compared to the prior Limited Bus ratings.

- The largest increase (0.89 on a five-point scale) from the "before" survey was for the attribute "cleanliness." This is an extraordinary improvement.

- "Frequency of buses" had the next highest increase at 0.61, with "value for fare paid" and "easy to identify the right bus" third with a 0.56 change.

- The overall rating of MTA service increased by 0.35, from 3.48 among previous limited riders to 3.83 among Metro Rapid riders.

- The improvements in ratings are statistically significant for all service attributes. "Routes go where I need to go" is the only element that is not significantly different at the p=.01 level.

Comparisons Between Local Service Before and After Metro Rapid (Table 2)

- Ratings have increased for all attributes except for "operator courtesy" which had a modest 0.04 decrease. This suggests a spillover effect from the positive impacts of Metro Rapid, since local service did not change appreciably.

- "Availability of seats" had the largest increase at 0.25. As passengers have flocked to Metro Rapid, there is additional capacity available on local routes.

- All the other attributes had relatively small increases, in line with the spillover hypothesis. Only "availability of seats" and "cleanliness" had statistically significant changes at the p=.01 level, while ratings for only three other attributes were statistically significant at the less stringent p=.05 level.

Table 1
Metro Rapid "After" and Limited "Before" Ratings

Service Attribute	Metro Rapid Rating	Limited Rating	Difference
Frequency of Buses	3.76	3.15	+0.61**
Routes go where I need to go	3.82	3.66	+0.16*
Reliability	3.74	3.30	+0.44**
Travel time on the bus	3.82	3.42	+0.40**
Value for fare paid	3.83	3.27	+0.56**
Availability of seats	3.47	3.00	+0.47**
Cleanliness	3.72	2.83	+0.89**
Information at bus stops	3.56	3.04	+0.52**
Operator courtesy	3.72	3.50	+0.22**
Personal safety on buses	3.88	3.40	+0.48**
Easy to identify the right bus	4.10	3.54	+0.56**
Overall rating of MTA service	3.83	3.48	+0.35**

** significant at p=.01 level
* significant at p=.05 level

- The overall rating of MTA service increased by 0.09, from 3.48 to 3.57 among local riders. This change is not statistically significant.

Comparisons Between Metro Rapid and Local Service in the "After" Phase (Table 3)

- Ratings for Metro Rapid bus are higher for <u>all</u> elements of service compared to the "after" Local Bus ratings.

- The largest differential (0.52) between Metro Rapid and Local service is for "cleanliness."

- "Travel time on the bus" shows the next highest differential (0.45). In the "before" surveys, the differential in travel time ratings between the limited and local routes was only 0.13 (as shown in Table 4).

- "Frequency of buses" is third in terms of the greatest differentials between Metro Rapid and Local service (0.44). This finding regarding perceptions of frequency is surprising because, at least on Ventura Boulevard, local buses operated more frequently than Metro Rapid buses.

- The differences in ratings are statistically significant for all service attributes at the p=0.5 level, and for all attributes except "routes go where I need to go" and "availability of seats" at the p=.01 level.

Table 2
Local "After" and "Before" Ratings

Service Attribute	Local "After" Rating	Local "Before" Rating	Difference
Frequency of Buses	3.32	3.18	+0.14*
Routes go where I need to go	3.68	3.60	+0.08
Reliability	3.42	3.29	+0.13*
Travel time on the bus	3.37	3.29	+0.08
Value for fare paid	3.50	3.37	+0.13*
Availability of seats	3.32	3.07	+0.25**
Cleanliness	3.20	2.98	+0.22**
Information at bus stops	3.19	3.10	+0.09
Operator courtesy	3.49	3.53	-0.04
Personal safety on buses	3.58	3.48	+0.10
Easy to identify the right bus	3.68	3.66	+0.02
Overall rating of MTA service	3.57	3.48	+0.09

** significant at p=.01 level
* significant at p=.05 level

Table 3
Metro Rapid and Local "After" Ratings

Service Attribute	Metro Rapid Rating	Local "After" Rating	Difference
Frequency of Buses	3.76	3.32	+0.44**
Routes go where I need to go	3.82	3.68	+0.14*
Reliability	3.74	3.42	+0.32**
Travel time on the bus	3.82	3.37	+0.45**
Value for fare paid	3.83	3.50	+0.33**
Availability of seats	3.47	3.32	+0.15*
Cleanliness	3.72	3.20	+0.52**
Information at bus stops	3.56	3.19	+0.37**
Operator courtesy	3.72	3.49	+0.23**
Personal safety on buses	3.88	3.58	+0.30**
Easy to identify the right bus	4.10	3.68	+0.42**
Overall rating of MTA service	3.83	3.57	+0.26**

** significant at p=.01 level
- significant at p=.05 level

Comparisons Between Limited and Local Service in the "Before" Phase (Table 4)

- The differences seen between ratings for Metro Rapid and for local buses are emphasized even further after an examination of the "before" ratings on limited and local service. As Table 4 shows, there were no statistically significant differences in passenger ratings of limited-stop and local service prior to the implementation of Metro Rapid.

Table 4
Limited and Local "Before" Ratings

Service Attribute	Limited Rating	Local "Before" Rating	Difference
Frequency of Buses	3.15	3.18	-0.03
Routes go where I need to go	3.66	3.60	+0.06
Reliability	3.30	3.29	+0.01
Travel time on the bus	3.42	3.29	+0.13
Value for fare paid	3.27	3.37	-0.10
Availability of seats	3.00	3.07	-0.07
Cleanliness	2.83	2.98	-0.15
Information at bus stops	3.04	3.10	-0.06
Operator courtesy	3.50	3.53	-0.03
Personal safety on buses	3.40	3.48	-0.08
Easy to identify the right bus	3.54	3.66	-0.12
Overall rating of MTA service	3.48	3.48	+0.00

** significant at p=.01 level
* significant at p=.05 level

Detailed Analysis of Service Attribute Ratings by Riders

Data collected on the before and after on-board surveys provide a wealth of information related to customer perceptions of MTA service attributes. In designing service improvements, MTA staff needs to know not only the customer ratings on individual service attributes but also the importance of each attribute in terms of overall satisfaction. The previous section focused on customer ratings; in this section, we consider the ratings together with the relative importance of each service attribute.

The simplest way to measure importance is to ask the customer to rate each element on a scale of 1 to 5, similar to the performance ratings. The drawback of this method is that it lengthens both the survey instrument and time needed to complete the survey, which in turn could diminish the response rate. An alternate technique to measure the importance of each service attribute is to derive importance by examining the relationship of each attribute to overall satisfaction.

