PASADENA-LOS ANGELES TRAFFIC IMPACT STUDY

IN SUPPORT OF REVISED DRAFT EIR

DRAFT REPORT

PREPARED FOR

LOS ANGELES COUNTY TRANSPORTATION COMMISSION

UNDER THE DIRECTION OF

BECHTEL CIVIL, INC.

SUBMITTED BY

DKS Associates

IN ASSOCIATION WITH

Katz, Okitsu and Associates

October 6, 1989

Table of Contents

LIST OF TABLES

LIST OF FIGURES

PASADENA TO LOS ANGELES LRT - TRAFFIC IMPACT STUDY
IN SUPPORT OF RECIRCULATED DRAFT ENVIRONMENTAL IMPACT REPORT

INTRODUCTION

REPORT CONTENTS

This report analyzes the traffic impacts of several new route options along the proposed Pasadena-Los Angeles light rail transit (LRT) corridor. Each new option which warranted updating traffic impacts to the year 2010 is described below. The findings of this report on impacted intersections and potential mitigations within the City of Pasadena supersede the Route Refinement Study results (Final Draft Report, June 1989). A direct comparison between the new year 2010 levels of service and the previous estimates is not recommended. The change in traffic impact projections is mostly due to the more explicit coverage of station-related impacts via the recent SCAG ridership data (summer 1989).

Although the intersection analysis in this report supersedes the result of the DKS Associates Route Retirement Study report of June 1989, the earlier report is still useful. That report documents the existing transit service in Pasadena, the base traffic conditions for the Year 2010 in downtown Pasadena, and the proposed roadway configuration at the LRT terminus in northeast Pasadena, as well as other proposed LRT routes along Colorado and Green Street.

This report is meant to be a companion piece to the Traffic Impacts' report for the Southwest Corridor EIR (October 1988). Both reports combined support the traffic impact analysis of the Recirculated DEIR.

NEW OPTIONS STUDIED

All the new segments pertain to the Highland Park Alternative. They consist of :

- Two new Downtown Connections in Los Angeles: the Second Street/Union Station option and the Union Station - "No Subway" option. Part 2 analyzes the potential traffic impacts of new LRT at-grade crossings under each option.

- The proposed extension of the Highland Park Alternative to East Pasadena: the line would follow the Santa Fe Railroad right-of-way from South Pasadena into downtown Pasadena and shift to the Foothill Freeway median up to the Sierra Madre Villa terminus. Part 3 analyzes traffic impacts of several LRT at-grade crossings and station activities for the length of the proposed extension.

- The interim phasing of the Highland Park Alternative to downtown Pasadena: the line would terminate north of Del Mar Boulevard at-grade crossing, near the existing AMTRAK depot. Part 5 analyzes traffic impacts of this phased extension.

PART 1 - EXISTING STREET AND HIGHWAY SYSTEM

Figure 1 shows the existing roadway network along the South Pasadena to northeast Pasadena segment of the Highland Park Alternative. Given below are average daily traffic (ADT) volumes on major roadway segments adjacent to the proposed LRT alignment. In areas without recent ADT data, estimates of current daily volumes were extrapolated from historical volumes by applying a two percent annual growth rate. Addendum A lists the various data sources.

Based on recent field checks of the study area, the paragraphs below summarize the number of traffic lanes and the availability of on-street parking on each roadway segment. Also referred to are the existing at-grade crossings along the Santa Fe Railroad line.

FREEWAYS

There are three major freeways in the study area. The Pasadena Freeway (I-110) terminates south of downtown Pasadena at the intersection of Arroyo Parkway and Glenarm Street. The segment of this north-south freeway close to downtown Pasadena carries approximately 80,000 daily vehicles. The proposed LRT alignment would not directly impact this existing roadway, as the Highland Park Alternative follows the Santa Fe Railroad right-of-way, fully grade-separated from the Pasadena Freeway.

The Long Beach Freeway (I-710) currently terminates northwest of downtown Pasadena in the vicinity of Pasadena Avenue and Del Mar Boulevard. In the current design, the roadway carries from 29,000 to 31,000 vehicles a day. The contemplated north-south extension of this freeway would significantly increase daily volumes on this facility. A related change in current travel patterns through west Pasadena is the likely diversion of through auto trips away from existing major north-south arterials. The proposed LRT alignment adjacent to Arroyo Parkway in downtown Pasadena would parallel the potential extension of this freeway. However, for the purpose of the year 2010 traffic impact assessment for the Highland Park LRT alignment, this report assumes no extension of I-710.

The Foothill Freeway (I-210) runs east-west along the San Gabriel Valley. This ten-lane roadway carries approximately 189,000 vehicles a day at the junction with the I-134 and I-710 in west Pasadena. Near the Lake Avenue interchange, the ADT volume increases up to 200,000 vehicles. Further east, near Sierra Madre Villa Avenue, where the northeast Pasadena LRT terminus is proposed, the ten-lane roadway carries daily volumes of the same magnitude as in west Pasadena. Major interchanges along this freeway are located at Los Robles Avenue, Lake Avenue, Hill Avenue, Allen Avenue and Altadena Drive. Current CalTrans plans call for the opening of a full interchange at Fair Oaks Avenue, immediately west of the proposed LRT route transition from the at-grade railroad right-of-way to the fully separated I-210 freeway median.

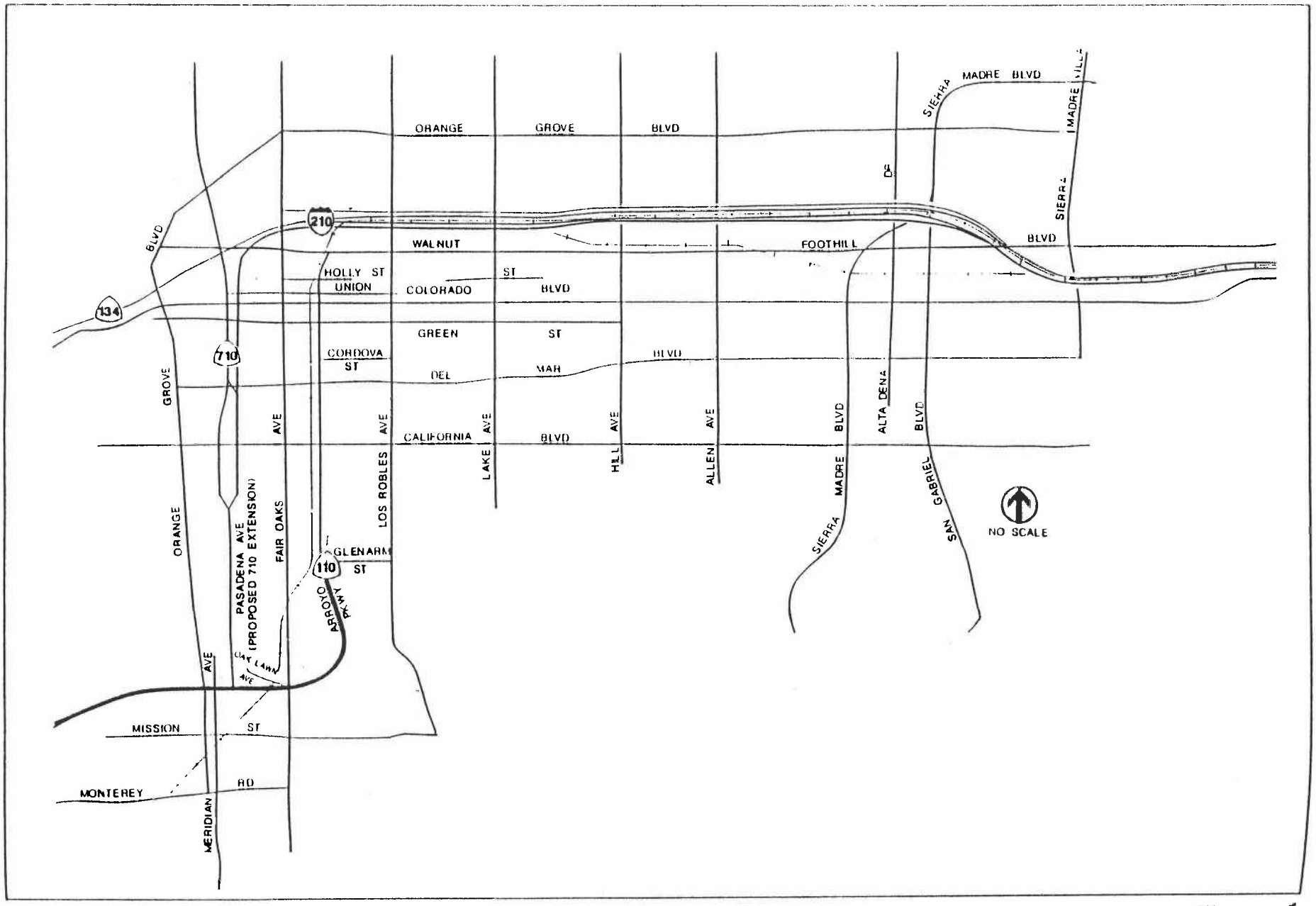

Figure 1

EXISTING STREET AND FREEWAY NETWORK IN SOUTH PASADENA AND PASADENA

ARTERIALS PARALLEL TO THE LRT LINE

In South Pasadena, Meridian Avenue runs north-south and parallels the proposed LRT line. This two-lane roadway carries approximately 4,400 vehicles a day near its intersection with Monterey Road.

In the northern part of South Pasadena, Fair Oaks Avenue runs north-south a few blocks west of the proposed LRT line. This four lane roadway carries from 25,000 vehicles a day south of California Boulevard to 19,000 vehicles a day near Colorado Boulevard.

Beyond Glenarm Street, Arroyo Parkway is a four to six-lane roadway, which runs immediately east of the proposed LRT line. This roadway carries approximately 38,000 vehicles a day south of Colorado Boulevard. Arroyo Parkway has some curbside parking on the blocks south of Del Mar Boulevard.

North of downtown Pasadena, the following east-west arterials run parallel to the I-210 freeway median LRT line:

- Walnut Street, a four lane roadway, carries 17,000 vehicles a day near Lake and Los Robles Avenues;
- Corson Street, a two-lane eastbound frontage road for the Foothill Freeway, carries 5,500 vehicles a day near downtown Pasadena. Volumes decrease to 4,000 vehicles a day east of downtown;
- Maple Street, a two-lane westbound frontage road for the Foothill Freeway, carries 4,400 vehicles a day near and east of downtown. Volumes increase to 10,500 vehicles a day west of downtown, near Fair Oaks Avenue.
- Foothill Boulevard, a four-lane roadway, carries approximately 19,400 vehicles a day near the proposed LRT terminus at Sierra Madre Villa.

ARTERIALS CROSSING THE LRT LINE

In South Pasadena, Mission Street runs east-west and crosses the Santa Fe Railroad at-grade in the vicinity of Meridian Avenue. This four-lane roadway carries approximately 13,000 vehicles a day near Orange Grove Boulevard, a few blocks to the west of the Santa Fe Railroad.

In downtown Pasadena the following major east-west arterials intercept the Santa Fe Railroad line:

- California Boulevard, a four lane roadway, carries approximately 24,300 vehicles a day;

- Colorado Boulevard, a four lane roadway, carries from 16,000 vehicles a day near Fair Oaks Avenue to 23,000 vehicles a day near Los Robles Avenue.

In addition to these two arterials, several east-west streets have existing at-grade crossings with the Santa Fe Railroad line. They include: Glenarm Street, Del Mar Boulevard, Cordova Street and Green Street to the south of Colorado Boulevard. Other at-grade crossings are located at Union Street and Holly Street to the north of Colorado Boulevard. The railroad line runs into a depressed cut under Walnut Street before approaching the I-210 freeway median. All these existing at-grade crossings would become LRT at-grade crossings along this segment of the Highland Park Alternative.

North and east of downtown Pasadena, the following north-south arterials run perpendicular to the proposed LRT alignment. Because the alignment follows the I-210 freeway median, there would be no at-grade crossing along this portion of the Highland Park Alternative.

- Los Robles Avenue, a four-lane roadway, carries approximately 19,000 vehicles a day in downtown Pasadena. Volumes increase to 20,500 vehicles a day near the I-210 freeway overpass.

- Lake Avenue, a four-lane roadway, carries approximately 28,000 vehicles a day south of Colorado Boulevard and up to 39,000 vehicles a day north of Colorado Boulevard. Volumes increase even further to 42,000 vehicles a day near the I-210 freeway overpass.

- Hill Avenue, a four-lane roadway, has some curbside parking near Colorado Boulevard. It carries from 15,000 vehicles a day south of Colorado Boulevard to 28,000 vehicles a day north of Colorado Boulevard. Volumes slightly decrease to 26,000 vehicles a day near the I-210 freeway underpass.

- Altadena Drive, a four-lane roadway, carries 12,000 vehicles a day near Foothill Boulevard, south of the I-210 freeway. Volumes increase to 18,000 vehicles a day north of the I-210 freeway underpass.

- Sierra Madre Boulevard, a four-lane roadway, carries approximately 14,000 vehicles a day south of Foothill Boulevard. Volumes decrease to 11,000 vehicles a day near the I-210 freeway underpass.

CURRENT PM PEAK TRAFFIC CONDITIONS

Figure 2 shows the proposed extension of the Highland Park Alternative through SouthPasadena and Pasadena. A total of ten potential station sites is to be evaluated for the proposed addition of 7 new stations. Park-and-ride lots are assumed to be built at the Glenarm Street Station, the Del Mar Boulevard Station and the Sierra Madre Villa terminus.

