



SR-710 Study

Alternatives Analysis Report

Appendix D

BRT Preliminary Operating Plans

Technical Memorandum





SR-710 Study

TECHNICAL MEMORANDUM

SR 710 Study – BRT Preliminary Operating Plans

PREPARED FOR: Michelle Smith/Metro
COPY TO: Caltrans
Study Team
PREPARED BY: CH2M HILL Team
DATE: December 12, 2012
PROJECT NUMBER: 428908

At a June 2010 meeting, the Los Angeles County Metropolitan Transportation Authority (Metro) in coordination with the California Department of Transportation (Caltrans), moved to broaden the search for multimodal solutions for the State Route 710 (SR 710) study area and move forward with the environmental review phase.

More recently, Metro has initiated the SR 710 Alternatives Analysis (AA) process to evaluate alternatives for transportation improvements in the SR 710 study area. A series of project alternatives have been developed, which include a Transportation Systems Management (TSM) alternative, freeway alternatives, Bus Rapid Transit (BRT) alternatives, and Light Rail Transit (LRT) alternatives.

Two Bus Rapid Transit (BRT) services were advanced from an evaluation of six candidate corridors, based on their potential to link important trip origins and destinations, carry significant ridership, and improve mobility in the SR 710 study area. These alternatives are identified as BRT-1, from Los Angeles Union Station to La Cañada Flintridge, and BRT-6, from East Los Angeles to Pasadena. Figures illustrating the BRT alternatives are attached at the end of this memorandum.

The intent of the two BRT alternatives is to improve on the existing Metro Rapid services in the study area, particularly Metro 762, by providing higher-frequency, faster and more efficient bus services connecting key origins and destinations in the study area. The selected corridors exhibited the greatest potential for travel time savings and preferential bus treatments such as curbside dedicated lanes (i.e., sufficient right-of-way) without significant disruption to existing roadways. This technical memorandum documents the approach used to develop preliminary operating plans and the operating and maintenance (O&M) cost methodology for each of the BRT alternatives.

Operating Assumptions and Plans

BRT 1: Los Angeles to La Cañada Flintridge

BRT-1 would provide Bus Rapid Transit service between Patsaouras Transit Plaza at Los Angeles Union Station and La Cañada Flintridge. The proposed route incorporates segments of existing Metro bus services (e.g., North Mission Road, Fair Oaks Avenue) into a new alignment.

Route Alignment

BRT vehicles would exit Union Station, travel east on Cesar Chavez Avenue, then turn north on Mission Road. The route would continue on Huntington Drive to Fair Oaks Avenue in South Pasadena, continuing on Fair Oaks Avenue through South Pasadena and Pasadena. Turning west on Woodbury Road, vehicles would continue to Oak



Grove Drive and terminate at the entrance to the NASA Jet Propulsion Laboratory. The total length of the route would be 14.7 miles from Union Station to La Cañada Flintridge.

The route alignment would improve and consolidate existing Metro bus route coverage, primarily including route 79 in the Mission Road and Huntington Avenue corridor and routes 260 and 762 on Fair Oaks Avenue. The new service would generally parallel the Metro Gold Line, provides valuable coverage to mixed use development off of the rail corridor, and serves the employment hub of the JPL at its northern terminus.

Stop Locations

BRT stops would be placed at approximately ½ mile intervals, at major activity centers and cross streets. Local bus routes would continue to serve their current stop locations.

BRT stops are proposed at the following locations (from south to north):

1. Union Station
2. Mission Road at Marengo Street/Daly Street
3. Mission Road at Valley Boulevard/Main Street
4. Huntington Drive at Soto Street
5. Huntington Drive at Monterey Road
6. Huntington Drive at Eastern Avenue
7. Huntington Drive at Poplar Boulevard
8. Huntington Drive at Main Street
9. Huntington Drive at Fremont Avenue
10. Fair Oaks Avenue at Mission Street
11. Fair Oaks Avenue at Glenarm Street
12. Fair Oaks Avenue at California Boulevard
13. Fair Oaks Avenue at Del Mar Boulevard
14. Fair Oaks Avenue at Colorado Boulevard
15. Fair Oaks Avenue at Orange Grove Boulevard
16. Fair Oaks Avenue at Washington Boulevard
17. Fair Oaks Avenue at Woodbury Road
18. Woodbury Road at Lincoln Avenue
19. NASA JPL

Span of Service

BRT service would operate from 6:00 A.M. to 9:00 P.M., seven days a week. Local bus routes in the area would continue to operate a longer span than BRT and limited stop services.

