FINAL REPORT

for

MILESTONE 12

SYSTEM PLAN

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
425 South Main Street
Los Angeles, California 90013

RTD

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FOREWORD

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The Metro Rail project, undertaken by the Southern California Rapid Transit District, will have a significant role in the future development of the Los Angeles region. As part of the 1976 Regional Transportation Development Program, Metro Rail is designed to help solve the increasing transportation problems of Los Angeles' high-density urban center--the regional core.

When Metro Rail goes into operation, it will have passed through the five conventional stages of rapid transit development: (1) planning and alternatives analysis; (2) preliminary engineering/ environmental impact analysis; (3) final design; (4) construction; and (5) operational testing.

The first phase of the project--planning and alternatives--ran from 1977 to 1980. In June 1980, the preliminary engineering phase was initiated. This phase had three major objectives: to define and resolve major design and engineering issues; to provide precise location and design data for detailed environmental analysis; and to produce reliable cost estimates. During this intensive effort, which concluded in fall 1983, the merits of all sound alternative configurations and designs have been investigated. This effort has encompassed the selection of a precise route alignment (where the trains will go), station locations (where the trains will stop), preliminary station designs (what the stations will look like), vehicle designs (what size the cars will be and how they will look), and construction methods. Simultaneous with the preliminary design work has been an extensive, detailed analysis of the possible environmental impacts of this project on the communities along Metro Rail's downtown-to-North Hollywood route.

The project has now entered continuing preliminary engineering, a phase of continued design development, while obtaining finalization of local, state, and federal funding commitments. Upon completion of the continuing engineering phase and pending acquisition of necessary capital funding, the final design phase will commence. This will be followed by a 4- to 6-year construction period culminating with system inspection and testing.

The preliminary engineering phase has proceeded under the policy direction of the SCRTD Board of Directors: Mike Lewis, President; Ruth E. Richter, Vice President; Jan Hall; Marvin L. Holen; John F. Day; Nate Holden; Nick Patsaouras; Jay Price; Charles H. Storing; Gordana Swanson; and George Takei. The effort has been under the general direction of the SCRTD General Manager and under the administrative and technical management of the Assistant General Manager for Transit Systems Development. SCRTD has also engaged the professional services of the following consulting firms for specialized consulting work: Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas, Inc. (ways and structures); Lindvall-Richter Associates (seismic analysis); Kaiser Engineers (California) Corporation (subsystems); Harry Weese & Associates, Ltd. (station architectural design); Booz, Allen & Hamilton Inc. (systems analysis); Sedway/Cooke (environmental analysis); Converse Consultants (general geotechnical analysis); Wilson-Ihrig Associates (noise and vibration); PSG/Waters (corrosion control); Gage-Babcock (fire protection); Schimpler-Corradino and Barton-Aschman (patronage estimates). The Metro Rail project staff has been responsible for the direction and control of the consultants' work. Together, the project staff and the consultants form the Metro Rail project team.

During the past year, the decision-making process for major points of project development has been underway. These vital, interrelated points--called milestones--represent successive steps in establishing a system plan that will become the basis for the final design and construction phases. This report, the last of the 12 milestone reports, addresses the system plan and summarizes the results of the previous 11 milestone reports.

The information in this report is presented in eight chapters. Chapter 1 provides an overview of the project's development and goals and briefly describes the Metro Rail system and its elements. Chapter 2 identifies the policies formulated to guide the final design and implementation of the system. Chapter 3 discusses the general requirements that affect all elements of the system, including those for rapid and convenient service, safety, security, and dependability. Chapters 4 through 7 provide descriptions of the specific elements of the system: ways and structures, stations, yard and shops, and subsystems. Finally, Chapter 8 summarizes the estimated costs of the Metro Rail system.

The report concludes with four appendices: Appendix A provides a glossary of key terms; Appendix B contains a bibliography for further information on the topics presented in the report; Appendix C documents the comments made by area residents during the Milestone 12 public meetings and gives SCRTD's responses to those comments; and Appendix D contains the comments and suggestions made by the Urban Mass Transportation Administration in Milestone Advisement Memorandum No. 12 and provides SCRTD's responses.

The contents of the report have been revised to incorporate modifications and refinements to the system plan that have occurred as of December 1983. The revisions include refinements to system patronage estimates and service characteristics (Chapter 3); a slight modification to the route alignment and to the number and/or location of traction power substations, ventilation shafts, and crossover tracks (Chapter 4); the addition of two stations--Wilshire/Crenshaw and Hollywood Bowl--and modifications to the design and location of other stations

(Chapter 5); modifications to the yard and shops area (Chapter 6); and refinements to system cost estimates (Chapter 8).

These revisions, described in detail in the body of the report, reflect the evolutionary nature of the design process. Although the system plan described herein represents all major design features of the Metro Rail system, refinements to the plan will continue as the definition of the system becomes more and more precise during the project's final design phase.

EXECUTIVE SUMMARY

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INTRODUCTION

The Southern California Rapid Transit District (SCRTD) completed, in fall 1983, the preliminary engineering phase of its 18-mile Metro Rail project. This phase, which was begun in June 1980, has had three major objectives: to define and resolve major design and engineering issues; to provide precise location and design data for detailed environmental analysis; and to produce reliable cost estimates. During this intensive effort, the merits of all sound alternative configurations and designs have been investigated. This effort has encompassed the selection of a precise route alignment, station locations, preliminary station designs, vehicle designs, and construction methods. Simultaneous with the preliminary design work has been an extensive, detailed analysis of the possible environmental impacts of this project on the communities along Metro Rail's downtown-to-North Hollywood route (see Exhibit 1).

