LOS ANGELES METRO ORANGE LINE EXTENSION
Transitional Analysis

Prepared for
Los Angeles County Transportation Commission

Prepared by
Bechtel Civil Company

in association with
Acoustical Analysis Associates
Katz, Okitsu & Associates
Manuel Padron & Associates
Michael Brandman Associates, Inc.
Ralph Stone and Company, Inc.

and assistance of
Southern California Rapid Transit District

July 1990

Metro Rail Transitional Analysis

Table of Contents

Page

Appendices (under separate cover):

A -- Los Angeles Metro Orange Line Extension, Transitional Analysis:
Task 4, Engineering Report (and drawings)

B -- Los Angeles Metro Orange Line Extension, Transitional Analysis:
Task 6, Environmental Analysis

C -- Technical Report, Rail Transit Patronage Analysis

D -- Study of Metro Rail Extension Through the Northern Segment of the Santa Ana Corridor:
- Task 1, Alignment Alternatives (and drawings)
- Task 2, Station Site Plans (and drawings)
- Task 3, Assessment of Impacts
- Task 4, Cost Estimates and Implementation Schedules

Executive Summary

The population of the Los Angeles region is expected to grow considerably by the year 2010, with jobs concentrated in the central business district, Wilshire area, and Hollywood. Job concentration in this relatively small geographic area results in high traffic volumes, congestion, and low travel speeds. To help address these future needs for improved accessibility and mobility, the Metro Rail system should be extended both east and west beyond the Locally Preferred Alternative (LPA). Such extensions would also focus growth in urbanized areas, support regional environmental goals, and respond to the public mandate of the 1980 referendum for rail system development (Proposition A).

The LPA is that portion of the Metro Rail system which has been cleared for construction under regulations of the National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ). It encompasses a section now under construction (MOS-1), plus two additional segments: MOS-2, which has been approved for UMTA funding, and MOS-3. The LPA extends west from Union Station through the Los Angeles central business district to the intersection of Western Avenue and Wilshire Boulevard, and north along Vermont Avenue through the Cahuenga Pass and Universal City into the San Fernando Valley. The LPA is shown on Exhibit A.

In 1989, the Southern California Association of Governments conducted a system planning study for the Los Angeles County Transportation Commission which identified a Central East/West Corridor as the highest priority for an LPA extension. The purpose of this Transitional Analysis is to demonstrate that an extension to the east and west of Metro Rail can meet UMTA's cost-effectiveness thresholds and, thereby, obtain UMTA's approval to proceed with an Alternatives Analysis/Draft Environmental Impact Statement.

Accordingly, several alternatives on the west and east sides of the corridor were analyzed in detail to establish the most promising alignments for Metro Rail extensions in these two sections of the corridor. The analysis included preparing plan and profile drawings of the alignments; station site plans; construction costs, operating costs, and ridership estimates; and environmental impact assessment.

UMTA cost-effectiveness indices were calculated for the Wilshire alternative in the west side of the corridor combined with the First Street alternative on the east side, and for Pico Long with Whittier Boulevard. These two combination alternatives provide a range of patronage and cost estimates for bracketing the cost-effectiveness indices.

For both combination alternatives, the total cost per new rider is under the threshold of $10.00 required to enter Alternatives Analysis. The values are $9.71 for the Wilshire/First alternative, and $9.16 for Pico/Whittier. The federal cost per new rider for both alternatives is about $5.00.

Projections used to calculate the cost-effectiveness indices are based on conservative assumptions, so the true value of the indices should be lower than indicated. Examples of the conservative nature of the projections include:

- Ridership projections are based on a zone fare with a transfer charge, which tends to discourage patrons from switching between bus and rail. (This fare policy is currently under review.)

- Ridership projections assume continuation of present real gasoline prices, even though some experts predict that real energy prices will increase significantly.

- Networks used for ridership forecasting assumed only modest changes in the bus system. During Alternatives Analysis, a more comprehensive program of bus-rail integration will be investigated.

- Capital cost estimates include a large reserve or contingency.

- Another combination of east and west side alignments may produce better results than the two combinations tested in this study.

Since the Cost per New Rider is below the threshold value of $10.00, the Central East/West Corridor meets UMTA's tests for proceeding into a full Alternatives Analysis/Draft Environmental Impact Statement for extensions to the Metro Rail LPA in the east/west corridor.

List of Tables

List of Figures

List of Exhibits

1. Introduction

In 1989, the Southern California Association of Governments (SCAG) prepared a System Planning Study[1] which identified the Central East/West Corridor as having the highest priority for extending the Metro Rail system beyond the Locally Preferred Alternative (LPA).

The LPA is that portion of the Metro Rail system which has been cleared for construction under regulations of the National Environmental Policy Act and Council on Environmental Quality. It encompasses a section now under construction (MOS-1), plus two additional segments: MOS-2, which has been approved for Urban Mass Transportation Administration (UMTA) funding, and MOS-3. The LPA extends west from Union Station through the Los Angeles central business district to the intersection of Wilshire Boulevard and Western Avenue, and north along Vermont Avenue through the Cahuenga Pass and Universal City into the San Fernando Valley.

UMTA regulations require that a corridor in which a project is proposed for federal funding must currently have at least 15,000 daily transit riders. In addition, UMTA requires that the proposed project is estimated to have a maximum cost of $10.00 per new (additional) transit rider to qualify for advancing to Alternatives Analysis/Draft Environmental Impact Statement.

The 1989 SCAG System Planning Study demonstrated that existing daily transit ridership within the Central East/West Corridor exceeds 15,000. The purpose of this Transitional Analysis is to determine if there is a set of alternative alignments within the Central East/West Corridor that satisfies UMTA's threshold of $10.00 per new rider.

The Transitional Analysis was conducted with the participation and involvement of affected local agencies and jurisdictions. The study tasks included:

- compilation and review of existing data, procedures and policy documents;
- development of travel demand forecasts;
- engineering and capital costing of alignment alternatives and stations;
- environmental analysis of the alternatives;

---

[1] Southern California Association of Governments, *Metro Red Line Extension System Planning Study*, for the Los Angeles County Transportation Commission, August 1989.

- operations and maintenance costs; and
- evaluation of alternatives, including calculation of UMTA's cost-effectiveness indices.

The Transitional Analysis also used a great deal of information developed in 1987 in a study of alignment alternatives through East Los Angeles to connect with the I-5 Freeway Corridor.[2]

Problem Definition and Objectives

The Southern California region covers over 38,500 square miles with most of the population on less than one-tenth of the land area. The population is concentrated in the Los Angeles Basin between the San Gabriel Mountains and the Pacific Ocean, where the proposed Metro Rail extension project is located.

The system planning study defines the Central East/West Corridor; the boundaries are shown in Figure 1-1. In 1984 the corridor had a population of 1.5 million, with many of its transportation zones having population densities greater than 12,000 people per square mile. Central East/West Corridor employment was 1.3 million in 1984.

Regional population is expected to grow considerably by the year 2010, with a substantial increase occurring in the Central East/West Corridor, where jobs will be concentrated in the central business district, Wilshire area, and Hollywood. The concentration of jobs in a relatively small geographic area results in high traffic volumes, congestion, and low travel speeds.

To help address these future needs for improved accessibility and mobility, the Metro Rail system should be extended both east and west beyond the LPA. Such extensions would also focus growth in urbanized areas, support regional environmental goals, and respond to the public mandate of the 1980 referendum for rail system development.[3]

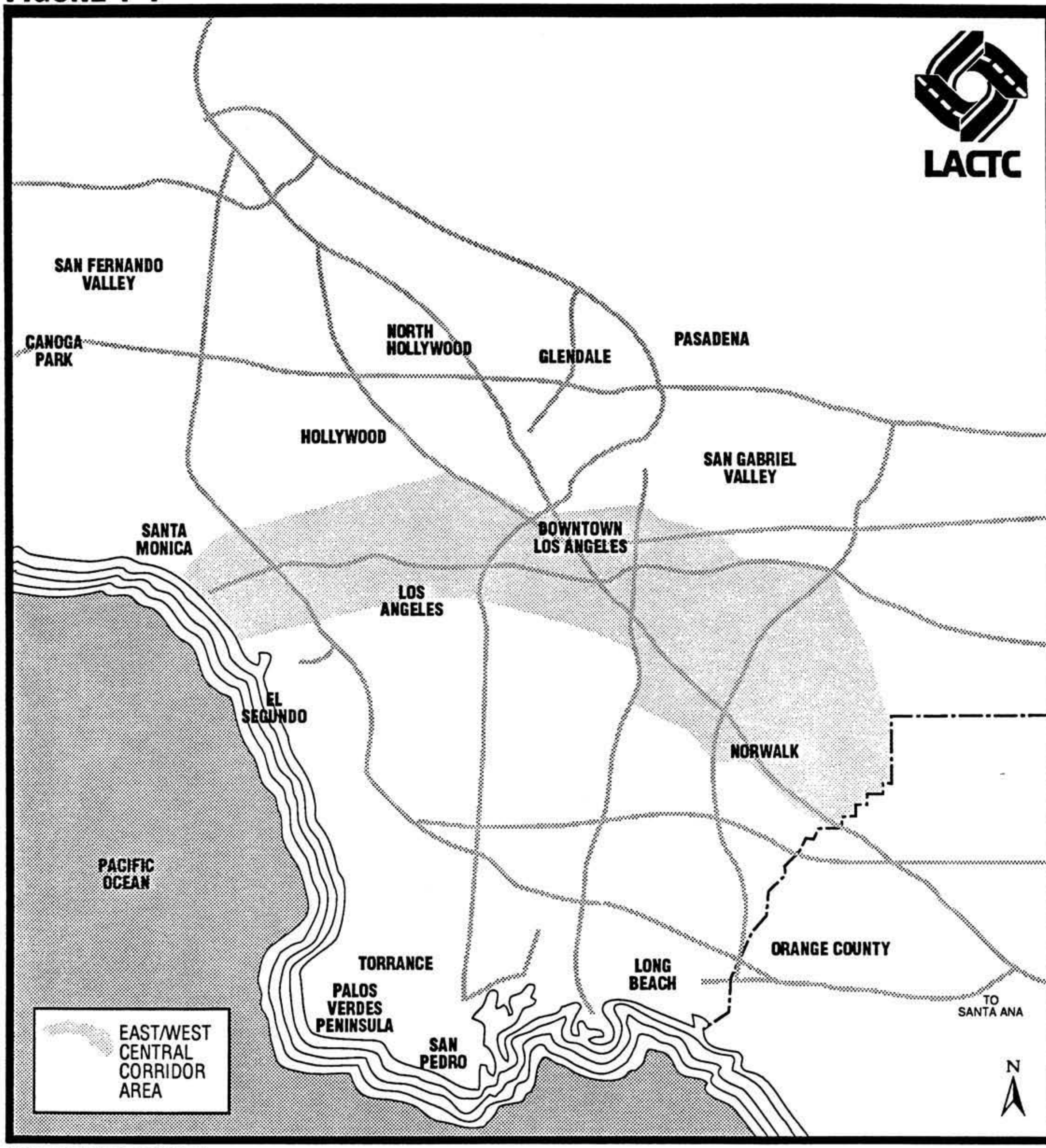
For additional information regarding project setting and need, refer to the ***FEIS, Los Angeles Rail Rapid Transit Project*** (December, 1983); the ***Draft SEIR*** (February, 1987); the ***Final SEIS/SEIR*** (July, 1989) and ***Metro Red Line Extension System Planning Study*** (August, 1989).

---

[2] The Sinclair/Tudor Group, *Study of Metro Rail Extension Through the Northern Segment of the Santa Ana Corridor*, July 1988.

[3] Proposition A calls for development of a 150-mile rail transit network in the region.

FIGURE 1-1



LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

Transitional Analysis

SOURCE: LACTC RAIL PLANNING SECTION

REGIONAL LOCATION
MAP NOT TO SCALE

MAY, 1990

2. Description of Alternatives

Nine alignment alternatives were studied and evaluated on the west side of the corridor. Four of these alignments were subsequently eliminated leaving five west side alignment alternatives. (See Appendix A for further detail.) On the east side of the corridor, four alignment alternatives were studied, three with subway and aerial variations. (Refer to Appendix D, Task 1 for additional information.)

West Side Alignment Alternatives

The west side alternatives are briefly described, as follows:

- **Wilshire Boulevard**

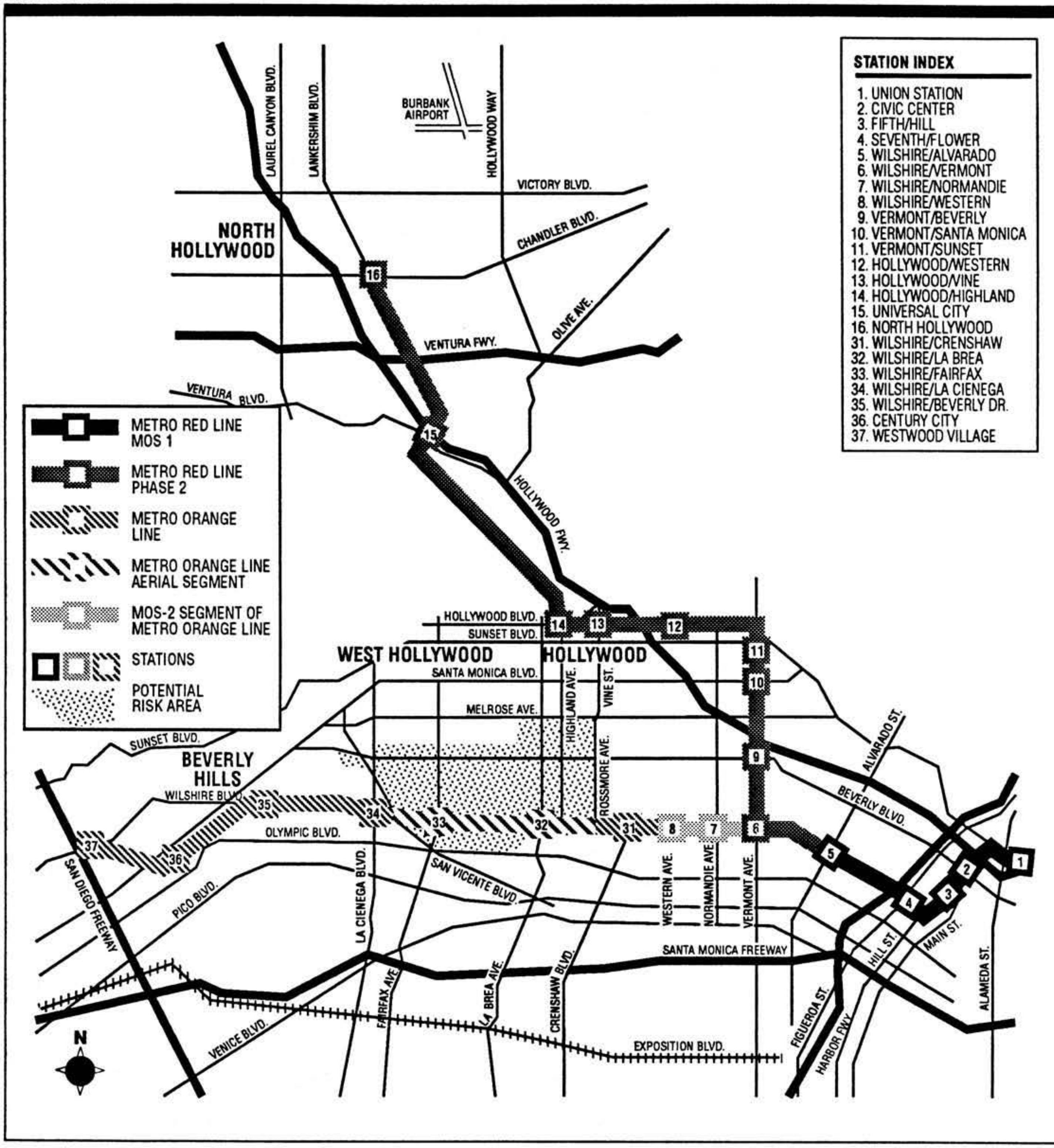
  This alignment begins in tunnel at the intersection of Wilshire Boulevard and Western Avenue, and proceeds west under Wilshire Boulevard. It continues as aerial guideway in the median of Wilshire Boulevard from Rossmore Avenue to La Jolla Avenue, then proceeds in tunnel along Wilshire Boulevard, generally turning southwest at Camden Drive to Century City, and terminating at Westwood Village.

  This alignment, shown in Exhibit A, runs for approximately 8.5 miles and has seven stations. Five stations are on Wilshire -- at Crenshaw Boulevard, La Brea Avenue, Fairfax Avenue, La Cienega Boulevard and Beverly Drive. The remaining stations are located in Century City and Westwood Village.

- **Pico Boulevard Short**

  Exhibit B shows this 9.4-mile alignment which runs in tunnel from the intersection of Wilshire Boulevard and Western Avenue, and continues west under Wilshire Boulevard, southwest along Crenshaw Boulevard, west along Pico Boulevard, and then northwest following San Vicente Boulevard back to Wilshire Boulevard. The alignment continues to Century City and terminates at Westwood Village.