Frequency of Service

BRT-1 service would operate at a frequency of every 10 minutes during peak periods (defined as 6:00-9:00 A.M. and 3:00-7:00 P.M. on weekdays) and every 20 minutes during off-peak periods. Shorter trips within segments such as Huntington Drive or Fair Oaks Avenue would continue to be served with more frequent service via local Metro routes.

Vehicle Requirements

Bus Rapid Transit service would incorporate modern, articulated buses with low-floor boarding to facilitate passenger entry and exit. Typical articulated buses feature two doors; however, three-door vehicles are becoming more common. Based on a one-way route length of 14.7 miles and an estimated travel time of 51.4 minutes, the BRT-1 alternative would require 12 peak vehicles for 10-minute frequency service and six off-peak vehicles for 20-minute service.

Service Amenities

Bus Rapid Transit service for BRT-1 would feature dedicated bus-only lanes for much of the planned alignment as well as transit signal priority (TSP) components to improve both bus and general traffic flow in the corridor. BRT bus stops would be recognizable through distinct branding, shelters, off-board ticket vending machines, and public information such as real-time arrival displays indicating the proximity of buses to the stop.

The BRT vehicles would operate in exclusive lanes, generally adjacent to the curb, in the following general areas:

- Mission Road from Cesar Chavez Boulevard to Huntington Drive
- Huntington Drive from Mission Road to Fair Oaks Avenue
- Fair Oaks Avenue from Huntington Drive to Columbia Street
- Fair Oaks Avenue from Columbia Street to Del Mar Boulevard (northbound only)
- Woodbury Road from Fair Oaks Avenue to Windsor Avenue

Operating Costs

Incremental operating costs for each BRT alternative are calculated based on the revenue vehicle hours of service for each route and applying a fully-allocated cost rate of \$134.70/hour from Metro's FY2013 budget. The following table breaks down the hours and days of operation and summarizes operating costs for alternative BRT-1.

TABLE 1
Estimated Operating Costs – BRT-1
Total operating costs based on annual revenue hours of service

Weekdays	Daily Revenue Vehicle Hours	Unit Cost/Hour*	Days per Year	Total
AM Peak	36	\$134.70	255	\$1,236,546
Midday	36	\$134.70	255	\$1,236,546
PM Peak	48	\$134.70	255	\$1,648,728
Subtotal	120	\$134.70	255	\$4,121,820
Saturdays	Daily Revenue Vehicle Hours	Unit Cost/Hour	Days per Year	Total
All Day	72	\$134.70	52	\$504,317
Sundays and Holidays	Daily Revenue Vehicle Hours	Unit Cost/Hour	Days per Year	Total
All Day	72	\$134.70	58	\$562,507
Annual	Annual Revenue Vehicle Hours	Unit Cost/Hour	Days per Year	Total
All Days	38,520	\$134.70	365	\$5,188,644

* FY2012 unit cost per revenue service hour from adopted Metro FY2013 budget, page 45.

Notes:

- Weekday PM peak hours assumes 1/3 more hours than AM peak hours.
- Saturday and Sunday hours assume 12 hours of service, double the off-peak weekday hours. (i.e., 7AM-7PM service)
- Days per year shows approximate number of weekdays, Saturdays, and Sundays/Holidays

BRT 6: East Los Angeles to Pasadena

The BRT-6 alternative would enhance the Atlantic Avenue-Fair Oaks Avenue corridor with additional limited stop, high frequency bus service, enhancements such as dedicated bus lanes, and transit signal priority measures. The route would provide new connectivity from the Atlantic Avenue Corridor to major educational institutions in Pasadena and employment in the Fair Oaks Avenue and East Colorado Boulevard corridors.