The Bay Area Rapid Transit District in Oakland, CA has developed a practical methodology to derive the importance of individual service attributes.[1] The methodology uses bivariate correlation analysis to estimate the importance of each service attribute. Specifically, Pearson correlation coefficients are calculated between the performance rating of each service attribute and the overall MTA service rating. While there is a degree of intercorrelation among the service attributes, the Pearson correlation coefficients can be used to measure the relative importance of each attribute. Importance is derived by calculating the ratio between the correlation coefficient for each attribute and the median correlation coefficient. An index score of 100 is assigned to the median correlation coefficient. Service attributes with a score above 100 are more correlated with overall satisfaction (as measured by the overall MTA rating), while service attributes with a score below 100 are less correlated.

Table 5 shows the Pearson correlation coefficient and the importance score for each service attribute for the before survey, the Metro Rapid after survey, and the Local after survey. Before limited stop and local services are analyzed together, based upon findings in Table 4 that there were no significant differences in passenger ratings of the two services.

The derived importance ratings are reasonably consistent across all service types. Frequency and reliability rate highly in terms of importance, while convenience ("Routes go where I need to go"), availability of seats and value for fare paid are relatively less important. Before and Metro Rapid After riders attach a high level of importance to travel time, but this attribute is less important to Local After riders, who are using a slower service. Metro Rapid After riders view cleanliness as important (and may have been attracted to Metro Rapid service by the new buses with a distinctive appearance), while Local After riders rate the ease of identifying the right bus as relatively important.

Performance and importance can be related through scatter diagrams, with derived importance on the x-axis and performance ratings on the y-axis. The scatter diagram is divided into quadrants, with an importance score of 100 and a performance rating of 3.5 (midway between "fair" and "good") serving as the dividing lines.

Items in the upper right hand quadrant represent important attributes with high performance ratings. These are things that the transit agency does well that are important to riders. The agency should take whatever actions are required to ensure continued high performance ratings on these attributes.

Items in the upper left hand quadrant receive high marks in terms of performance but are relatively unimportant to riders. Often, attributes in this quadrant receive lower importance ratings from passengers precisely because the agency does a good job in these areas. Riders, like everyone else, tend to take areas in which their needs are met for granted. This suggests that the transit agency needs to continue to monitor service delivery in these areas to ensure high performance, but that these elements of service are not top priorities for improvements.

[1] Aaron Weinstein, "Customer Satisfaction Among Transit Riders – How Do Customers Rank the Relative Importance of Various Service Attributes?" Presented at the 79th Annual Meeting of the Transportation Research Board and scheduled for publication in an upcoming **Transportation Research Record**.

Table 5
Importance of Service Attributes

Service Attribute	Before		Local After		Metro Rapid After	
	Pearson Corr. Coeff.	Importance Index	Pearson Corr. Coeff.	Importance Index	Pearson Corr. Coeff.	Importance Index
Frequency of Buses	0.596	106.62	0.644	102.22	0.655	109.90
Routes go where I need to go	0.471	84.26	0.524	83.17	0.516	86.58
Reliability	0.641	114.67	0.706	112.06	0.644	108.05
Travel time on the bus	0.630	112.70	0.625	99.21	0.654	109.73
Value for fare paid	0.532	95.17	0.529	83.97	0.549	92.11
Availability of seats	0.513	91.77	0.605	96.03	0.592	99.33
Cleanliness	0.544	97.32	0.612	97.14	0.653	109.56
Information at bus stops	0.572	102.33	0.630	100.00	0.576	96.64
Operator courtesy	0.547	97.85	0.637	101.11	0.621	104.19
Personal safety on buses	0.581	103.94	0.635	100.79	0.595	99.83
Easy to identify the right bus	0.559	100.00	0.656	104.13	0.596	100.00

Items in the lower left hand quadrant are relatively unimportant to riders and relatively low-scoring in terms of agency performance. While performance levels are relatively low for these attributes, these are not strong candidates for improvement due to their low levels of importance to riders.

Items in the lower right hand quadrant are key priorities for the transit agency. Riders consider these attributes important, but current performance ratings are less than desired.

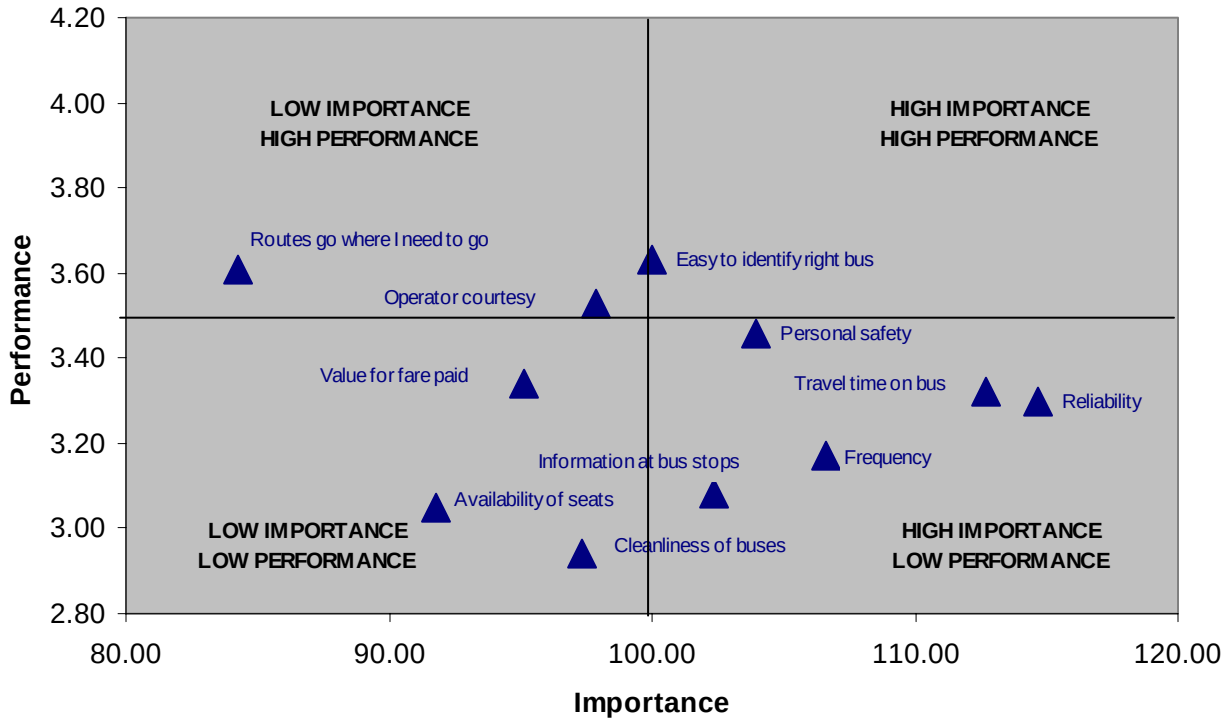
Figures 1, 2, and 3 are scatter diagrams that relate importance and performance for Before, Local After, and Metro Rapid After riders and services, respectively. Figure 1 shows the results of the Before survey. No service attributes fall into the high importance/high performance quadrant (although Easy to identify the right bus is on the median for importance). Low-importance attributes are split in terms of performance ratings, with two in the upper left hand quadrant and three in the lower left hand quadrant. There are several attributes in the lower right hand quadrant, representing important service elements that need improvement: Information at bus stops, Frequency, Reliability, Travel time on the bus, and Personal safety. The Before quadrant analysis depicts the situation facing MTA and its Board when it made the decision to move forward with the Metro Rapid demonstration program.