EXHIBIT A



LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

TRANSITIONAL ANALYSIS

SOURCE: LACTC RAIL PLANNING SECTION

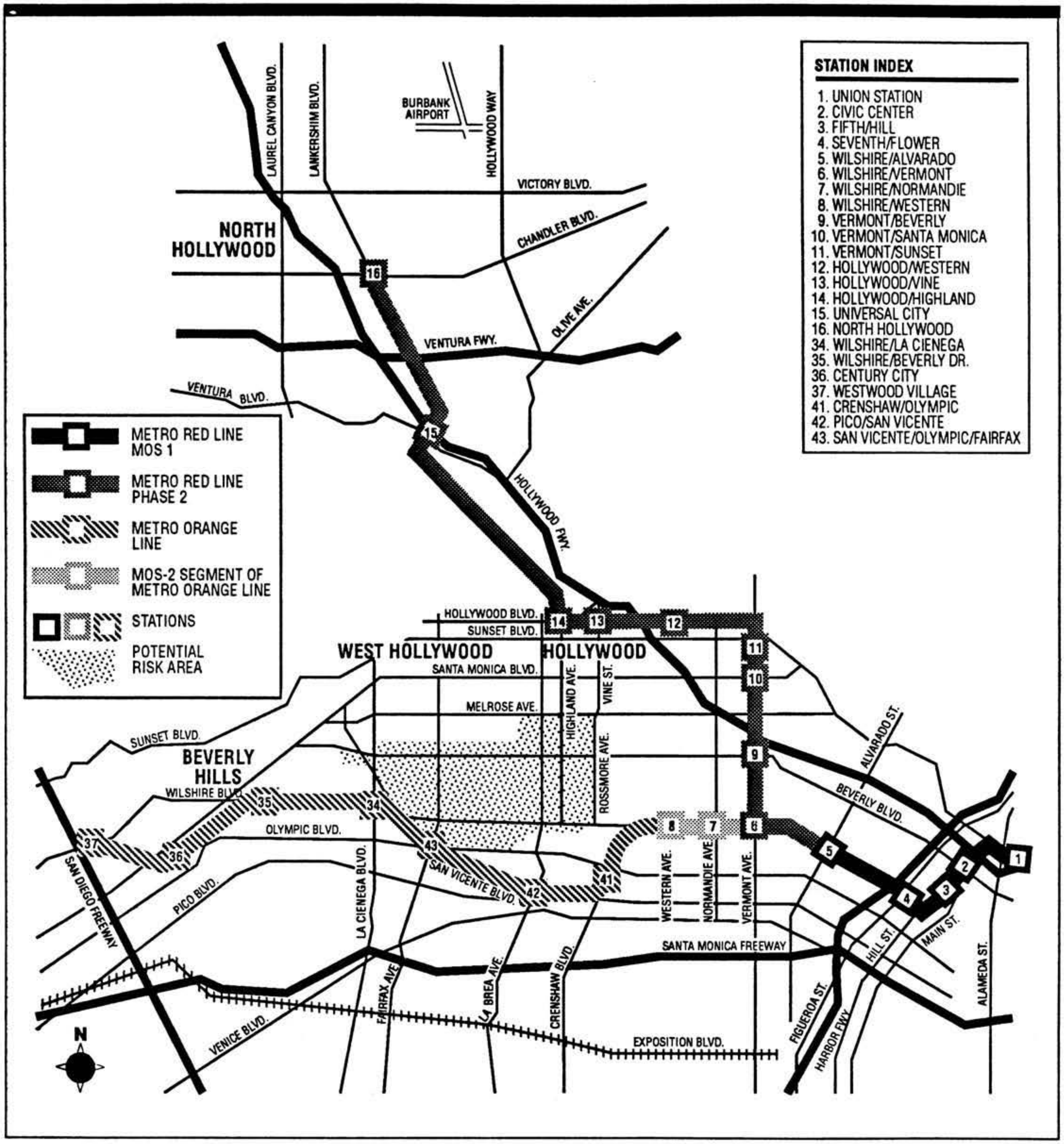
WESTERN ALIGNMENT ALTERNATIVES

WILSHIRE CORRIDOR

SCALE: 1 INCH=1.7 MILES

DATE: MAY, 1990

EXHIBIT B



LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

TRANSITIONAL ANALYSIS

SOURCE: LACTC RAIL PLANNING SECTION

WESTERN ALIGNMENT ALTERNATIVES

PICO CORRIDOR (SHORT)

SCALE: 1 INCH=1.7 MILES

DATE: MAY, 1990

This alignment has seven stations: Crenshaw Boulevard/Olympic Boulevard, Pico Boulevard/San Vicente Boulevard, San Vicente Boulevard/ Olympic Boulevard/Fairfax Avenue, Wilshire Boulevard/La Cienega Boulevard, Wilshire Boulevard/Beverly Drive, Century City and Westwood Village.

- **Santa Monica Boulevard**

This tunnel alignment extends for nearly 7.5 miles, beginning at Highland Avenue and Hollywood Boulevard, then running southwest along Santa Monica Boulevard to Century City and terminating at Westwood Village.

Exhibit C shows the five stations for this alignment -- three along Santa Monica Boulevard (at Fairfax Avenue, San Vicente Boulevard and Beverly Drive), and one each at Century City and Westwood Village.

- **Pico Boulevard Long**

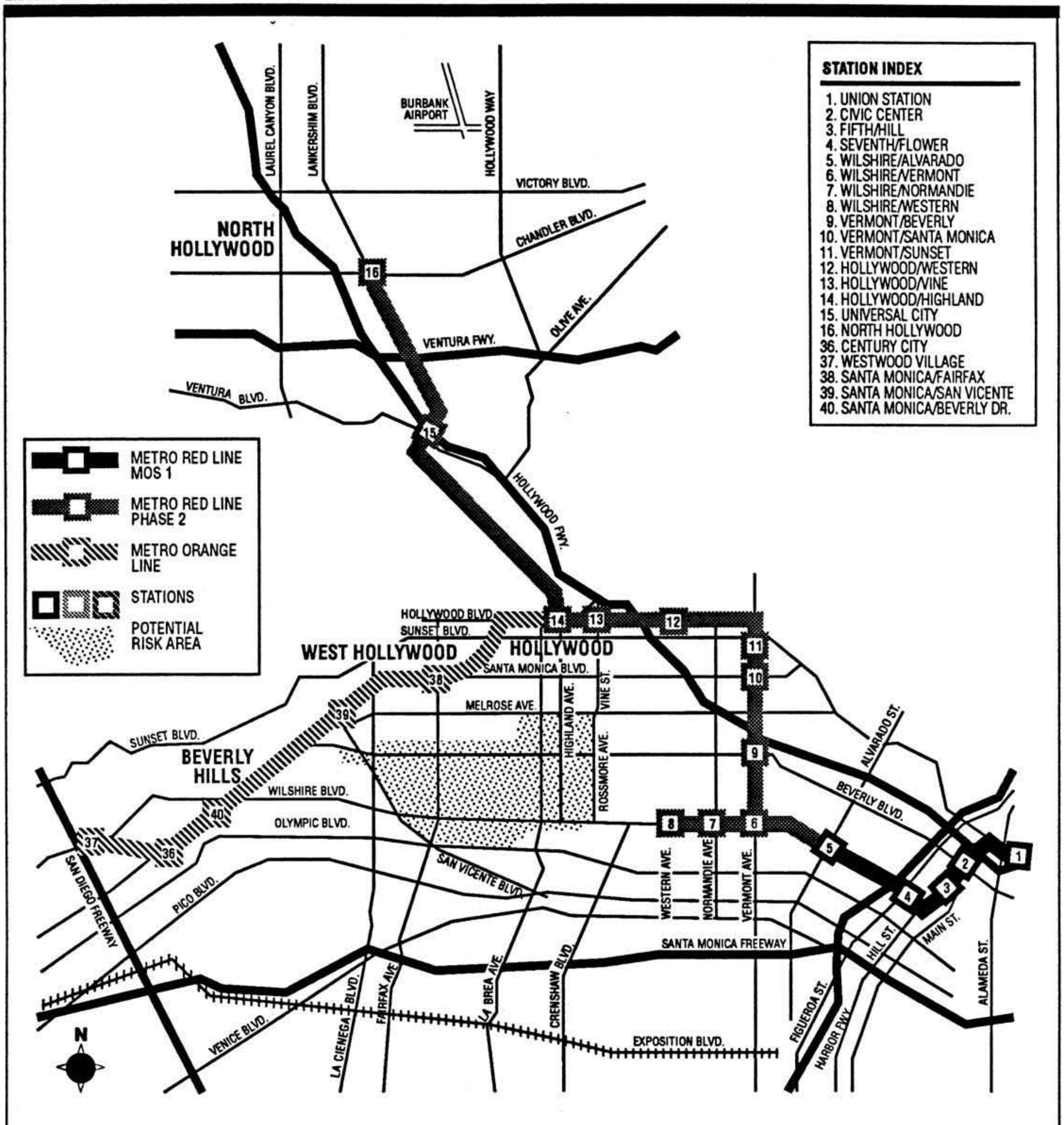
From Western Avenue, this alignment runs west in tunnel under Wilshire Boulevard, turning southwest at Crenshaw and continuing west along Pico Boulevard. It follows the Wilshire Boulevard alignment from Century City to Westwood Village.

Exhibit D shows this alignment, which has seven stations and is a little more than nine miles long. The stations are located at the intersections of Crenshaw Boulevard/Olympic Boulevard, Pico Boulevard/San Vicente Boulevard, Pico Boulevard/Fairfax Avenue, Pico Boulevard/La Cienega Boulevard, Pico Boulevard/Beverly Drive, Century City and Westwood Village.

- **Olympic Boulevard Short**

This 9-mile tunnel alignment begins at Western Avenue and Wilshire Boulevard. It turns southwest to Olympic Boulevard, continues west along Olympic Boulevard, and then northwest along San Vicente. After joining Wilshire Boulevard, it continues to Century City, terminating at Westwood Village.

EXHIBIT C



LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

TRANSITIONAL ANALYSIS

SOURCE: LACTC RAIL PLANNING SECTION

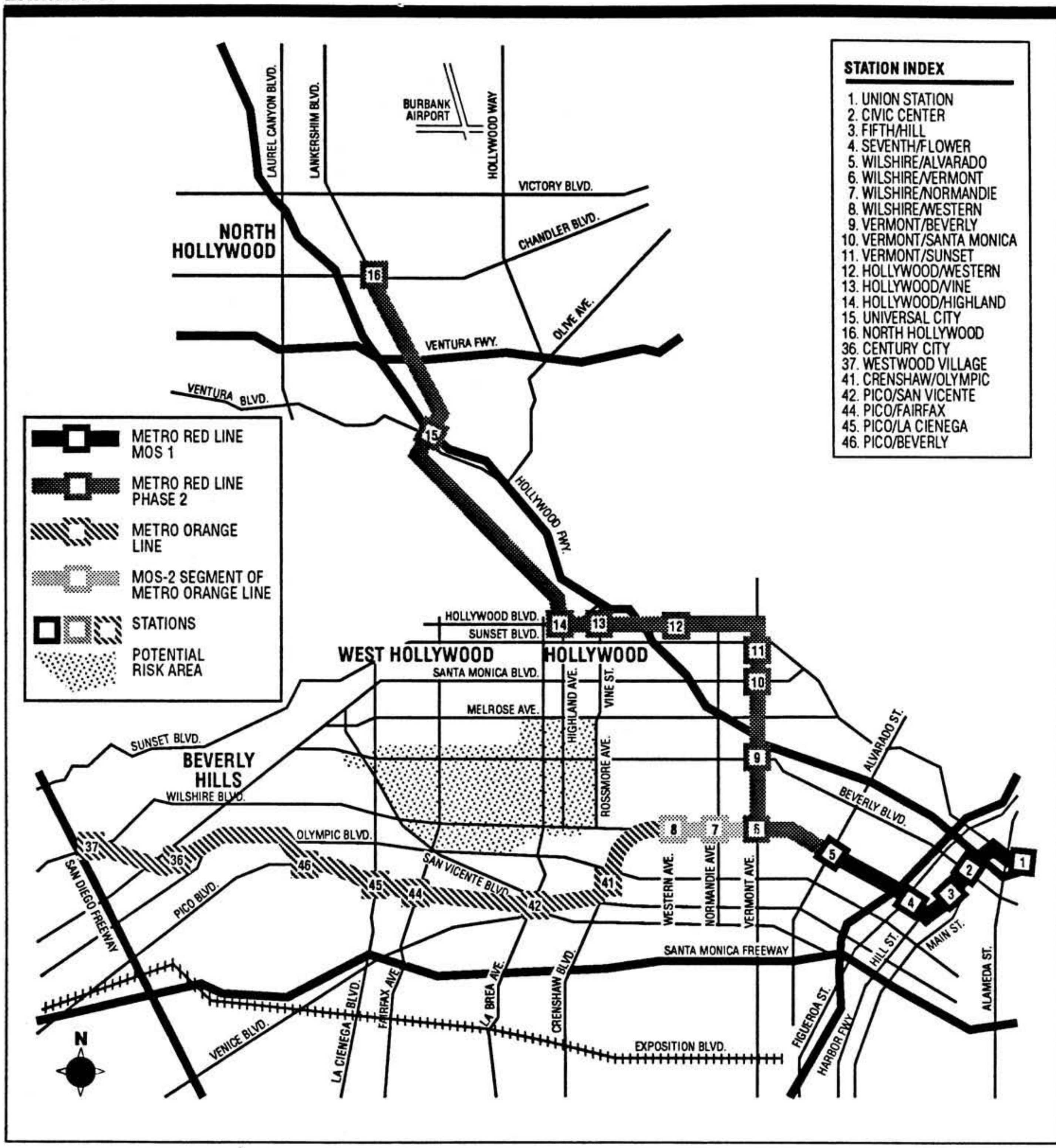
WESTERN ALIGNMENT ALTERNATIVES

SANTA MONICA CORRIDOR

SCALE: 1 INCH=1.7 MILES

DATE: MAY, 1990
Revised DEC. 1990

EXHIBIT D



LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

TRANSITIONAL ANALYSIS

SOURCE: LACTC RAIL PLANNING SECTION

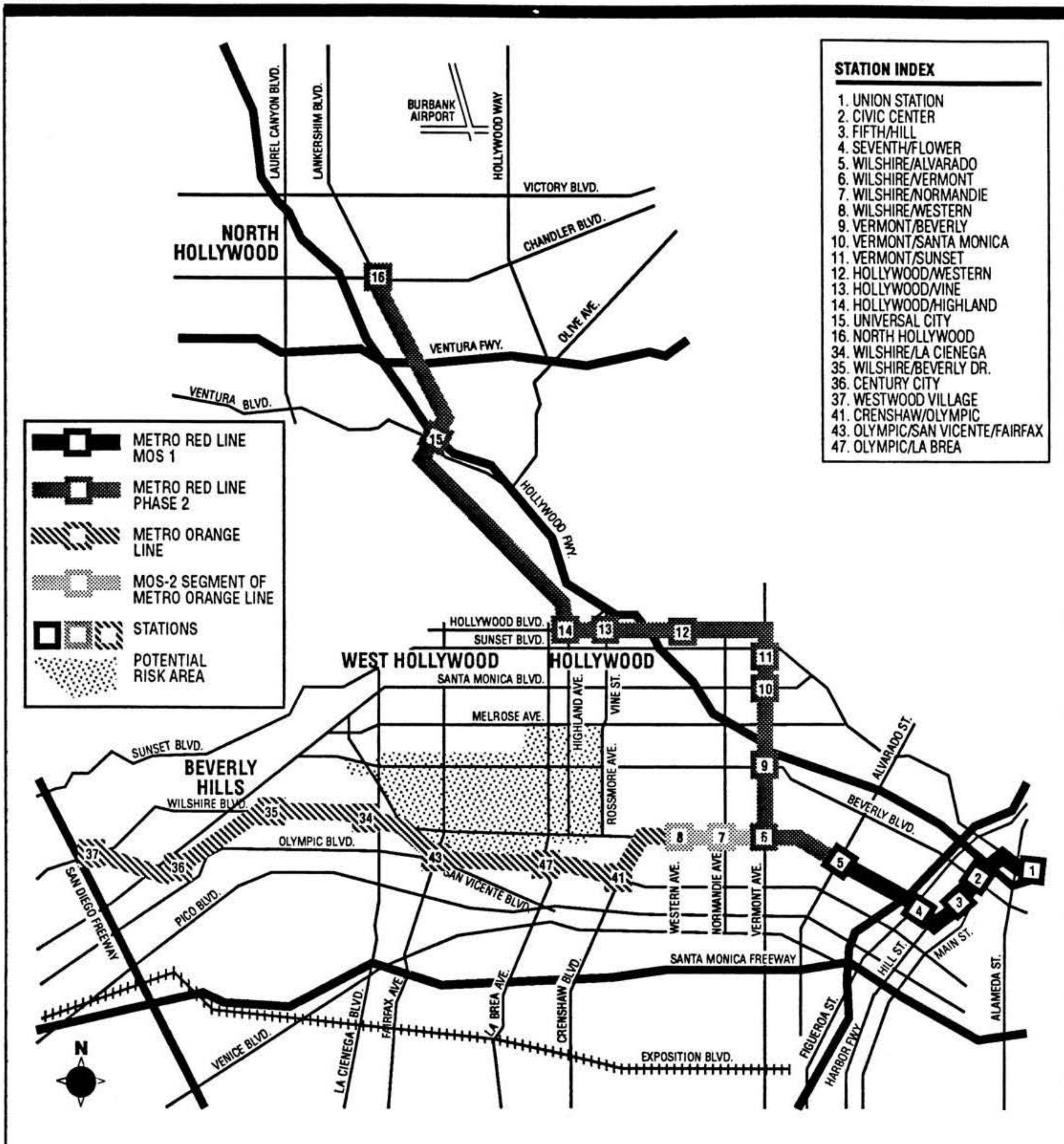
WESTERN ALIGNMENT ALTERNATIVES

PICO CORRIDOR (LONG)

SCALE: 1 INCH=1.7 MILES

DATE: MAY, 1990

EXHIBIT E



LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

TRANSITIONAL ANALYSIS

SOURCE: LACTC RAIL PLANNING SECTION

WESTERN ALIGNMENT ALTERNATIVES

OLYMPIC CORRIDOR (SHORT)

SCALE: 1 INCH=1.7 MILES

DATE: MAY, 1990

Exhibit E shows the location of the seven stations along this alignment: Crenshaw Boulevard/Olympic Boulevard, Olympic Boulevard/La Brea Avenue, Olympic Boulevard/San Vicente Boulevard/Fairfax Avenue, Wilshire Boulevard/La Cienega Boulevard, Wilshire Boulevard/Beverly Drive, Century City and Westwood Village.