Figures 3 and 4 show the study intersections. These intersections are adjacent to the proposed LRT line and stations. Evening peak hour traffic volume were obtained from the 1987 FETSIM data base, supplemented by a few 1989 traffic counts. Table 1 summarizes the existing Volume/Capacity (V/C) ratio and Level of Service (LOS) at each intersection. An interpretation of Level of service is provided in Addendum B. Figures 6 and 7 show the resulting PM peak hour levels of service.

Most study intersections along the alignment portion with at-grade crossings experience Levels of Service B or A. Two exceptions are found at Arroyo Parkway and Glenarm Street as well as Fair Oaks Avenue and Colorado Boulevard. Both intersections currently operate at Level of Service E. The former is at the northern terminus of the Pasadena Freeway, in close proximity to the proposed Glenarm Street LRT station. The latter is in west Pasadena near the I-134/210/710 freeway junction.

Higher levels of service are observed along the frontage roads for the I-210 Freeway. Nearly half of these intersections experience Levels of Service C or D in the PM peak hour. This is due to the proximity of the Foothill Freeway interchanges. Of all existing interchange approaches, the Lake Avenue/I-210 is the busiest. An LRT station in the vicinity of this interchange is proposed, although an alternate station site is proposed at the Hill Avenue/I-210 interchange.

CURRENT TRANSIT OPERATIONS

The Route Refinement Study Traffic Impact Report described in detail the existing bus transit network in Pasadena. Briefly stated, most existing bus routes run along major arterials. Two express-commuter routes to downtown Los Angeles collect their passengers in northeast and northwest Pasadena, before accessing the Pasadena Freeway. Colorado Boulevard carries the heaviest volume of local transit service through the Pasadena area.

DKS Associates

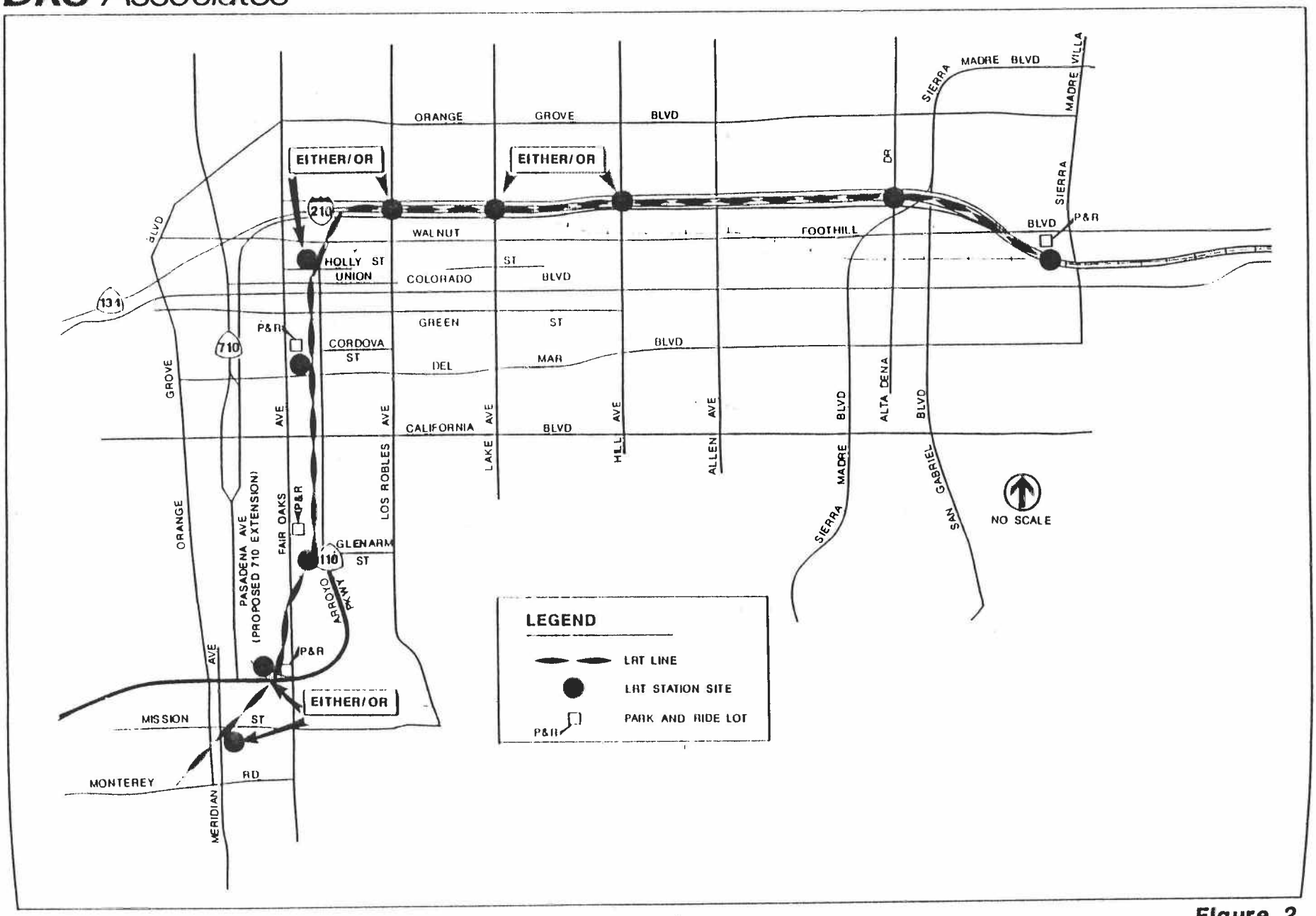

Figure 2

PROPOSED HIGHLAND PARK ALTERNATIVE TO EAST PASADENA

DKS Associates

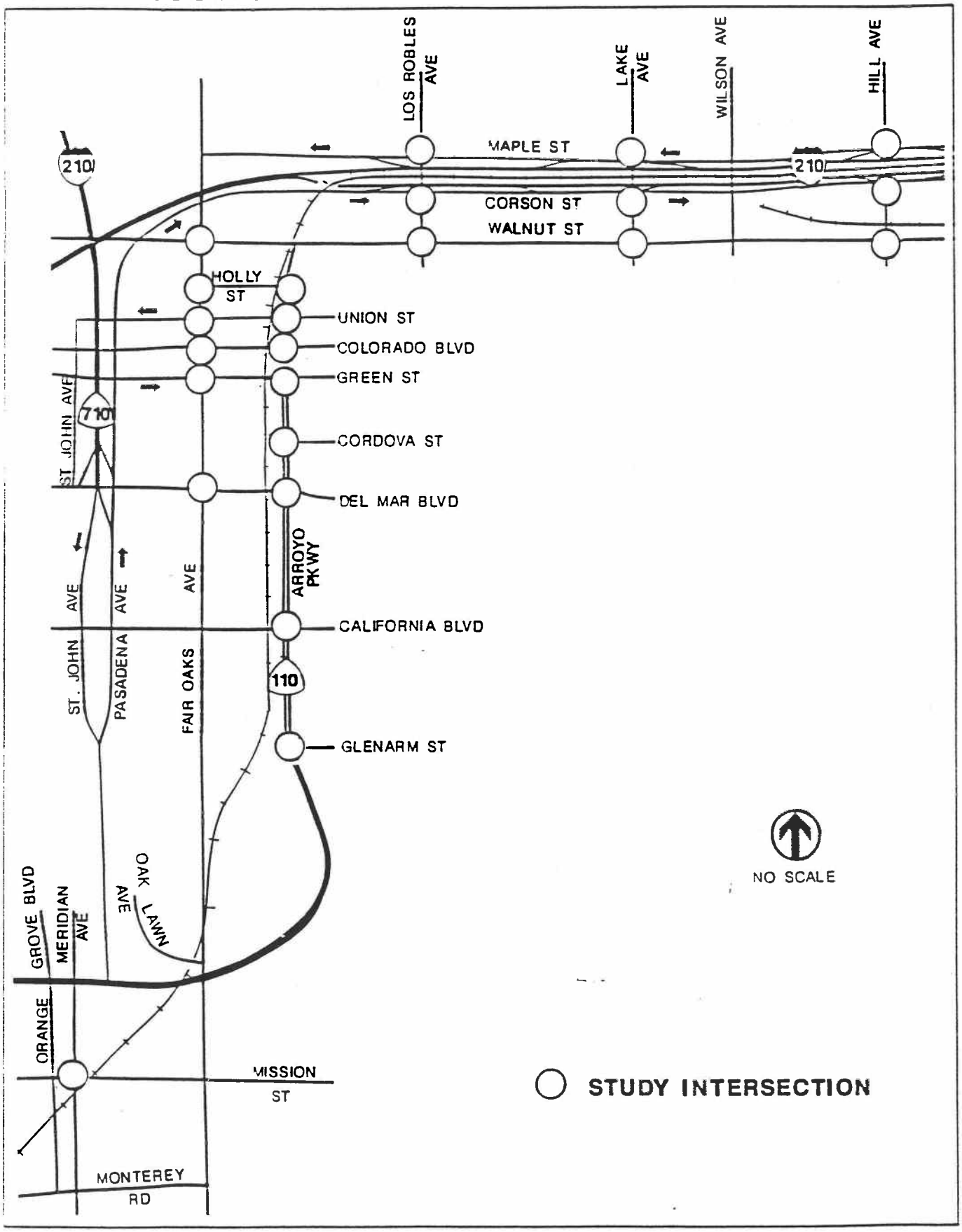

Figure 3

STUDY INTERSECTIONS IN SOUTH PASADENA AND PASADENA

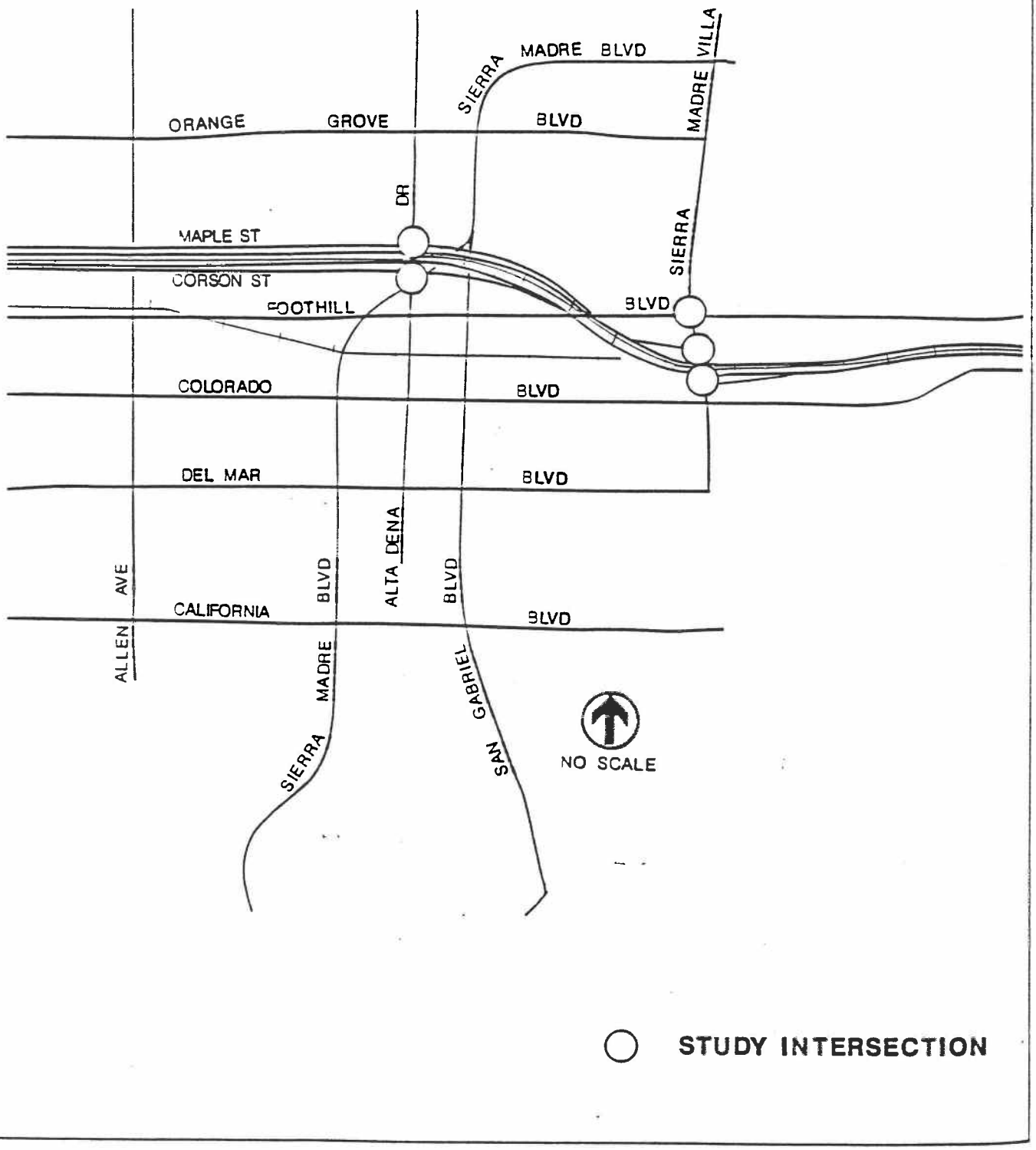

Figure 4

STUDY INTERSECTIONS IN EAST PASADENA

Table 1
Existing PM Peak
Levels of Service at Study Intersections

Intersection	V/C	LOS
a) Segment with At-Grade Crossings		
Meridian Ave./Mission St.	0.32	A
Arroyo Pkwy./Glenarm St.	0.89	D
Arroyo Pkwy./California Blvd.	0.59	A
Fair Oaks Ave./Del Mar Blvd.	0.60	B
Arroyo Pkwy./Del Mar Blvd.	0.60	B
Arroyo Pkwy./Cordova St.	0.44	A
Fair Oaks Ave./Green St.	0.41	A
Arroyo Pkwy./Green St.	0.35	A
Fair Oaks Ave/Colorado Blvd.	0.95	E
Arroyo Pkwy./Colorado Blvd.	0.46	A
Fair Oaks Ave./Union St.	0.32	A
Arroyo Pkwy./Union St.	0.17	A
Fair Oaks Ave./Holly St.	0.51	A
Arroyo Pkwy./Holly St.	0.27	A
Fair Oaks Ave./Walnut St.	0.54	A
b) Segment within I-210 Median		
Los Robles Ave./Maple St.	0.40	A
Los Robles Ave./Corson St.	0.57	B
Los Robles Ave./Walnut St.	0.49	A
Lake Ave./Maple St.	0.91	E
Lake Ave./Corson St.	0.81	D
Lake Ave./Walnut St.	0.76	C
Hill Ave./Maple St.	0.85	D
Hill Ave./Corson St.	0.72	C
Hill Ave./Walnut St.	0.89	D
Altadena Dr./Maple St.	0.62	B
Altadena Dr./Corson St.	0.71	C
Foothill Blvd./Sierra Madre Villa	0.75	C
Sierra Madre Villa/WB Frontage Rd	0.62	B
Sierra Madre Villa/EB Frontage Rd.	0.63	B