Figure 2 presents the quadrant analysis for Local service after the implementation of the Metro Rapid program. Of the five priority items in the lower right hand quadrant on the Before chart, only two remain in the same quadrant. Frequency and Reliability are major service attributes, but Personal safety is now in the upper right hand quadrant, while Information at bus stops and Travel time on the bus are less important now to local riders (those who value Travel time highly

are presumably riding Metro Rapid). Operator courtesy is now in the high importance/low performance quadrant, although just barely (its performance rating is a shade below 3.5), and Information at bus stops is on the median line for importance. Overall, however, the situation is improved for Local bus riders today compared to the Before survey.

The dramatic change in perception of MTA performance has occurred among Metro Rapid riders, as shown in Figure 3. Reliability, Frequency, Travel time, Cleanliness, and Operator

Figure 1
Importance vs. Performance for Service Attributes
Local and Limited-Stop Before



Courtesy all fall into the upper right hand quadrant representing high levels of importance and performance. Only one service attribute, Availability of seats, has a performance rating below the cutoff mark of 3.5, and this attribute is judged relatively unimportant by Metro Rapid riders. In sharp contrast to the other figures, there are no service attributes in the lower right hand quadrant in Figure 3.

Figure 2
Importance vs. Performance for Service Attributes
Local Bus After

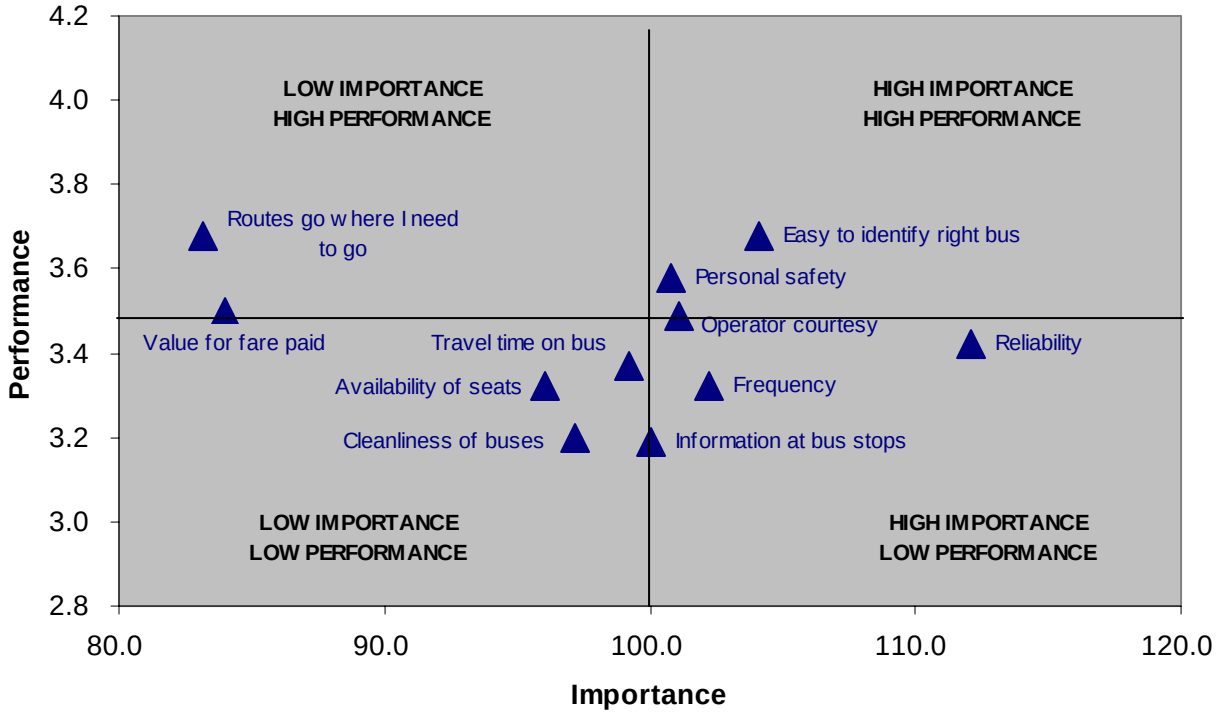
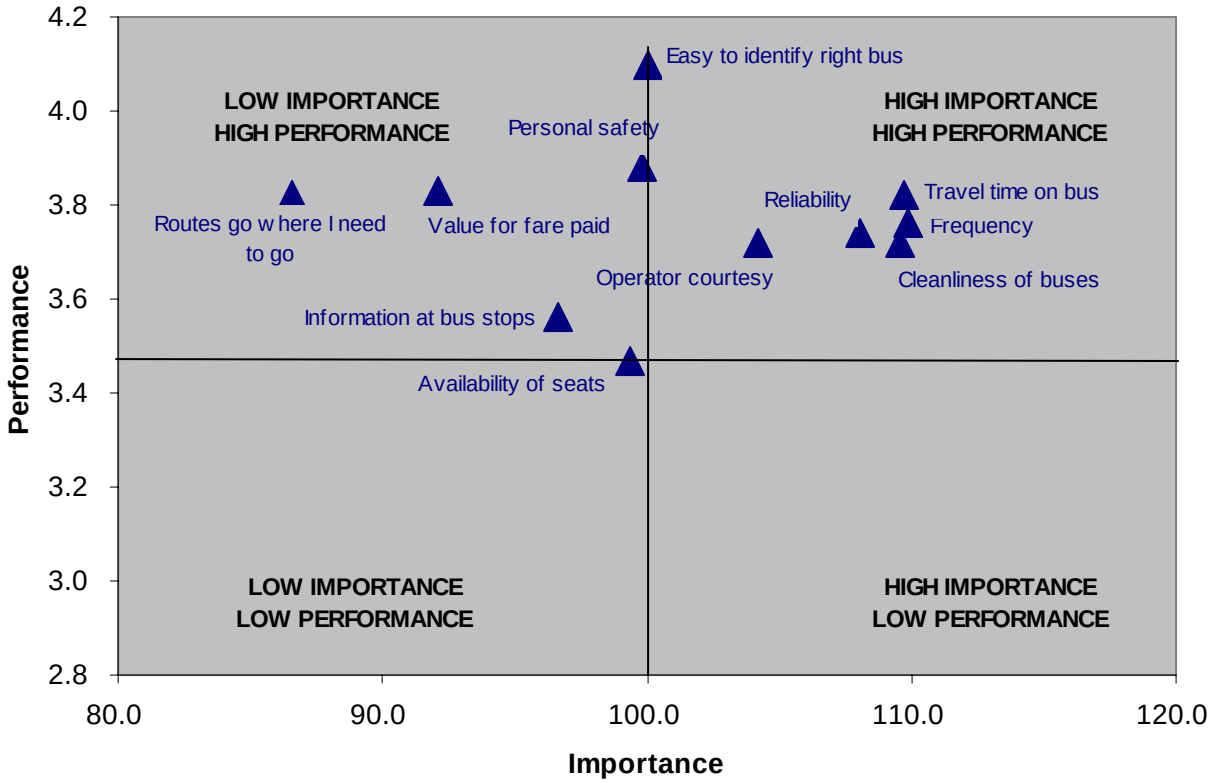