Route Alignment

BRT-6 would provide Bus Rapid Transit service between Atlantic Boulevard at Whittier Boulevard, south of the Gold Line Atlantic Station, and Pasadena City College (PCC) and the California Institute of Technology (Caltech) in Pasadena. The route would replicate the existing 762 Metro Rapid service for much of its length, with a new eastward connection in Pasadena to PCC and Caltech. The existing 762 Rapid service would continue to operate in its full alignment, taking advantage of newly created bus lanes and thus improving its own travel time and reliability. Routes would share bus stop locations, with separation of boarding space for BRT and local/Rapid services to ensure efficient interplay between routes.

The total length of the route would be 12.1 miles. BRT vehicles would travel along Atlantic Boulevard to Huntington Drive, west along Huntington Drive to Fair Oaks Avenue, then northbound on Fair Oaks Avenue into Pasadena. In Pasadena, the BRT vehicles would travel along Colorado Boulevard, making a loop to PCC and Caltech via Hill Avenue and returning to Fair Oaks Avenue via California Boulevard.

Stop Locations

BRT stops would be placed at approximately ½ mile intervals, at major activity centers and cross streets. Local bus routes would continue to serve their current stop locations.

BRT stops are proposed at the following locations (from south to north):

1. Atlantic Boulevard at Whittier Boulevard
2. Atlantic Boulevard at Pomona Boulevard/Beverly Boulevard
3. Atlantic Boulevard at Riggin Street
4. Atlantic Boulevard at Cadiz Street
5. Atlantic Boulevard at Garvey Avenue
6. Atlantic Boulevard at Valley Boulevard
7. Atlantic Boulevard at Main Street
8. Atlantic Boulevard at Alhambra Road
9. Huntington Drive at Garfield Road
10. Huntington Drive at Marengo Avenue
11. Fair Oaks Avenue at Mission Street
12. Fair Oaks Avenue at Glenarm Street
13. Fair Oaks Avenue at California Boulevard
14. Fair Oaks Avenue at Del Mar Boulevard
15. Fair Oaks Avenue at Colorado Boulevard
16. Colorado Boulevard at Los Robles Avenue
17. Colorado Boulevard at Lake Avenue
18. Colorado Boulevard at Hill Avenue

- 19. California Boulevard at Hill Avenue
- 20. California Boulevard at Lake Avenue

Span of Service

BRT-6 service would operate from 6:00 A.M. to 9:00 P.M., seven days a week. Local bus routes in the area would continue to operate a longer span than BRT and limited stop services.

Frequency of Service

The BRT-6 alternative, which is developed within an already transit-rich corridor served by the 260 Metro Local and 762 Metro Rapid buses, would operate on a peak frequency of every 20 minutes and an off-peak frequency of every 40 minutes. Combined with the 260 (10 minutes peak; 20 minutes off-peak) and the 762 (15 minutes peak; 30 minutes off-peak), this frequency of 10 minutes peak and 20 minutes off-peak would provide exceptional levels of service between East Los Angeles and Pasadena.

Vehicle Requirements

Bus Rapid Transit service would incorporate modern, articulated buses with low-floor boarding to facilitate passenger entry and exit. Typical articulated buses feature two doors; however, three-door vehicles are becoming more common. Based on a one-way route length of 12.1 miles and an estimated travel time of 47.4 minutes, the BRT-6 alternative would require six peak vehicles for 20-minute frequency service and three off-peak vehicles for 40-minute service. Additional vehicles would continue to operate on the 726 Rapid service as they do currently for greater combined frequency.

Service Amenities

Bus Rapid Transit service for BRT-6 would feature dedicated bus-only lanes for much of the planned alignment as well as transit signal priority (TSP) components to improve both bus and general traffic flow in the corridor. BRT bus stops would be recognizable through distinct branding, shelters, off-board ticket vending machines, and public information such as real-time arrival displays indicating the proximity of buses to the stop.

The BRT vehicles would operate in exclusive lanes, generally adjacent to the curb, in the following areas:

- Atlantic Boulevard from Whittier Boulevard to Beverly Boulevard (northbound only)
- Atlantic Boulevard from Floral Avenue to Harding Avenue
- Atlantic Boulevard from Harding Avenue to Valley Boulevard (southbound only)
- Huntington Drive from Atlantic Boulevard to Fair Oaks Avenue
- Fair Oaks Avenue from Huntington Drive to Columbia Street
- Fair Oaks Avenue from Columbia Street to Del Mar Boulevard (northbound only)
- Colorado Boulevard from Fair Oaks Avenue to Hill Avenue
- Hill Avenue from Del Mar Boulevard to California Boulevard
- California Boulevard from Hill Avenue to Lake Avenue
- Lake Avenue from California Boulevard to Colorado Boulevard

Operating Costs

Incremental operating costs for each BRT alternative are calculated based on the revenue vehicle hours of service for each route and applying a fully-allocated cost rate of \$134.70/revenue service hour from Metro’s FY2013 budget. The following table breaks down the hours and days of operation and summarizes operating costs for alternative BRT-6.