Four west side alignment alternatives were eliminated from consideration after study. These alignments, and the reasons for elimination, are described in Appendix A.

East Side Alignment Alternatives

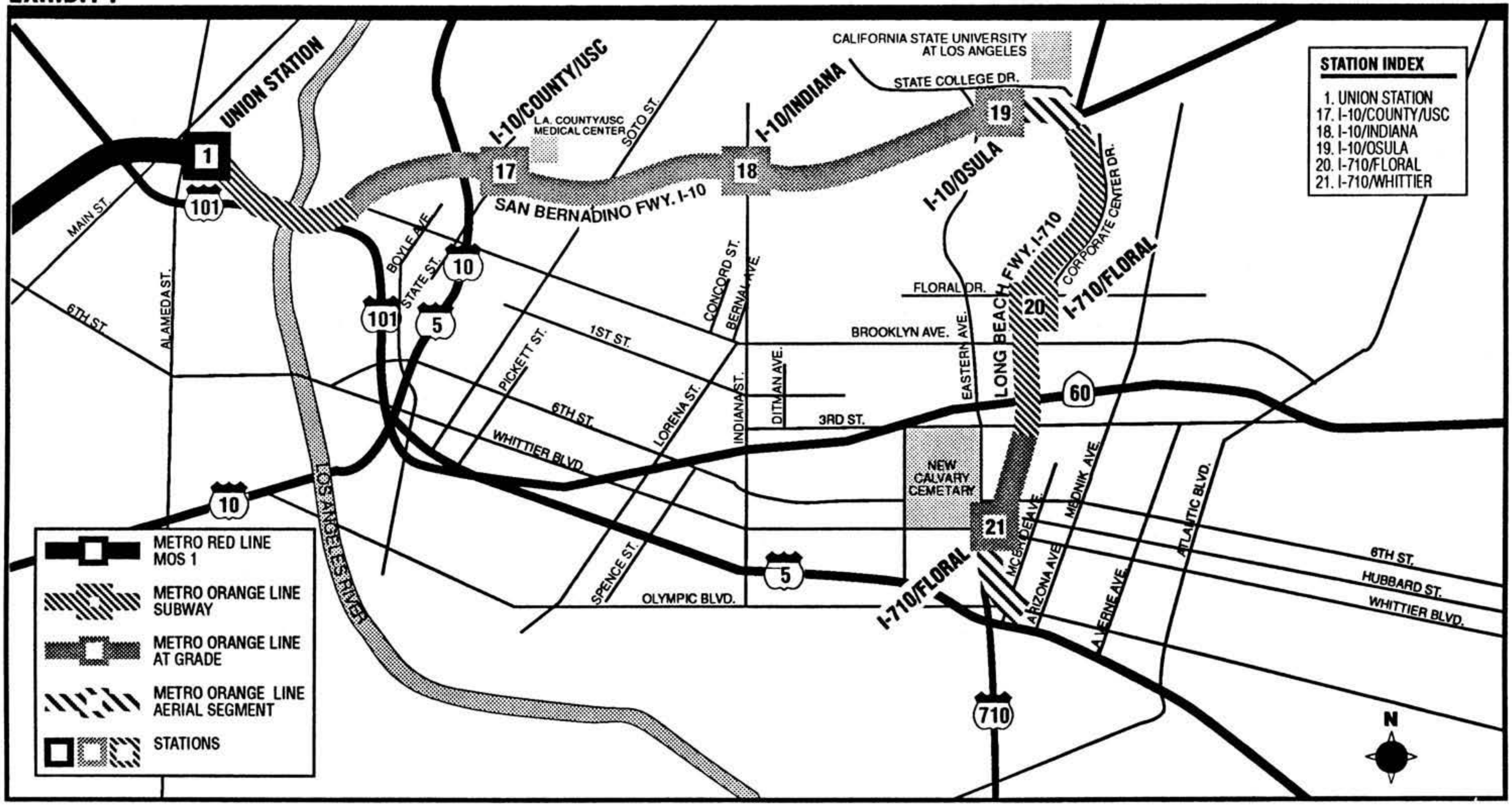
The four alignment alternatives studied on the east side are along the San Bernardino and Long Beach freeways, and along three major surface streets -- Brooklyn Avenue, First Street, and Whittier Boulevard. These alternatives are described, as follows.

- **Freeway**

  The proposed Freeway alignment would extend east from Union Station and travel along the San Bernardino Freeway (I-10). The segment between Union Station and I-10 is proposed as a subway. The segment along the I-10 is proposed to be at-grade, replacing the existing El Monte Busway. The line then makes a transition southward along the eastern periphery of the Long Beach Freeway (I-710). The transition itself would be aerial, whereas the section of the alignment between the I-10 junction and approximately Third Street would run as a subway near or within the freeway right-of-way. South of Third Street, the line would be at-grade within the freeway right-of-way up to Whittier Boulevard, beyond which it would be aerial to the Golden State-Santa Ana Freeway (I-5).

  Of the five stations proposed for the Freeway alignment, three would be located along I-10 and two along I-710. Exhibit F illustrates the alignment and station locations. The total length of this alignment is approximately 8.8 miles.

EXHIBIT F



LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

TRANSITIONAL ANALYSIS

SOURCE: LACTC RAIL PLANNING SECTION

EASTERN ALIGNMENT ALTERNATIVES

I-10, I-710 FREEWAY CORRIDOR

SCALE: 1 INCH=.07 MILE

DATE: MAY, 1990

- **Brooklyn Avenue**

Brooklyn Avenue is a non-freeway-oriented alignment, proposed with both subway and aerial alternatives. The Brooklyn alignment is proposed as a subway between Union Station and Bernal Avenue, and would be either aerial or subway from Bernal to the rail terminus. The alignment generally follows Brooklyn Avenue until it curves south at Herbert Avenue to Eastern Avenue. The alignment then makes a series of curves -- easterly to Whittier Boulevard, southerly to Whittier Boulevard, and southerly to the East Los Angeles Station.

Two stations are proposed on Brooklyn Avenue, at State and Indiana streets. One station is proposed for Whittier Boulevard at Arizona Avenue. This alignment, shown in Exhibit G, is about 6.6 miles long.

- **First Street**

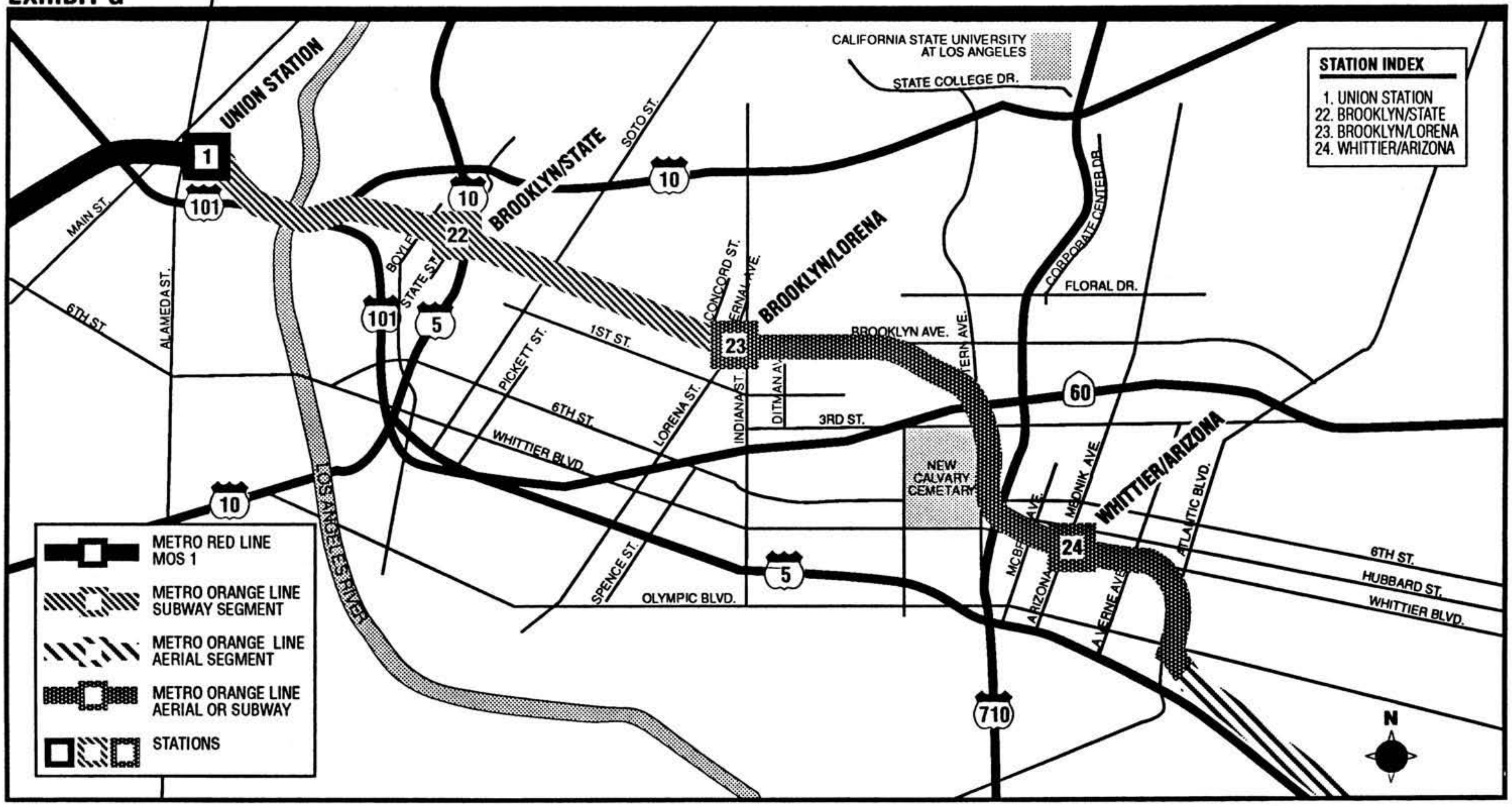
The First Street alignment is proposed as subway between Union Station and St. Louis Street, and either aerial or subway from St. Louis to the rail terminus. The alignment generally follows First Street until it takes a northeasterly to southeasterly arc from Rowan Avenue to Eastern Avenue. From Eastern Avenue, the alignment curves southeasterly to Whittier Boulevard, and southeasterly to the rail terminus. From Eastern Avenue, the First Street alignment duplicates the Brooklyn alignment.

Of the three station locations proposed, two are on First Street (between Boyle Avenue and State Street, and east of Hicks Avenue). The third station is located at Whittier Boulevard and Arizona Avenue, as in the Brooklyn alignment. This alignment is about 6.4 miles long and is shown in Exhibit H.

- **Whittier Boulevard**

The Whittier Boulevard alignment is proposed as a subway between Union Station and the rail terminus. Alternatively, this alignment could be in subway to approximately Anderson Street, and aerial from there to the end of the line.

EXHIBIT G



LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

TRANSITIONAL ANALYSIS

SOURCE: LACTC RAIL PLANNING SECTION

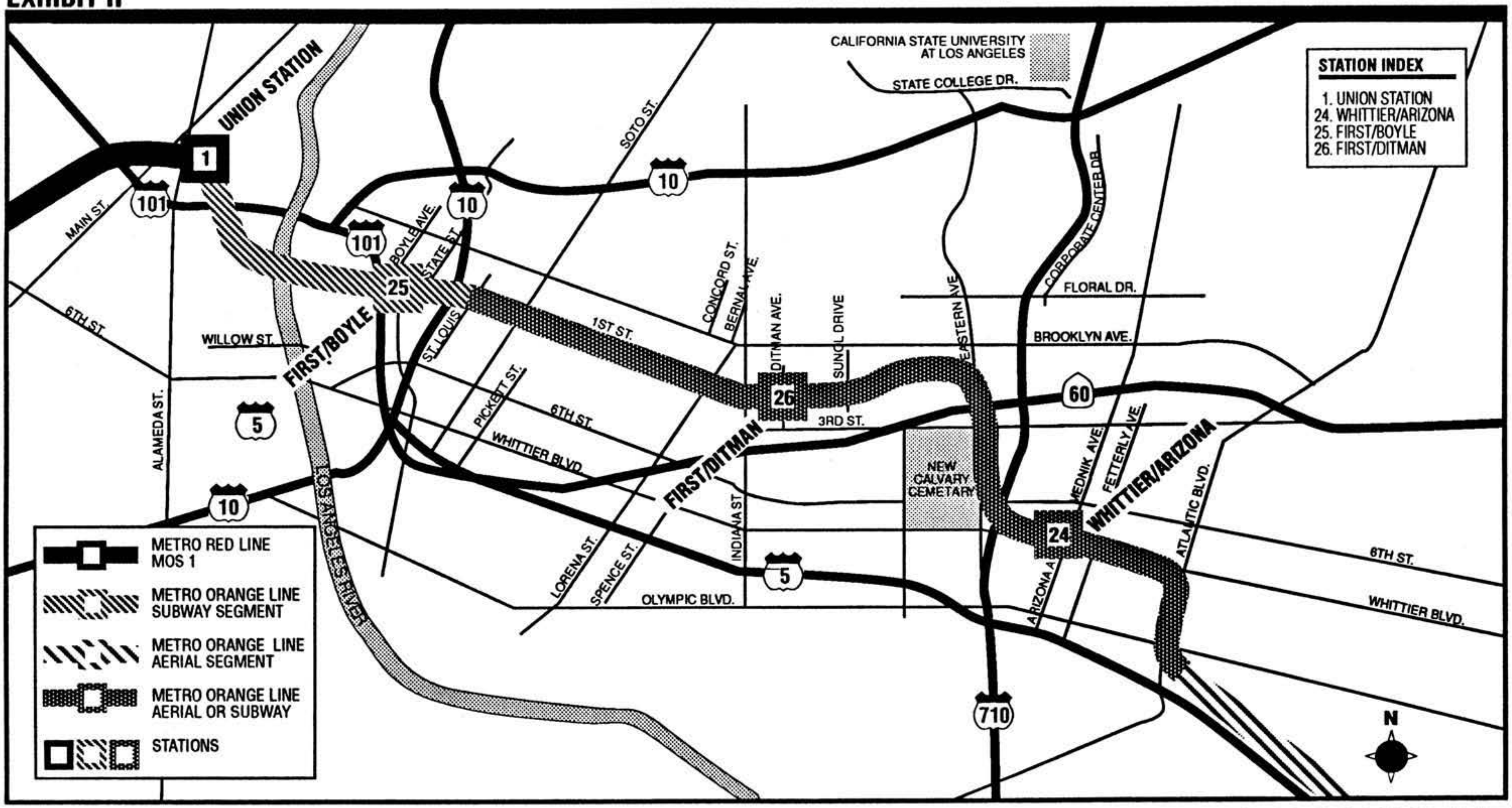
EASTERN ALIGNMENT ALTERNATIVES

BROOKLYN CORRIDOR

SCALE: 1 INCH=.07 MILE

DATE: MAY, 1990

EXHIBIT H



LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

TRANSITIONAL ANALYSIS

SOURCE: LACTC RAIL PLANNING SECTION

EASTERN ALIGNMENT ALTERNATIVES

FIRST STREET CORRIDOR

SCALE: 1 INCH=.07 MILE

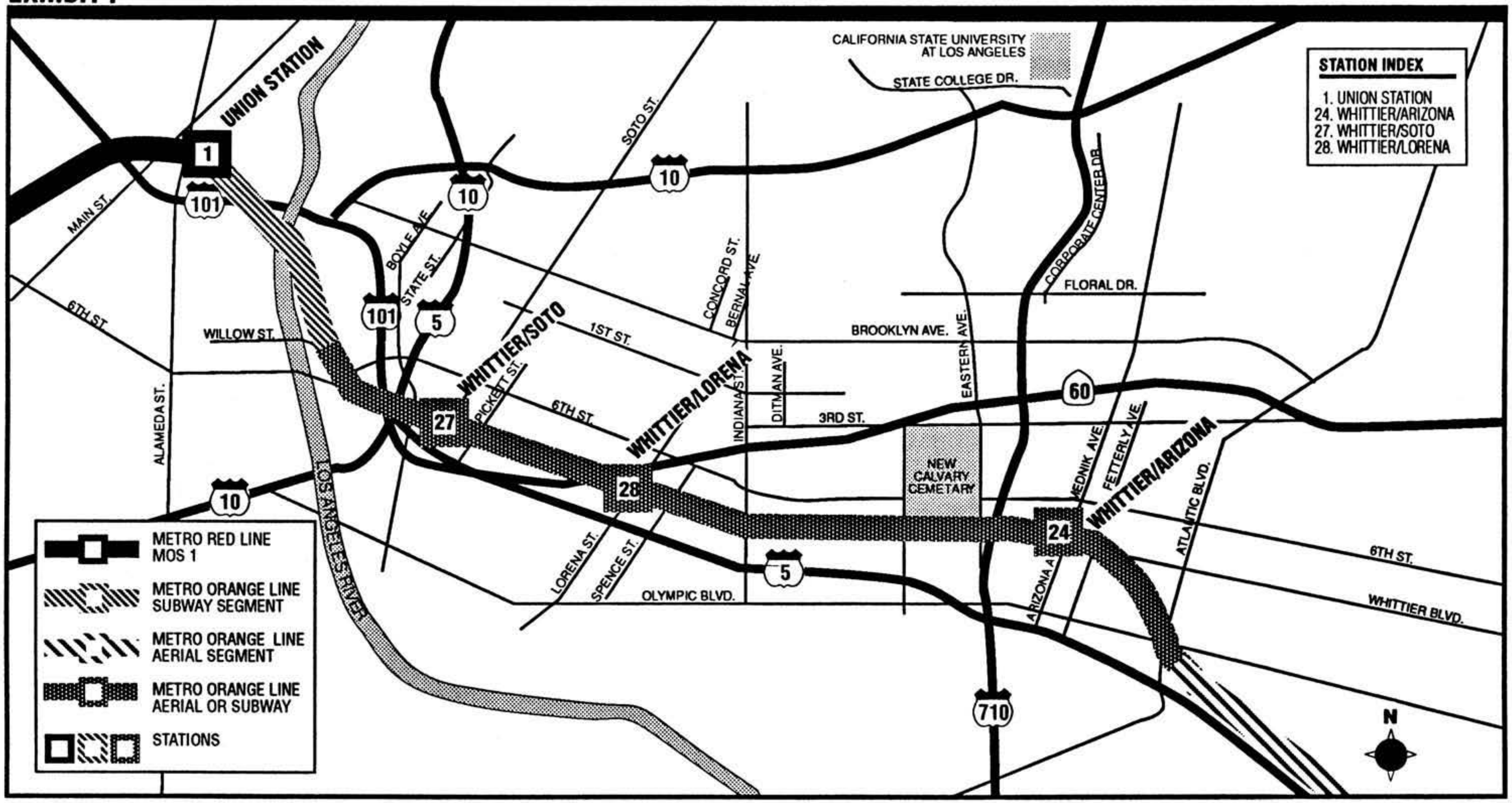
DATE: MAY, 1990

The alignment generally follows Whittier Boulevard, but takes a southeasterly curve after the Whittier/Arizona Station to the rail terminus. The length of this alignment is approximately 6.4 miles.