Figure 3
Importance vs. Performance for Service Attributes
Metro Rapid



Taken together, the quadrant analyses clearly show that Metro Rapid riders perceive a quantum leap in service performance. Changes of this magnitude in performance ratings are rare, particularly over a relatively short time frame. MTA has essentially raised the bar in terms of service quality for its riders through the Metro Rapid demonstration program.

Demographics

Riders were asked certain questions to ascertain their age, ethnic origin, sex, income, and vehicle availability. The most interesting findings include:

- Metro Rapid has a higher percentage of male riders (54.2 percent) compared to the locals (41.4 percent) and former limited lines (42.6 percent), suggesting that the new service is drawing new, non-traditional riders (see Figure 4).

- Vehicle availability is surprisingly similar for Metro Rapid and local bus riders (Figure 5). Approximately one-quarter of riders in both groups are from households with at least two cars.

- The majority of Metro Rapid and local bus riders report Income levels below $15,000 annually (Figure 6). However, 13.1 percent of Metro Rapid riders have incomes above $50,000.

Figure 4
Gender of MTA Riders

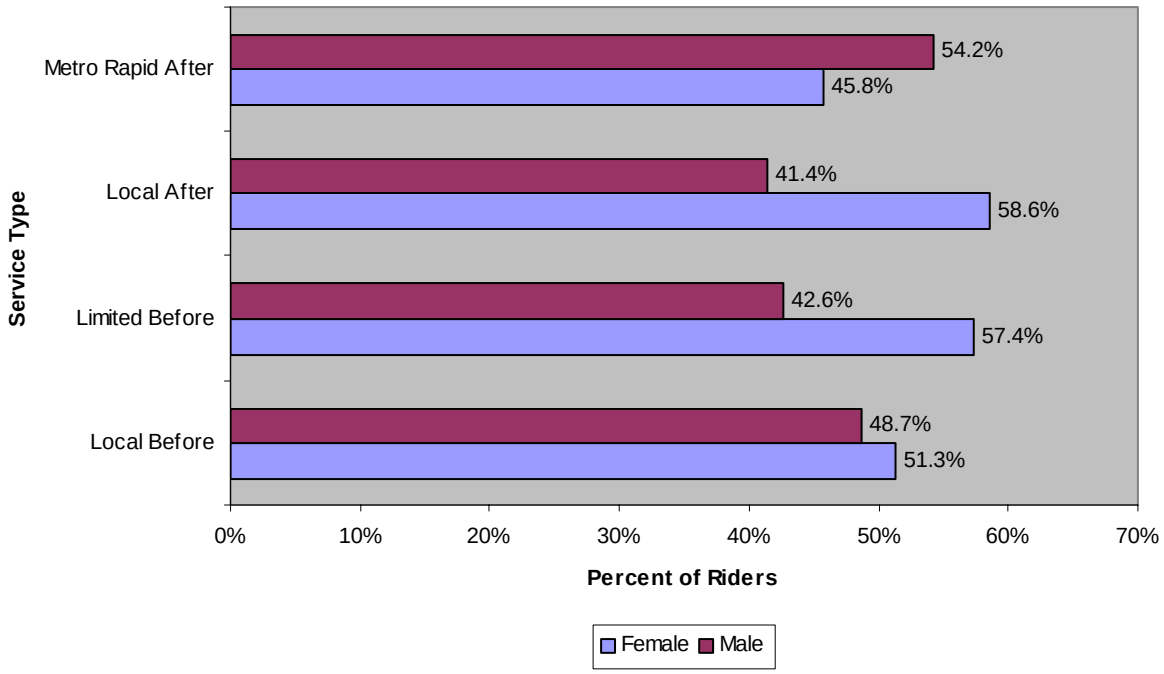


Figure 5
Vehicle Availability of MTA Riders

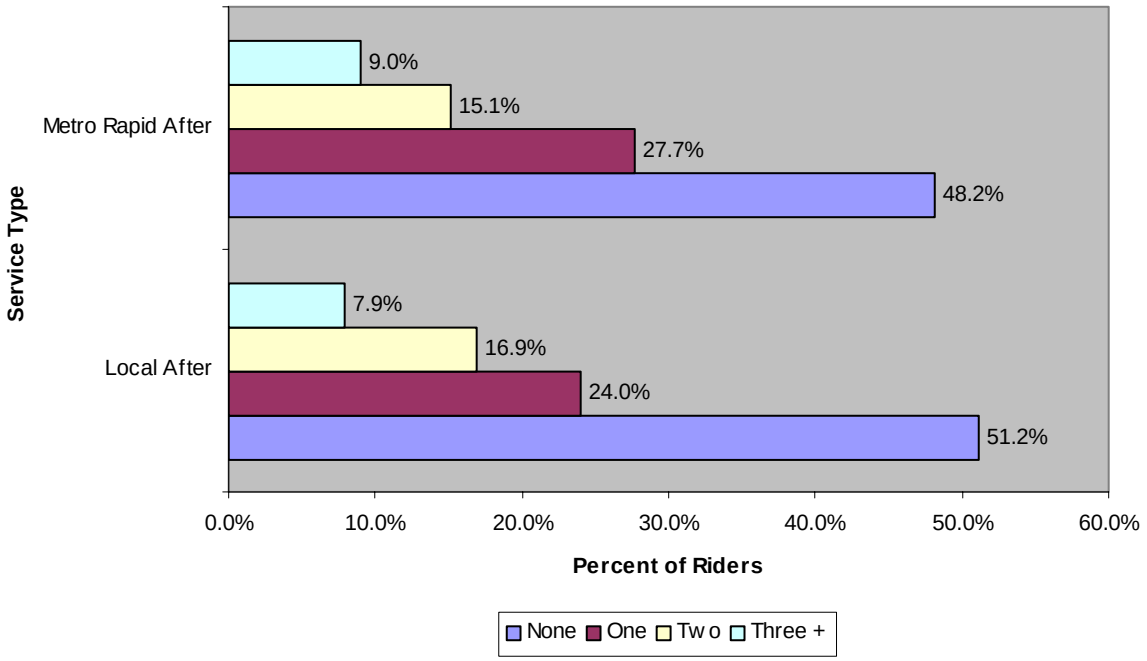
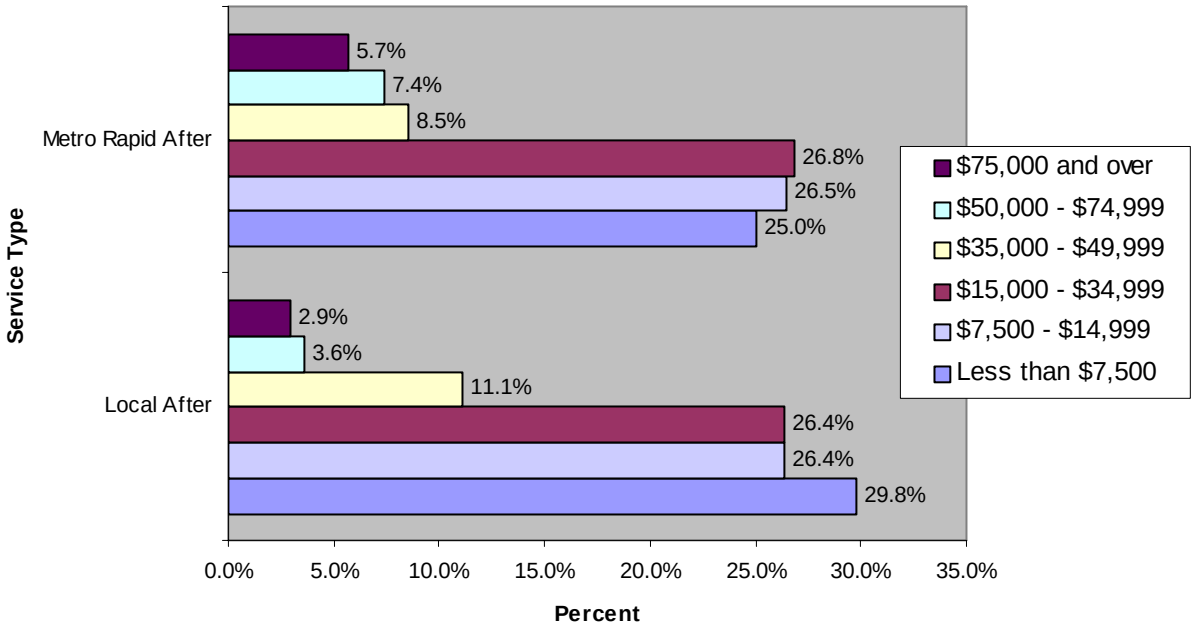


Figure 6
Income of Riders



Previous Mode of Travel

The "After" survey on Metro Rapid asked riders for their previous mode of travel. Table 5 shows the results, with results broken down by Metro Rapid line.

- As expected, most Metro Rapid passengers are former transit users.
- However, 10.8 percent of Metro Rapid riders did not make this trip previously, and another 9.5 percent used a non-transit mode (most likely the automobile). Many of these new riders are new to transit.

Table 5
Previous Mode of Travel for Metro Rapid Riders

Previous Mode	Line 720 (Wilshire-Whittier)	Line 750 (Ventura)	Metro Rapid Total
Bus	63.0%	60.0%	61.1%
Rail	2.5%	7.6%	5.7%