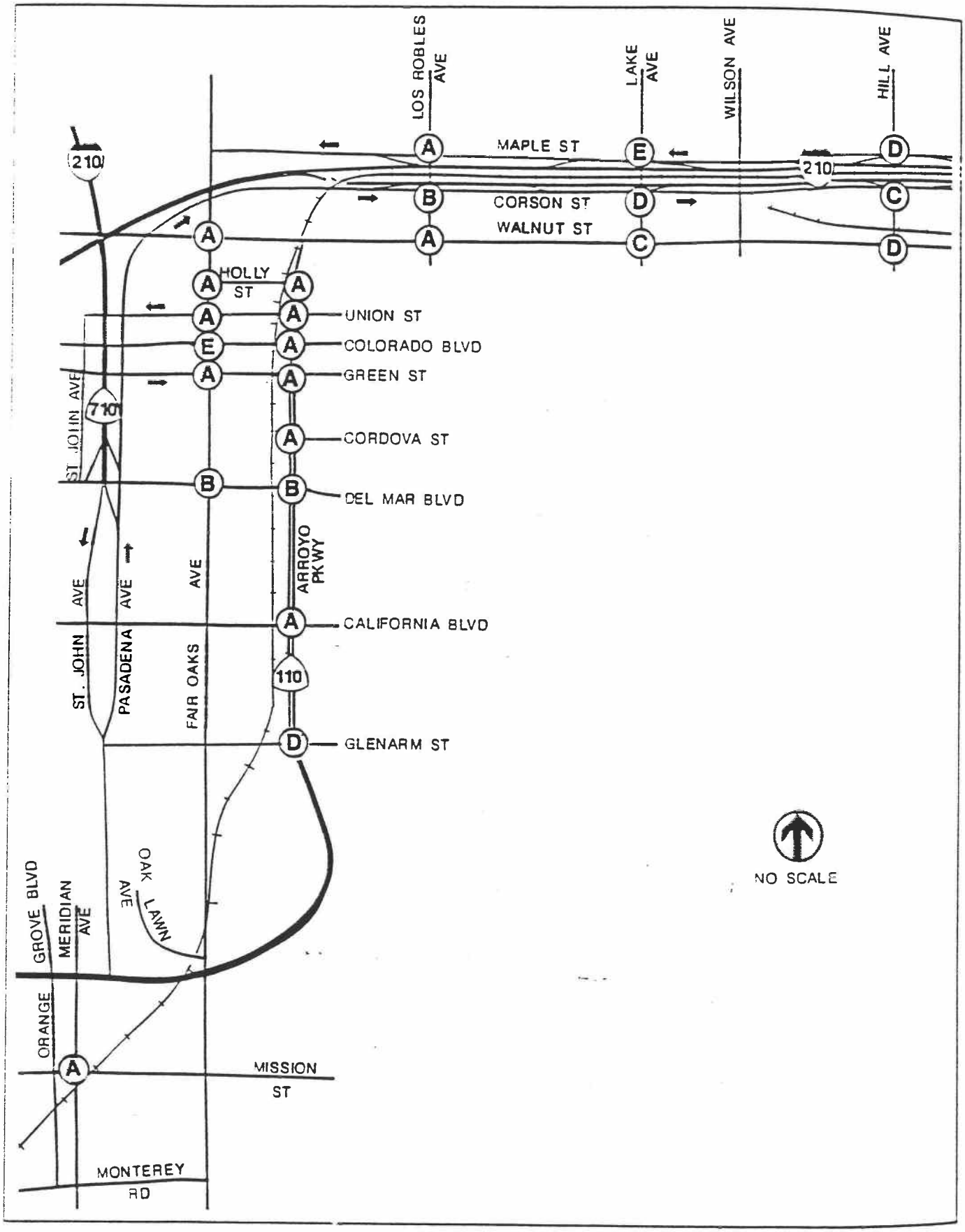

Figure 6

EXISTING LEVELS OF SERVICE AT STUDY INTERSECTIONS IN SOUTH PASADENA AND PASADENA

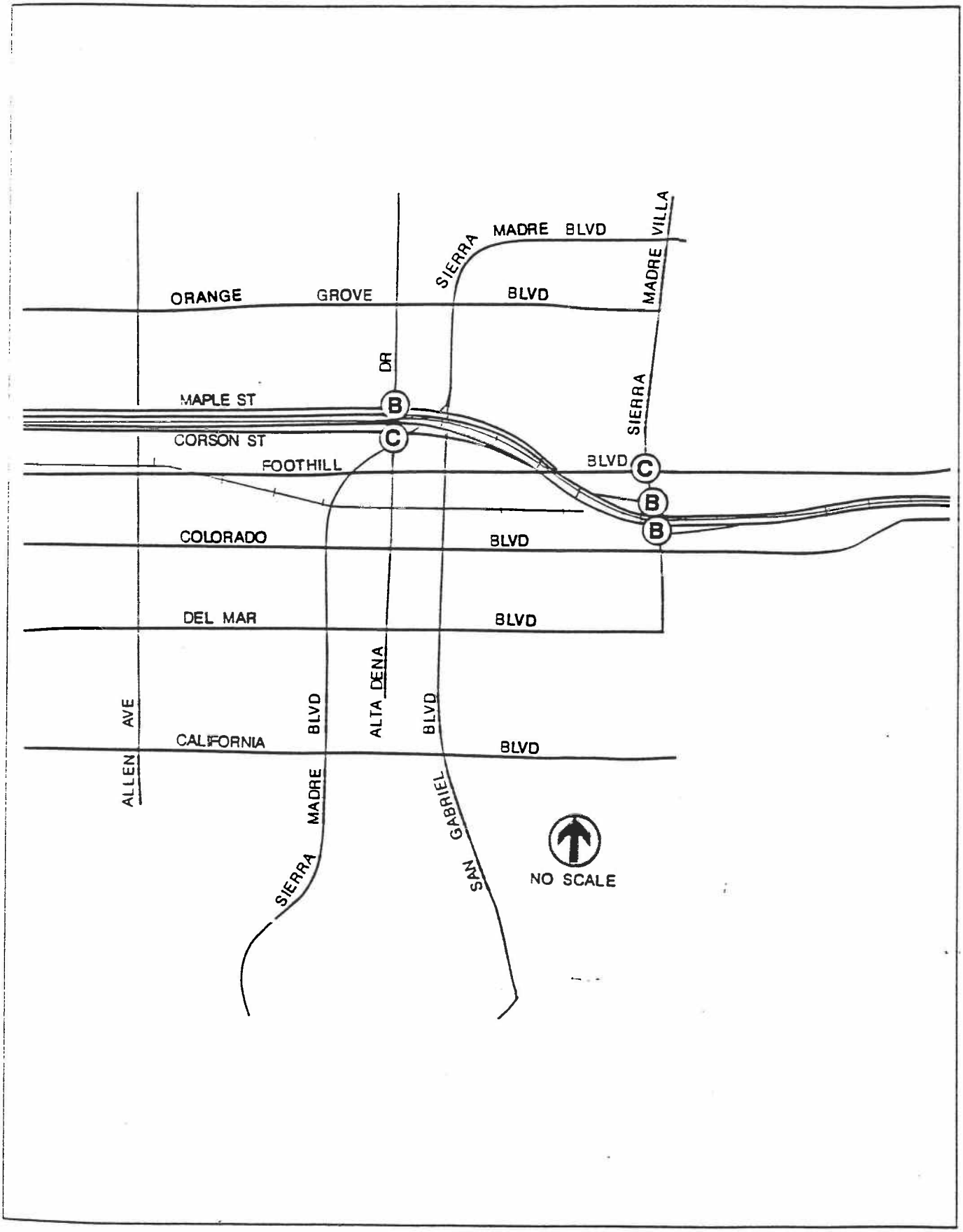

Figure 7
EXISTING LEVELS OF SERVICE
AT STUDY INTERSECTIONS IN EAST PASADENA

PART 2 - LRT TRAFFIC IMPACTS NEAR UNION STATION

The traffic impacts of various LRT route options in the vicinity of Chinatown and Union Station have been analyzed in DKS Associates "Southwest Corridor EIR Traffic Impacts", October 13, 1988. Since then, a number of other LRT route options have been proposed. Of these, two routes were considered to potentially impact traffic.

The Union Station No Subway option, shown in Figure 5-A, features an at-grade LRT alignment running along existing railroad tracks with two grade crossings: North Main Street north of College Street and North Spring Street north of College Street.

The Second Street Union Station option, shown in Figure 5-B, is a mostly subway route with little impact on traffic until it reaches a portal at College Street east of North Spring Street. This portal would require the closing of College Street between North Main Street and North Spring Street. North of the portal, the LRT would cross North Spring Street at-grade north of College Street.

NORTH MAIN STREET GRADE CROSSING

The Union Station No Subway option uses the existing grade crossing of North Main Street north of College Street. North Main Street is a 4-lane arterial street which carries about 13,000 vehicles per day. The nearest signalized intersections are North Main Street and Ann Street, about 900 feet to the north, and North Main Street and Alpine Street/Vignes Street, about 900 feet to the south. In the "Southwest Corridor EIR Traffic Impacts" report of October 1988, the intersection of North Main Street, Alpine Street, and Vignes Street was found to operate at Level of Service A under existing conditions. It will operate at Level of Service B in the year 2010, without LRT. The intersection of North Main Street and College Street is not signalized.

The North Main Street crossing would be protected by railroad gates, bells, and flashers. LRT vehicles are expected to operate at 6 minute headways, and the expected duration of blockage to North Main Street by railroad gates is about 30 seconds per LRT vehicle. The crossing site, therefore, would create no more delay than any of the actuated traffic signals along North Main Street. With the nearest signalized intersections lying 900 feet away, traffic queues from the crossing site would not interfere with those intersections. As a result, the impact to traffic at this crossing is not considered significant.

NORTH SPRING STREET GRADE CROSSING

Both the Union Station No Subway and the Second Street-Union Station options feature a grade crossing of North Spring Street north of College Street. North Spring Street carries about 15,000 vehicles per day. The nearest signalized intersection is the 5-legged intersection of Alameda Street, North Spring Street, and College Street.

Like the North Main Street crossing, this crossing would be protected by railroad gates, bells, and flashers, and would create no more delay than a typical actuated traffic signal. However, unlike the North Main Street crossing, traffic queues at this crossing could create problems. Southbound traffic on North Spring Street during the morning peak hour is expected to be about 1100 cars per hour in the year 2010, assuming a 1% annual growth rate from existing volumes. Northbound 2010 traffic in the evening peak hour is expected to be about 1750 cars per hour. In the morning, southbound traffic queues could possibly back up from the Alameda Street-College Street intersection for a distance of about 230 feet, although most of the time the maximum morning peak hour queue length would be less than half that distance. In the evening, northbound peak hour queues at the LRT crossing could back up a distance of about 370 feet, although the expected queues would be about half that distance. As a result, the LRT crossing should be kept at least 370 feet away from the Alameda Street-College Street intersection to prevent traffic queues from spanning that distance.

For the Union Station No Subway option, the crossing would be located between 800 to 950 feet north of College Street, too far for traffic queues to reach the intersection. For the Second Street-Union Station option where the LRT traverses the southeast portion of the Southern Pacific rail yard, the crossing could be as far as 700 feet north of the College Street intersection. However, with the Second Street-Union Station option where the LRT traverses the northwest portion of the rail yard, the LRT track alignment would cross North Spring Street at a site only 300 feet away from the intersection. Under this option, traffic could conceivably back up from the crossing gate and through the intersection during the evening peak hour. This scenario would happen only if the gates were to stay down for as long as one minute, which could happen if a southbound LRT vehicle were to arrive at the crossing just as a northbound LRT vehicle were departing. The traffic queues would not cause a hazardous condition, but they would impact intersection operations.

COLLEGE STREET CLOSURE

For the Second Street-Union Station option, the underground LRT route would emerge from a portal constructed east of the Alameda Street-College Street-North Spring Street intersection. The portal would require the closure of College Street between North Spring Street and North Main Street. This segment of College Street carries 280 vehicles during the morning peak hour, and 330 vehicles during the evening peak hour. These vehicles would divert to other east-west streets, such as Ann Street to the north, or Alpine Street to the south.