Three station locations are proposed, all on Whittier Boulevard, at Soto Street, Indiana Street and Arizona Avenue. The Whittier Boulevard alignment is illustrated in Exhibit I.

The alignments described above were developed in the 1988 study by the Sinclair/Tudor Group. More recent studies by the Southern California Rapid Transit District (SCRTD) have considered an extension to the southeast to join the I-5 corridor. Patronage forecasts for this study assumed an additional station at I-5 and Garfield Avenue. Capital and operating cost forecasts were generated which also reflected this one-station extension. Although detailed environmental studies are incomplete, the line is proposed to run alongside I-5, an existing transportation corridor.

EXHIBIT I



LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

TRANSITIONAL ANALYSIS

SOURCE: LACTC RAIL PLANNING SECTION

EASTERN ALIGNMENT ALTERNATIVES

WHITTIER BLVD. CORRIDOR

SCALE: 1 INCH=.07 MILE

DATE: MAY, 1990

3. Capital Cost Estimates

Methodology

Capital cost estimates for the Metro Rail alternatives are based on unit costs derived from actual bids received on the first phase (MOS-1) of Metro Rail. Real estate estimates developed by LACTC staff were also based on MOS-1 experience. These unit costs were validated by comparison with the budget estimates for MOS-2, included in the recently-approved full-funding agreement with UMTA.

The unit costs derived from Metro Rail bids are the result of an evaluation by the cost-estimating personnel of SCRTD and the Metro Rail Transit Consultants, and were prepared following a work breakdown structure common to the rapid transit industry. (The work breakdown structure provides a checklist to ensure that the total scope of the project is covered.)

These unit costs are shown in Table 3-1, and are self-explanatory, except as noted below.

- Since SCRTD used 1985 as the base year for capital costs, the unit costs derived by MRTC/SCRTD were inflated to 1990 using the ratio of the **Means Construction Cost Index** for January 1990 (213.4) to the average for 1985 (189.1). Accordingly, SCRTD's unit costs were inflated by a factor of 1.13.

- For vehicle costs, a unit cost of $1.4 million was used based on the bid received by SCRTD for MOS-1 in 1988. The unit cost was derived from the contract option for 42 additional cars at a total cost of $58 million. The vehicle unit cost may vary from that assumed in these estimates, depending on the size of a new order. However, the project reserve allowance (25%) should cover such variation.

- Unit costs for guideway construction are based on twin-bore (two-track) tunnels. Guideway costs include site preparation and concrete work, tunnel liners, vent shafts, walkways, cable tray supports, special structures, and utility relocation.

- Station unit costs are based on cut and cover construction for a 450-foot long center platform station with two mezzanines. Including ancillary rooms at the ends of the platform, the box for the station would be 560 to 590 feet long. This station design is conservative, since final design may determine that a single mezzanine will suffice for certain stations. Station costs include site preparation and concrete work, surface road reconstruction, special structures, and utility relocation.

- SCRTD's estimates for train control, communications and traction power are lump sum. To derive unit costs for these items, formulae were developed using regression analysis to determine the correlation between driving variables (e.g., route length) and the corresponding cost of systemwide equipment, as originally estimated for each segment by SCRTD. The regression analysis for train control costs was based on two independent variables -- route feet (RF) and number of stations (STA). The cost equation is as follows:

  $$\text{Train control} = \$8{,}067{,}000 + \$218 * RF + \$512{,}000 * STA$$

  The regression analysis for traction power costs was also based on RF and STA, as follows:

  $$\text{Traction power} = \$295 * RF + \$302{,}000 * STA$$

The adjusted unit costs were then applied to the appropriate quantities (e.g., miles of guideway construction by type, stations by type, etc.) in the alternative alignments. The quantities for two west and two east side alternatives are listed in Table 3-2. Cost estimates for all five west side and four east side alignments are in Appendix A.

Allowances for testing and operations mobilization (2.5%) and owners insurance (8%) were added to the construction and equipment procurement costs. The allowances, expressed as percentages of construction and procurement costs, are also based on LACTC's and SCRTD's experience.

Right-of-way costs are then added (see discussion of methodology below).

An allowance for project services was then added to the total of all previous items. This allowance of 25% includes design, construction management, and agency staff. Finally, a project reserve or contingency allowance (25%) was applied to the sum of all cost items above.

Real Estate Costs

LACTC staff developed real estate estimates for the west side alignment alternatives using (1) land value, (2) property improvements, and (3) relocation and goodwill costs. Approximately 10 percent of the land value was added for legal, escrow, title and appraisal costs. Valuations were prepared for off-street and corresponding in-street station locations for each specific site. Property required for off-street locations would be more extensive, but could produce significant return on investment through joint development. In addition to parking facilities, the property required for in-street stations would include acquisitions for entrances, emergency exits, and ventilation shafts which protrude beyond the street right-of-way. Real estate costs incorporated in the capital cost estimates reflect in-street station and line construction, where applicable. Real estate costs do not reflect value capture.

Real estate estimates for the east side alignment alternatives were prepared in 1988 by the Sinclair/Tudor Group. The east side alignment alternatives assume all-subway construction for both the First Street and the Whittier Boulevard alignments, except for the last 1.2 miles of both alignments which would be in the I-5 right-of-way. Real estate estimates for the east side alternatives were prepared in 1988 by the Sinclair/Tudor Group. These estimates were factored to 1990 at a rate of four percent per year, with an added allowance for an additional station at I-5/Garfield Avenue.

Capital Costs of Alternatives

For the five west side alternatives, capital cost estimates were prepared based on the unit costs discussed above and the quantity take-offs from the alignments developed in this study. The west side alternatives range from about $900 million for the Santa Monica alignment to $1.2 billion for Pico Long. Both figures are in 1990 dollars.

For the four east side alternatives, capital cost estimates were prepared by applying the unit costs discussed above to the quantities calculated in 1988 by the Sinclair/Tudor Group. The east side alternatives range from $940 to $970 million, in 1990 dollars.

Capital costs were calculated for all nine alternatives in the west and east side extensions, and are presented in Appendix A. Based on these costs, two east/west alignment combinations were chosen for patronage simulation -- Wilshire/First Street and Pico

Long/Whittier. These two combination alternatives provide a range of patronage and cost estimates for bracketing the cost-effectiveness indices.

Table 3-2 lists the quantities for various types of construction, along with the estimated number of vehicles (see discussion of operating plans in Section 5). Table 3-3 lists the resulting estimates of facility and equipment costs. Table 3-4 shows the summary of facility, system, and overhead costs for each of the selected alternatives on both west and east sides, along with the combined costs. All capital cost estimates are in 1990 dollars.

Metro Rail Extension
Transitional Analysis

Table 3-1. Capital Costs -- Unit Cost List

Item	Code	Unit Cost ($1990)	Unit
Guideway Costs			
Tunnel Construction	1	$5,700	RF
Tunnel Construction (mountains)	2	$9,000	RF
C&C w/pocket track (shallow)	3	$14,100	RF
C&C w/crossover (deep)	4	$30,500	RF
Transition (subway/aerial)	5	$5,700	RF
C&C 2-track (shallow)	6	$14,100	RF
Aerial Guideway Construction	10	$4,400	RF
Aerial Pocket Track	11	$0	Each
Aerial Tailtracks (2)	12	$2,260,000	Each
Station Costs			
Subway Station in C&C (560')	20	$31,010,000	Each
Subway Station in C&C (590')	21	$32,670,000	Each
Subway Station (over/under w/turnout	23	$84,750,000	Each
Aerial Station	30	$10,170,000	Each
Aerial (with X-over)	31	$4,600	LF
Systemwide Equipment Costs			
Trackwork (incl. special work)	50	$450	RF
Escalator/Elevator	51	$2,750,000	Station
Signs/Graphics	52	$288,000	Station
Fans/Air Handling/UPS	53	$2,150,000	Station (sub)
Train Control	54	(1)	RF & Station
Traction Power	55	(2)	RF & Station
Vehicles	56	$1,400,000	Each
Communications	57	(3)	RF & Station
Fare Collection	58	$1,330,000	Station
Other Costs			
Testing & Ops. Moblization	TEST	2.50%	of Total Capital
Insurance	INSUR	8.00%	of Total Capital
Right-of-Way		INPUT	
Proj. Service (Design, CM, Agency)	SERV	25.00%	of Total Capital incl ROW
Contingency (Project Reserve)	CONT	25.00%	of all above

Notes:
(1) Train Control Cost = $8,067,000 + ($218 * RF) + ($512,000 * STA)
(2) Traction Power Cost = ($295 * RF) + ($990,000 * STA)
(3) Communications Cost = ($206 * RF) + ($302,000 * STA)
(4) 1985 unit costs inflated to 1990 dollars using 13% increase in Engineering Construction Index, 1985-1990.

Prepared by Manuel Padron & Associates

18-Apr-90
MRTACAP2

Metro Rail Extension
Transitional Analysis

Table 3-2. Facility Cost Input Quantities

Item	Extension Alternatives: Western – Wilshire	Western – Pico Long	Eastern – First St.	Eastern – Whittier
Distances in Route Foot Feet (RF):				
Tunnel Construction	27,200	43,410	26,860	26,213
Tunnel Construction (mountain)	0	0	2,500	2,500
C&C w/Crossover (deep)	410	410	1,580	1,580
Transition (subway/aerial)	2,100	0	0	0
C&C 2-Track (shallow)	1,100	0	700	0
Aerial Guideway Construction	9,920	0	6,200	6,200
Subway Station in C&C (560')	0	0	3	3
Subway Station in C&C (590')	5	7	0	0
Aerial Station	2	0	1	1
Total RF	44,860	47,950	40,110	38,763
Total Stations	7	7	4	4
Add'l. Vehicles	46	46	35	35
Total Miles	8.50	9.08	7.60	7.34

Prepared by Manuel Padron & Associates

18-Apr-90
MRTACAP2

Metro Rail Extension
Transitional Analysis

Table 3-3. Facility & Systems Costs
(1990 Dollars)

	Extension Alternatives			
	Western		Eastern	
Item	**Wilshire**	**Pico Long**	**First St.**	**Whittier**
Facilities				
Tunnel Construction	$155,040,000	$247,437,000	$153,102,000	$149,414,100
Tunnel Construction (mountain)	$0	$0	$22,500,000	$22,500,000
C&C w/Crossover (deep)	$12,505,000	$12,505,000	$48,190,000	$48,190,000
Transition (subway/aerial)	$11,970,000	$0	$0	$0
C&C 2-Track (shallow)	$15,510,000	$0	$9,870,000	$0
Aerial Guideway Construction	$43,648,000	$0	$27,280,000	$27,280,000
Subway Station in C&C (560')	$0	$0	$93,030,000	$93,030,000
Subway Station in C&C (590')	$163,350,000	$228,690,000	$0	$0
Aerial Station	$20,340,000	$0	$10,170,000	$10,170,000
Guideway Cost	$238,673,000	$259,942,000	$260,942,000	$247,384,100
Station Cost	$183,690,000	$228,690,000	$103,200,000	$103,200,000
Total Facilities Cost	$422,363,000	$488,632,000	$364,142,000	$350,584,100
Systems				
Trackwork	$20,187,000	$21,577,500	$18,049,500	$17,443,350
Escalator/Elevator	$19,250,000	$19,250,000	$11,000,000	$11,000,000
Signs/Graphics	$2,016,000	$2,016,000	$1,152,000	$1,152,000
Fans/Air Handling	$10,750,000	$15,050,000	$6,450,000	$6,450,000
Train Control	$21,430,480	$22,104,100	$18,858,980	$18,565,334
Traction Power	$20,163,700	$21,075,250	$15,792,450	$15,395,085
Communications	$11,355,160	$11,991,700	$9,470,660	$9,193,178
Fare Collection	$9,310,000	$9,310,000	$5,320,000	$5,320,000
Auxiliary Vehicles	$0	$0	$0	$0
Misc. Equipment	$1,700,000	$1,700,000	$1,700,000	$1,700,000
Add. Yard Track	$1,720,000	$1,720,000	$1,720,000	$1,720,000
Total Systems Cost	$117,882,340	$125,794,550	$89,513,590	$87,938,947

Orange Line Extension
Transitional Analysis

Table 3-4. Capital Costs

	Extension Alternatives			
	Western		Eastern	
	Wilshire	Pico Long	First St.	Whittier
Facilities: Guideways	$238,673,000	$259,942,000	$260,942,000	$247,384,100
Stations	$183,690,000	$228,690,000	$103,200,000	$103,200,000
Total	$422,363,000	$488,632,000	$364,142,000	$350,584,100
Systems	$117,882,340	$125,794,550	$89,513,590	$87,938,947
Vehicles	$64,400,000	$64,400,000	$49,000,000	$49,000,000
Subtotal	$604,645,340	$678,826,550	$502,655,590	$487,523,047
Test & Oper. Mobiliz. (2.5%)	$15,116,134	$16,970,664	$12,566,390	$12,188,076
Owners Insurance (8%)	$48,371,627	$54,306,124	$40,212,447	$39,001,844
Right-of-Way	$53,663,741	$40,108,156	$65,035,053	$62,784,243
Subtotal	$721,796,842	$790,211,494	$620,469,480	$601,497,210
Project Service (25%)	$180,449,210	$197,552,873	$155,117,370	$150,374,303
Subtotal	$902,246,052	$987,764,367	$775,586,850	$751,871,513
Project Reserve (25%)	$225,561,513	$246,941,092	$193,896,712	$187,967,878
TOTAL COST	$1,127,807,565	$1,234,705,459	$969,483,562	$939,839,391
Miles	8.50	9.08	7.60	7.34
COST PER MILE ($million)	$133	$136	$128	$128

Wilshire/First Combination	$2,097,291,127
Pico/Whittier Combination	$2,174,544,850

NOTES:
(1) 1985 unit costs inflated to 1990 dollars.
(2) ROW cost for western extensions estimated by LACTC (memo from J. Wiley to J. Sowell, 2/12/90); ROW cost for eastern extensions estimated by Sinclair/Tudor (July 1988), inflated by 4.0% annual inflation rate for two years to 1990 dollars; plus $10 million for I-5/Garfield Station.

4. Travel Demand Forecasts

Travel demand forecasts are used to evaluate the effectiveness of each alternative in reducing travel time and attracting new riders. They are important elements in UMTA's procedure for determining the overall cost effectiveness of a proposed project, since the key cost-effectiveness index is based on the cost of attracting new transit riders.

The future travel demand forecasts for the Metro Rail alternatives were estimated using SCRTD's travel simulation procedures. These techniques are the same (with several enhancements) as those used in prior patronage forecasts for MOS-1 and Phase 2 environmental analyses and Metro Rail system design. SCRTD's travel forecasting methodology is the only one approved by UMTA for detailed project-level transit analysis in the Los Angeles region. This forecasting process contains a set of models specifically calibrated for Los Angeles conditions and is incorporated within the Urban Transportation Planning System (UTPS) created by the U.S. Department of Transportation.