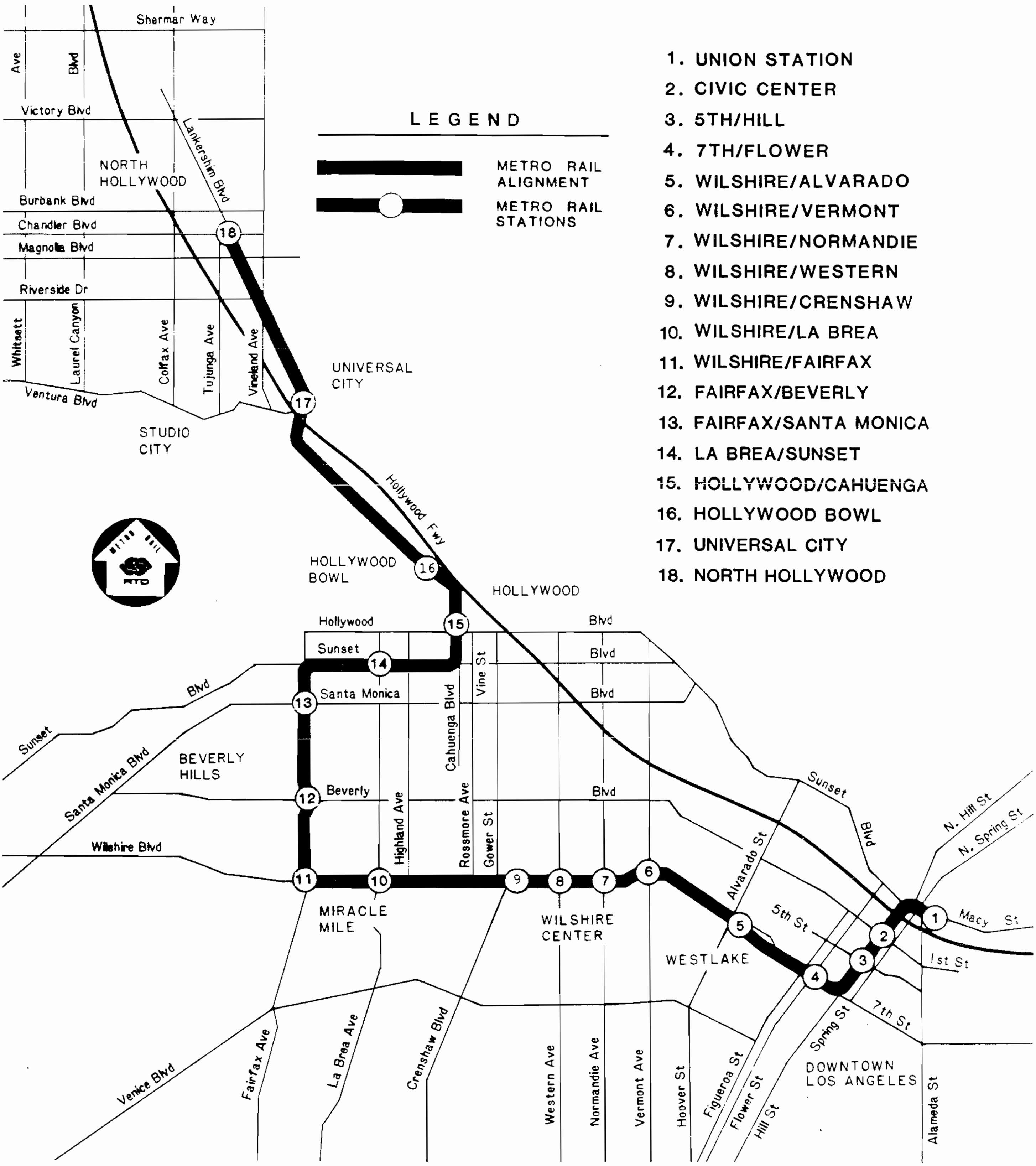
During the past year, the decision-making process for major points of project development has been underway. The vital, interrelated points--called milestones--represent successive steps in establishing a final system plan to serve as the basis for the detailed design and construction phases. This report, the last of the 12 milestone reports, addresses the system plan. It summarizes the results of the previous 11 reports, with revisions to reflect all major modifications to the system design that have occurred as of December 1983.

The report identifies the policies and requirements developed during preliminary engineering to guide the final design, construction, and operation of the Metro Rail system. It describes the specific elements of the system as defined by the preliminary design, which has brought the design to a level of completion of approximately 30 percent. Finally, it presents estimated costs for each of the system elements--ways and structures, stations, yard and shops, and subsystems (passenger vehicles, automatic train control, communications, electric power, fare collection equipment, and auxiliary vehicles).

METRO RAIL SYSTEM POLICIES

During the course of the preliminary engineering effort on the Metro Rail project, a number of policy concepts have been formulated to provide direction for the project's activities. In previous milestone reports, some of these concepts were addressed implicitly within the technical discussion of the report, while others were presented as explicit statements of policy and have been adopted by the SCRTD Board of Directors. These various policy concepts and enunciations have been gathered into a

EXHIBIT 1
Metro Rail Route Alignment and Station Locations



consistent and formal set of policy statements that comprehensively delineate the policies that will guide the final design and implementation of the Metro Rail system. They are grouped in three major categories:

- Community-impact policies
- Land use and development policies
- Design and operation policies.