The intersection analysis results for Alameda Street, College Street, and North Spring Street are shown in Table 2.

The results indicate that the closure of College Street would actually improve the intersection level of service. The intersection would become simpler by the removal of one of the approaches, with fewer conflicting traffic movements. Other intersections in the area may

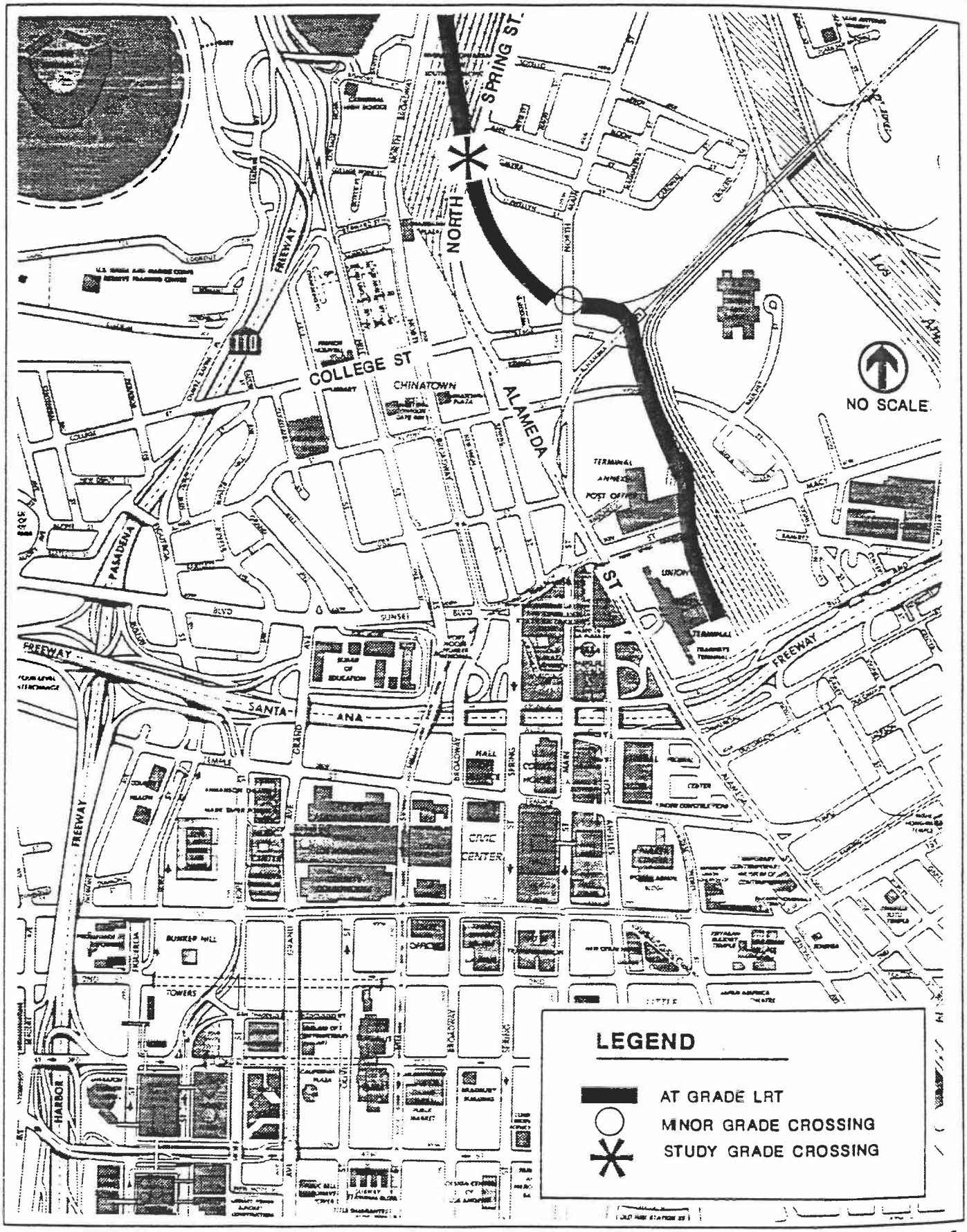

Figure 5-A

GRADE CROSSINGS FOR THE UNION STATION NO SUBWAY OPTION

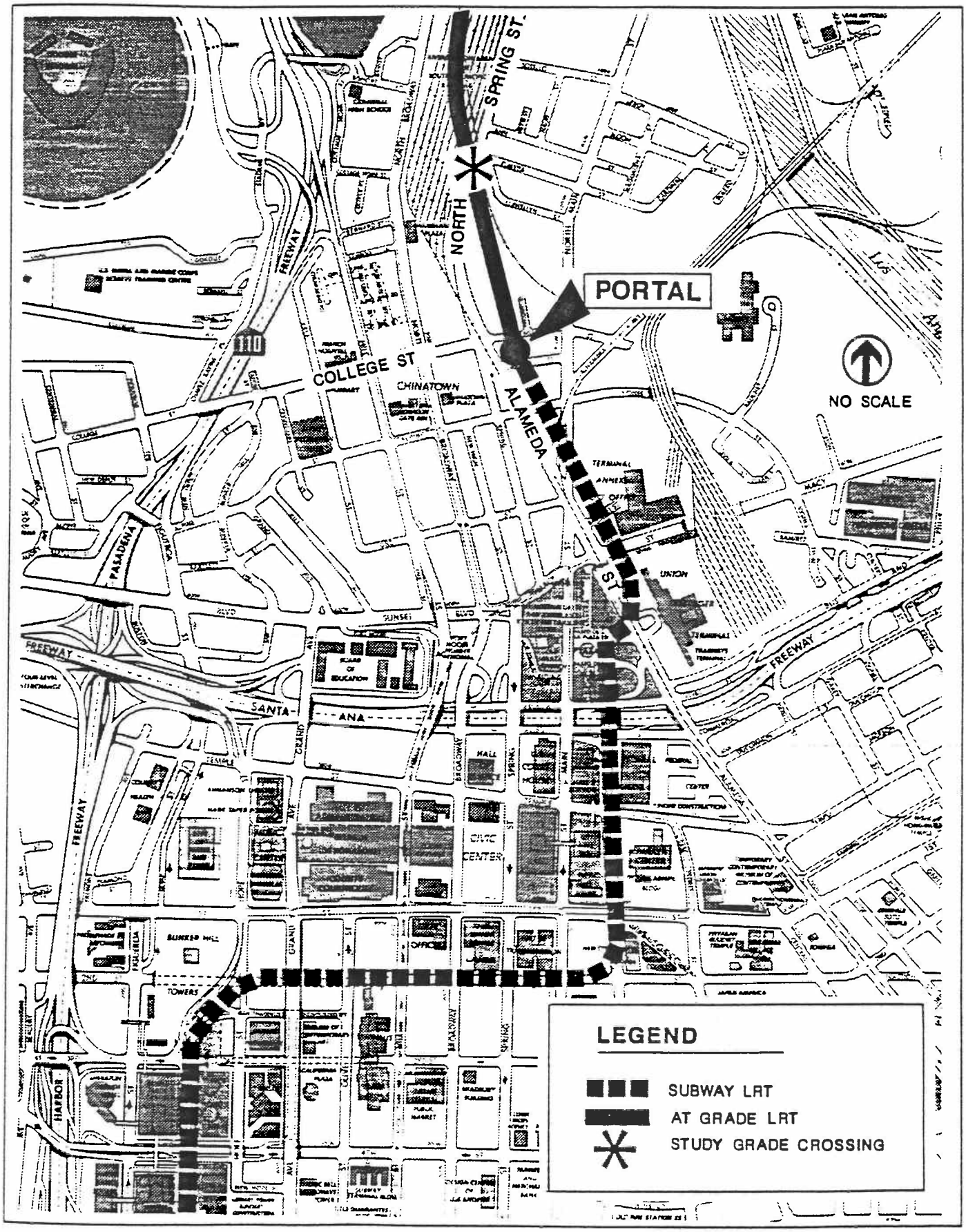

Figure 5-B

GRADE CROSSINGS FOR THE SECOND STREET UNION STATION OPTION

experience an increase in V/C ratios because of the addition of diverted traffic. However, since the level of service at surrounding intersections along Alameda Street and North Main Street is generally good, they should be able to handle the diverted traffic.

The portion of College Street to the west of the portal should be closed up to North Spring Street. East of the portal, College Street could become a cul-de-sac with access only from North Main Street. The design of the cul-de-sac should allow for maneuvers made by trucks in accessing businesses along College Street.

Table 2
Intersection Analysis
Alameda Street, College Street, and North Spring Street

Condition	V/C	LOS
Existing PM	0.81	D
Base 2010 PM	1.02	F
With LRT Portal, 2010 PM	0.79	C

PART 3 - FUTURE TRAFFIC CONDITIONS ALONG FULL LENGTH HIGHLAND PARK ROUTE

Given below are estimates of year 2010 traffic conditions along the South Pasadena and Pasadena portions of the Highland Park Alternative. First, future levels of service are projected for each study intersection before LRT implementation. Second, criteria for year 2010 traffic impact are explicitly stated. Third, peak hour auto trips generated by the new LRT stations are derived from the recent SCAG ridership forecasts for the full-length Highland Park route. Fourth, future levels of service with the proposed LRT operations are quantified at each study intersection. Finally, potential mitigations are defined at each intersection projected to be significantly impacted by the year 2010.

LEVELS OF SERVICE BEFORE LRT

The Route Refinement Study gave several estimates of future LOS in downtown Pasadena before LRT implementation. For all previously studied intersections, this report assumes the same year 2010 projections as previously estimated for the base-case scenario without the I-710 freeway extension. For new intersections, not previously studied, the year 2010 projections use an ambient growth rate of one percent a year. Addendum C gives the back up assumptions on ambient growth rates.

For simulating year 2010 conditions, two study intersections are assumed to be restriped in the vicinity of the Lake Avenue interchange. This upgrading results in the following improvements in their V/C ratios over existing:

- Lake Avenue/Maple Street will change from a current LOS E (see Table 1) to a future LOS D before LRT;
- Lake Avenue/Corson Street will change from a current LOS D (see Table 1) to a future LOS C before LRT.

Table 3 summarizes the projected V/C ratios at each study intersection before LRT implementation. Figure 8 shows the corresponding PM peak levels of service in South Pasadena and Pasadena. Figure 9 shows the corresponding PM peak levels of service in northeast Pasadena, beyond the Hill Avenue station.

As shown on Table 3 (compared to Table 1), the most noticeable increases in traffic congestion would occur at the following sites:

- at the intersections of Arroyo Parkway and Glenarm Street, and Fair Oaks Avenue and Colorado Boulevard, with future LOS F;

Table 3
Projected PM Peak
Levels of Service at Study Intersections Without LRT

Intersection	V/C	LOS
a) Segment with At-Grade Crossings		
Meridian Ave./Mission St.	0.41	A
Arroyo Pkwy./Glenarm St.	1.10	F
Arroyo Pkwy./California Blvd.	0.81	D
Fair Oaks Ave./Del Mar Blvd.	0.83	D
Arroyo Pkwy./Del Mar Blvd.	0.82	D
Arroyo Pkwy./Cordova St.	0.58	A
Fair Oaks Ave./Green St.	0.57	A
Arroyo Pkwy./Green St.	0.47	A
Fair Oaks Ave/Colorado Blvd.	1.64	F
Arroyo Pkwy./Colorado Blvd.	0.73	C
Fair Oaks Ave./Union St.	0.50	A
Arroyo Pkwy./Union St.	0.28	A
Fair Oaks Ave./Holly St.	0.69	B
Arroyo Pkwy./Holly St.	0.38	A
Fair Oaks Ave./Walnut St.	0.85	D
b) Segment within I-210 Median		
Los Robles Ave./Maple St.	0.56	A
Los Robles Ave./Corson St.	0.82	D
Los Robles Ave./Walnut St.	0.94	E
Lake Ave./Maple St.	0.89	D
Lake Ave./Corson St.*	0.73	C
Lake Ave./Walnut St.*	1.17	F
Hill Ave./Maple St.	1.08	F
Hill Ave./Corson St.	0.95	E
Hill Ave./Walnut St.	1.25	F
Altadena Dr./Maple St.	0.76	C
Altadena Dr./Corson St.	0.87	D
Foothill Blvd./Sierra Madre Villa	0.93	E
Sierra Madre Villa/WB Frontage Rd	0.76	C
Sierra Madre Villa/EB Frontage Rd.	0.77	C

* The projected LOS at each intersection is better than existing due to expected lane restriping to be installed in late 1989.