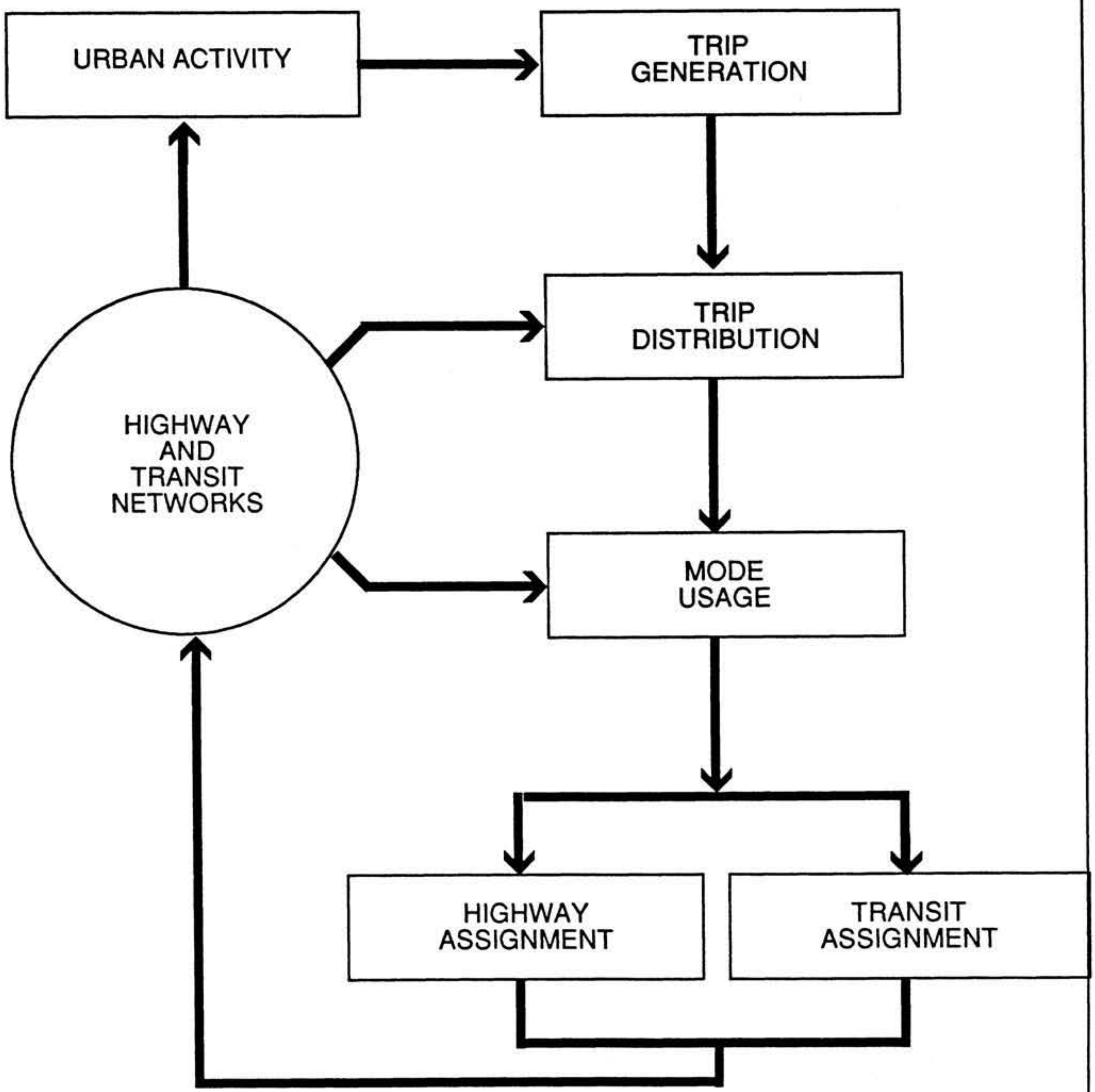
The travel demand forecasting process consists of four basic elements:

- trip generation, which forecasts the number of trips that will be made;
- trip distribution, which determines where the trips will go;
- mode usage (choice), which predicts how the trips will be divided among the available modes of travel; and
- trip assignment, which predicts the routes that trips will take, resulting in highway system vehicle forecasts and transit system patronage forecasts.

Figure 4-1 shows the interrelationship of these elements. Urban activity forecasts provide information on the location and intensity of future activity in the area. This is the primary input to trip generation. Descriptions of the highway and transit systems define the "supply" of transportation in the area; the four model elements predict the travel "demand". The feedback arrows show how checks of earlier assumptions for travel characteristics determine if adjustments are necessary. This may be necessary if increased urban activity results in increased traffic congestion and slower travel speeds, or suggests a need for new transportation links between activity centers.

Figure 4-2 presents a sample of how the travel forecasting process works.

FIGURE 4-1



LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

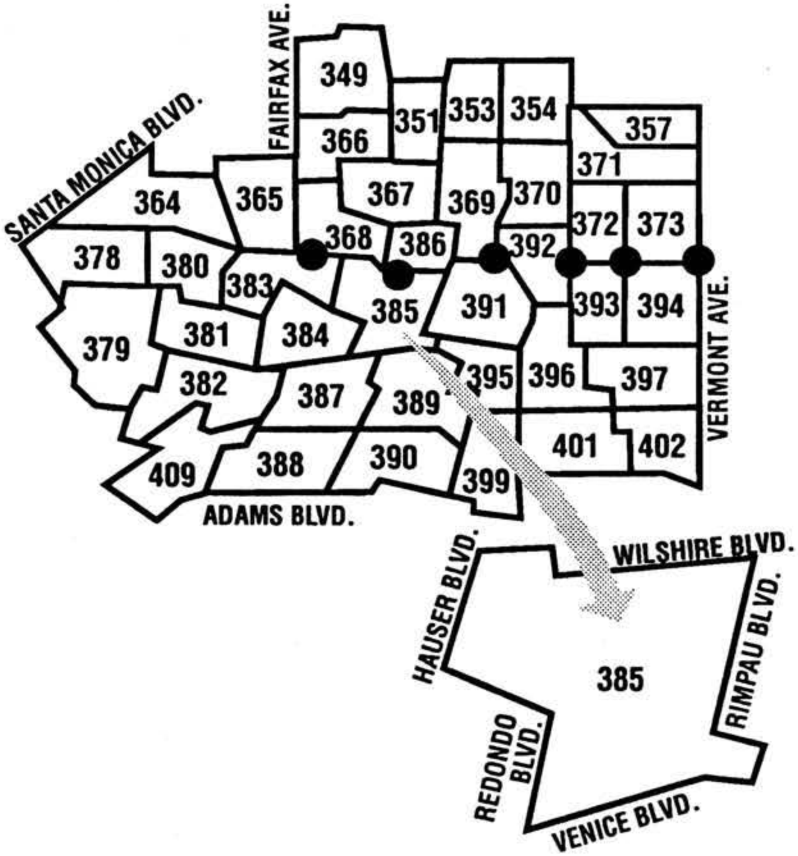
TRANSITIONAL ANALYSIS

TRAVEL FORECASTING PROCESS

SOURCE: SCRTD PLANNING DEPARTMENT

MAY, 1990

FIGURE 4-2



1. The Southern California Association of Governments (SCAG) estimated that in 1980, Zone 385 had a population of 10,985 and 4,994 jobs. The median income of people living in Zone 385 is near the median income of Los Angeles Region Transportation Study (LARTS) area.

2. Using the population estimate, the trip generation model indicates that Zone 385 produced 7,098 home based work trips. Los Angeles County will produce 4,600,814 home based work trips.

3. The trip distribution model indicates how many of the 7,098 home based work trips produced by Zone 385 will go to each of the other 1627 zones in LARTS area. This model distributes the trips in relationship to jobs available and travel time to other zones.

4. The modal split model indicates the number of trips traveling between each pair of zones which will go by transit and by auto. Of the 7,098 work trips produced by Zone 385 there were 1,278 trips or 18% involving a bus or rapid transit ride.

5. The trip assignment model indicates the route each trip takes, the number of vehicles on each highway, and the number of persons riding in each bus or rapid transit vehicle. Highway trips are loaded onto the shortest highway time path. Transit trips are loaded onto the shortest transit time path. Highway trips between 385 and downtown would use the Santa Monica Freeway while transit trips would use the rapid transit line because these trip paths are the fastest for each mode.

LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

TRANSITIONAL ANALYSIS

SOURCE: SCRTD PLANNING DEPARTMENT

HOW PATRONAGE FORECASTING MODELS WORK

MAY, 1990

SCRTD's travel simulation procedure is detailed in a report for the Los Angeles County Transportation Commission entitled, ***East Los Angeles/Santa Ana Freeway Corridor Rail Transit Patronage Analysis Technical Report*** (May, 1989). With the exception of the modifications and improvements made specifically for this study, and described in this section, the procedures remain the same.

Travel Simulation Model Modifications

Since the simulations of future patronage conducted for the earlier Metro Rail environmental reports and the LACTC East Los Angeles study, several enhancements to the transportation networks and travel simulation models have been implemented. These enhancements improve the responsiveness of the models to conditions anticipated for the Los Angeles area by the year 2010.

Highway Network

Prior travel forecasts by the SCRTD used highway simulation networks obtained from the Southern California Association of Governments (SCAG) and the California Department of Transportation (CalTrans). These networks did not reflect future year traffic congestion associated with projected future travel demand, but instead assumed that freeway capacity would be sufficiently expanded to maintain minimum "policy" speeds. This approach resulted in unrealistically high transportation system speeds for future year scenarios which reduced the competitive speed advantage of exclusive fixed-guideway transit and high-occupancy vehicle facilities. Both agencies have now altered this approach by adopting simulation procedures to reflect future year congestion through the use of capacity restraint techniques in highway assignments. Travel speeds on these networks are now more representative of the impact of increasing travel on the regional transportation system.

Highway network simulation is performed with the HNET and UROAD modules from the UTPS package.

Transit Network

Similarly, with the change in highway simulation techniques, the SCRTD is now able to reflect the impact of future year congestion on the future bus network. Prior procedures assumed the continuation of current transit travel speeds since there was no valid method available to represent the impact of congestion on future bus travel. More realistic highway speeds from the new procedure will result in slower bus speeds operating in mixed traffic.

The implication for this study is that the expected competitive speed advantage of exclusive fixed-guideway (bus and rail) transit over mixed-traffic transit service has been restored.

An additional improvement in transit simulation procedures is the inclusion of transit fares in the path-tracing algorithm, which determines how travel is made from one traffic analysis zone (TAZ) to another. Prior studies used only travel time, which implies that all trips would be made on their minimum travel time paths regardless of cost. However, this is not realistic since economically-disadvantaged travellers are more likely to take the minimum travel cost path. The trade-off between time and cost now used for the path-tracing algorithm was established during the calibration of the mode choice model and is based upon actual travel survey responses. As a result, it should be noted that this may lead to lower patronage estimates on services with higher fares (such as the rail lines in this study) since patrons from lower socioeconomic groups may opt for less expensive travel.

Transit network simulation is performed using the INET, UPATH, UPSUM, and ULOAD modules from the UTPS package.

Mode Choice

The changes in transportation network simulation, noted above, required corresponding adjustments to the mode choice models (to the bias coefficients) to maintain the calibrated shares among the six travel modes: auto drive alone, 2-person carpools, 3+ person carpools, walk/bus transit, kiss-ride transit, and park-ride transit. These adjustments were performed prior to this study and validated against observed 1985 vehicle ground counts.

Focused Travel Simulation

A specialized travel simulation technique was used for a quick, cost effective and reasonably accurate comparison of the Transitional Analysis alternatives. A sketch planning modeling procedure called the "focusing" technique was used to forecast patronage. This technique enabled the simulation process to retain the interaction of the Transitional Analysis corridor with the remaining regional transportation system, although at the expense of retaining accuracy outside the study area. This focusing technique was employed at two levels:

- a 1205-zone level which included all TAZs in the SCRTD transit service area (southern Los Angeles County and northwest Orange County) while aggregating all other zones into SCAG Regional Statistical Areas; and

- a 701-zone level which duplicates the 1205-zone level but with further aggregation of TAZs outside the 1980 Proposition A fixed-guideway corridors into "districts" that are subdivisions of Regional Statistical Areas.

The 1205-zone system was used to simulate the base Transportation Systems Management (TSM) alternative and both combination alternatives of Metro Rail extensions. These simulations provide the most accurate patronage projections of the Transitional Analysis alternatives. The 701-zone system was used in the simulation of the five western Metro Rail extensions, the two east-west combination extensions, as well as the base TSM alternative. These simulations were used primarily to determine the relative performance of the Transitional Analysis alternatives and to identify the combination alternative to be evaluated under the 1205-zone system. Figures 4-3 and 4-4 illustrate the two zone systems employed in the focusing procedure for the patronage forecasts.

Modeling Assumptions for the Year 2010

Travel demand forecasts for the year 2010 require a set of assumptions describing this future scenario. Assumptions include the base transportation system, demographic characteristics, travel factors, and economic conditions. The majority of these assumptions are projected through the use of complex forecasting models that are based upon currently observed trends and/or local and regional policies. Current values are assumed to continue for parameters that cannot be projected with any reasonable degree of confidence.

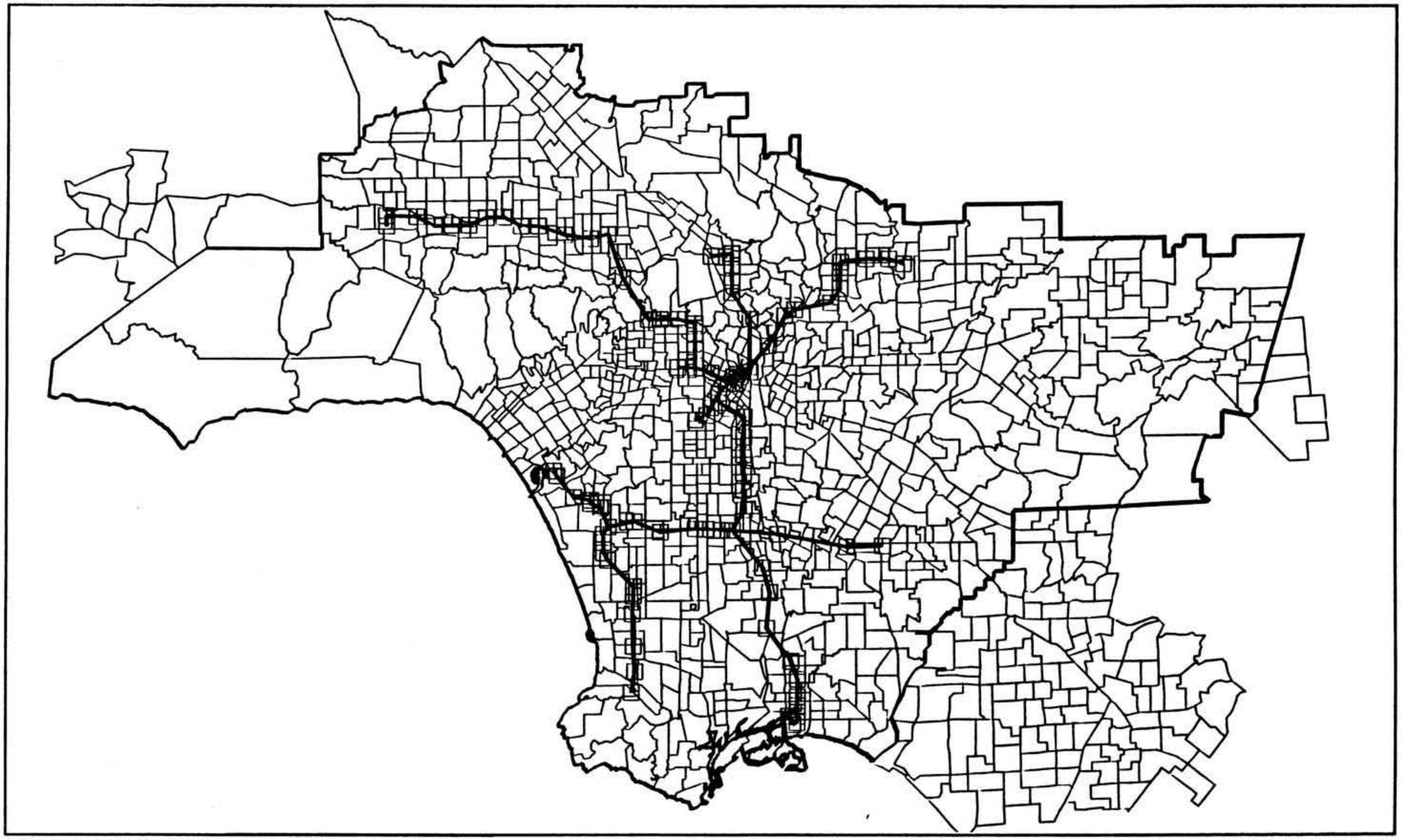
Base Transit Network

For modeling purposes, the Transitional Analysis used a base transit network developed in the fall of 1989 by the District under the direction of LACTC staff. This network, assumed to be in operation by the year 2010, includes the following fixed-guideway systems based on service implementation in priority corridors:

Rail Transit Lines

- Locally Preferred Alternative from Union Station to Wilshire/Western and to North Hollywood (Metro Red Line)
- Long Beach to downtown Los Angeles (Metro Blue Line)
- Norwalk to Marina Del Rey, and Norwalk to Torrance (Metro Green Line with coastal extensions)
- North Hollywood to Canoga Park