Community impact policies relate to the necessity for the Metro Rail project to maintain sensitivity to the public's interests, and to eliminate or mitigate to the greatest extent possible any negative impacts of the project on the citizens or the environment of the area. To this end, policies have been formulated to ensure:

- Public involvement in the project's planning and decision-making process, through the establishment of a formal Community Participation Program
- The identification and elimination or mitigation of any adverse environmental impacts
- Fair, uniform, and equitable treatment to any persons displaced from their businesses or residences as a result of the acquisition of property for Metro Rail purposes
- The maintenance of utility services, without interruption, to all users during Metro Rail construction.

Land use and development policies focus on ensuring the conformance of station area development with specific area plans of the city and county, and the realization of Metro Rail's goal of capturing some of the monetary benefits arising from public investments in the system, through joint public/private ventures, value capture, and project packaging mechanisms. To facilitate and guide these efforts, an institutional framework will be established by means of cooperative agreements with such agencies as the Community Redevelopment Agency of the City of Los Angeles.

Policies that affect the design and operation of the system include those establishing the need for a system that maximizes transit mobility and accessibility, provides levels of safety and security equaling or surpassing those of other rail rapid transit systems, and maximizes capital and operating cost-effectiveness in terms of costs per passengers carried and passenger miles traveled.

In addition, design and operation policies have been set to ensure that the Metro Rail system is effectively integrated with other modes of transportation. These policies direct the modification of bus routes to maximize Metro Rail use while maintaining convenient bus service and facilitating bus/rail transfers. Also, the implementation of measures to minimize impacts or traffic flows are specified, including traffic signal changes, parking restrictions, and other station access provisions.

Design and operation policies also have been formulated which relate directly to Metro Rail stations and subsystems (passenger vehicles and fare collection equipment). With regard to stations, these policies establish criteria guiding the use of advertising, artwork, and concessions; the provision of limited bicycle and parking facilities for Metro Rail users; the use of restroom facilities by the public on an emergency basis; and the design of stations for centralized operation, rather than reliance on full-time station agents. With regard to subsystems, the policies set the need for passenger vehicles to be pleasing in appearance and provide safety, comfort, and dependability, and establish that the system will be designed to use an automated barrier approach to fare collection.

Finally, design and operations policies have been formulated to guide future development of the transit system, including the necessity that the system design facilitate future rail extensions, and that light rail systems be considered for use where they could provide either increased service or reduced operating cost in comparison with buses.

The policies established by the SCRTD Board of Directors have been reflected in the requirements developed for the system, and in the design of the specific elements of the system, as described below.

SYSTEM-LEVEL REQUIREMENTS

The most important system-level requirements imposed on Metro Rail are those to provide convenient, rapid, and cost-effective transportation service through the year 2000 and beyond, and safety and security to Metro Rail passengers and employees.

To ensure the system has the capacity to carry the estimated demand of 364,000 passengers per weekday in the year 2000, the following service standards have been set:

- Loading--The loading standard for each Metro Rail car has been set at 162 passengers during peak periods and 90 passengers during off-peak times.

- Service frequency--To maintain the loading standards identified above, the following minimum train frequencies--or maximum headways--have been established:

- Weekday peak period (6:30-9:00 A.M. and 3:30 P.M.)--A headway not greater than 6 minutes between trains will be maintained.

- Weekday midday (approximately 9 A.M. - 3:30 P.M.)--A headway not in excess of 7-1/2 minutes between trains will be maintained.

- Evenings, weekends, holidays--A headway not greater than 15 minutes between trains will be maintained. Late-night service may be less frequent.

- Train size--The Metro Rail system will be designed to accommodate trains of a maximum length of six cars, with each car approximately 75 feet long. This train size will enable Metro Rail to handle peak passenger demand in the year 2000 with a time between trains of about 3-1/2 minutes. Six-car trains will also provide the capacity for 50 percent growth beyond the year 2000 when operated at a headway of about 2-1/2 minutes between trains.

- Operating hours--The system should be capable of operating 24 hours a day, 7 days a week at the policy headway. Actual operating hours and late night service levels will be established by community needs and usage.

These standards and the performance characteristics of the system will provide the peak-period travel time shown in Exhibit 2. As indicated, it is estimated that the time required to travel the entire system from Union Station to North Hollywood will be 36-1/2 minutes during peak hours.

Given these operating standards, 108 vehicles will be required to serve Metro Rail's year 2000 passenger demand. To ensure that a fleet of this size will be available for revenue service, additional vehicles will be needed to account for maintenance and standby needs. Because it is expected that the availability of vehicles for service will be 88 percent, a fleet of 130 vehicles will be required by the system--108 vehicles for revenue service, 16 vehicles in maintenance, and 16 vehicles for standby service.

To ensure the system attains levels of safety and security that equal or surpass those of other systems, the Metro Rail project has developed system safety and security program plans that define design requirements, activities, and responsibilities for safety and security throughout all phases of the project. These plans emphasize prevention of hazards through the incorporation of special design provisions, such as adequate lighting, non-slip walking surfaces, surveillance of station areas by closed-circuit television, etc. Special measures are being developed for emergency preparedness in the event of fires, earthquakes, or other major disasters.