DKS Associates

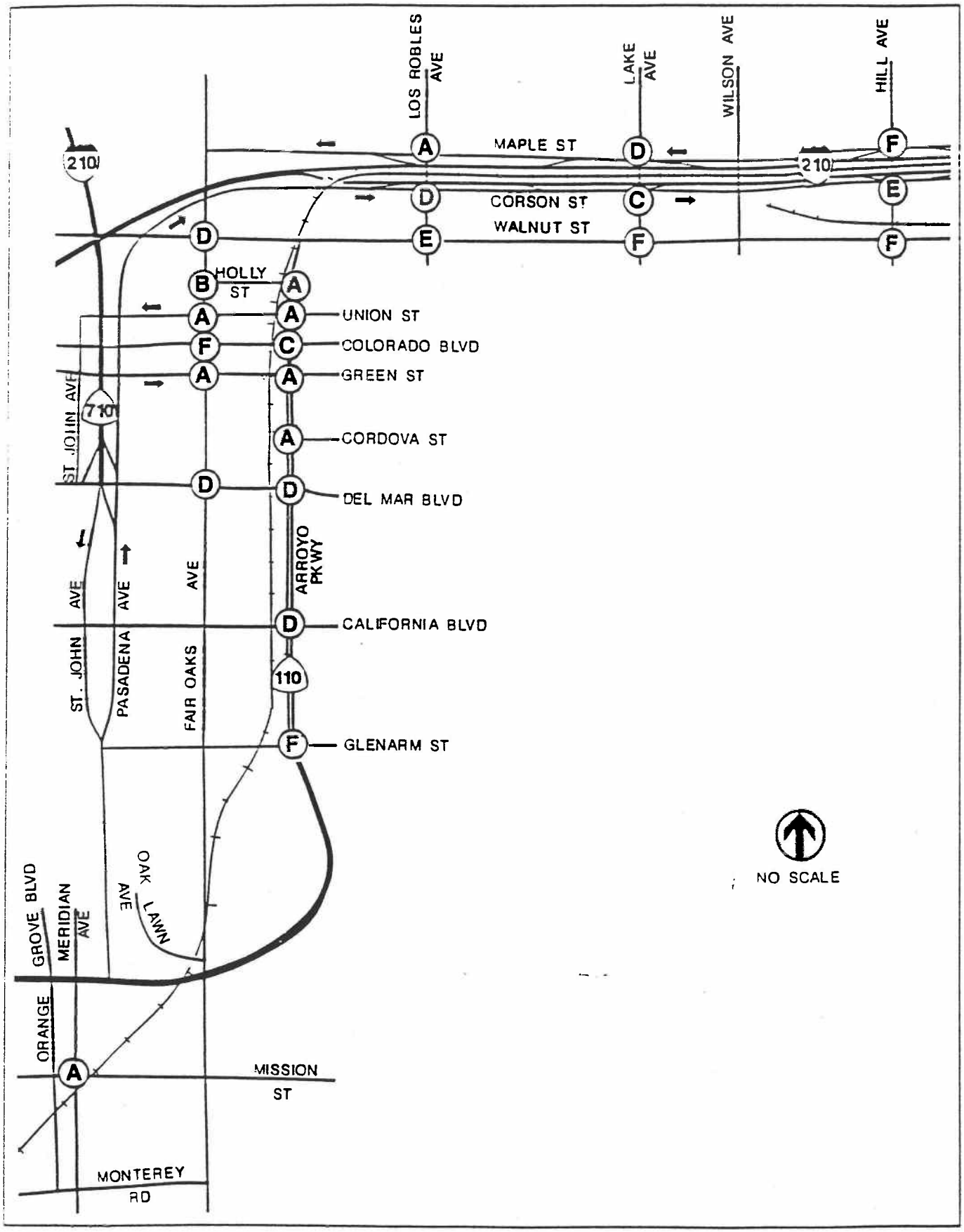

Figure 8
FUTURE LEVELS OF SERVICE
IN SOUTH PASADENA AND PASADENA WITHOUT LRT

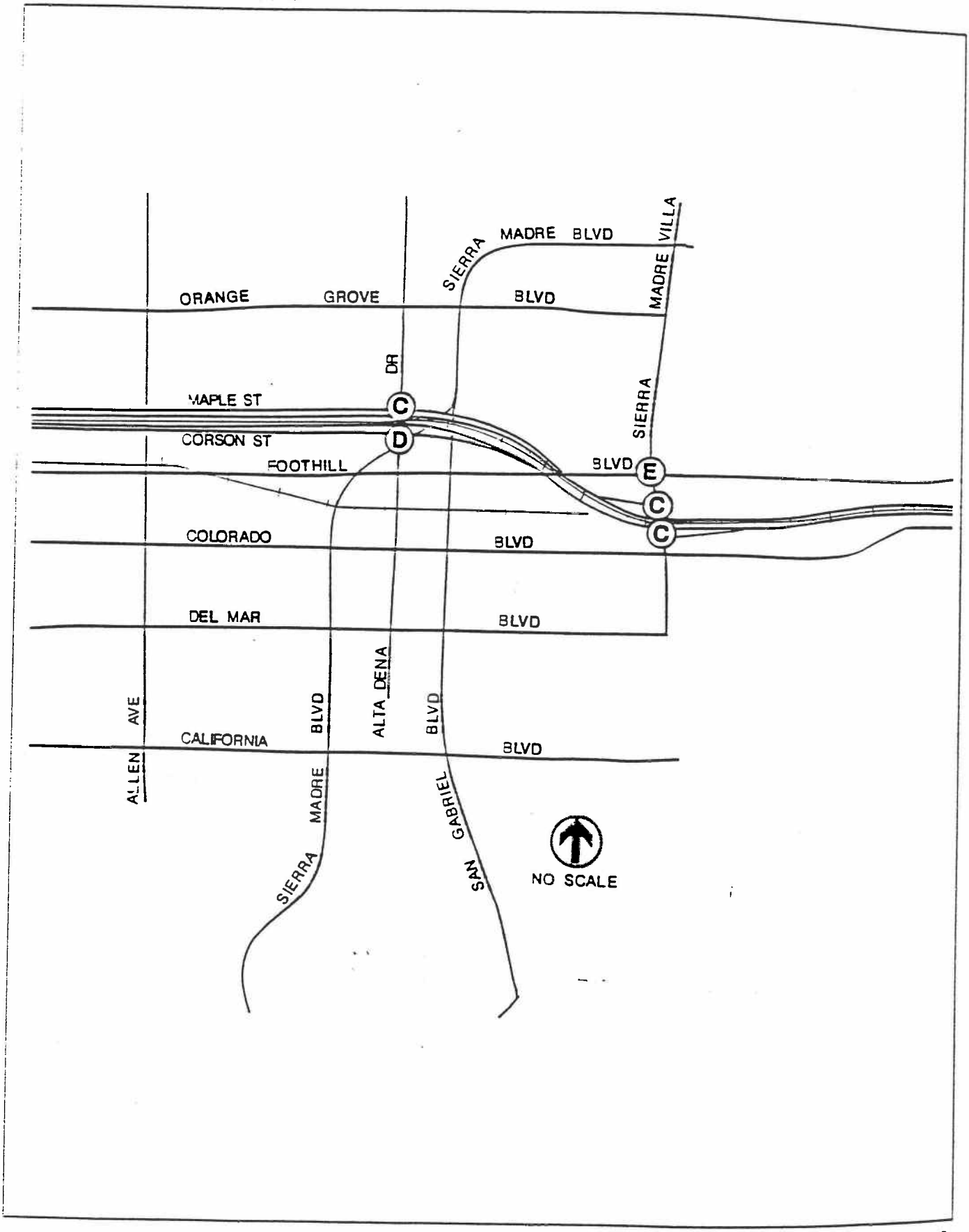

Figure 9
FUTURE LEVELS OF SERVICE IN EAST PASADENA WITHOUT LRT

- at the Los Robles Avenue and Walnut Street intersection with a future LOS E, in contrast to an existing LOS A;

- at the Lake Avenue and Walnut Street intersection with a future LOS F, in contrast to an existing LOS C;

- at the Hill Avenue and Walnut Street intersection with a future LOS F, in contrast to an existing LOS D; and

- at the Hill Avenue and Maple Street westbound approach to the I-210 freeway with a future LOS F, in contrast to an existing LOS D.

Overall traffic conditions before LRT will worsen along the Walnut Street segment within downtown Pasadena. This reflects both future downtown development south of the I-210 freeway and increased activities to/from the I-210 freeway interchange.

YEAR 2010 TRAFFIC IMPACT CRITERIA

The criteria used to determine whether a study intersection warrants mitigation as a result of LRT impacts vary as follows:

- between Pasadena and Wilson Avenue, downtown Pasadena intersections (north of California Boulevard and south of Corson Street) have a threshold V/C ratio of 0.89. Hence, an acceptable V/C ratio corresponds to LOS D or better at these sites;

- Study intersections in Pasadena found near the I-210 interchanges have a threshold V/C ratio of 0.99. Hence, an acceptable V/C ratio corresponds to LOS E or better at each freeway approach;

- Other Pasadena study intersections (south of California or east of Wilson) located away from I-210 interchanges, have a threshold ratio of 0.79. Hence, an acceptable V/C ratio corresponds to LOS C or better at these sites.

Mitigations measures will be needed if the LRT impacts cause the V/C ratio to exceed the corresponding threshold values. At those study intersections where the pre-LRT V/C ratio already exceeds the threshold, mitigation measures will be needed if LRT impacts cause a V/C ratio increase equal to or greater than 0.02.

Mitigation measures were defined at the study intersections impacted by LRT to achieve the following results:

either

- lower the V/C ratio to the applicable threshold (i.e., 0.89 or below in downtown, 0.99 or below at interchanges),

or

- lower the V/C ratio to the estimated pre-LRT 2010 V/C ratio, whichever is greater.

PEAK HOUR AUTO TRIPS GENERATED BY NEW LRT STATIONS

Table 4 summarizes the PM peak hour auto trips generated by the proposed LRT stations, north of Monterey Road in South Pasadena. The first column gives the projected number of park-and-ride stalls at two intermediate stations and the Sierra Madre Villa terminus. The second and third columns show the one-way evening peak hour auto trips due to year 2010 park-and-ride access: in the PM peak hour, most of these trips leave the station (commute direction) while fewer reverse commute trips arrive at the station.

In view of variations in several proposed station sites, the following simplifying

assumptions were made:

- the same auto trips would apply either to the Mission Street or the Fair Oaks Avenue station in South Pasadena;

- the same auto trips would apply either to the Holly Street or the Los Robles Avenue station in downtown Pasadena; and

- the same auto trips would apply either to the Lake Avenue or the Hill Avenue interchanges station along the I-210 freeway.

The fourth and fifth columns show the two-way auto trips due to kiss-and-ride access. Due to the special nature of kiss-and-ride travel, with a relatively short wait-time for the driver, each vehicle is assumed to arrive at the station and to leave the station within the PM peak hour. The kiss-and-ride trips tend to be greater at those stations with permanent park-and-ride facilities. Addendum D details the quantitative assumptions used to derive both park-and-ride and kiss-and-ride auto trips from the year 2010 SCAG LRT ridership forecasts. Addendum E shows the station access traffic volumes during the evening peak hour.

LRT AT-GRADE CROSSINGS

The proposed LRT alignment will run along the existing north-south Santa Fe Railroad right-of-way to the west of Arroyo Parkway. The existing railroad track is currently used by AMTRAK and freight train operations. On this segment, the LRT vehicles will cross several

Table 4
PM Peak Hour Auto Trips at LRT Stations Along Full Length Highland Park Alternative

Station Name(s)	# of Stalls	Park-and-Ride (One-Way Trips) From Station	Park-and-Ride (One-Way Trips) To Station	Kiss-and-Ride (Two-Way Trips) Pick-Up	Kiss-and-Ride (Two-Way Trips) Drop-Off
Mission St. or Fair Oaks Ave.	*	----	----	49	----
Glenarm St.	200	65	10	27	4
Del Mar Blvd. (Existing AMTRAK station)	600	404	64	164	26
Holly St. or Los Robles Ave.	----	----	----	39	----
Lake Ave. or Hill Ave.	----	----	----	38	----
Altadena Dr.	----	----	----	17	----
Sierra Madre Villa Terminus	1,000	444	71	180	28
Total	**1,800 stalls**** North of Monterey Road				

* An existing lot (40-50 stall capacity) is assumed to function at it current size, next to the Fair Oaks Avenue LRT station. The separate quantitative analysis of park-and-ride trips was not performed at this site.

** A net balance of 450 stalls was assumed at several intermediate LRT stations between South Pasadena and downtown Los Angeles for a resulting total supply of 2,250 stalls.

east-west streets at-grade without yielding to cross-street automobile traffic. Railroad bells, flashers, and gates will stop automobile traffic to allow passage of the LRT vehicles. LRT vehicles are expected to operate at 6-minute headways during peak periods by the year 2010. They would cross about 20 times during the peak hour, blocking traffic for about 36 seconds each time. Three of the crossings are at local streets: Fillmore Street, Pico Street and Bellevue Street. The LRT impacts to traffic on these lightly traveled street will be minor.

In contrast, much higher traffic volumes are found on the other roadways along this segment. These are:

- Glenarm Street
- California Boulevard
- Del Mar Boulevard
- Green Street
- Colorado Boulevard
- Union Street
- Holly Street

In addition to gates, flashers, and bells, each of these crossings currently has a traffic signal to the east on Arroyo Parkway which is preempted by trains. When a train approaches, gates are dropped to prevent cars from crossing the tracks. The traffic signal stops all traffic except for the eastbound direction, allowing cars that might be stopped on the rail crossing to clear the intersection. The traffic signal then displays flashing red indications to all directions, allowing cars that are not blocked by railroad gates to move. Most of these crossings also have a signal to the west, on Raymond Avenue, which behaves similarly during train preemptions.

LRT operations will cause the signal to preempt in the same manner. The frequency of the preemptions will be much higher, although the duration of each preemption will be shorter, than for existing freight and AMTRAK operations. These LRT preemptions will cause a reduction in the intersection capacity, on the order of 10 percent. This impact has been accounted for by adjusting the V/C ratios at the above study intersections.