FIGURE 4-3



LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

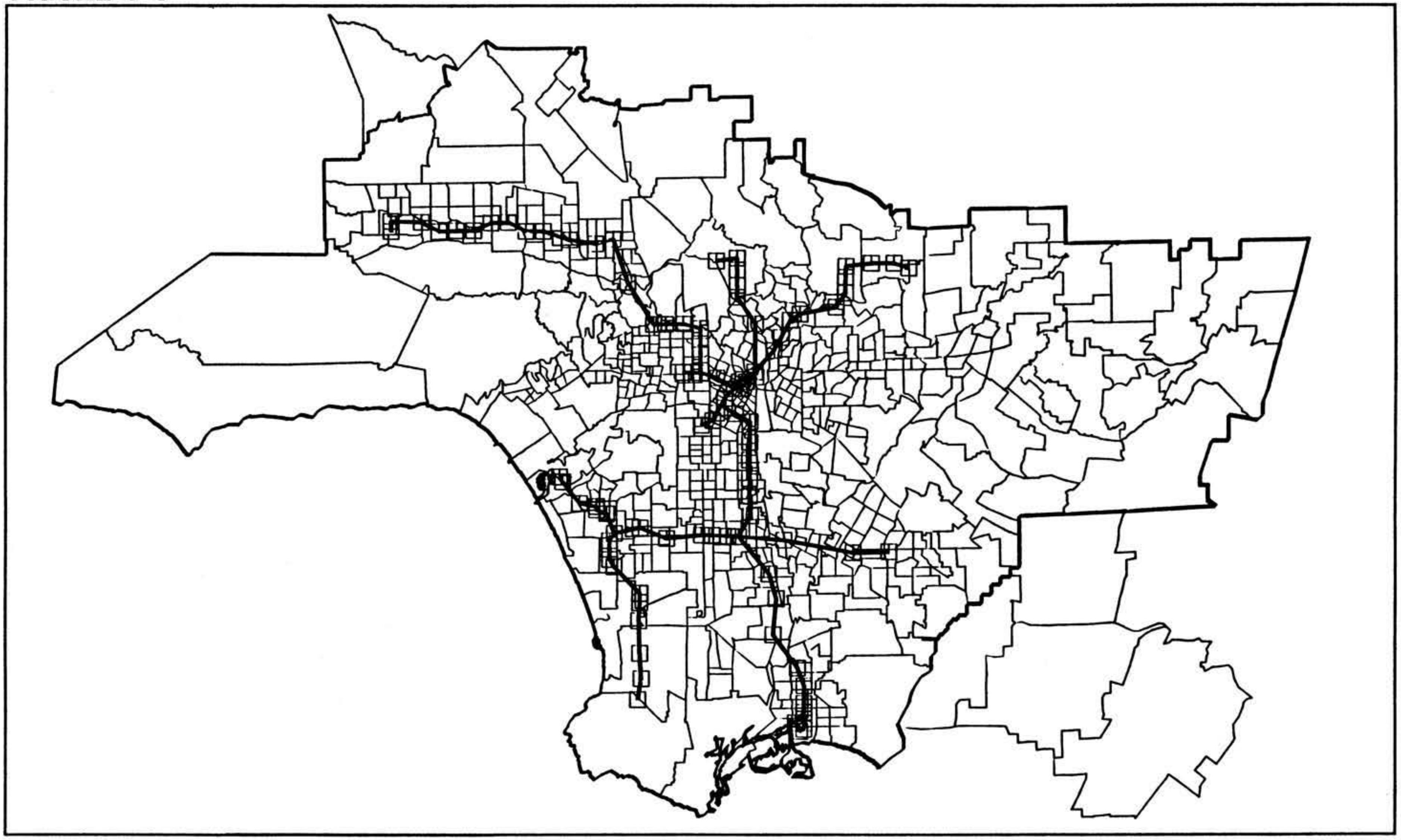
TRANSITIONAL ANALYSIS

SOURCE: LACTC RAIL PLANNING SECTION

1205–ZONE SYSTEM
AND YEAR 2010
TSM RAIL SYSTEM

MAY, 1990

FIGURE 4-4



LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

TRANSITIONAL ANALYSIS

701–ZONE SYSTEM
AND YEAR 2010
TSM RAIL SYSTEM

SOURCE: LACTC RAIL PLANNING SECTION

MAY, 1990

- Pasadena to downtown Los Angeles
- Glendale to downtown Los Angeles

Busways

- I-10, downtown Los Angeles to El Monte
- I-10, downtown Los Angeles to Artesia

Commuter Rail

- ATSF and SPTC, Los Angeles to San Bernardino County
- SPTC, Los Angeles to Ventura County
- SPTC, Los Angeles to Santa Clarita Valley

This network also contains modifications to the current bus network (for all Los Angeles County fixed-route transit services) to serve all fixed-guideway stations[4]. The rail transit systems and approximate station locations for this network are shown in Figure 4-3.

Base Highway Network

The highway networks and their characteristics were provided by SCAG, the LACTC, and CalTrans. These networks include additional improvements that are proposed to be implemented by the year 2010 according to the SCAG Regional Mobility Plan Existing Plus Funded Network and the LACTC Carpool Lane Plan including:

- I-105: new construction of the Century Freeway from Sepulveda Boulevard to I-605 including HOV lanes
- I-110: HOV lanes from downtown Los Angeles to Route 91
- I-210: HOV lanes from Route 134 to San Bernardino County
- I-10 : HOV lane extension to downtown Los Angeles
- I-405: HOV lanes from Route 90 to Orange County

[4] Southern California Rapid Transit District, *Bus/Rail Interface Design Guideline Manual*, October 1988.

Modeling Parameters

In addition to the base highway and transit networks, the travel simulation models also require a set of assumptions which describe the future year 2010 scenario. The basic assumptions and parameters, shown in Table 4-1, are used primarily in the mode choice analysis and include:

- trip-maker characteristics -- income, auto ownership, household size, and licensed driver or employed worker;
- trip characteristics -- specifically whether the trip is for work, school, shopping, recreation, etc.; and
- transportation system characteristics -- including the cost (fare, parking, gasoline); time (walking, waiting, transfer, riding, parking, and driving); and the distance of the trip for each mode available to the trip-maker.

Year 2010 Modeling Results

Results of the patronage forecasts for the Transitional Analysis alternatives are shown in Table 4-2 and in Appendix C.

701-Zone Simulations

For all west side alternatives, patronage was estimated using the (less expensive) 701-zone network. This provided a comparison between alternatives and a basis for selecting the alternatives to model with the 1205-zone network. The results are shown in Appendix C. The 701 and 1205-zone figures were used to calculate a factor for converting the 701-zone simulation results into 1205-zone simulation results. Overall regional linked transit trips will increase as much as 6.5 percent under the Transitional Analysis alternatives. (A boarding is recorded each time a person boards a vehicle, whereas a linked trip is recorded with each origin-to-destination travel and may contain several boardings to complete the travel.)

The primary transportation benefits of the Transitional Analysis alternatives are associated with home-based work trips made on rail, which increase by more than nine percent. Each of the alternatives shows an approximate 12 percent transit share of home-based work trips.

Table 4-1
Mode Choice Model Assumptions

Variable/Parameter	Source and/or Description
Highway Access Time and Distance	CalTrans
Highway Terminal Time	CalTrans
Parking Cost	SCAG: Year 2010 estimates reflect limited CBD parking supply
Percent of Zone within Transit Walking Distance	SCRTD: Percent trip-makers within 0.4-mile transit-serving zone
Auto Ownership	SCAG: Year 2010 market segmentation
Licensed Drivers	SCAG: Year 2010 market segmentation
Number of Workers	SCAG: Year 2010 market segmentation
Annual Household Income	SCAG: Year 2010 market segmentation
Highway Time and Distance by Auto Occupancy: 1, 2, 3+	SCRTD: Revised travel impedences based upon year 2010 network assignment
Transit Time and Distance by Access Mode: Walk, P&R, K&R	SCRTD: Based upon background bus network using 2010 highway link speeds: walk, wait and riding
Transit Fares	SCRTD: $1.10 boarding -- bus & rail; $0.40 rail/ express bus zone fare (one grace rail zone); $0.25 transfer (any mode); $1.00 Metro Red Line station parking cost; reduced municipal bus fares ($1989)
Person Trips	SCAG: Year 2010 estimate from most recent SCAG Growth Management Plan (GMA4)
Gasoline Price	$1.07/gallon (Jan. 1989 average) including a $0.04/ gallon gas tax increase
Average Fuel Economy	18.5 miles/gallon (1988 average); projections for the year 2010 suggest 30+ mpg based upon improved technology
Regulation 15/Demand Management	None per SCAG Growth Management Plan modeling & staff recommendation

Table 4-2. Year 2010 Patronage Forecasts, 1205-Zone & Unconstrained Runs

	1205-Zone Runs			701-Zone Runs				
	TSM (1205) (Base)	Wilshire/First (1205)		TSM (701) (Base)	Wilshire/First (701) Constrained		Wilshire/First (701 U) Unconstrained	
	#	#	%Chg	#	#	%Chg	#	%Chg
Daily Rail Boardings	448,546	578,389	28.95%	432,880	548,100	26.62%	671,529	55.13%
Daily Transit Trips	1,502,650	1,582,934	5.34%	1,225,557	1,297,010	5.83%	1,410,934	15.13%
Home-based Work	1,078,711	1,162,982	7.81%	904,407	980,075	8.37%	1,092,206	20.76%
% Trn	12.06%	13.00%	7.81%	11.28%	12.22%	8.36%	13.63%	20.88%
Non-work	423,939	419,952	-0.94%	321,150	316,935	-1.31%	318,728	-0.75%
Daily Vehicle Trips	27,536,996	27,466,935	-0.25%	23,062,717	23,001,116	-0.27%	22,899,831	-0.71%
Home-based Work	6,935,236	6,862,556	-1.05%	6,006,036	5,941,712	-1.07%	5,841,599	-2.74%
Non-work	20,601,759	20,604,379	0.01%	17,056,681	17,059,404	0.02%	17,058,232	0.01%
RTD Bus (unconstrained)								
Peak Vehicles	2,560	2,471	-3.48%	2,294	2,245	-2.14%	2,421	5.54%
Offpeak Vehicles	953	959	0.63%	884	892	0.90%	946	7.01%
Annual Bus Hours	7,695,470	7,583,078	-1.46%	7,014,844	6,971,628	-0.62%	7,455,060	6.28%
Annual Bus Miles	145,190,072	143,541,299	-1.14%	130,745,192	130,132,198	-0.47%	138,300,372	5.78%
Boardings/Hour	145.9	151.1	3.61%	137.2	141.5	3.17%	142.8	4.14%
Boardings/Mile	7.7	8.0	3.27%	7.4	7.6	3.02%	7.7	4.63%
RTD Annual Boardings	1,258,491,849	1,321,352,734	4.99%	1,093,267,339	1,152,588,198	5.43%	1,268,278,437	16.01%
Bus	1,122,582,411	1,146,100,867	2.10%	962,104,699	986,513,898	2.54%	1,064,805,150	10.67%
Rail	135,909,438	175,251,867	28.95%	131,162,640	166,074,300	26.62%	203,473,287	55.13%
Daily Transit Revenue	$1,093,098	$1,152,103	5.40%	$864,319	$912,617	5.59%	$1,009,810	16.83%
Rail	$226,362	$326,046	44.04%	$212,555	$299,356	40.84%	$371,923	74.98%
Bus	$866,736	$826,057	-4.69%	$651,764	$613,261	-5.91%	$637,887	-2.13%
Cost Effect. (Annualized)								
Annual User Benefits	NA	12,809,216	NA	NA	11,693,053	NA	12,578,585	NA
Daily Work Hrs	NA	43,325	NA	NA	39,755	NA	42,698	NA
Daily Non-Work Hrs	NA	(761)	NA	NA	(882)	NA	(887)	NA
Travel Time Savings	NA	5,372,167	NA	NA	5,061,659	NA	5,001,110	NA
Annual Daily Work	NA	4,984,673	NA	NA	4,544,826	NA	4,484,420	NA
Annual Non-Work Hrs	NA	387,494	NA	NA	516,833	NA	516,690	NA
Linked Transit Trips	465,209,043	489,296,135	5.18%	378,713,296	400,131,656	5.66%	434,526,417	14.74%

Source: SCRTD Planning Department

However, due to the higher fares for rail travel, which replaces bus service in some study corridors, and the greater sensitivity of non-work travel to cost, non-work trips decline slightly under each alternative. As these Metro Rail extensions are analyzed in future studies, consideration should be given to rail system off-peak pricing differentials or flat fares to at least maintain non-work trip making and possibly encourage additional non-work travel on the rail system and on transit overall. It should also be noted that many non-work trips are not reflected in the patronage forecasting results due to the focusing procedure. This is because most non-work trips generally stay "close to home" within the same zone (especially when zones are aggregated in focusing) and such intrazone travel is neither analyzed in the simulation models nor assigned to the simulation networks.

Although the decline in regional daily work vehicle trips is small in percentage terms, it is the equivalent of the capacity of ten arterial lanes or four freeway lanes (assuming trips are spread over six peak-period hours) under the west Los Angeles alternatives. For the combination alternatives, the decline in daily work vehicle trips is the equivalent of approximately 16 arterial lanes or six freeway lanes. Due to the slight deflection of non-work trips from transit, regional non-work vehicle trips also increase slightly. However, since these trips are generally spread over the entire day, the small increase in non-work trips would have a negligible impact on traffic congestion.

Statistics for the impact upon the SCRTD bus system are shown in the table. The alternatives which serve Wilshire Boulevard through Beverly Hills with rail transit will decrease the total peak bus vehicle requirement since the rail system removes the need for limited and/or express bus service on Wilshire Boulevard. The Pico Long alternative, which requires that Wilshire Boulevard bus services be maintained, shows a slight increase in the peak vehicle requirement. All alternatives show increases in passenger boardings per bus-mile and bus-hour. This is due to the greater productivity of the bus system resulting from its use as a feeder service to the rail system.

Annual boardings on the rail and SCRTD bus systems increase under all alternatives. The west-east combination alternatives show the largest increases due to the impact of the rail extensions into east Los Angeles in combination with the west Los Angeles alternatives.

Total systemwide transit revenue (including other municipal operators) increases under each alternative. Revenue is assigned to the bus system or the rail system based upon where the fare transaction occurs. Although bus revenue declines, this is more than compensated by the increase in rail revenues.

The last section of Table 4-2 presents data which is used in the evaluation of cost effectiveness.[5] The Annual User Benefits figure is used in the cost-effectiveness index to measure the travel time savings for both new and existing transit patrons. This is important due to the expected travel time savings that these patrons will experience under the increased traffic congestion conditions projected for the future. The Travel Time Savings estimate measures the benefits accruing only to existing transit riders in the calculation of cost per new rider. Calculation of the cost-effectiveness indices is presented in Section 7.

1205-Zone Simulations

Because of cost considerations, only two patronage simulations were made using the 1205-zone network. The 701-zone and 1205-zone networks were compared for the TSM and combined Wilshire/First alignments. A factor was calculated by dividing the 1205-zone result by the 701-zone result. This factor allowed conversion from 701-zone to 1205-zone results by multiplying the factor by the 701-zone results.

Table 4-2 presents the results of the 1205-zone simulations of the TSM and the combination alternatives. Overall transit trips are increased because of the lesser aggregation of the 1205-zone system (TAZs outside the SCRTD service area remain aggregated). As a consequence, more trips are analyzed in mode choice and assigned to the highway and transit networks.

Results of the 1205-zone simulations essentially mirror those of the 701-zone simulations -- especially in the percentage change from the TSM alternative. (Comparable 701-zone simulations are also shown in Table 4-2.) However, because of the greater level of detail associated with the 1205-zone simulations, these values are the most appropriate for subsequent use in the cost effectiveness analysis.

Unconstrained Station Parking Capacity

The 701-zone and 1205-zone simulations that were conducted for the Transitional Analysis alternatives were based upon a limited supply of off-street parking at station sites where space is assumed to be available. Several of the stations for each alternative induced more rail transit parking demand than could be accommodated. The simulation models

---

[5] These estimates were calculated according to the procedures described in UMTA documents: *A Detailed Description of UMTA's System for Rating Proposed Major Transit Investments* (May 1984), and *Application of the Major Investment Policy for Fiscal Year 1986: Calculation of Indices, Possible Revisions, and Data Requirements* (September 1984).

redistribute the excess parking demand proportionately to the remaining modes of travel available on the affected zonal interchanges.

To evaluate the impact of additional parking capacity at the stations on the Wilshire/First Street alternative, a simulation was conducted which provided unlimited parking supply at the stations where parking was designated. The results of this unconstrained parking simulation are shown in Table 4-2 as Wilshire-1st (701 U). As expected, transit trips increase nearly 10 percent more where parking is unconstrained as compared to the same alternative with constrained parking.

5. Operating Plans and Costs

Rail Operating Plans

The patronage forecasts (discussed in Section 4) were used to develop operating plans for the rail system. Operating plans were prepared for several, though not all, of the alternative alignments. Based on the results of the patronage forecasts and capital cost estimates, two of the five western alignments were selected for detailed analysis, which included operating cost forecasts and subsequent calculation of cost effectiveness. The two chosen alignments were initially believed to be the most cost effective (Wilshire) and least cost effective (Pico Long). Thus, the results for these two alignments would bracket the other western alternatives.

A single set of operating plans was developed for the assumed year 2010 rail transit lines connecting with Metro Rail because operating plans are unlikely to be affected by the interaction of these lines. These plans were then used to produce estimates of rail operating costs for each extension alternative.

The patronage forecasts produced by SCRTD also included estimates of bus operating statistics. These statistics were used to estimate bus operating costs. The patronage data prepared by SCRTD required some adjustments, since two of the five alternatives (TSM and Wilshire/First) were modeled at both the 701-zone and 1205-zone level, while the other three were only modeled at the 701-zone level. Since the more detailed forecasts produce higher estimates of transit trips, including peak line loads, the 701-zone forecasts for the latter three alternatives were adjusted (using factors developed in Section 4) by comparing the two zone system forecasts for the TSM and Wilshire/First alternatives.