NORTH HOLLYWOOD																	
3.5	UNIVERSAL CITY																
7.0	3.5	HOLLYWOOD BOWL															
9.0	5.5	2.0	HOLLYWOOD/CAHUENGA														
11.5	8.0	4.5	2.5	LA BREA/SUNSET													
14.0	10.5	7.0	5.0	2.5	FAIRFAX/SANTA MONICA												
16.0	12.5	9.0	7.0	4.5	2.0	FAIRFAX/BEVERLY											
18.5	15.0	11.5	9.5	7.0	4.5	2.5	WILSHIRE/FAIRFAX										
20.0	16.5	13.0	11.0	8.5	6.0	4.0	1.5	WILSHIRE/LA BREA									
22.5	19.0	15.5	13.5	11.0	8.5	6.5	4.0	2.5	WILSHIRE/CRENSHAW								
24.0	20.5	17.0	15.0	12.5	10.0	8.0	5.5	4.0	1.5	WILSHIRE/WESTERN							
25.5	22.0	18.5	16.5	14.0	11.5	9.5	7.0	5.5	3.0	1.5	WILSHIRE/NORMANDIE						
27.5	24.0	20.5	18.5	16.0	13.5	11.5	9.0	7.5	5.0	3.5	2.0	WILSHIRE/VERMONT					
29.5	26.0	22.5	20.5	18.0	15.5	13.5	11.0	9.5	7.0	5.5	4.0	2.0	WILSHIRE/ALVARADO				
32.0	28.5	25.0	23.0	20.5	18.0	16.0	13.5	12.0	9.5	8.0	6.5	4.5	2.5	7TH/FLOWER			
33.5	30.0	26.5	24.5	22.0	19.5	17.5	15.0	13.5	11.0	9.5	8.0	6.0	4.0	1.5	5TH/HILL		
35.0	31.5	28.0	26.0	23.5	21.0	19.0	16.5	15.0	12.5	11.0	9.5	7.5	5.5	3.0	1.5	CIVIC CENTER	
36.5	33.0	29.5	27.5	25.0	22.5	20.5	18.0	16.5	14.0	12.5	11.0	9.0	7.0	4.5	3.0	1.5	UNION STATION

EXHIBIT 2
Estimated Peak-Hour Travel Time (Minutes)

WAYS AND STRUCTURES

Ways and structures on the Metro Rail system include the tracks, tunnels, power substations, and Central Control facility.

Tunnels and Trackwork

The Metro Rail system will be constructed in twin tunnels, with one tunnel for each direction of travel. They will be bored tunnels approximately 17-1/2 feet in diameter and will be lined primarily with precast segmented liners of reinforced concrete.

Because Metro Rail will operate on a two-way track system, provisions will be needed to allow trains to cross over to the opposite track to bypass stalled trains, to turn back at each end of the line, and so on. A total of six crossovers will be provided on the system. In addition, one pocket track will be constructed on the system at the Hollywood/Cahuenga Station.

Metro Rail will use a standard 4 foot, 8-1/2 inch gauge, 115 pound-per-yard conventional rail. All rails in the line will be continuous, with welded joints to reduce noise, vibration, and track and wheel maintenance.

Tunnels will be ventilated through shafts located at each station site and between certain station locations. The surface structure of these shafts will be designed to integrate successfully with the surrounding neighborhood. Bidirectional fans will provide emergency tunnel ventilation.

Power Substations and Central Control Facility

Electric power to operate the Metro Rail system will be received at 23 substations located along the line as required to provide distribution of power. Of these power substations, 18 will include traction power equipment--the equipment necessary to convert conventional alternating current to the direct current required by rail rapid transit trains--in addition to the auxiliary power equipment needed to operate the system's stations, yard and shops, and other facilities and equipment. One traction power substation will be located at the main yard and the remaining 17 will be located along the transit route. Of those on the transit route, all will be located below surface level except for two, one at the La Brea/Sunset Station and one mid-line between the Hollywood Bowl and Universal City Stations. These substations will be housed in above-ground structures approximately 50 feet by 160 feet by 18 feet in size and designed to be compatible with the area in which they are located.

The remaining five power substations will contain only auxiliary power equipment. Two of these will be located below surface level within the structures of the 5th/Hill and Wilshire/ Normandie Stations. The remaining three will be housed in above-ground structures, approximately 50 feet by 80 feet by 18 feet, at the site of the mid-line ventilation shafts on Wilshire Boulevard, north of Hollywood Bowl, and between the Universal and North Hollywood Stations.

The Central Control facility will be a conventional building located near the east entrance of Metro Rail's Union Station. It will house an operations and communications center, a surveillance and security center, and a data processing room.

STATIONS

To serve transit passengers within the Los Angeles regional core, 18 stations are planned along Metro Rail's initial line:

- In the central business district--at Union Station, Civic Center, 5th/Hill, and 7th/Flower

- Along Wilshire Boulevard--at Alvarado, Vermont, Normandie, Western, Crenshaw, La Brea, and Fairfax

- On Fairfax Avenue--at Beverly and Santa Monica

- On the Hollywood/North Hollywood route--at La Brea/Sunset, Hollywood/Cahuenga, Hollywood Bowl,* Universal City, and North Hollywood.

The design of the Metro Rail stations has been influenced by a general design approach which emphasizes standardization to minimize costs and to provide an identity for the system. Within the limits imposed by standardization, however, each station will be allowed to develop a somewhat individual appearance through the use of such elements as varying site development, landscaping, entrances, finish materials, artwork, and color. With regard to artwork, a program is being established which includes procedures for both the acceptance of donated artwork and the commissioning of artwork by SCRTD. A maximum of 0.5 percent of the estimated cost of station structure will be budgeted for artwork at each station.

All stations on the Metro Rail line will be located in underground structures, 10 under existing streets and 8 at off-street locations. All stations will be constructed using cut-and-cover techniques.