Bus and Rail	14.4%	12.1%	12.9%
Did not make trip	11.5%	10.4%	10.8%
Other non-transit mode	8.6%	9.9%	9.5%

Table 6 presents responses regarding the history of transit use.

- Nearly 14 percent of Metro Rapid riders began using MTA services within the last three months (since the start of Metro Rapid and the Metro Red Line extension to the SFV). By comparison, only nine percent of local riders began using MTA services in this same time frame.

Table 6
Length of Time Using MTA Services

Length of Time	Line 720 (Wilshire-Whittier)	Line 750 (Ventura)	Metro Rapid Total	Local Bus Total
0-3 months	11.8%	15.1%	13.9%	9.0%
3-6 months	4.9%	7.0%	6.2%	7.7%
6-12 months	10.6%	10.3%	10.4%	14.4%
1 to 5 years	26.9%	22.8%	24.4%	26.4%
Over 5 years	45.7%	44.7%	45.1%	42.6%

A summary of responses to all questions concerning rider demographics and usage patterns is contained in the appendix.

SURVEY INSTRUMENT AND TABLES OF RESPONSE

METROPOLITAN TRANSPORTATION AUTHORITY (MTA) RIDER SURVEY

Before Survey

DEAR BUS RIDER: Please take a minute to fill this out and help us plan for your transit needs. Place the survey in the collection box as you exit the bus, or hand it to the person who gave it to you.

1. Why are you riding the bus today? (Check all that apply)
1 ___ Avoid traffic 2 ___ No other way to go
3 ___ Less expensive 4 ___ Parking problems
5 ___ More convenient 6 ___ Other _____

2. What is the main purpose of your trip today?
1 ___ Work 2 ___ Shopping 3 ___ School
4 ___ Medical 5 ___ Visit/Personal 6 ___ Other

3. How did you get to the bus stop for this bus?
1 ___ Transferred from Line # _____
2 ___ Walked 3 ___ Drove 4 ___ Got a ride
5 ___ Bicycle 6 ___ Other

4. Where are you coming from? (the start of your trip, not where you got on this bus)
_____&_____
(nearest street intersection)

5. How did you pay for your fare on this bus?
1 ___ Cash 2 ___ Transfer 3 ___ Token
4 ___ Weekly Pass 5 ___ Monthly Pass

6. What will you do when you get off this bus?
1 ___ Transfer to Line # _____
2 ___ Walk 3 ___ Drive 4 ___ Get a ride
5 ___ Bicycle 6 ___ Other