Red Line

TSM Alternative: The TSM alternative is the base transit network described in the previous section. It includes the 16-mile Red Line LPA, running from Union Station to North Hollywood and to Wilshire/Western. A line load of about 8,900 occurs between Universal City and Hollywood/Highland Stations in the AM peak hour. The corresponding operating plan consists of two services: North Hollywood to Union Station at five-minute headways, and Wilshire/Western to Union Station at ten-minute headways (see Table 5-1).

Metro Rail Extension
Transitional Analysis

Table 5-1. Operating Plans — LPA with East/West Extensions Year 2010

Rte	From	To	Run Time (min)	Dist (mi)	Headway Pk	Headway Base	Headway E/L	Consist Pk	Consist Base	Consist E/L	Vehicles Pk	Vehicles Total	Annual Car-Mi (MM)	Annual Tr-Hr (M)	Patronage AM Pk MLP	Patronage Load Factor	Patronage Max Load Point
TSM Alternative (LPA)																	
1	N. Hollyw'd	Union Sta.	27.97	14.53	5.0	10.0	10.0	6	4	2	84	97	5.73	59.85	8943	2.07	Hol/High
2	Wilsh/West	Union Sta.	12.12	5.07	10.0	10.0	20.0	4	4	2	16	19	1.20	22.85	1624	1.13	Normandie
		Totals									100	116	6.92	82.70	7888	1.37	Alvarado
	Trunk Line Averages				3.3	5.0	6.7										
Wilshire/First St. Combination																	
1	N. Hollyw'd	I-5/Garfield	38.65	21.92	5.0	10.0	10.0	6	4	2	114	132	8.64	84.25	8387	1.94	W.Hol/High
															7587	1.76	E.Boyle
2	Westwood	Union Sta.	26.53	13.37	5.0	10.0	10.0	4	4	2	56	65	4.47	59.85	5031	1.75	Beverly
		Totals									170	197	13.11	144.10	9827	1.38	W.Alvarado
															9360	1.30	E.Union Sta
	Trunk Line Averages				2.5	5.0	5.0										
Pico Long/Whittier Combination																	
1	N. Hollyw'd	I-5/Garfield	38.25	21.79	5.0	10.0	10.0	6	4	2	114	132	8.59	84.25	8359	1.93	W.Hol/High
															7587	1.76	E.Boyle
2	Westwood	Union Sta.	27.52	14.05	5.0	10.0	10.0	4	4	2	56	65	4.70	59.85	5246	1.82	Beverly
		Totals									170	197	13.28	144.10	9801	1.36	W.Alvarado
															9360	1.30	E.Union Sta
	Trunk Line Averages				2.5	5.0	5.0										

NOTES:

1. Patronage for 2010 from SCRTD; TSM network for Metro Rail Transitional Analysis, 1205 zones. Pico/Whittier extrapolated to 1205 zones by MPA.
2. North Hollywood to Union Station distance based on CORE Study plan & profile drawings. Travel time estimated by SCRTD (11/4/88).
3. Western extension distance based on plan drawings by Bechtel, Fall 1989.
4. Travel times estimated by MPA run time model.
5. East extension run times from above, plus scaled distances for extension from Whittier/Arizona to I-5/Garfield.
6. System includes SFV Line plus Blue & Green Lines, including Coast, Glendale, & Exposition Park.

Prepared by Manuel Padron & Associates

11-Apr-90

OPSTARED

Metro Rail Eastern and Western Extension Alternatives: Operating plans for the Wilshire and Pico Long west side alternatives are similar. The peak load occurs in the Universal City to Hollywood/Highland segment, although the volume is somewhat lower (7,800 to 8,300 versus 8,900). The peak load for the Wilshire Branch would be about 5,000 between Century City and Beverly stations. For the Pico Long alignment, the peak load would be about 5,000 east of the Pico/Fairfax Station. The operating plan for these two western extensions would consist of five-minute peak service on both branches, with a 2.5 minute combined headway from Wilshire/Vermont to Union Station. The Hollywood Branch would use six-car trains, while the Wilshire Branch would use four-car trains (refer back to Table 5-1).

The peak line load east of Union Station would be about 7,600. This load is similar to the maximum load on the Hollywood branch. Accordingly, the operating plan calls for the North Hollywood service to be extended east to the terminal at I-5 and Garfield Avenue. Wilshire Branch trains would turn back at Union Station (refer back to Table 5-1).

The Metro Rail fleet would be 162 cars with the western extension alone, and 197 cars with both the western and eastern extensions. The capacity of the existing yard is approximately 180 vehicles. Therefore the projected fleet size with both extensions would exceed this capacity somewhat. However, it probably would not be cost effective to build an entire new yard. Excess cars could be accommodated by storing them on tail tracks or at end-of-line station platforms, ready for next-day operations. If 24-hour service is operated, some cars would be in service at all times, so the total fleet would not have to be stored at one time.

Other Rail Lines

Patronage on the other rail transit lines connecting with the Metro Rail Line varies somewhat with different alternative extensions of Metro Rail. However, the variation is not sufficient to warrant adjusting headways, and therefore the same operating plan for these separate lines was used for the Metro Rail extension alternatives. Summary statistics for these operations are included in Table 5-2.

The Blue Line assumed by SCRTD for ridership forecasting included the extension of this Long Beach-Los Angeles line via a downtown subway to the Pasadena Line, as well as the Glendale and Exposition Park Branches. A three-service operating plan was assumed for peak periods. Each service would use two-car trains on 7.5 minute headways, for a combined 2.5-minute headway through downtown Los Angeles.

Metro Rail Extension
Transitional Analysis

Table 5-2. Summary of Operating Statistics & Cost Forecasts

		Composite Alternatives	
	TSM	Wilsh./1st	Pico/Whit.
SCRTD Bus			
Peak Vehicles	2,560	2,471	2,517
Annual Rev. Bus-Miles	145.2	143.5	143.8
Annual Rev. Bus-Hours	7.70	7.58	7.63
Annual O&M Cost	$795.4	$788.1	$793.1
Red Line			
Peak Vehicles	100	170	170
Annual Rev. Car-Miles	6.92	13.11	13.28
Annual Rev. Train-Hours	0.08	0.14	0.14
Annual O&M Cost	$58.2	$104.6	$105.6
Blue Line & San Fernando Valley Extension			
Peak Vehicles	146	146	146
Annual Rev. Car-Miles	11.04	11.04	11.04
Annual Rev. Train-Hours	0.26	0.26	0.26
Annual O&M Cost	$69.1	$69.1	$69.1
Green Line (Century-Coast)			
Peak Vehicles	43	43	43
Annual Rev. Car-Miles	7.8	7.8	7.8
Annual Rev. Train-Hours	0.23	0.23	0.23
Annual O&M Cost	$30.7	$30.7	$30.7
Operating Cost Totals			
Rail Subtotal	$157.9	$204.4	$205.3
Total Bus & Rail	$953.4	$992.5	$998.5
Incremental O&M Cost	0	$39.1	$45.1

Note: Operating statistics (miles, hours) in millions; costs in millions of 1990 doll

One service would run from the Long Beach Loop to the Glendale Branch. The second service would run from the end of the Pasadena Line to the Exposition Branch. The third service would turn back at Willow on the south and Del Mar on the north, and would operate during peak periods only. Recently, LACTC decided that the Pasadena Line would be independent of the Long Beach Line, with a terminus at Union Station. This change will be incorporated in the Alternatives Analysis.

The Green Line would have two services, each with single cars (automated) on four-minute headways. One service would operate from Norwalk to the North Coast Line, while the other would run from Norwalk to the South Coast Line. The trunk of the Green Line (on the Century Freeway) would have two-minute headways. The eastern portion of the Green Line is affected by the eastern extension of the Red Line, with the peak load westbound to Imperial Station falling from about 4,000 in the TSM alternative to 3,100 in the Wilshire-First alternative. However, the operating plan of the Green Line is controlled by the peak loads of its branches (North and South Coast Lines).

The San Fernando Valley extension assumes a transfer onto the Red Line at North Hollywood, and extends to Canoga Park. The peak line load is about 6,500 in all alternatives, occurring at the Sepulveda Station. This would require four-car trains operating on five-minute headways. This headway would match the headway of the Red Line at the North Hollywood Station. Adjustments would be made in the Alternatives Analysis to reflect its shorter length to Sepulveda, and its potential to eliminate the transfer at North Hollywood if confirmed as a direct extension of the Red Line.

Bus Operations

SCRTD coded bus networks for each of the alternatives. These networks incorporate rerouting and/or truncation of numerous routes in order to connect with the rail system. Bus operating statistics produced by SCRTD were adjusted for the alternatives run at the 701-zone level. Key statistics are listed in Table 5-2. Changes in bus service are relatively small, since only a small portion of the total SCRTD service area is affected by changes among the rail alternatives. There may be additional opportunities for reductions in bus operations along rail corridors based on a more detailed analysis of the projected diversion of trips from bus to rail.

Detailed estimates of operating changes and costs for the municipal bus operators were not made in this study. However, some of the municipal bus operators would be affected by the proposed rail extensions. For example, Santa Monica and Culver City operations would be affected by the western extensions of Metro Rail. There could be some savings as a result of not running some bus routes to or near downtown Los Angeles. These savings could be transferred to operating new feeder service, or simply to reduce operating costs. In either case, the effect would be fairly small compared to the impact on SCRTD bus and rail operating costs. However, this effect would lower (improve) the cost-effectiveness indices. This subject should be analyzed in the proposed Alternatives Analysis.

Operating Costs

Operating costs were estimated with models developed by Manuel Padron & Associates (MPA) for LACTC under a separate contract. The bus cost model was calibrated using FY89 and FY90 data for SCRTD's bus operations. The rail cost models were based on detailed start-up estimates of operating costs for the Blue and Red Lines, which in turn have been based on operating experience of other cities with modern rail systems, but take into account unique conditions, labor rates and other factors specifically relevant to SCRTD.

Table 5-2 summarizes key operating statistics for each line/mode in each alternative. Other factors are also used in the operating cost models, such as miles of track, number of stations, number of garages/yards, etc. Table 5-2 also shows the projected costs for operations in the year 2010, in 1990 dollars. Since the same operating plans were used for the Blue Line, Green Line, and San Fernando Valley extension for all Metro Rail extension alternatives, there is no difference in operating costs for those lines. Therefore all incremental changes are attributable to Metro Rail extensions and SCRTD bus operations.

Of the two alternatives selected as representative of western extensions, the Wilshire alignment has lower incremental operating costs, with the difference attributable to lower bus operating costs for the Wilshire alignment. However, there may be opportunities for additional savings in bus operating costs for Pico Long, and these should be analyzed in more detail in the proposed Alternatives Analysis.

The Wilshire/First combination alternative has a lower incremental operating cost than Pico/Whittier. However, the difference is less than for the western alternatives alone. This indicates that, on the east side, the Whittier alternative is somewhat more efficient than the First Street alternative in terms of operating costs. This suggests that a combination of the Wilshire and Whittier alignments may be more efficient than either of the combinations that have been tested in this study. This should be examined in the Alternatives Analysis.

6. Summary of Potential Environmental Impacts

The purpose of this portion of the Transitional Analysis is to provide a preliminary environmental evaluation of the priority corridor and alternatives for extending Metro Rail. Presented here is a comparative analysis of the data to determine whether significant environmental constraints exist for the alternatives.

The evaluation addresses potential physical, social, and environmental effects of the alternatives. Potentially severe (i.e., fatal flaws) environmental constraints associated with an alternative, if any, are identified for consideration in the selection of alternatives for the later environmental documentation phase.[6] Refer to Appendix B for further detail on west side alternatives and to Appendix D for additional information on east side alternatives.

West Side Alternatives

Following is a summary of potential effects for the five west side alignment alternatives. For additional information, refer to Appendix B.

Traffic

The aerial portion of the Wilshire alignment creates traffic impacts due to the supporting columns for the guideway and guideway stations and the transitions from aerial to subway. The other, all-subway alternatives have possible traffic impacts due to changes in traffic patterns at station parking areas.

Land Use

Displacement or disruption occurs at most station sites. Wilshire and Pico Long alignments have the most displacements, with the other three alternatives having significantly fewer displacement impacts.

---

[6] The analysis evaluates a wide range of issues and utilizes UMTA Circular 5620.1, the National Environmental Policy Act (NEPA), Council on Environmental Quality regulations for NEPA, and the California Environmental Quality Act (CEQA) and Guidelines for guidance on the determination of the potential significance of an impact.

Neighborhood Cohesion

Wilshire -- Impacts to neighborhood cohesion could occur at Wilshire and Fairfax.

Pico Short -- Impacts to neighborhood cohesion could occur in the vicinity of Carthay Circle.

Pico Long -- Pico/Fairfax neighborhood cohesion could be impacted.

Santa Monica -- Impacts to cohesion could occur in the neighborhoods of Santa Monica/San Vicente and Santa Monica/Fairfax.

Visual and Aesthetics

Because of the aerial segment, the Wilshire alternative has the greatest visual impact. The other alternatives would have impacts limited to station entrances.

Geology and Hydrology

All stations would have similar exposure to potential groundshaking.

Wilshire -- The aerial section of the Wilshire alignment is located in a high-risk methane gas area. No tunneling would occur here. Water table levels beneath this alignment are unknown. However, perched groundwater levels within the project area have been rising since the late 1970s.

Pico Short -- This alignment would be adjacent to, but outside, the high-risk methane gas area. Water table levels beneath this alignment are not known, although perched groundwater levels within the project area have been rising since the late 1970s.

Pico Long -- This alignment would be adjacent to, but outside, the high-risk methane gas area. Water table levels beneath this alignment are unknown, although perched groundwater levels within the project area have been rising since the late 1970s.

Olympic -- This alignment would be adjacent to, but outside, the high-risk methane gas area. Water table levels beneath this alignment are not known. However, perched groundwater levels within the project area have been rising since the late 1970s.

Santa Monica -- This alignment would be outside of the high-risk methane gas area, located over a perched water table which reaches the surface and floods. The alignment is also subject to liquefaction during ground movement. Adequate drainage systems would be required.

Toxic and Hazardous Materials Contamination

Wilshire -- Two hazardous materials sites are located along the Wilshire alignment.

Pico Short -- Two hazardous materials sites have been identified along this alignment.

Pico Long -- Five hazardous materials sites have been identified along this alignment.

Olympic -- One hazardous materials site has been identified along the Olympic alignment.

Santa Monica -- Seven hazardous materials sites have been identified along this alignment.

Cultural Resources

Wilshire

Historical -- Two historic sites are listed on or eligible for the National Register of Historic Places. Seven sites have been determined to be potentially eligible.

Archaeological -- There are two recorded sites along the Wilshire aerial alignment. It is likely that archaeological sites would be encountered during excavation.

Paleontological -- The Rancho La Brea Tar Pits along the Wilshire alignment is an area of extremely high paleontological sensitivity. Other portions are of moderate to no sensitivity.

Pico Short

Historical -- One historic site is listed on or is eligible for the National Register; one site has been determined to be potentially eligible.

Archaeological -- It is likely that archaeological sites would be encountered during excavation.

Paleontological -- This is an area of moderate paleontological sensitivity.

Pico Long

Historical -- One historic site is listed on or eligible for the National Register of Historic Places. One site has been determined to be potentially eligible.

Archaeological -- It is likely that archaeological sites would be encountered during excavation.

Paleontological -- This alignment passes through an area of moderate paleontological sensitivity.

Olympic

Historical -- One historic site is listed on or eligible for the National Register of Historic Places; one site is potentially eligible.

Archaeological -- Archaeological sites probably would be encountered during excavation.

Paleontological -- This alignment is an area of moderate paleontological sensitivity.

Santa Monica

Historical -- One historic site is listed on or eligible for the National Register of Historic Places. One site has been determined to be potentially eligible.

Archaeological -- It is likely that archaeological sites would be encountered during excavation.

Paleontological -- This area is one of moderate paleontological sensitivity.

Parks

No parks are directly affected by any of the alternative alignments. There is a potential visual impact to Hancock Park/La Brea Tar Pits.

East Side Alternatives

The alignments and station locations have been discussed previously, and shown in Exhibits F, G, H and I.

Table 6-1 summarizes possible environmental impacts due to the four east side alignment alternatives. The matrix in Table 6-1 indicates the four alternative route alignments that were assessed in this analysis, as well as variations in the type of construction (subway, at-grade, aerial) and lengths of the different types of construction. Issue areas revealing the greatest differentiation among the alternatives were selected and included in this matrix to provide the most pertinent information. (Refer to Appendix D for additional information.)

Predicted Displacement Impact

The greater the number of aerial structures, the greater the loss of residences and businesses, particularly when a station site or route alignment departs from existing roadways and crosses developed areas. Areas in the vicinity of the transition from subway to aerial (where the rail system breaches the surface) are also likely to be severely impacted.

Loss of Parking and Access

The loss of parking and access is due to displacement caused by the construction of station sites only. Lack of detailed parking inventory data for each of the alternative alignments prevents a comparison of potential parking loss due to the alternative types of construction of the rail line. The parking impact analysis does not consider whether there is currently sufficient excess parking in the immediate area to absorb the loss of the parking area. Nonetheless, the information is useful to discern areas in which parking and access could be potentially controversial.