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*In December 1983, the SCRTD Board of Directors reached a decision to include provisions for the Hollywood Bowl Station in the design of the Metro Rail system, but to exclude the cost of that station from the project's federal grant application. Design of the station is to proceed until it reaches a 50 percent level of completion, and other sources of funds are to be sought to enable the station's design and construction to proceed within the current project implementation schedule.

The stations will have 450-foot-long platforms to accommodate six-car trains and to provide for unobstructed passenger movements during normal and emergency operations. Platforms will be of a center-island configuration at all stations except Wilshire/Fairfax, which will have side platforms, one stacked over the other. Ancillary and mechanical equipment rooms will be located at the platform and intermediate levels of the stations.

Fare collection will take place at intermediate mezzanines, the configuration of which will depend on expected patronage levels and the number and location of entrances. These mezzanines will provide the transition area between the off-street, plaza-type entrances and the platforms and will contain fare vending equipment, system maps, telephones, and fare collection gates. A limited function control panel for station agents will be located at the fare collection area of mezzanines to allow agents to communicate easily with the Central Control operation. All public facilities will be fully accessible to the handicapped and elderly through the provision of such special-access elements as elevators. Stairs and escalators will be provided for uncongested movement within the stations. In addition, emergency evacuation stairs will be provided at the station platforms to permit rapid evacuation during any emergency. For passenger security and convenience, all Metro Rail stations will include an intercom system, a public address system, closed-circuit television monitors, and emergency telephones.

Access to the Metro Rail stations will be provided by the facilities summarized in Exhibit 3.

MAIN YARD AND SHOPS

The main yard and shops comprise the facilities required to store, clean, and maintain Metro Rail transit vehicles and to provide maintenance to the system's physical plant and equipment. These storage and maintenance facilities will be located east of the central business district of Los Angeles on a site of approximately 40 acres. The site will extend from the Santa Ana Freeway on the north to about 1,100 feet south of the 6th Street Bridge, and will be bounded on the east by the Los Angeles River and on the west by Santa Fe Avenue (see Exhibit 4).

The yard and maintenance facility will be able to accommodate the fleet of vehicles needed to operate the initial 18-mile system at maximum capacity (198 vehicles). It is estimated that no more than 24 of these vehicles will require maintenance at any one time, and that a minimum of 12 will be in storage for standby service.

Transit vehicles will enter the main yard from Metro Rail's Union Station. The main body of the yard will consist of the storage yard for Metro Rail transit vehicles. Other facilities at the yard will include a main shop building for vehicle maintenance,

EXHIBIT 3
Summary of Station Access Features

STATION	Auto Facilities		Bus Facilities		Bicycle
	Park-and-Ride	Kiss-and-Ride	Terminals	Pull-Offs	Parking
Union Station	●	●			●
Civic Center				●	
5th/Hill					
7th/Flower					
Wilshire/Alvarado		●		●	●
Wilshire/Vermont		●	●	●	●
Wilshire/Normandie				●	
Wilshire/Western			●	●	●
Wilshire/Crenshaw			●	●	●
Wilshire/La Brea				●	●
Wilshire/Fairfax	●			●	●
Fairfax/Beverly	●	●		●	●
Fairfax/Santa Monica				●	●
La Brea/Sunset					●
Hollywood/Cahuenga		●	●		●
Hollywood Bowl					
Universal City	●	●	●		●
North Hollywood	●	●	●	●	●