7. Where are you going to? (the end of your trip, not where you get off this bus)
_____&_____
(nearest street intersection)

8. How would you make this trip if not by bus?
1 ___ Drive 2 ___ Walk 3 ___ Bike 4 ___ Taxi
5 ___ Get a ride 6 ___ Wouldn't make trip

9. Please rate MTA's performance on the following elements of bus service on a 1-5 scale, with 1 being very poor and 5 being excellent:

	Very Poor	Poor	Fair	Good	Excellent
1 Frequency of buses (how often they run)	1	2	3	4	5
2 Routes go where I need to go	1	2	3	4	5
3 Reliability	1	2	3	4	5
4 Travel time on the bus	1	2	3	4	5
5 Value for fare paid	1	2	3	4	5
6 Availability of seats	1	2	3	4	5
7 Cleanliness	1	2	3	4	5
8 Information at bus stops	1	2	3	4	5
9 Operator courtesy	1	2	3	4	5
10 Personal safety on buses	1	2	3	4	5
11 Easy to identify the right bus	1	2	3	4	5
12 Overall rating of MTA service	1	2	3	4	5

Finally, for statistical purposes, tell us a little about yourself. All replies are confidential.

10. How often do you ride the bus?
1 ___ 5+ days per week 2 ___ 3-4 days per week
3 ___ 1-2 days per wk 4 ___ Less than once a wk

11. How long have you been using MTA service?
1 ___ Less than 6 mos 2 ___ 6 months to 1 year
3 ___ More than 1 year

12. Your age is...
1 ___ 17 years or under 2 ___ 18 to 44 years
3 ___ 45 to 64 years 4 ___ 65 years or more

13. You are: 1 ___ Female 2 ___ Male

14. Your ethnic origin is...
1 ___ Afr. Am./Black 2 ___ White 3 ___ Hispanic
4 ___ Asian/Pacific Islander 5 ___ Other

15. How many working motor vehicles are available in your household?
1 ___ None 2 ___ One 3 ___ Two 4 ___ Three+

16. Your total annual household income is..
1 ___ Less than $7,500 4 ___ $35,000-$49,999
2 ___ $7,500-$14,999 5 ___ $50,000-$74,999
3 ___ $15,000-34,999 6 ___ $75,000 and over

Any Other Comments? _____

_____

THANK YOU FOR YOUR PARTICIPATION.

METROPOLITAN TRANSPORTATION AUTHORITY (MTA) RIDER SURVEY

Metro Rapid After

DEAR METRO RAPID RIDER: Please take a minute to fill this out and help us evaluate our service. Place the survey in the collection box as you exit the bus, or hand it to the person who gave it to you.

1. Why are you riding the bus today? (Check all that apply)
1 ___ Avoid traffic 2 ___ No other way to go
3 ___ Less expensive 4 ___ Parking problems
5 ___ More convenient 6 ___ Other _____

2. What is the main purpose of your trip today?
1 ___ Work 2 ___ Shopping 3 ___ School
4 ___ Medical 5 ___ Visit/Personal 6 ___ Other

3. How did you get to the bus stop for this bus?
1 ___ Transferred from Bus Line # _____
2 ___ Transferred from Rail 3 ___ Walked
4 ___ Drove 5 ___ Got a ride 6 ___ Bicycle
7 ___ Other

4. How did you pay for your fare on this bus?
1 ___ Cash 2 ___ Transfer 3 ___ Token
4 ___ Weekly Pass 5 ___ Monthly Pass
6 ___ Half-Monthly Pass

5. Where are you coming from? (the start of your trip, not where you got on this bus)
_____&_____
(nearest street intersection)

6. What will you do when you get off this bus?
1 ___ Transfer to Bus Line # _____
2 ___ Transfer to Rail 3 ___ Walk 4 ___ Drive
5 ___ Get a ride 6 ___ Bicycle 7 ___ Other

7. Where are you going to? (the end of your trip, not where you get off this bus)
_____&_____
(nearest street intersection)

8. How did you make this trip before Metro Rapid?
1 ___ Bus 2 ___ Rail 3 ___ Bus and Rail
4 ___ Did not make trip 5 ___ Other

8a. If you answered "Bus" or "Bus and Rail" on Question 8, what bus line or lines did you use previously?
Line # _____

8b. Has your travel time changed with Metro Rapid?
1 ___ More than 15 minutes faster
2 ___ 11-15 minutes faster
3 ___ 6-10 minutes faster 4 ___ 1-5 minutes faster
5 ___ About the same 6 ___ Slower

9. Please rate MTA's performance on the following elements of bus service on a 1-5 scale, with 1 being very poor and 5 being excellent:

	Very Poor	Poor	Fair	Good	Excellent
1 Frequency of buses (how often they run)	1	2	3	4	5
2 Routes go where I need to go	1	2	3	4	5
3 Reliability	1	2	3	4	5
4 Travel time on the bus	1	2	3	4	5
5 Value for fare paid	1	2	3	4	5
6 Availability of seats	1	2	3	4	5
7 Cleanliness	1	2	3	4	5
8 Information at bus stops	1	2	3	4	5
9 Operator courtesy	1	2	3	4	5
10 Personal safety on buses	1	2	3	4	5
11 Easy to identify the right bus	1	2	3	4	5
12 Overall rating of MTA service	1	2	3	4	5

Finally, for statistical purposes, tell us a little about yourself. All replies are confidential.

10. How often do you ride the bus?
1 ___ 5+ days per week 2 ___ 3-4 days per week
3 ___ 1-2 days per wk 4 ___ Less than once a wk

11. How long have you been using MTA service?
1 ___ Less than 3 mos. 2 ___ 3 to 6 months
3 ___ 6 mos. to 1 year 4 ___ 1 to 5 years
5 ___ More than 5 years

12. Your age is...
1 ___ 17 years or under 2 ___ 18 to 44 years
3 ___ 45 to 64 years 4 ___ 65 years or more

13. You are: 1 ___ Female 2 ___ Male

14. Your ethnic origin is...
1 ___ Afr. Am./Black 2 ___ White 3 ___ Hispanic
4 ___ Asian/Pacific Islander 5 ___ Other

15. How many working motor vehicles are available in your household?
1 ___ None 2 ___ One 3 ___ Two 4 ___ Three+

16. Your total annual household income is..
1 ___ Less than $7,500 4 ___ $35,000-$49,999
2 ___ $7,500-$14,999 5 ___ $50,000-$74,999
3 ___ $15,000-34,999 6 ___ $75,000 and over

METROPOLITAN TRANSPORTATION AUTHORITY (MTA) RIDER SURVEY

Local After

DEAR LOCAL BUS RIDER: Please take a minute to fill this out and help us evaluate our service. Place the survey in the collection box as you exit the bus, or hand it to the person who gave it to you.