TABLE 2

Estimated Operating Costs – BRT-6

Total operating costs based on annual revenue hours of service

Weekdays	Daily Revenue Vehicle Hours	Unit Cost/Hour*	Days per Year	Total
AM Peak	12	\$134.70	255	\$412,182
Midday	12	\$134.70	255	\$412,182
PM Peak	16	\$134.70	255	\$549,576
Subtotal	40	\$134.70	255	\$1,373,940
Saturdays	Daily Revenue Vehicle Hours	Unit Cost/Hour	Days per Year	Total
All Day	24	\$134.70	52	\$168,106
Sundays and Holidays	Daily Revenue Vehicle Hours	Unit Cost/Hour	Days per Year	Total
All Day	24	\$134.70	58	\$187,502
Annual	Annual Revenue Vehicle Hours	Unit Cost/Hour	Days per Year	Total
All Days	12,840	\$134.70	365	\$1,729,548

^a FY2012 unit cost per revenue service hour from adopted Metro FY2013 budget, page 45.

Notes:

- Weekday PM peak hours assumes 1/3 more hours than AM peak hours.
- Saturday and Sunday hours assume 12 hours of service, double the off-peak weekday hours. (i.e., 7AM-7PM service)
- Days per year shows approximate number of weekdays, Saturdays, and Sundays/Holidays

BRT 6A: East Los Angeles to Pasadena

The BRT-6A alternative maintains the overall route structure of BRT-6, with a modified terminal loop in Pasadena. Given the restriction to a northbound-only dedicated lane for buses in BRT-6 on Fair Oaks Avenue (Columbia Street to Del Mar Boulevard), an alternate southbound return from California Boulevard to Raymond Avenue, Glenarm Street and back to Fair Oaks Avenue would afford the BRT alignment dedicated running ways in central Pasadena. This option would not provide only eastbound service on Colorado Boulevard and westbound service on California Boulevard.

Route Alignment

From its endpoint at Hill Avenue and California Avenue in Pasadena, BRT-6A would return southbound via California Avenue, Raymond Avenue, Glenarm Street and back to Fair Oaks Avenue before resuming the same route as BRT-6. This option has minimal impact on the overall route length and functionality of the BRT-6 alternative. An additional intermodal connection would be available with a stop location on Raymond Avenue at Fillmore Street, facilitating transfers to or from the Metro Gold Line at the Fillmore station.

Stop Locations

Stop locations for BRT-6A would mirror those of BRT-6 with the following exceptions:

1. California Boulevard at Los Robles Avenue (replaces Colorado Boulevard at Los Robles Avenue)
2. California Boulevard at Raymond Avenue
3. Raymond Avenue at Fillmore Street

Span of Service

Same as BRT-6.

Frequency of Service

Same as BRT-6.

Vehicle Requirements

Same as BRT-6.

Service Amenities

BRT vehicles would operate in exclusive lanes, generally adjacent to the curb, in the same areas designated in the BRT-6 alternative, with the following modifications:

- California Boulevard from Hill Avenue to Raymond Avenue
- Raymond Avenue from California Boulevard to Glenarm Street

Operating Costs

Same as BRT-6.

TSM Alternative (Bus Components)

The Transportation Systems Management (TSM) alternative includes significant enhancements to existing bus services throughout the study area. These enhancements relate primarily to frequency of service. By providing higher frequency service throughout the study area, local bus transit becomes an increasingly viable alternative to private automobile travel while reducing travel times and enhancing mobility significantly for existing transit users. The TSM alternative would also complement the implementation of one or both of the Bus Rapid Transit alternatives by improving connectivity to and from these major corridors and expanding the reach of transit as a whole.