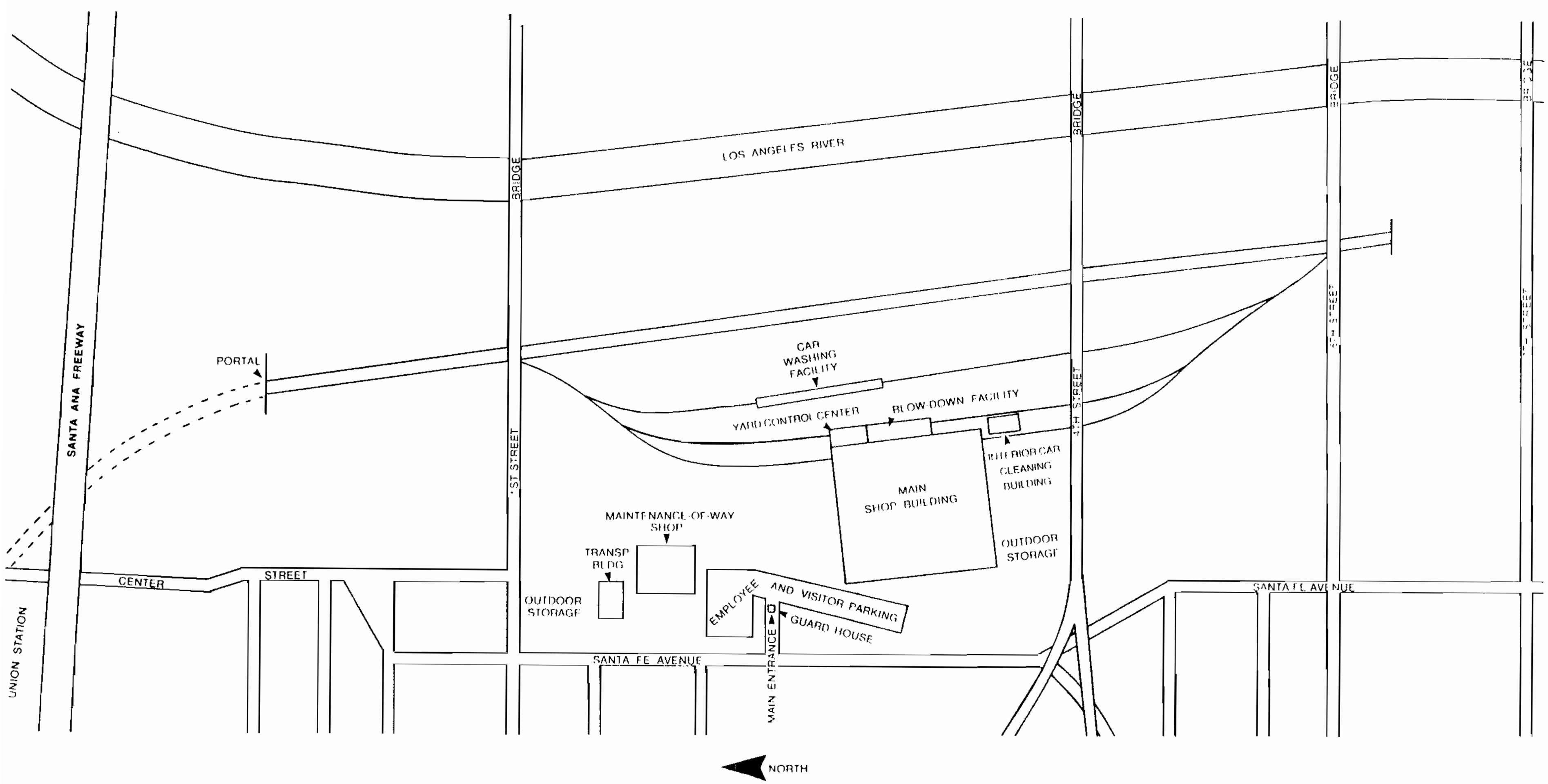

EXHIBIT 4
Yard and Shop Facilities

vehicle cleaning and washing facilities, and a maintenance-of-way shop.

SUBSYSTEMS

The major Metro Rail subsystems include passenger vehicles, Automatic Train Control, communications, electric power, fare collection, and auxiliary vehicles.

Passenger Vehicles

The passenger vehicle of the Metro Rail system will be a stainless steel, heavy rail type car similar to those used in Washington, D.C., Atlanta, and Baltimore and planned for use in Miami and Houston.

Nominal vehicle dimensions will be 75 feet long, 12 feet high, and 10-1/2 feet wide. The basic operating unit will be a dependent pair of cars coupled together, with an operator's cab located at each end of the pair. Complete trains will operate in consists of one, two, or three dependent pairs.

Each operator's cab will contain an operator's console, communications equipment, various electrical controls, and annunciators that will display subsystem status. Functions essential to train operation will be initiated by an operator in the train's lead cab. All other operator's cabs on a train will remain locked for security.

The vehicles will be equipped with direct current traction motors which will allow a fully loaded train to accelerate at 3 mph per second and achieve a maximum train speed of 63 mph under normal conditions and 70 mph for schedule recovery. The current to the motors will be regulated by a series direct current chopper.

Electrical braking will provide the primary type of braking. However, at speeds below about 5 mph, electrical braking will not be available, and pneumatically actuated disc brakes will be required to supplement the electrical braking equipment.

Automatic Train Control

Safe, rapid movement of trains on the Metro Rail system will be ensured by the use of an Automatic Train Control (ATC) subsystem. The ATC subsystem will enable Metro Rail trains to operate at closer headways and with more reliable schedules than would be possible if the system were to rely only on operators and wayside signals.

The ATC subsystem will provide three main functions: automatic train protection (ATP); automatic train operation (ATO); and automatic train supervision (ATS).

Automatic train protection (ATP) is based on a knowledge of each train's location on the system and when it is safe for a train to proceed. Detection of train locations will be accomplished on the Metro Rail system by monitoring the tracks in sections or blocks ranging in length up to approximately a thousand feet. When a train enters one of these sections or blocks, the steel wheels and axle will complete an electric circuit between the two rails. The completed circuit or shunt will cause a vital or fail-safe relay to open, indicating that the block is occupied. Train movement will be controlled by various logic functions, all of which will be fully automatic, including monitoring of train separation, enforcement of speed limits, prevention of vehicle movement while car doors are open, and prevention of unintentional rollback.

The automatic train operation (ATO) function will control the manual or automatic mode of operations, regulate train speeds, and control programmed entry and stopping of trains at stations. Train operators will control the operation of passenger vehicle doors, train dwell times in stations, and train departure.

The automatic train supervision (ATS) function is designed to maintain intended train headways and schedules and to minimize the effects of train delays on the system's operating schedule. The ATS functions will include:

- Modifying train operating speeds and/or acceleration rates
- Providing train identification and destination information for use at Central Control
- Controlling whether trains stop at or bypass a particular station
- Controlling train routing and movement at turnbacks
- Monitoring and displaying train movements and routing at Central Control
- Displaying alarms at Central Control and in the train operator's cab.

Communications

The principal functions of the Metro Rail communications sub-system will include:

- Providing accurate and rapid transfer of information between equipment and operating personnel to ensure orderly system operations and rapid, well-informed responses to service disruptions or incidents

- Providing communications equipment in the passenger stations and vehicles for security, emergencies, and passenger assistance

- Providing management of operations, security, and maintenance activities

- Providing emergency communications with local authorities and agencies.