1. Why are you riding the bus today? (Check all that apply)
1 ___ Avoid traffic 2 ___ No other way to go
3 ___ Less expensive 4 ___ Parking problems
5 ___ More convenient 6 ___ Other _____

2. What is the main purpose of your trip today?
1 ___ Work 2 ___ Shopping 3 ___ School
4 ___ Medical 5 ___ Visit/Personal 6 ___ Other

3. How did you get to the bus stop for this bus?
1 ___ Transferred from Bus Line # _____
2 ___ Transferred from Rail 3 ___ Walked
4 ___ Drove 5 ___ Got a ride 6 ___ Bicycle
7 ___ Other

4. How did you pay for your fare on this bus?
1 ___ Cash 2 ___ Transfer 3 ___ Token
4 ___ Weekly Pass 5 ___ Monthly Pass
6 ___ Half-Monthly Pass

5. Where are you coming from? (the start of your trip, not where you got on this bus)
_____&_____
(nearest street intersection)

6. What will you do when you get off this bus?
1 ___ Transfer to Bus Line # _____
2 ___ Transfer to Rail 3 ___ Walk 4 ___ Drive
5 ___ Get a ride 6 ___ Bicycle 7 ___ Other

7. Where are you going to? (the end of your trip, not where you get off this bus)
_____&_____
(nearest street intersection)

8. Why are you not using Metro Rapid for this trip?
1 ___ Metro Rapid stop is too far to walk
2 ___ I just catch the next bus
3 ___ Local bus is less crowded
4 ___ Don't know enough about Metro Rapid

9. Please rate MTA's performance on the following elements of bus service on a 1-5 scale, with 1 being very poor and 5 being excellent:

	Very Poor	Poor	Fair	Good	Excellent
1 Frequency of buses (how often they run)	1	2	3	4	5
2 Routes go where I need to go	1	2	3	4	5
3 Reliability	1	2	3	4	5
4 Travel time on the bus	1	2	3	4	5
5 Value for fare paid	1	2	3	4	5
6 Availability of seats	1	2	3	4	5
7 Cleanliness	1	2	3	4	5
8 Information at bus stops	1	2	3	4	5
9 Operator courtesy	1	2	3	4	5
10 Personal safety on buses	1	2	3	4	5
11 Easy to identify the right bus	1	2	3	4	5
12 Overall rating of MTA service	1	2	3	4	5

Finally, for statistical purposes, tell us a little about yourself. All replies are confidential.

10. How often do you ride the bus?
1 ___ 5+ days per week 2 ___ 3-4 days per week
3 ___ 1-2 days per wk 4 ___ Less than once a wk

11. How long have you been using MTA service?
1 ___ Less than 3 mos. 2 ___ 3 to 6 months
3 ___ 6 mos. to 1 year 4 ___ 1 to 5 years
5 ___ More than 5 years

12. Your age is...
1 ___ 17 years or under 2 ___ 18 to 44 years
3 ___ 45 to 64 years 4 ___ 65 years or more

13. You are: 1 ___ Female 2 ___ Male

14. Your ethnic origin is...
1 ___ Afr. Am./Black 2 ___ White 3 ___ Hispanic
4 ___ Asian/Pacific Islander 5 ___ Other

15. How many working motor vehicles are available in your household?
1 ___ None 2 ___ One 3 ___ Two 4 ___ Three+

16. Your total annual household income is..
1 ___ Less than $7,500 4 ___ $35,000-$49,999
2 ___ $7,500-$14,999 5 ___ $50,000-$74,999
3 ___ $15,000-34,999 6 ___ $75,000 and over

THANK YOU FOR YOUR PARTICIPATION.

Table A-1 Reasons for Using Transit

	Local Before		Limited Before		Local After		Metro Rapid After	
	#	Percent	#	Percent	#	Percent	#	Percent
Avoid traffic	123	14.1%	29	10.1%	90	13.3%	145	20.2%
No other way to go	462	53.0%	141	49.0%	396	58.6%	332	46.2%
Less expensive	194	22.3%	45	15.6%	120	17.8%	154	21.4%
Parking problems	64	7.3%	21	7.3%	39	5.8%	40	5.6%
More convenient	200	23.0%	68	23.6%	139	20.6%	221	30.7%
Other	79	9.1%	27	9.4%	58	8.6%	55	7.6%
	1,122		331		842		947	

Table A-2 Trip Purpose

	Local Before		Limited Before		Local After		Metro Rapid After	
	#	Percent	#	Percent	#	Percent	#	Percent
Work	520	61.7%	175	63.6%	443	67.6%	528	75.4%
Shopping	61	7.2%	23	8.4%	41	6.3%	35	5.0%
School	79	9.4%	37	13.5%	88	13.4%	62	8.9%
Medical	59	7.0%	13	4.7%	28	4.3%	23	3.3%
Visit/Personal	59	7.0%	11	4.0%	33	5.0%	29	4.1%
Other	65	7.7%	16	5.8%	22	3.4%	23	3.3%
Total	843	100.0%	275	100.0%	655	100.0%	700	100.0%

Table A-3 Access to Bus Stop

	Local Before		Limited Before		Local After		Metro Rapid After	
	#	Percent	#	Percent	#	Percent	#	Percent
Transferred from Bus	315	38.3%	82	30.6%	190	29.0%	260	37.6%
Transferred from Rail					69	10.5%	116	16.8%
Walked	432	52.5%	160	59.7%	319	48.7%	232	33.6%
Drove	15	1.8%	2	0.7%	7	1.1%	34	4.9%
Got a ride	35	4.3%	9	3.4%	40	6.1%	38	5.5%
Bicycle	2	0.2%	3	1.1%	7	1.1%	8	1.2%
Other	24	2.9%	12	4.5%	23	3.5%	3	0.4%
Total	823		268	100.0%	655	100.0%	691	100.0%

Table A-4 Fare Payment Method

	Local Before		Limited Before		Local After		Metro Rapid After	
	#	Percent	#	Percent	#	Percent	#	Percent
Cash	223	27.1%	71	26.5%	146	22.5%	130	18.8%
Transfer	60	7.3%	15	5.6%	57	8.8%	75	10.9%
Token	124	15.0%	47	17.5%	110	16.9%	94	13.6%
Weekly Pass	104	12.6%	36	13.4%	83	12.8%	103	14.9%
Monthly Pass	260	31.6%	75	28.0%	210	32.3%	227	32.9%
Half-Monthly Pass/Other	53	6.4%	24	9.0%	44	6.8%	62	9.0%
Total	824	100.0%	268	100.0%	650	100.0%	691	100.0%