The TSM alternative focuses on viable frequency enhancements that will increase ridership overall without resulting in significant impacts on productivity or operating costs. Furthermore, it is assumed that Metro will provide TSM alternative levels of service as demand warrants, i.e., the TSM frequencies represent a target based on travel demand forecasting and anticipated demand in the year 2035.

The TSM alternative was developed in an iterative fashion, beginning first with across-the-board increases to frequencies (reductions to headways) based on existing service levels in the study area. Bus frequencies were generally increased incrementally, whereby a local route with 60 minute headways would be upgraded to 30 minute headways. Thirty minute headways would be improved to 20 or 15 minutes, and 15 minute headways would shift to 10 minutes. These increases were applied to the Metro travel demand forecast model to determine anticipated ridership and productivity levels for the 2035 horizon and were reviewed by Metro. In cases where notably drops in productivity were seen, i.e., too much service was added for insufficient gain in ridership, improvements were scaled back. Where productivity remained relatively constant or improved, the frequency increases were maintained. The following table summarizes the Metro bus routes in the study designated for frequency increases, along with their existing and recommended peak hour headways.

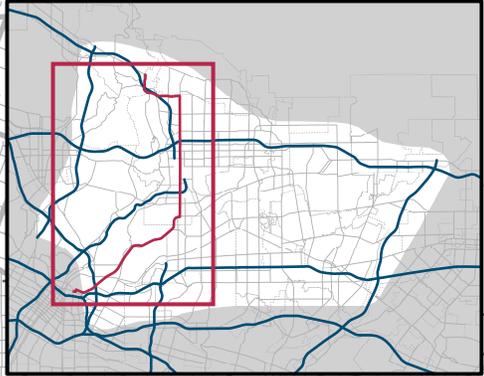
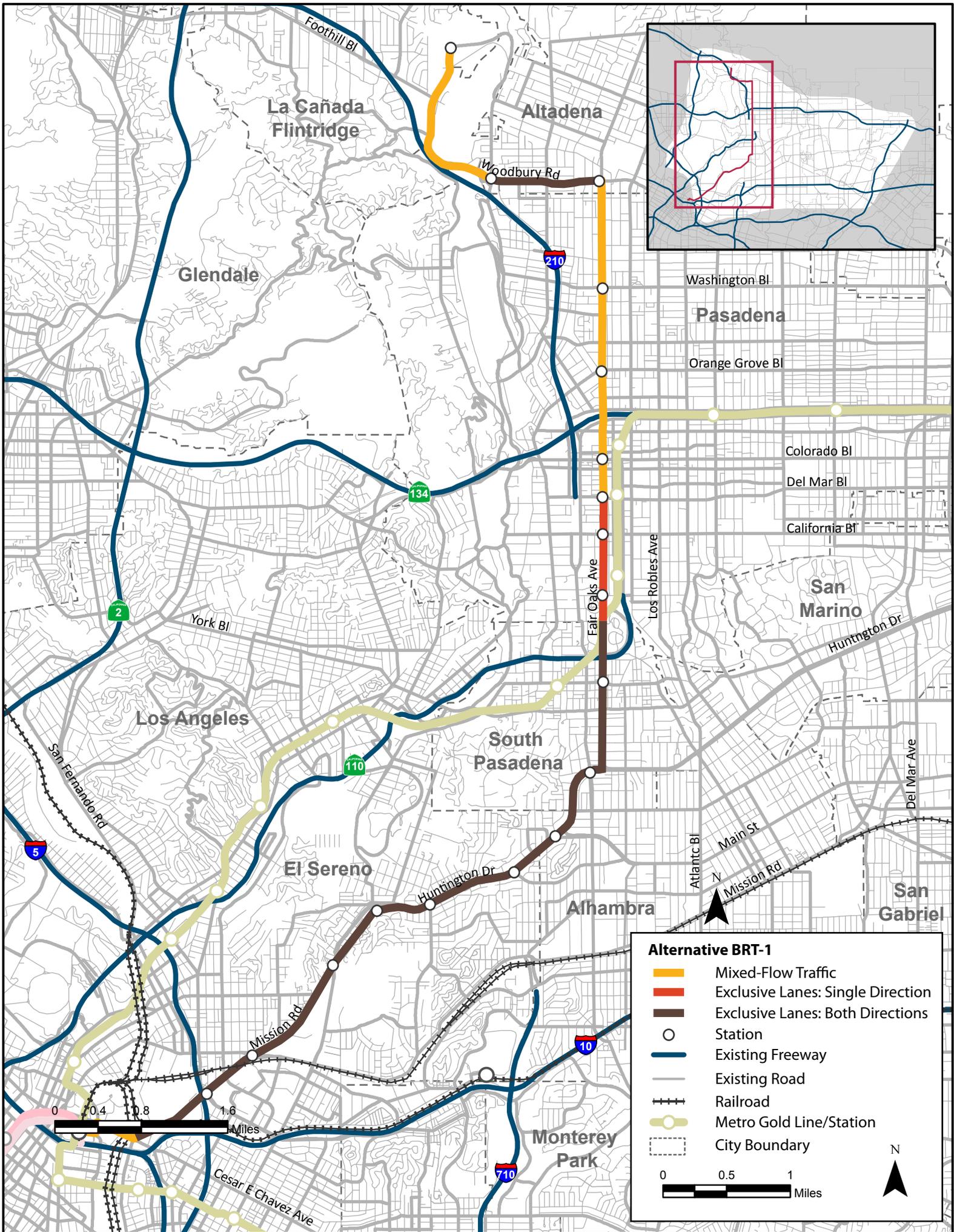
TABLE 3
TSM Bus Improvements
Proposed increases in frequencies for bus routes in the SR 710 study area