The equipment for the communications subsystem will be located in the Metro Rail Central Control facility and in stations, vehicles, tunnels, and other work locations. This equipment will fall into eight major categories: radio, telephone, public address, fire and security, closed-circuit television, intercom, data transmission, and cable transmission equipment.

Electric Power

The Metro Rail electric power subsystem will convert the high voltage power received from utility companies to the correct voltage and type of electricity needed to operate the system's trains, stations, yard and shops, tunnel ventilating equipment, and other machinery. The electric power subsystem will also include equipment to distribute and control power. In addition, the electric power subsystem will provide standby power for the operation of those subsystems and equipment items considered essential for the safety of the public.

The electric power subsystem will comprise the following:

- Utility company service equipment

- Primary electrical distribution, at 34,500 or 16,000 volts alternating current

- Traction power, at 750 volts direct current

- Auxiliary power for stations, tunnels, and elsewhere, at 480 volts and 208/120 volts alternating current

- Standby power equipment and batteries

- Controls and protective equipment.

Fare Collection

The Metro Rail system will have a fare collection subsystem of the automatic barrier type, with fare gates equipped with machines to read encoded tickets and passes. The fare collection subsystem will include fare gates, ticket vending equipment, change machines, and add-fare machines which will be located on the mezzanines of Metro Rail stations. The number of gates and ticket vending and related machines to be installed in each station will be determined on the basis of peak-period patronage projections at the station.

A console at the Central Control facility will indicate the status, and permit the control, of the fare collection equipment at each station. A closed-circuit television monitor and telephone connection will allow passengers needing assistance to communicate directly with Central Control personnel.

The Metro Rail fare collection subsystem will be designed to handle various tickets, passes, and transfers, including single-trip tickets, multi-trip tickets, monthly passes, reduced-fare monthly passes, and transfers to or from light rail vehicles or buses.

Auxiliary Vehicles

The Metro Rail system will require various secondary, or auxiliary, vehicles to perform miscellaneous work functions. These will include:

- A locomotive to move heavy loads, or to haul passenger vehicles when disabled, in yards or on the main line
- Self-propelled cranes for lifting heavy items such as rail sections or special trackwork
- Small diesel-powered on/off rail car movers to move cars and other vehicles at relatively low speeds within the yard and shops
- Emergency pumping equipment
- Rail grinding equipment
- Tunnel cleaning/maintenance vehicles
- Flatcars.

In addition, mechanical and hydraulic jacking equipment will be required to rerail passenger vehicles. This equipment will be moved to a derailment site by small vehicles.

ESTIMATED COSTS, SCHEDULE, AND FUNDING

A primary objective of the preliminary engineering effort for the Metro Rail project has been to develop system cost estimates that provide a reliable basis for major funding decisions by federal, state, and local officials. Such estimates have been developed for the system's capital costs--costs associated with design, procurement, installation, and construction--and for the annual operating and maintenance costs the system is likely to incur.

These cost estimates are provided in Exhibits 5 and 6, respectively, for the Metro Rail system's initial 18-mile line and also for the "minimum operable segment" of that line. The latter represents the minimum-distance segment of the system that can provide reasonable service levels and operational capability. Its identification is required by the Urban Mass Transportation Administration. For Metro Rail, it has been defined as extending from Union Station to the Fairfax/Beverly Station and includes the main yard and shops.

The cost of the Hollywood Bowl Station is excluded from the estimated capital costs of the 18-mile system given in Exhibit 5. However, its cost is included in the estimated annual operating and maintenance costs of the system provided in Exhibit 6. This approach is in accordance with the decision of the SCRTD Board of Directors to exclude the cost of the Hollywood Bowl Station from the project's federal grant application and to seek other sources of funding to enable the station's design and construction to be completed within the current project implementation schedule.

The implementation schedule for the final design and construction phases of the Metro Rail project is illustrated in Exhibit 7. As indicated, construction is expected to occur in four overlapping phases:

- A-1 - Union Station to Wilshire/Vermont
- A-2 - Wilshire/Vermont to Fairfax/Beverly
- A-3 - Fairfax/Beverly to Hollywood Freeway
- A-4 - Hollywood Freeway to North Hollywood.

Phases A1 and A2 constitute the minimum operable segment, which is projected to be ready for revenue service by February 1990. The total 18-mile system is projected to be ready for revenue service by November 1990.

To accomplish this implementation schedule, a stable annual commitment of funds is necessary from various sources. Exhibit 8 shows the anticipated annual commitment of funds from the various agencies expected to participate in the project. As the exhibit indicates, UMTA Section 3 funds will supply the largest proportion of project requirements, accounting for 62 percent of project funds in fiscal years 1984 through 1990 and approximately 77 percent in fiscal year 1983.

EXHIBIT 5
Estimated Capital Costs of the Metro Rail System
(1st Quarter 1983 Prices)

COST ELEMENT	ESTIMATED COST: TOTAL SYSTEM	ESTIMATED COST: MINIMUM OPERABLE SEGMENT
Fixed Facilities and Subsystems		
Guideways	$ 524,500,000	$ 278,000,000
Stations*	669,700,000	471,600,000
Utilities	26,300,000	17,600,000
Parking	9,000,000	3,100,000
Central Control Building	1,500,000	1,500,000
Main Yard and Shops	40,000,000	40,000,000
Trackwork	79,100,000	51,500,000
Train Control	57,000,000	36,200,000
Communications	21,700,000	16,700,000
Traction Power	38,100,000	21,700,000
Fare Collection	18,400,000	15,400,000
Passenger Vehicles	130,000,000	74,000,000
Auxiliary Vehicles	1,300,000	1,300,000
Subtotal	$1,616,600,000	$1,028,600,000
Design Contingency (15% for fixed facilities; 10% for subsystems)	229,200,000	146,000,000
Right-of-Way	176,000,000	118,000,000
Design and Construct. Mgmt. (13% for fixed facilities; 10% for subsystems)	231,200,000	147,200,000
Agency	80,800,000	53,100,000
Insurance	77,500,000	51,000,000
TOTAL CAPITAL COST	$2,411,300,000	$1,543,900,000
TOTAL CAPITAL COST Escalated at 7% to Midpoint of Each Design/Construction Contract	$3,309,000,000	$2,133,500,000

*Includes costs of pocket and crossover tracks.