In South Pasadena, at-grade crossings north of the Monterey Road Station will be protected by the existing railroad gates, flashers and bells at the following Crossings:

- Indiana Avenue
- Orange Grove Avenue
- El Centro Street
- Meridian Avenue and Mission Street
- Hope Street
- Fairview Avenue
- Magnolia Street
- Fremont Avenue and Grevalia Street

Among these crossings, only the Meridian Avenue-Mission Street intersection was analyzed for LRT impacts to traffic. The V/C ratio was adjusted to account for blockage by crossing gates. The other crossings have much less traffic, and will not be impacted by LRT.

Window Preemption: An alternative scheme at grade crossings is the use of "window preemption". This scheme attempts to preserve the traffic signal coordination currently in place on the streets. LRT vehicles would be restricted to crossing intersections only at the optimal time in the signal cycle when the impact of preemption would be least. For instance, the LRT vehicles would cross Del Mar Boulevard only at the end of the east-west green light for Del Mar Boulevard at Arroyo Parkway. The LRT vehicles would be held at the upstream station by means of a signal at the station. This LRT signal would display a "GO" indication at the instant when the LRT should proceed so as to arrive at the crossing at the optimum moment.

Under window preemption, the LRT vehicles would still receive full protection at each crossing with gates, bells, and flashers. Traffic signals at the crossing would still be preempted, so that cars that may be queued across the tracks could be cleared out of the intersection by a green light. Motorists would benefit from the better coordination of the signals. However, LRT vehicles would be delayed at stations by up to 70 seconds. Analysis conducted for the Long Beach-Los Angeles Rail Transit Project showed that motorist delay could be reduced on the order of 10%. However, for each person-hour of reduction in delay to motorists, the delay to LRT passengers could increase by 4 or 5 person-hours. Because window preemption would create a relatively small benefit to motorists at the cost of much delay to LRT passengers, it is not recommended for this light rail project.

LRT Signals at Grade Crossings: Another alternative at grade crossings would be the use of traffic signals to control LRT vehicles. The crossings would not be controlled by gates, bells, and flashers. Instead, the LRT vehicle would be controlled by a traffic signal: it would have to stop at a red light, until a green light appeared. From a traffic standpoint, this scheme has no advantages over normal railroad preemption featuring gates, bells, and flashers. From the standpoint of the LRT, the delay encountered could be considerable, even worse than window preemption. This delay could be reduced by providing the LRT vehicles with priority over motor vehicles. This concept has been recommended for a short segment in Highland Park Route, between Avenue 50 and Avenue 57. It is only recommended as a measure to reduce noise impacts at crossings.

For the intersection analysis that follows, the assumed treatment at each grade crossing is standard railroad preemption.

PROJECTED LEVELS OF SERVICE WITH LRT

Table 5 summarizes the projected V/C ratios at each study intersection with LRT. Figure 10 shows the projected PM peak levels of service in South Pasadena and Pasadena, before mitigation. Figure 11 shows the projected PM peak levels of services in East Pasadena, before mitigation.

Based on the year 2010 traffic impact criteria, the following seven study intersections would be impacted by the LRT operation:

- Arroyo Parkway & Glenarm Street;
- Arroyo Parkway & California Boulevard;
- Arroyo Parkway & Del Mar Boulevard;
- Fair Oaks Avenue & Del Mar Boulevard;
- Fair Oaks Avenue & Colorado Boulevard;
- Hill Avenue & Maple Street, with an LRT station at Hill Avenue; and
- Sierra Madre Villa Avenue & Foothill Boulevard

At the Meridian Avenue (or the alternate Fair Oak Avenue site) station, the variations in V/C ratios are too small to result in any significant impacts in South Pasadena. The existing intersection of Meridian Avenue and Mission Street is not currently signalized. The year 2010 estimates of auto trips generated by kiss-and-ride patrons do not suggest the need for adding a signal at this site.

Listed below are potential mitigation measures:

- Adding a north to east right-turn only lane on Arroyo Parkway at Glenarm Street, requiring the purchase of additional right-of-way.

- Adding a south to west right-turn only lane on Arroyo Parkway at California Boulevard, requiring the purchase of additional right-of-way.

- Adding a west to north right-turn only lane on California Boulevard at Fair Oaks Avenue, requiring the purchase of additional right-of-way.

- Adding an east to south right-turn only lane on Del Mar Boulevard at Arroyo Parkway, by widening Del Mar Boulevard by 2 feet west of the intersection, and reducing sidewalk width to 9 feet.

- Adding a west to north right-turn only lane on Colorado Boulevard at Fair Oaks Avenue, by restriping Colorado Boulevard.

Table 5
Projected PM Peak
Levels of Service at Study Intersections With LRT

Intersection	V/C	LOS Before Mitigation
a) Segment with At-Grade Crossings		
Meridian Ave./Mission St.[1]	0.52	A
Arroyo Pkwy./Glenarm St.	1.14	F
Arroyo Pkwy./California Blvd.	0.92	E
Fair Oaks Ave./Del Mar Blvd.	0.91	E
Arroyo Pkwy./Del Mar Blvd.	0.90	E
Arroyo Pkwy./Cordova St.	0.60	B
Fair Oaks Ave./Green St.	0.62	B
Arroyo Pkwy./Green St.	0.49	A
Fair Oaks Ave/Colorado Blvd.	1.67	F
Arroyo Pkwy./Colorado Blvd.	0.86	D
Fair Oaks Ave./Union St.[2]	0.56	A
Arroyo Pkwy./Union St.[2]	0.34	A
Fair Oaks Ave./Holly St.[2]	0.73	C
Arroyo Pkwy./Holly St.[2]	0.39	A
Fair Oaks Ave./Walnut St.[2]	0.87	D
b) Segment within I-210 Median		
Los Robles Ave./Maple St.[3]	0.56	A
Los Robles Ave./Corson St.[3]	0.82	D
Los Robles Ave./Walnut St.[3]	0.94	E
Lake Ave./Maple St.[4]	0.91	E
Lake Ave./Corson St.[4]	0.73	C
Lake Ave./Walnut St.[4]	1.17	F
Hill Ave./Maple St.[5]	1.08	F
Hill Ave./Corson St.[5]	0.95	E
Hill Ave./Walnut St.[5]	1.25	F
Altadena Dr./Maple St.	0.78	C
Altadena Dr./Corson St.	0.89	D
Foothill Blvd./Sierra Madre Villa	0.97	E
Sierra Madre Villa/WB Frontage Rd	0.84	D
Sierra Madre Villa/EB Frontage Rd.	0.89	D

Footnotes to Table 5

[1] V/C increases to 0.54 with an LRT station at Mission Street instead of further north near Fair Oaks Avenue. The .02 increase is due to the kiss-and-ride trips, as no park-and-ride lot was assumed at this South Pasadena station.

[2] Whether the LRT station is at Holly Street or at Los Robles Avenue, a comparable LOS would prevail at each of these study intersections. Table 5 shows the V/C ratios assuming a station on Memorial Park on Holly Street. If the station were instead at Los Robles Avenue, the V/C ratio at Fair Oaks/Holly would decrease by 0.02, at Fair Oaks/Walnut and Arroyo/Holly by 0.01 and by a negligible amount at Fair Oaks/Union and Arroyo/Union.

[3] Table 5 shows the V/C ratios assuming a station at Memorial Park on Holly Street. With an LRT station at the Los Robles Avenue interchange instead of at Holly Street, the V/C ratio at Los Robles/Maple will increase by 0.02, at Los Robles/Corson by 0.03, and at Los Robles/Walnut by a negligible amount. A comparable LOS would prevail in either case.

[4] Table 5 shows the V/C ratios assuming a station at the Lake Avenue interchange. If the station were instead at the Hill Avenue interchange, the V/C ratios at Lake/Maple would be 0.89 instead of 0.91. The V/C ratios at Lake/Corson and Lake/Walnut would decrease as a negligible amount.

[5] Table 4 assumes a station at the Lake Avenue interchange. With the station at the Hill Avenue interchange, instead, the V/C ratios at Hill/Maple, Hill/Corson and Hill/Walnut would be 1.10, 0.96 and1.25 respectively.