Bus Route	From/To	Current Weekday Peak Frequency	TSM Peak Frequency
70 (Metro Local)	Downtown LA to El Monte	10-12 minutes	10 minutes
770 (Metro Rapid)	Downtown LA to El Monte	10-13	10
76 (Metro Local)	Downtown LA to El Monte	12-15	10
78 (Metro Local)	Downtown LA to Irwindale	10-20	10
378 (Metro Limited)	Downtown LA to Irwindale	18-23	20
79 (Metro Local)	Downtown LA to Santa Anita	20-30	15
180 (Metro Local)	Hollywood to Altadena	30	30
181 (Metro Local)	Hollywood to Pasadena	30	15
256 (Metro Local)	Commerce to Altadena	45	30
258 (Metro Local)	Paramount to Alhambra	48	20
260 (Metro Local)	Compton to Altadena	16-20	16-20
762 (Metro Rapid)	Compton to Altadena	25	15
266 (Metro Local)	Lakewood to Pasadena	30-35	30-35
766* (Metro Rapid)	Lakewood to Pasadena	NA	15
267 (Metro Local)	El Monte to Pasadena	30	15
485 (Metro Express)	Union Station to Altadena	40	40
487 (Metro Express)	Westlake to El Monte	18-30	18-30
489 (Metro Express)	Westlake to East San Gabriel	18-20	15
270 (Metro Local)	Norwalk to Monrovia	40-60	30
780 (Metro Rapid)	West LA to Pasadena	10-15	10-15
187 (Metro Local)	Pasadena to Montclair	20	15

^a New Metro Rapid route proposed as part of TSM alternative

Operating Costs

An order of magnitude cost estimate was developed for the TSM alternative, focusing on the directly comparable number of revenue vehicle service hours included in the demand forecast model. The model compared the 2006 service levels to the 2035 full implementation of the TSM alternative. Furthermore, vehicle hours were only developed for the weekday AM peak and midday periods; PM peak periods are added by adding an additional hour to the AM peak total. Based on Metro's unit cost of \$134.70 per vehicle service hour, the relative cost increase from the 2035 no build condition to full implementation of the TSM would be \$19,647,342 annually for these time periods. This number would increase depending upon service changes in the early morning, evening, and overnight periods.