Table A-5 Egress from Bus Stop

	Local Before		Limited Before		Local After		Metro Rapid After	
	#	Percent	#	Percent	#	Percent	#	Percent
Transfer to Bus	264	33.2%	79	31.2%	166	27.7%	235	35.9%
Transfer to Rail					55	9.2%	118	18.0%
Walk	446	56.1%	147	58.1%	297	49.5%	260	39.7%
Drive	11	1.4%	2	0.8%	9	1.5%	6	0.9%
Get a ride	26	3.3%	10	4.0%	35	5.8%	18	2.7%
Bicycle	9	1.1%	1	0.4%	4	0.7%	7	1.1%
Other	39	4.9%	14	5.5%	34	5.7%	11	1.7%
Total	795	100.0%	253	100.0%	600	100.0%	655	100.0%

Table A-6 Frequency of Bus Use

	Local Before		Limited Before		Local After		Metro Rapid After	
	#	Percent	#	Percent	#	Percent	#	Percent
5+ days per week	574	72.1%	191	71.5%	489	77.6%	511	77.0%
3-4 days per week	126	15.8%	47	17.6%	81	12.9%	95	14.3%
1-2 days per week	50	6.3%	19	7.1%	37	5.9%	37	5.6%
Less than once a week	46	5.8%	10	3.7%	23	3.7%	21	3.2%
Total	796	100.0%	267	100.0%	630	100.0%	664	100.0%

Table A-7 Length of Time Using MTA Services

	Local Before		Limited Before		Local After		Metro Rapid After	
	#	Percent	#	Percent	#	Percent	#	Percent
Less than 3 months					55	9.0%	92	13.9%
3 to 6 months					47	7.7%	41	6.2%
Less than 6 months	111	14.5%	41	16.1%	102	16.7%	133	20.1%
6 months to 1 year	111	14.5%	39	15.3%	88	14.4%	69	10.4%
More than 1 year	541	70.9%	175	68.6%	421	69.0%	459	69.5%
1 to 5 years					161	26.4%	161	24.4%
More than 5 years					260	42.6%	298	45.1%
Total	763	100.0%	255	100.0%	611	100.0%	661	100.0%

Table A-8 Age

	Local Before		Limited Before		Local After		Metro Rapid After	
	#	Percent	#	Percent	#	Percent	#	Percent
17 years or under	47	6.0%	24	9.1%	49	8.0%	33	5.0%
18 to 44 years	472	60.4%	163	62.0%	351	57.5%	417	63.4%
45 to 64 years	201	25.7%	69	26.2%	175	28.7%	178	27.1%
65 years or more	61	7.8%	7	2.7%	35	5.7%	30	4.6%
Total	781	100.0%	263	100.0%	610	100.0%	658	100.0%

Table A-9 Gender

	Local Before		Limited Before		Local After		Metro Rapid After	
	#	Percent	#	Percent	#	Percent	#	Percent
Female	368	51.3%	135	57.4%	283	58.6%	213	45.8%
Male	349	48.7%	100	42.6%	200	41.4%	252	54.2%
Total	717	100.0%	235	100.0%	483	100.0%	465	100.0%

Table A-10 Ethnic Origin

	Local Before		Limited Before		Local After		Metro Rapid After	
	#	Percent	#	Percent	#	Percent	#	Percent
African-American/Black	115	15.2%	36	14.1%	97	15.8%	84	13.0%
White	162	21.3%	35	13.7%	100	16.3%	137	21.2%
Hispanic	384	50.6%	159	62.1%	321	52.4%	349	54.1%
Asian/Pacific Islander	61	8.0%	18	7.0%	70	11.4%	54	8.4%
Other	37	4.9%	8	3.1%	25	4.1%	21	3.3%
Total	759	100.0%	256	100.0%	613	100.0%	645	100.0%

Table A-11 Vehicle Availability

	Local Before		Limited Before		Local After		Metro Rapid After	
	#	Percent	#	Percent	#	Percent	#	Percent
None	360	47.7%	106	42.7%	297	51.2%	306	48.2%
One	231	30.6%	83	33.5%	139	24.0%	176	27.7%
Two	119	15.8%	40	16.1%	98	16.9%	96	15.1%
Three +	45	6.0%	19	7.7%	46	7.9%	57	9.0%
Total	755	100.0%	248	100.0%	580	100.0%	635	100.0%

Table A-12 Household Income

	Local Before		Limited Before		Local After		Metro Rapid After	
	#	Percent	#	Percent	#	Percent	#	Percent
Less than $7,500	212	31.4%	58	25.9%	167	29.8%	153	25.0%
$7,500 - $14,999	173	25.6%	73	32.6%	148	26.4%	162	26.5%
$15,000 - $34,999	148	21.9%	59	26.3%	148	26.4%	164	26.8%
$35,000 - $49,999	86	12.7%	19	8.5%	62	11.1%	52	8.5%
$50,000 - $74,999	34	5.0%	9	4.0%	20	3.6%	45	7.4%
$75,000 and over	23	3.4%	6	2.7%	16	2.9%	35	5.7%
Total	676	100.0%	224	100.0%	561	100.0%	611	100.0%

Table A-13 Alternate Mode (Before Only)

	Local Before		Limited Before	
	#	Percent	#	Percent
Drive	146	20.2%	46	19.3%
Walk	112	15.5%	34	14.3%
Bicycle	34	4.7%	12	5.0%
Taxi	53	7.3%	11	4.6%
Get a ride	195	26.9%	73	30.7%
Would not make trip	184	25.4%	62	26.1%
Total	724	100.0%	238	100.0%

Table A-14 Prior Mode (Metro Rapid Only)

	Metro Rapid After	
	#	Percent
Bus	407	61.1%
Rail	38	5.7%
Bus and Rail	86	12.9%
Did not make trip	72	10.8%
Other	63	9.5%
Total	666	100.0%

Table A-15 Perceived Travel Time Change (Metro Rapid Only)

	Metro Rapid After	
	#	Percent
15 minutes or more faster	313	50.2%
11-15 minutes faster	105	16.9%
6-10 minutes faster	76	12.2%
1-5 minutes faster	30	4.8%
About the same	66	10.6%
Slower	33	5.3%
Total	623	100.0%

Table A-16 Reasons for Not Using Metro Rapid (Local Only)

	Local After	
	#	Percent
Too far to walk	258	41.4%
I just catch the next bus	161	25.8%
Local bus is less crowded	43	6.9%
Don't know enough	99	15.9%
Total	561	100.0%