TABLE 6-1

ALTERNATIVES	Type of Construction Proposed (per mi)	Predicted Displacement Impact	Predicted Loss of Parking and Access	Transportation Impacts	ENVIRONMENTAL IMPACTS				
					Noise and Vibration	Other Environmental Issues	Potential for Encountering Hazardous Materials	Potential for Encountering Groundwater	Potential for Encountering Utilities
1. FREEWAY ALIGNMENT		Overall: Low	Overall: High	Overall: High	Overall: Low	Moderate-High			
	Subway: 2.3 At-Grade: 4.2 Aerial: 2.3	Businesses: 0 Residences: 21	Parking: 200 Access: 1	High Loss of High-Occupancy Vehicle Lane	Low Existing Noise Levels are High	Safety & Security Impacts-Most Distant Parking	High Particularly Along L.A. River	High Particlarly Along L.A. River	Low None Presently Known
2. BROOKLYN AVENUE ALIGNMENT		Overall: High	Overall: Mod	Overall: Moderate	Overall: Moderate				
Option 1: Subway for Entire Length	Subway: 6.6	Businesses: 22 Residences: 31	Parking: 100 Access: 4	Low Minimum Roadway Disruption	Moderate Vibration During Construction	High Potential For Encountering Historical Resources	Moderate-High Particularly Along L.A. River	High Partiolarly Along L.A. River	High Waterline, Sewer, Storm Drains
Option 2: Subway to Indiana Street, Aerial to End of Line	Subway: 2.5 Aerial: 4.1	Businesses: 168 Residences: 241	Parking: 156 Access: 4	Moderate-High Aerial Transition Occurs off Roadway	High Aerial Structure Over School Site	High Air Quality Impact-Low Potential Reduction in Vehicular Traffic			
Option 3: Subway to Eastern and Sixth Aerial to End of Line	Subway: 4.4 Aerial: 2.2	Businesses: 66 Residences: 147	Parking: 110 Access: 4	Moderate Roadway Currently at LOS D or E	Low All Impacts can be Mitigated				
3. FIRST STREET ALIGNMENT		Overall: High	Overall: Low	Overall: Moderate	Overall: Moderate				
Option 1: Subway for Entire Length	Subway: 6.4	Businesses: 47 Residences: 12	Parking: 10 Access: 1	Low Minimum Roadways Disruption	Moderate Vibration During Construction	Low Safety & Security Impacts-Closest Parking	High Along L.A. River Existing Oil Fields	Moderate Lower Groundwater Levels	Moderate 3 Storm Drains
Option 2: Subway to Chicago Street, Aerial to End of Line	Subway: 1.5 Aerial: 4.9	Businesses: 114 Residences: 233	Parking: 10 Access: 2	High Loss of Roadway at Aerial Transition	High Aerial Structure Over Residential	High Air Quality Impacts-Low Potential Reduction in Vehicular Traffic			
Option 3: Subway to Eastern and Sixth, Aerial to End of Line	Subway: 4.5 Aerial: 1.9	Businesses: 90 Residences: 128	Parking: 10 Access: 1	Moderate Roadway Currently at LOS C or D	Low All Impacts can be Mitigated				
4. WHITTIER BOULEVARD ALIGNMENT		Overall: Moderate	Overall: Low	Overall: Moderate	Overall: Moderate				
Option 1: Subway for Entire Lengh	Subway: 6.4	Businesses: 38 Residences: 12	Parking: 20 Access: 2	Low Minimum Roadway Disruption	Moderate Moderate Vibration During Construction	Alignment With Lowest Potential For Encountering Archeological and Historical Resources	High Along L.A. River, Existing Oil Fields	Low Deepest Groundwater Levels	Moderate Waterline, Sewer, Storm Drain
Option 2: Subway to Anderson and Sixth, Aerial to End of Line	Subway: 1.1 Aerial: 5.3	Businesses: 90 Residences: 186	Parking: 20 Access: 2	High Roadway Currently at LOS E or F	Low All Impacts Can Be Mitigated				

LOS ANGELES COUNTY
TRANSPORTATION COMMISSION

METRO ORANGE LINE EXTENSION

TRANSITIONAL ANALYSIS

SOURCE: LACTC RAIL PLANNING SECTION

SUMMARY OF ENVIRONMENTAL IMPACTS

MAY, 1990

Transportation Impacts

Transportation impacts are significant, depending on the type of construction proposed, with the subway scenarios having the least effect. Transportation impacts are greater when the alignment remains on the roadway; the impact decreases when the alignment departs from the roadway. The existing level of service is also important, as this may indicate how well the roadway can absorb the loss of a traffic lane because of the presence of the footings for the aerial track.

Noise and Vibration

Impacts caused by additional noise and vibration from the proposed project are important both for the construction and the operational phases. During the construction phase, mitigation measures are available to limit impacts from surface noise; however, some vibration impacts from underground tunneling and construction may be impossible to fully mitigate. During the operational phase, there are means to minimize vibration from the subway movement of the train; however, it may be difficult to shield receptors sufficiently from the noise of aerial facilities.

Other Environmental Issues

Several environmental issues besides noise and vibration are considered in this report, including traffic, historic resources, and archaeological/paleontological resources. However, these did not demonstrate sufficient differences within their rankings to warrant inclusion in this summary table. Instead, the potential environmental impacts that were found to be exceptionally high or low have been noted to illustrate the relative advantages or disadvantages of each alignment.

Hazardous Materials

In the vicinity of Union Station and the Los Angeles River, there are several locations in which hazardous waste may be encountered. All of the proposed alignments in this area are subway, but the two northernmost alignments are more likely to encounter hazardous waste than are the ones to the south. The two southernmost alignments, however, have greater probabilities of encountering materials associated with petroleum fields than do the northernmost alignments, particularly as the alignment proceeds eastward.

Ground Water

In this area, ground water tends to be at lower levels as one proceeds southward. Hence, the Whittier Boulevard alignment is least likely to encounter groundwater, while the Freeway alignment has the greatest probability. Subway construction is hampered by the presence of ground water.

Utilities

Not based on naturally occurring factors but rather on the installation of utility lines along certain roadways, Brooklyn Avenue offers the highest potential number of utilities that may be affected by the proposed project. The Freeway alignment potentially has the smallest number of utility facilities to be affected.

7. Evaluation of Alternatives

The main objective of the Transitional Analysis is to determine whether the proposed Metro Rail extensions meet UMTA's guidelines for undertaking a full Alternatives Analysis. Therefore the major element of this study is to calculate the cost effectiveness indices, and compare them to the threshold values which UMTA uses in its process for evaluating major transit investments. UMTA's cost-effectiveness indices use several of the quantities that have been presented in earlier sections of this report including capital costs, operating costs, and various measures of ridership, such as total transit trips, travel time savings, and user benefits.

UMTA cost-effectiveness indices were calculated for the Wilshire alternative in the west side of the corridor combined with the First Street alternative on the east side, and for Pico Long combined with Whittier Boulevard. These two combination alternatives provide a range of patronage and cost estimates for bracketing the cost-effectiveness indices.

It is not necessary at this stage of the process to select a single alignment for the extensions, since several alternatives would be studied in the Alternatives Analysis. The cost-effectiveness evaluation was conducted for the two composite alternatives: Wilshire/First and Pico Long/Whittier.

Cost-Effectiveness Indices

UMTA has defined two indices of cost effectiveness. The first index is the Cost per New (additional) Rider. The formula is:

$$\frac{\text{(O\&M Cost)} + \text{(Capital Cost)} - \text{(Travel Time Savings)}}{\text{(New Riders)}}$$

All quantities in the formula are annualized for the forecast year, which for this study is 2010. All quantities are incremental, with the TSM alternative being the base for comparison.

The second index is the User Benefits Index. This was developed by UMTA in response to criticism of the Cost per New Rider Index as being overly sensitive to the number of new riders, while possibly understating other benefits. The User Benefit Index combines the benefits received by both existing and new transit riders into a single measure of user benefits. The measure is in hours of travel time savings, but it is supposed to represent the total "cost" of a trip, with financial cost converted to an equivalent amount of time using factors specified by UMTA. UMTA has suggested, though not officially adopted, a threshold value of $12.00 per hour of user benefit to enter Alternatives Analysis, and $8.00 per hour for project funding. The formula for the User Benefit Index is:

$$\frac{\text{(O\&M Cost)} + \text{(Capital Cost)}}{\text{(User Benefits)}}$$

Both indices can also be calculated to reflect different financial perspectives. The total indices include the total costs of the project, regardless of who is paying them. The federal version of each index includes only the federal portion of the capital cost.

Ridership Inputs

Section 4 described the methodology and results of the ridership forecasts. Table 7-1 summarizes key indicators of ridership, including those used in the cost-effectiveness indices, as well as several others that are of interest in evaluating the alternatives.

As stated above, patronage for some of the alternatives was only forecast at the 701-zone level. These forecasts were adjusted to be comparable to the 1205-zone forecasts, by using expansion factors based on alternatives which were forecast at both levels.

Linked transit trips are shown on a daily and annual basis. The annualization factors have been developed by SCRTD based on survey data. The increment of annual linked trips between the TSM alternative and each of the extension alternatives is the number of new transit riders used in the first UMTA cost-effectiveness index.

Annual transit boardings reflect all passenger activity on the system, including transfers. The figures for rail include other rail transit lines expected to be in operation as well as Metro Rail. The total number of boardings is an operating cost model input (see Section 5).

The boardings for Metro Rail are broken down to show riders on the base system (LPA) and the western and eastern extension. On the west side, the Wilshire alignment attracts more riders than Pico Long. However, on the east side the Whittier alignment performs better than the First Street alignment. This suggests that a combination of the Wilshire and Whittier alignments may perform better than either of the combination alternatives that were analyzed, and that this new combination should be studied in the Alternatives Analysis.

Travel time savings represent the decrease in travel time realized by existing transit riders (those who would use transit in the TSM alternative -- and who would save time by riding the extended Metro Rail system). Work and non-work trips are shown separately, since different values of time ($4.00 and $2.00, respectively) apply to these trip purposes in order to calculate total travel time savings. Travel time savings are then applied as a credit to the cost of each alternative in the Cost per New Rider Index.

User Benefit Hours is an expanded version of the travel time savings, which attempts to reflect the total benefit received by both existing and new transit riders. It reflects the change in transit "price", which includes measures of both the time and fare differential between old and new travel paths. It therefore reflects the assumed fare structure as well as the projected time savings.

Cost Inputs

Capital costs for each alternative were presented in Section 3. The total capital cost for each alternative appears in Table 3-4. Incremental costs, relative to the TSM alternative, were annualized using a discount rate of slightly over 10 percent. This was derived using UMTA's recommended factors for the useful life of structures, right-of-way, vehicles, etc.

Operating costs are presented in Section 5. Table 5-3 includes operating cost estimates for each transit mode (bus, heavy rail, light rail, AGT) in each alternative. The incremental operating cost for the year 2010 (in 1990 dollars) is used in computing the cost effectiveness indices.

Results of Cost-Effectiveness Evaluation

Table 7-2 summarizes the basic inputs to the cost effectiveness indices, and shows the calculated values for both the total and federal versions of the Cost per New Rider and the User Benefit Index.

Both the Wilshire/First and Pico/Whittier alternatives have a Total Cost per New Rider under the threshold of $10.00 required to enter Alternatives Analysis. The value for the Wilshire/First alternative is $9.71, and for Pico/Whittier it is $9.16. The Federal Cost per New Rider for both alternatives is about $5.00.

The Pico/Whittier alternative has higher capital costs than the Wilshire/First alternative, due to the longer line and more tunnelling. It also involves higher operating costs, primarily because of fewer savings in bus operations. Further analysis should produce a more efficient feeder bus network and more bus operating cost savings.

As stated above, there is probably a more cost-effective combination alternative than either of those analyzed in this study. On the west side, the Wilshire alignment scores better than Pico Long in terms of ridership, operating cost, and capital cost. On the east side, the Whittier alignment produces higher ridership, with a slight advantage in costs. This suggests that a Wilshire/Whittier combination might have better cost-effectiveness indices than either the Wilshire/First or Pico/Whittier alternatives. This should be tested in the Alternatives Analysis.

Several other factors which could be analyzed in the full Alternatives Analysis should result in lower indices for all alternatives:

- The performance of all alternatives can probably be improved by further modifying the bus network to provide more connections to the rail system, and reducing the level of service on parallel routes. This would also include consideration of the impacts on municipal bus operations.

- The assumed fare structure penalizes transfers between bus and rail, since a 25¢ transfer charge is assessed in each direction. It also applies zone fares to longer rail trips. Both policies are currently under review by LACTC. If the transfer and/or zone charges were eliminated or reduced, higher patronage forecasts should result for the rail lines, as well as improvement in the measure of User Benefit Hours, which reflects the fare.

Metro Rail Extension
Transitional Analysis

Table 7-1. Summary of Patronage Forecasts

	TSM	Wilshire/ First	Pico/ Whittier
Transit Trips (linked)			
Total Daily	1,502,650	1,582,934	1,593,000
Annual (million)	465	489	492
Annual Boardings (million)			
Bus	1,123	1,146	1,163
Rail	136	175	171
Total	1,258	1,321	1,334
Daily Metro Rail Boardings			
LPA	151,000	162,000	170,000
Western Extension	NA	92,000	88,000
Eastern Extension	NA	36,000	42,000
Total Metro Rail System	151,000	290,000	300,000
Travel Time Savings			
Annual Work Hours	Base	4,984,673	4,684,926
Annual Non-Work Hours	Base	387,494	373,560
Cost-Effectiveness Inputs			
Annual New Riders	Base	24.1	27.2
Travel Time Savings	Base	$20.7	$19.5
User Benefit Hours	Base	12.81	14.30

Note: Patronage statistics for TSM and Wilshire/First from 1205-zone assignments.
Statistics for other alternatives extrapolated from 701-zone assignments.

Prepared by Manuel Padron & Associates 18-Apr-90

Metro Rail Extension
Transitional Analysis

Table 7-2. Cost-Effectiveness Evaluation

	Wilshire/ First	Pico/ Whittier
Input Data (in millions)		
Annual New Riders	24.1	27.2
Incremental Operating Cost ($O&M)	$34.4	$40.4
Incremental Capital Cost	$2,097	$2,175
Annualized Incr. Capital Cost ($CAP)	$220.2	$228.3
Travel Time Savings ($TTS)	$20.7	$19.5
User Benefit Hours	12.81	14.30
UMTA Cost-Effectiveness Indices		
Cost per New Rider - Total	$9.71	$9.16
Cost per New Rider - Federal	$5.14	$4.96
User Benefit Index - Total	$19.88	$18.79
User Benefit Index - Federal	$11.28	$10.81

UMTA Cost-Effectiveness Formulas

$$\text{Cost per New Rider} = \frac{\$O\&M + \$CAP + \$TTS}{\text{NEW RIDERS}}$$

$$\text{User Benefit Index} = \frac{\$O\&M + \$CAP}{\text{USER BENEFITS}}$$

Note: Federal indices use only Federal share of capital costs, assumed to be 50%.

Prepared by Manuel Padron & Associates

14-Jun-90
MRTA$EF2

8. Conclusions

The System Planning Study conducted by SCAG in 1989 found that extension of the rail system to the east and west of Metro Rail would support regional mobility and air quality management plans and serve an area of dense population and employment. Ridership in this Central East/West Corridor well exceeded the UMTA threshold of 15,000 existing daily transit riders.

This Transitional Analysis studied five alignment alternatives on the west side of the corridor and four on the east. UMTA cost-effectiveness indices were calculated for several alignments to see if they met the UMTA requirement of attracting new riders at a cost of less than $10.00 each. Two representative combinations of alignments, Wilshire/First and Pico Long/Whittier, could attract new riders at a cost per person of $9.71 and $9.16, respectively. Each of the combination alternatives would attract over 80,000 new transit riders, compared with the TSM option. Since the costs per new rider are below the threshold value of $10.00, and existing daily transit riders exceed UMTA requirements of 15,000, the Central East/West Corridor meets UMTA's tests for proceeding into a full Alternatives Analysis/Draft Environmental Impact Statement.

Several issues that were identified in this Transitional Analysis should be studied in more detail in the Alternatives Analysis. These include:

- Consideration of other possible combinations of eastern and western extensions, such as Wilshire on the west with Whittier on the east.
- Refinement of plans for conversion of existing bus routes to feeder routes.
- Updating of assumptions on fare structure.
- Refinement of engineering alignments, with possible reduction in contingency allowance.

The projections used to calculate the cost-effectiveness indices are based on conservative assumptions. Some of the items cited above deal with those assumptions. Therefore, the final values of the cost-effectiveness indices should be lower than those indicated in this report.

9. List of References

The Sinclair/Tudor Group, ***Study of Metro Rail Extension Through the Northern Segment of the Santa Ana Corridor***, Volumes 1-4 (and drawings), July, 1988.

Southern California Association of Governments, ***Metro Red Line Extension System Planning Study***, August, 1989.

Southern California Rapid Transit District, ***FEIS: Los Angeles Rail Rapid Transit Project***, December, 1983.

Southern California Rapid Transit District, ***Draft SEIR: Los Angeles Rail Rapid Transit Project***, February, 1987.

Southern California Rapid Transit District, ***Bus/Rail Interface Design Guideline Manual***, October, 1989.

Southern California Rapid Transit District, ***Final SEIS/SEIR: Los Angeles Rail Rapid Transit Project***, July, 1989.

Southern California Rapid Transit District, ***East Los Angeles/Santa Freeway Corridor Rail Transit Patronage Analysis Technical Report***, May, 1989.

Urban Mass Transportation Administration, ***A Detailed Description of UMTA's System for Rating Proposed Major Transit Investments***, May, 1984.

Urban Mass Transportation Administration, ***Application of the Major Investment Policy for Fiscal Year 1986: Calculation of Indices, Possible Revisions, and Data Requirements***, September, 1984.