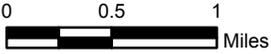


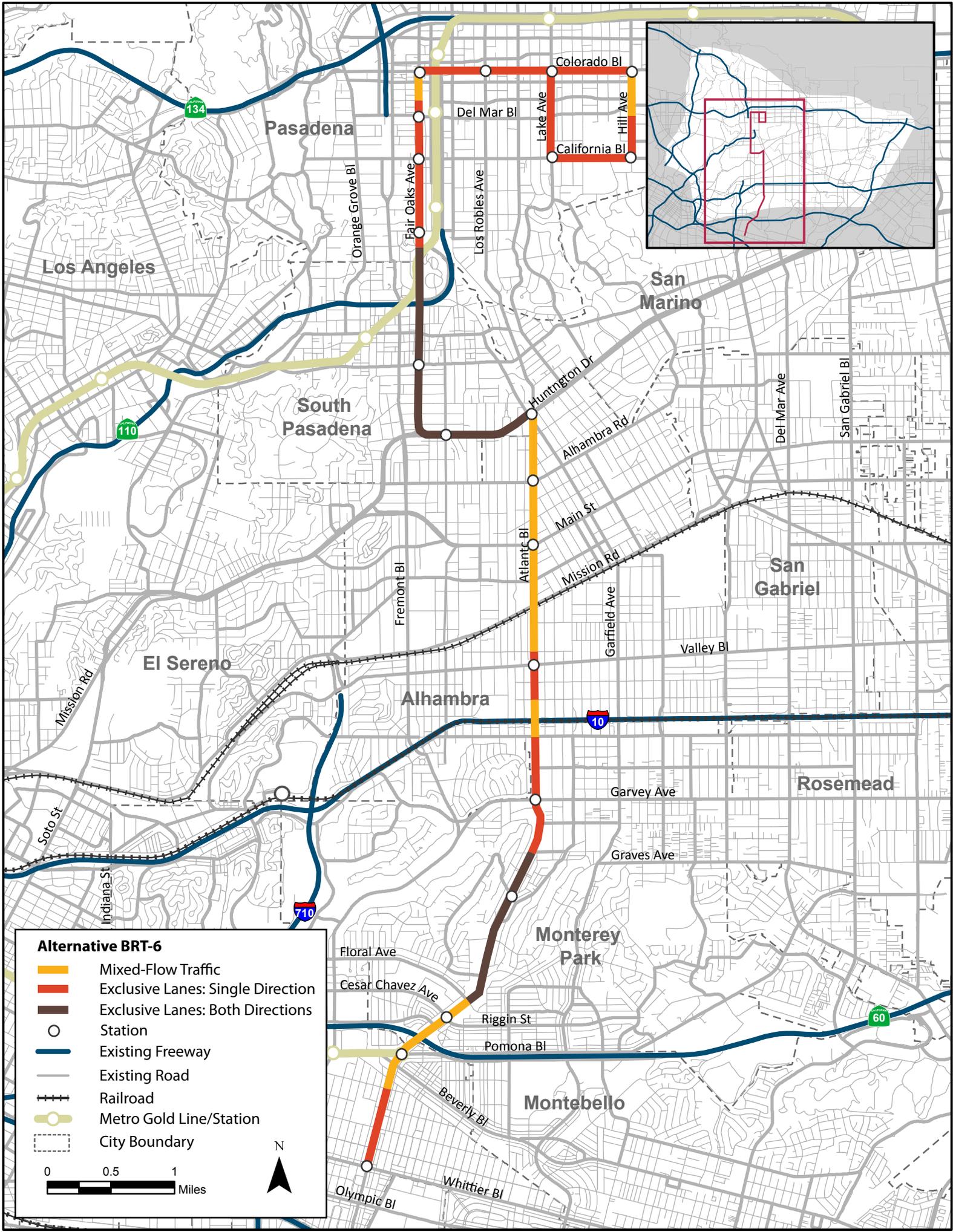
Alternative BRT-1

- Mixed-Flow Traffic
- Exclusive Lanes: Single Direction
- Exclusive Lanes: Both Directions
- Station
- Existing Freeway
- Existing Road
- Railroad
- Metro Gold Line/Station
- City Boundary