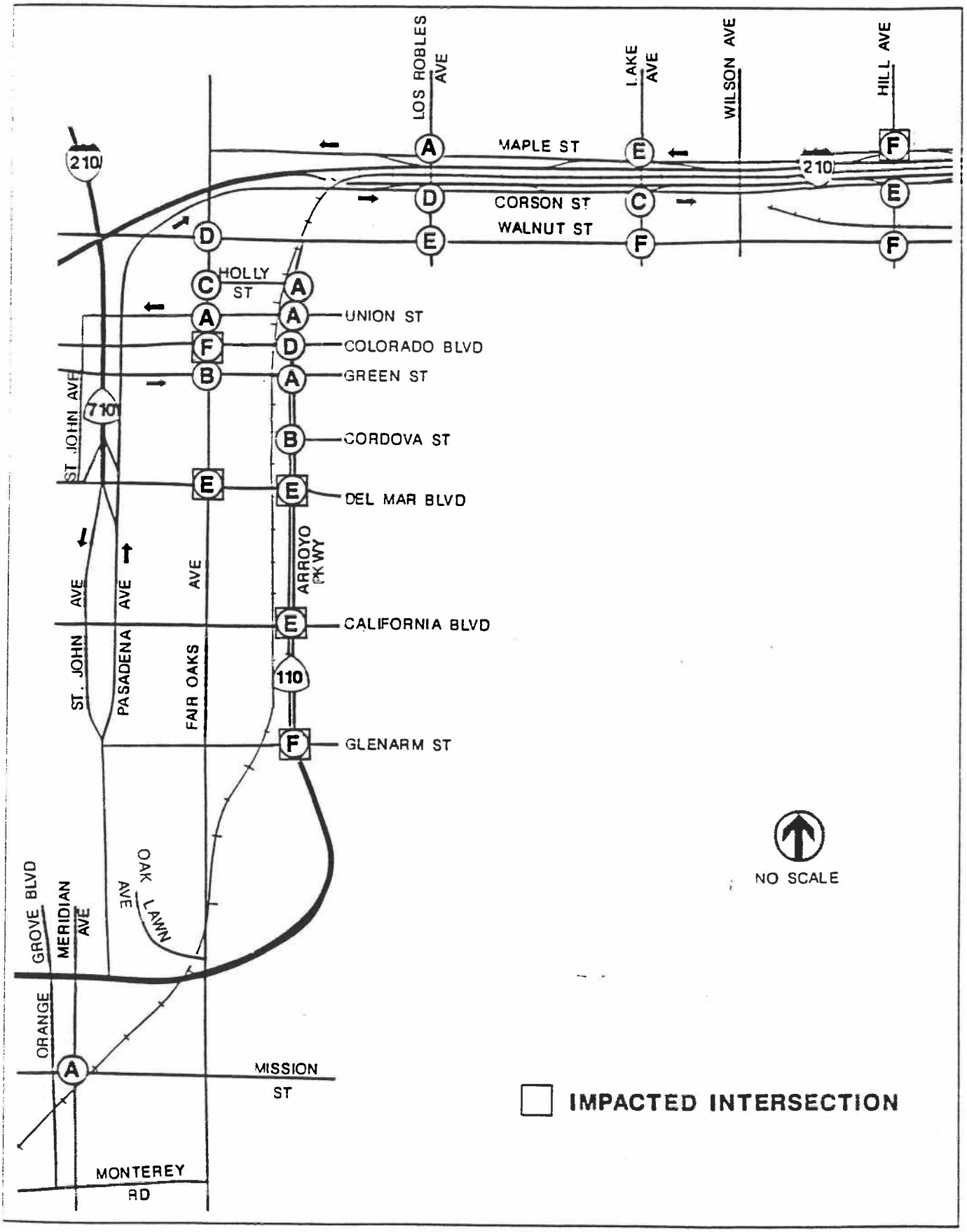

Figure 10
FUTURE LEVELS OF SERVICE
IN SOUTH PASADENA AND PASADENA WITH LRT

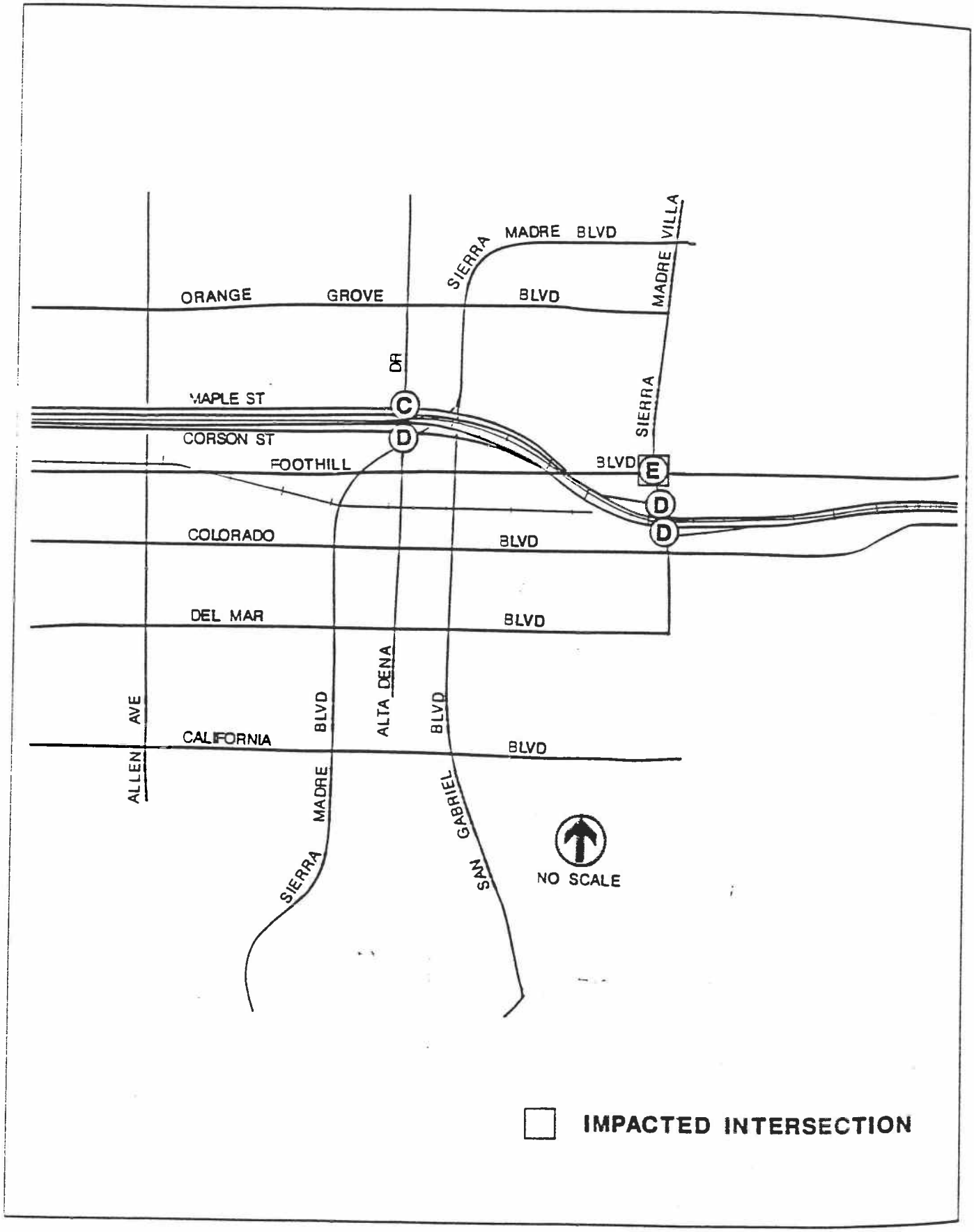

Figure 11
FUTURE LEVELS OF SERVICE IN EAST PASADENA WITH LRT

- Restriping the westbound approach to Hill Avenue at Maple Street intersection to provide an additional west to south left-turn lane on Maple Street. This mitigation measure would only be required if an LRT station is built at the Hill Avenue interchange.

- Restriping the westbound approach to Sierra Madre Villa Avenue at Foothill Boulevard to provide a double left-turn lane(instead of the current single left-turn lane) on Foothill Boulevard. This mitigation would require the removal of the existing right-turn only lane on the eastbound approach to this intersection.

Table 6 summarizes the adjusted V/C ratios and resulting LOS at the above seven intersections after mitigation. Addendum F shows sketches of these mitigations.

A comparison between proposed station sites along the Pasadena to Northeast Pasadena line segment shows the likely variation in LRT impacts:

- With a station at Memorial Park on Holly Street instead of at Los Robles Avenue, the projected V/C ratios vary at several intersections. However, these variations are too small to result in a change in the number and locations of impacted intersections in northwest Pasadena. This primarily comes from the more local nature of kiss-and-ride trips, than would be expected with a permanent park-and-ride lot at either site.

- With a Lake Avenue station instead of a Hill Avenue station, the projected V/C ratio at the Hill Avenue and Maple Street intersection decreases by .02; this reduced value is identical to the projected ratio before LRT. Thus moving the LRT station from Hill Avenue to Lake Avenue is another way to mitigate potential LRT impacts at this intersection.

Table 6
Adjusted PM Peak Levels of Service at Impacted Study Intersections

Intersection	Without LRT [1] V/C	Before Mitigation With LRT [2] V/C	After Mitigation With LRT V/C	Adjusted LOS
Arroyo Pkwy./Glenarm St.	1.10	1.14	0.95	E
Arroyo Pkwy./California Blvd.	0.81	0.92	0.89	D
Arroyo Pkwy./Del Mar Blvd.	0.82	0.90	0.85	D
Fair Oaks Ave./Del Mar Blvd.	0.83	0.91	0.85	D
Fair Oaks Ave./Colorado Blvd.	1.64	1.67	1.61	F
Hill Ave./Maple St.	1.08	1.10	0.92	E
Sierra Madre Villa Ave./ Foothill Blvd.	0.93	0.97	0.94	E

1 *From Table 3.*

2 *From Table 5. The higher V/C ratio at Hill Avenue and Maple Street reflects a station site at Hill Avenue instead of Lake Avenue. No mitigation is warranted at this intersection, if the Lake Avenue station replaces the Hill Avenue station.*

PART 4 - POTENTIAL CONSTRUCTION IMPACTS

Given below are the types of LRT construction impacts upon traffic operations expected along the new segments of the Highland Park Alternative. Without a detailed construction plan showing proposed staging areas and schedule of the activities, these impacts can only be described qualitatively.

a) Downtown Los Angeles Connections via Union Station

Construction of the Union Station "No-Subway" segment of the Highland Park Alternative would have minimal traffic impacts. Under the newly proposed options, the LRT construction would occur at an existing rail station (Union Station), within the Southern Pacific rail yard and along connecting branch lines north of Union Station. Traffic detours will be needed at the grade crossings on North Main and North Spring Streets.

The magnitude of other LRT construction-related impacts upon downtown Los Angeles traffic varies somewhat among the full-length options, their sub-options and phasing options:

- Any LRT implementation with Union Station at its southern terminus would have little impact south and west of Union Station.

- Subway construction between the 7th & Flower Station and Union Station would impact traffic at cut-and-cover station locations. Although some traffic would be able to pass over wooden decking at the cut-and-cover site, full detours would be needed on occasions when the entire street must be closed.

- In the case of the Second Street-Union Station option, an LRT subway portal transition to an at-grade line is proposed east of the intersection of College Street and North Spring Street. This portal requires the permanent closure of College Street. Once College Street is closed, the impacts to traffic construction would be considered minimal.

- There is no major difference in the magnitude of construction impacts to traffic between the north side and south side LRT route options within the Southern Pacific rail yard.

b) South Pasadena to Downtown Pasadena via Santa Fe Railroad

Construction would mostly occur within the Santa Fe Railroad right-of-way along this route segment. Construction impacts upon traffic would be significant at approximately 10 to 15 at-grade crossings. Other impacts of a lesser magnitude would take place at those LRT stations with new construction or proposed expansion of park-and-ride

facilities. During LRT construction, care should be taken to avoid closing too many adjacent crossings at the same time.

c) Downtown Pasadena to East Pasadena Terminus via I-210 Median

The LRT construction along this fully grade-separated segment is expected to have significant impacts upon traffic operations. The lack of convenient access points by heavy equipment and the narrow width of the existing median will contribute further to the following disruptions along the Foothill Freeway corridor:

- The construction of LRT station platforms and their vertical circulation elements will conflict with the freeway traffic at each proposed station site: Los Robles Avenue, Lake or Hill Avenue, Altadena Drive and Sierra Madre Boulevard.

- At each station site the required widening of an existing under or overpass will also interfere with traffic using the interchange approaches.

- For the full length of the impacted freeway median (from north of Walnut Street portal to east of Sierra Madre Villa), the installation of the LRT tracks may warrant closures of one or two center lane(s); this would impact the I-210 capacity through this congested section of the corridor.

Some potential mitigations to these impacts include:

- Limiting center-lane closures to off peak or late evening hours;
- Closing only one lane at a time instead of both center lanes;
- Implementing a ramp metering program at all construction hours;
- Proposing interim high-occupancy vehicle lanes along the Foothill Freeway through the Pasadena area.
- Diverting some through traffic to Walnut Street and Colorado Boulevard via variable message sign.

Such measures would need a more detailed study and close review by CalTrans and the City of Pasadena as well as other local jurisdictions along the Foothill Freeway corridor.

PART 5 - FUTURE TRAFFIC CONDITIONS ALONG INTERIM PHASING TO DEL MAR BOULEVARD

A proposed phasing option would have an interim northern terminus at Del Mar Station. This section addresses how this interim terminus would alter the findings for the full length option reported in Part 3.

Figure 12 shows the proposed phasing of the Highland Park Alternative. Table 7 gives the projected PM peak hour auto trips generated by the proposed LRT stations along the shorter route. At the three new stations north of Monterey Road, the year 2010 assumptions on park-and-ride supply are identical to the ones made for the full length option (given in Table 4). In particular, the interim terminus, which would lie next to the existing AMTRAK depot, would accommodate the same 600-stall lot as for the full-length option.

If one compares Tables 4 and 7, the South Pasadena, Glenarm Street and Del Mar Boulevard stations shows very similar projections of auto trips to/from each site. These projections would therefore result in very comparable increases in V/C ratios at study intersections along the interim LRT line. This finding stems from nearly identical volumes of riders (boarding and alighting) on the LRT at each station - whether the line extends to Del Mar Boulevard or to Sierra Madre Villa Avenue. It also reflects the identical park-and-ride lot sizes assumed for each option.

Thus phasing LRT operations to Del Mar Boulevard would result in the following five study intersections being impacted:

- Arroyo Parkway & Glenarm Street;
- Arroyo Parkway & California Boulevard;
- Arroyo Parkway & Del Mar Boulevard;
- Fair Oaks Avenue & Del Mar Boulevard;

and

- Fair Oaks Avenue & Colorado Boulevard.

The year 2010 V/C ratios with LRT at these intersections are the same as the ones given in Table 5. Potential mitigation at these sites are identical to the ones described in Part 3.

Figures 13 and 14 show the corresponding PM Peak levels of service with the interim terminus at Del Mar Station. The levels of service for all study intersections south of Colorado Boulevard are virtually the same as for the full length LRT option. Beyond Colorado Boulevard, the levels of service are the same as the base no-LRT condition.

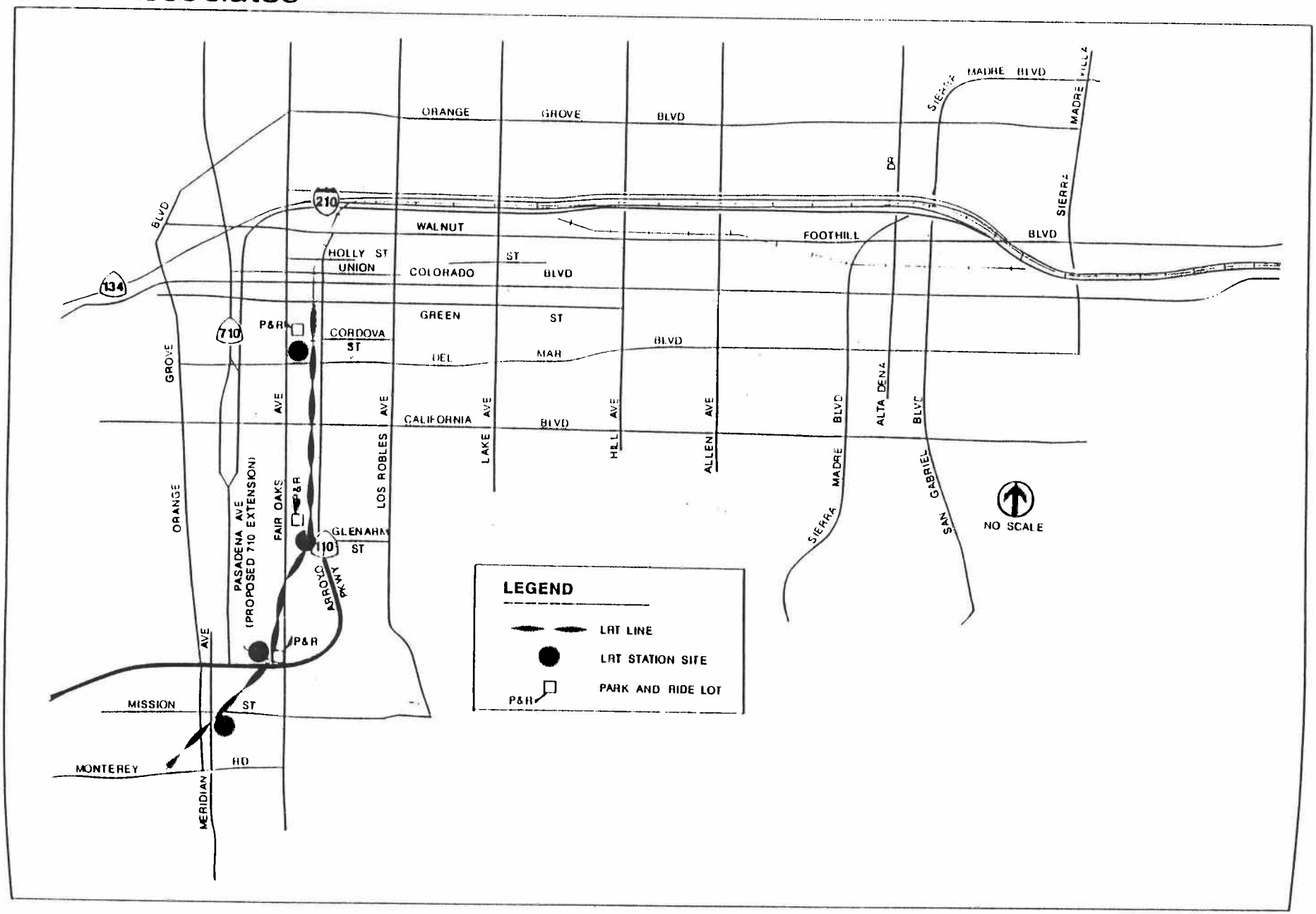

Figure 12

INTERIM PHASING OF HIGHLAND PARK ALTERNATIVE TO DEL MAR

Table 7
PM Peak Hour Auto Trips
at New LRT Stations Along
Highland Park Alternative to Del Mar Boulevard

Station Name(s)	# of Stalls	Park-and-Ride (One-Way Trips) From Station	Park-and-Ride (One-Way Trips) To Station	Kiss-and-Ride (Two-Way Trips) Pick-Up	Kiss-and-Ride (Two-Way Trips) Drop-Off
Mission St. or Fair Oaks Ave.	*	----	----	49	----
Glenarm St.	200	68	11	27	4
Del Mar Blvd. (Interim Terminus)	600	394	63	160	2
TOTAL	800 stalls**				

* An existing lot (40-50 stall capacity) is assumed to function at it current size, next to the Fair Oaks Avenue LRT station. The separate quantitative analysis of park-and-ride trips was not performed at this site.