0 0.5 1 Miles

N





Pasadena

Los Angeles

South Pasadena

San Marino

El Sereno

Alhambra

San Gabriel

Rosemead

Monterey Park

Montebello

134

110

10

710

60

Orange Grove Bl

Fair Oaks Ave

Los Robles Ave

Del Mar Bl

Lake Ave

California Bl

Colorado Bl

Hill Ave

Huntington Dr

Alhambra Rd

Main St

Mission Rd

Fremont Bl

Atlantic Bl

Garfield Ave

Valley Bl

Garvey Ave

Graves Ave

Floral Ave

Cesar Chavez Ave

Riggin St

Pomona Bl

Beverly Bl

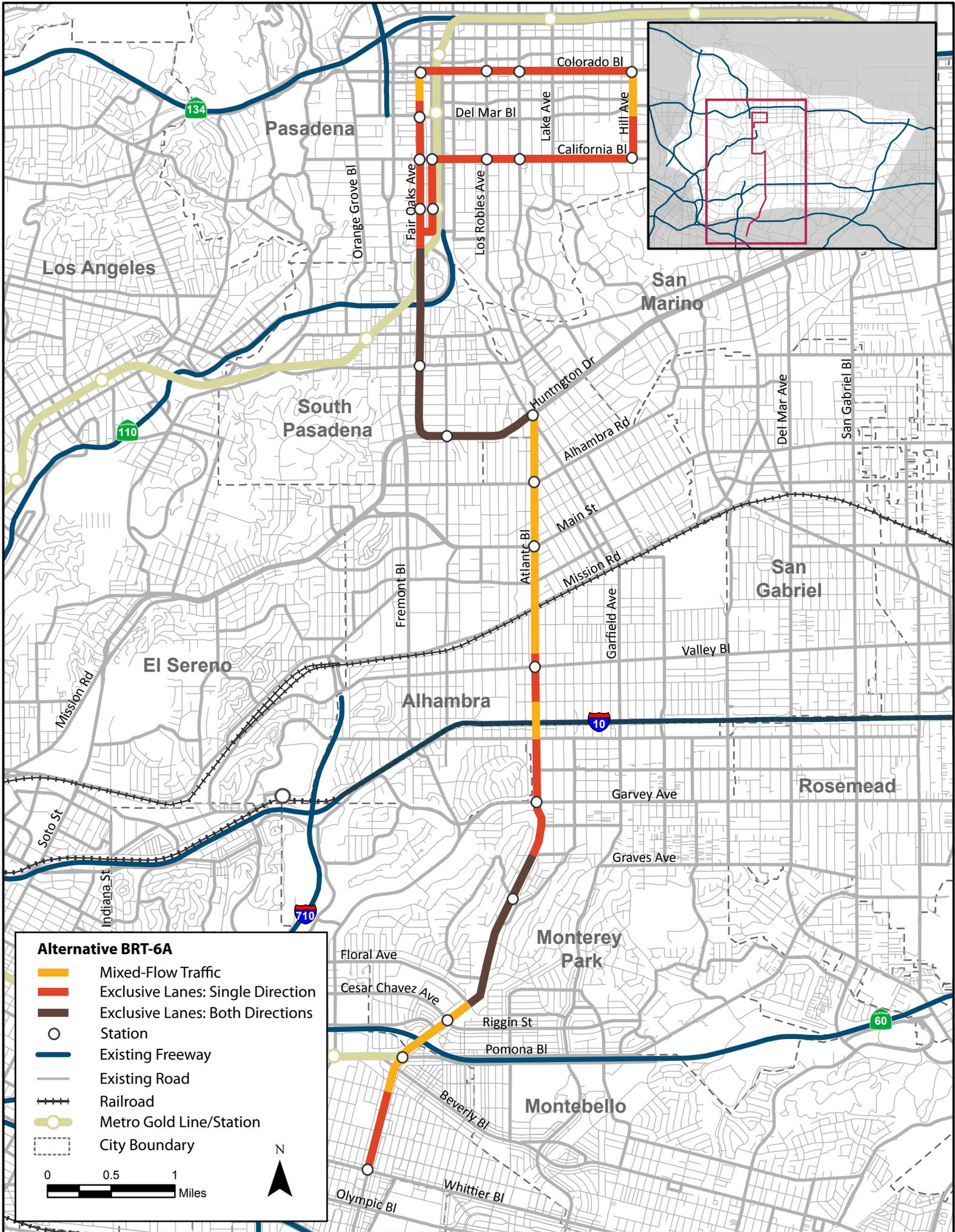
Olympic Bl

Whittier Bl

Del Mar Ave

San Gabriel Bl

N



Alternative BRT-6A

- Mixed-Flow Traffic
- Exclusive Lanes: Single Direction
- Exclusive Lanes: Both Directions
- Station
- Existing Freeway
- Existing Road
- Railroad
- Metro Gold Line/Station
- City Boundary