** A net balance of 450 stalls was assumed at several intermediate LRT stations between South Pasadena and downtown Los Angeles for a resulting total supply of 1,250 stalls.

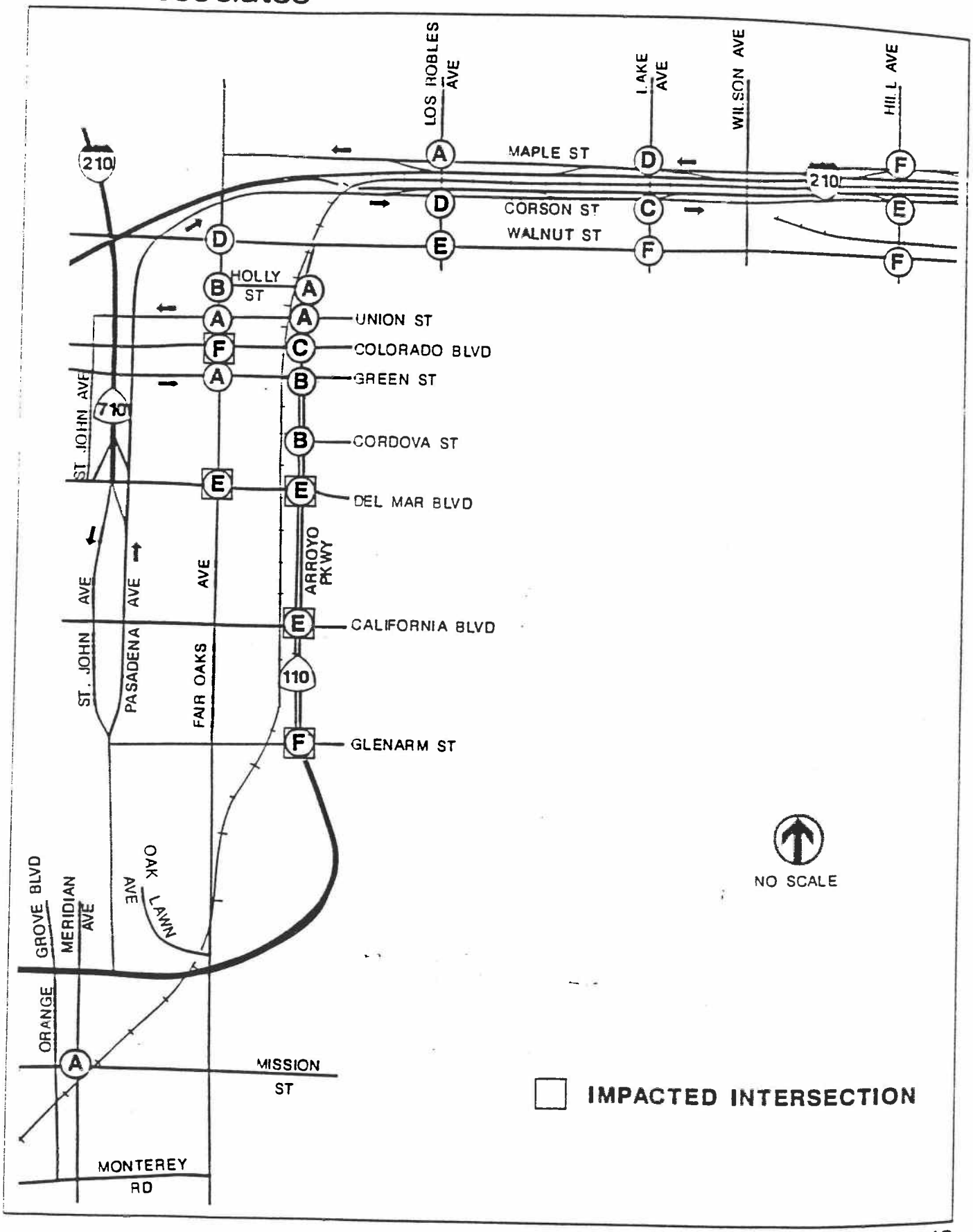

Figure 13

FUTURE LEVELS OF SERVICE IN SOUTH PASADENA AND PASADENA WITH LRT TO DEL MAR BLVD.

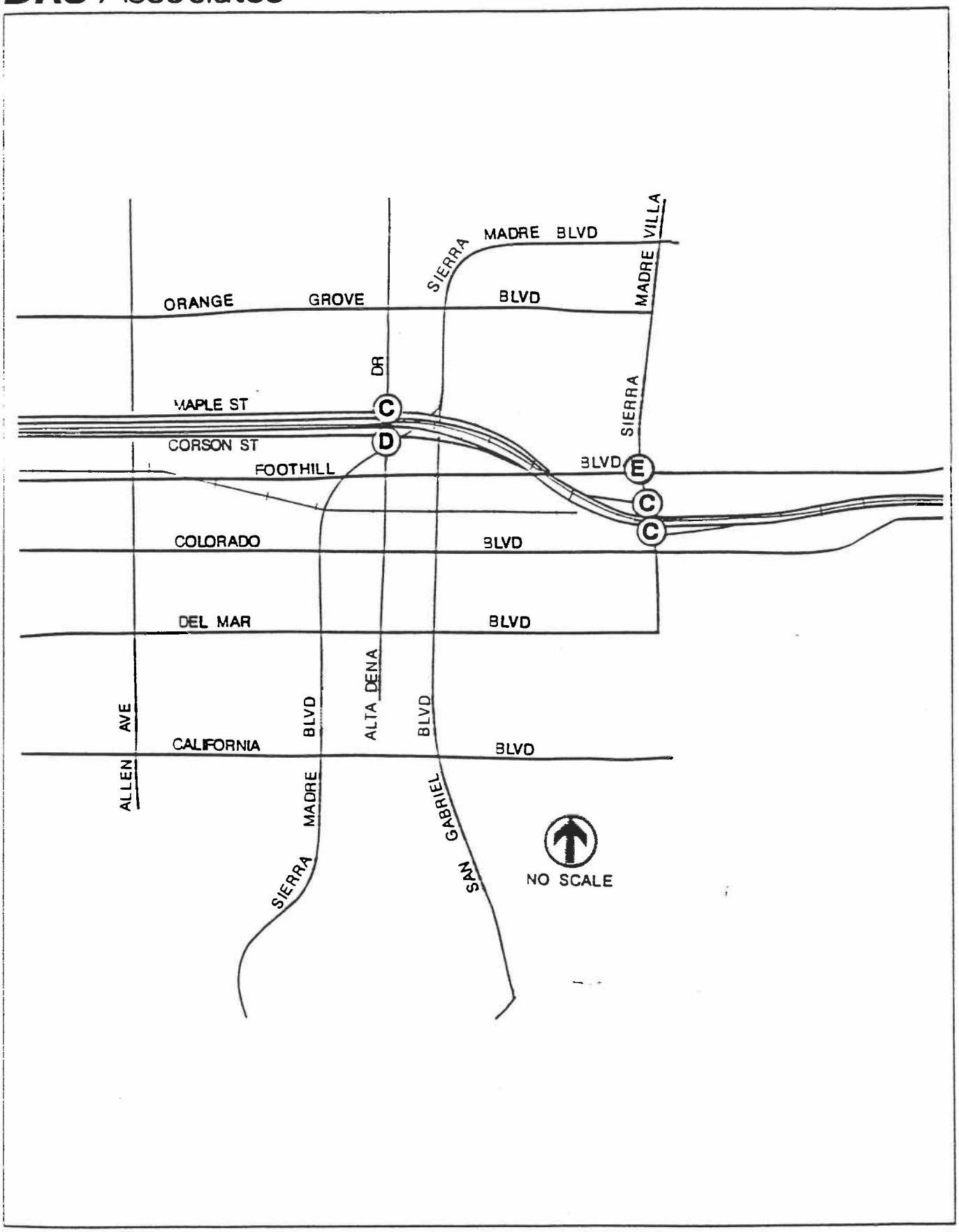

Figure 14
FUTURE LEVELS OF SERVICE
IN EAST PASADENA WITH LRT TO DEL MAR BLVD

PART 6 SUMMARY OF FINDINGS

Findings from earlier parts are given from south to north along the Pasadena-Los Angeles LRT corridor. These findings only pertain to the Highland Park Alternative.

- Two of the downtown alignment options feature an LRT at-grade crossing of North Spring Street north of College Street. LRT should not impact traffic at this crossing as long as the crossing is a sufficient distance away from the intersection of Alameda Street and College Street to prevent traffic queues from spanning the distance. The proposed North Main Street crossing used by the Second Street-Union Station option should not impact traffic.

- Under the Second Street/Union Station option, the proposed portal north of Union Station requires the permanent closure of College Street between North Spring Street (Alameda Street) and North Main Street. This closure appears feasible from a traffic standpoint, since nearby intersections should be able to handle diverted traffic.

- In South Pasadena, whichever station site is assumed (Mission Street at Meridian Avenue or Fair Oaks Avenue north of the Pasadena Freeway), the LRT operation would have no significant traffic impact due to at-grade crossings and kiss-and-ride access.

- Along the Pasadena route segment with at-grade crossings, the LRT operation would impact a total of 5 study intersections. Impacts reflect the combined effects of station related park-and-ride and kiss-and-ride auto trips as well as the at-grade crossings. Moving the proposed Memorial Park Station at Holly Street to Los Robles Avenue would not alter the location or the degree of such impacts. Two out of the five intersections can be mitigated without acquiring new right-of-way.

- Along the Pasadena route segment within the Foothill Freeway median, the full-length option would impact two study intersections. At all intermediate freeway stations, the LRT operation would generate kiss-and-ride auto trips and feeder bus activities. At the Sierra Madre Villa terminus, the LRT operation would also bring park-and-ride auto trips. Lane restriping would be adequate to mitigate each of these impacted intersections. As an alternative solution, moving the Hill Avenue Station to Lake Avenue would mitigate the kiss-and-ride impacts at Hill Avenue and Maple Street.

- In Pasadena, the phasing option that terminates at the Del Mar Station would impact five study intersections. These intersections and their mitigations are identical to the above findings along the Pasadena route segment with at-grade crossings under the full-length option.

- Expected construction impacts would occur at approximately 15 at-grade crossings in South Pasadena and near Arroyo Parkway in Pasadena. Significant construction impacts would prevail along the entire length of the full-length route within the I-210 median. These may warrant temporary closures of center lanes, traffic detours away from interchanges with LRT stations and disruptions of existing under or overpasses. A detailed mitigation plan would need to be prepared and approved by Caltrans, the City of Pasadena and other local jurisdictions along the I-210 corridor.

- Construction of the phasing option to Del Mar Station would result in much fewer impacts upon the I-210 freeway. LRT construction impacts in South Pasadena and near Arroyo Parkway would be identical to the full-length option.

ADDENDUM A

1. Data Sources for ADT Counts Quoted in Section 1

- CALTRANS - 1986 Traffic Volumes on California State Highways; Route 110 (pp.125-126); Route 210 (p.166); Route 710 (p.191).
- City of Pasadena - 1984 Traffic Flow Map - 24-hour Volumes.[1]
- City of South Pasadena - 1973 Traffic Flow Map - Directional Daily Volumes.

2. Multipliers Used to Derive 1989 Estimates

- 1.0612 for 1986 data on California Freeways
- 1.3382 for 1984 data on Pasadena Streets and Arterials
- 1.3728 for 1973 data on South Pasadena Streets and Arterials

---

[1] The more recent Arroyo Parkway counts from CALTRANS were used in lieu of the Pasadena Flow Map for the arterial portion of the 110 corridor.

ADDENDUM B

TABLE B-1
LEVEL OF SERVICE INTERPRETATION

Level of Service	Volume to Capacity Ratio	Description
A	0-.59	Excellent operation. All approaches to the intersection appear quite open, turning movements are easily made, and nearly all drivers find freedom of operation.
B	.60-.69	Very good operation. Many drivers begin to feel somewhat restricted within platoons of vehicles. This represents stable flow. An approach to an intersection may occasionally be fully utilized and traffic queues start to form.
C	.70-.79	Good operation. Occasionally drivers may have to wait more than 60 seconds, and back-ups may develop behind turning vehicles. Most drivers feel somewhat restricted.
D	.80-.89	Fair operation. Cars are sometimes required to wait more than 60 seconds during short peaks. There are no long-standing traffic queues. *This level is typically associated with design practice for peak periods.*
E	.90-1.00	Poor operation. Some long-standing vehicular queues develop on critical approaches to intersections. Delays may be up to several minutes.
F	Over 1.00	Forced flow. Represents jammed conditions. Backups from locations downstream or on the cross street may restrict or prevent movement of vehicles out of the intersection approach lanes; therefore, volumes carried are not predictable. Potential for stop and go type traffic flow.

Source: *Highway Capacity Manual*, Highway Research Board, Special Report No. 87, Washington, DC, 1965 and the update of the manual.