EXHIBIT 6
Estimated Annual Operating and Maintenance Costs
of the Metro Rail System
(1983 Dollars)

COST ELEMENT	ESTIMATED COSTS: TOTAL SYSTEM	ESTIMATED COSTS: MINIMUM OPERABLE SEGMENT
Operations	$ 9,735,702	$ 6,893,289
Vehicle Maintenance	8,307,436	4,963,710
Ways and Structures Maintenance	5,066,852	3,744,578
Subsystems Operation and Maintenance:		
Electric Power	9,877,500	5,551,649
Other	9,663,448	6,767,050
Subtotal	19,540,948	12,318,699
General Administration	3,956,042	2,765,204
Liability	1,900,000	1,254,992
TOTAL OPERATING AND MAINTENANCE COSTS	$48,506,980	$31,940,472

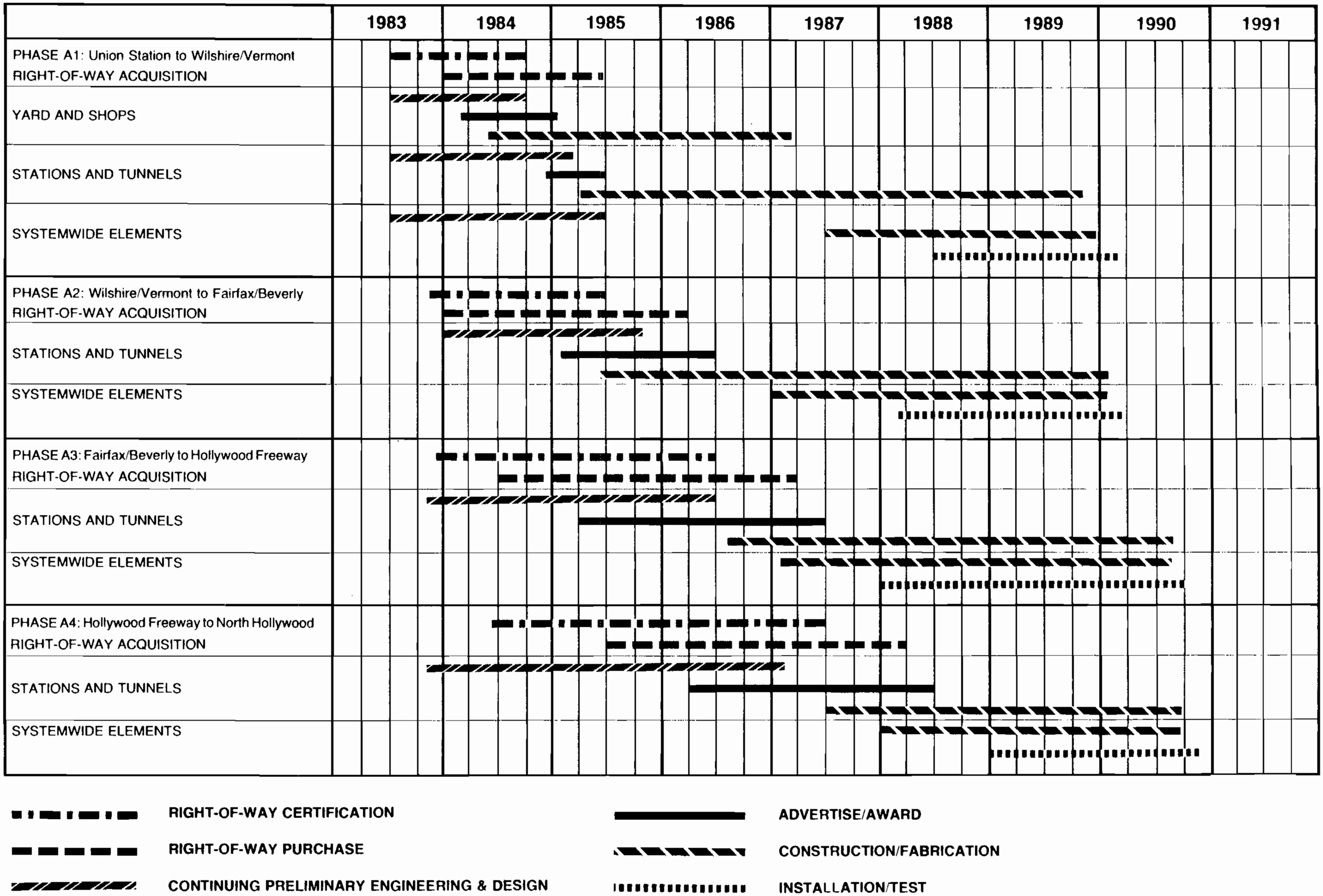

EXHIBIT 7
Preliminary Implementation Schedule of the Metro Rail Project

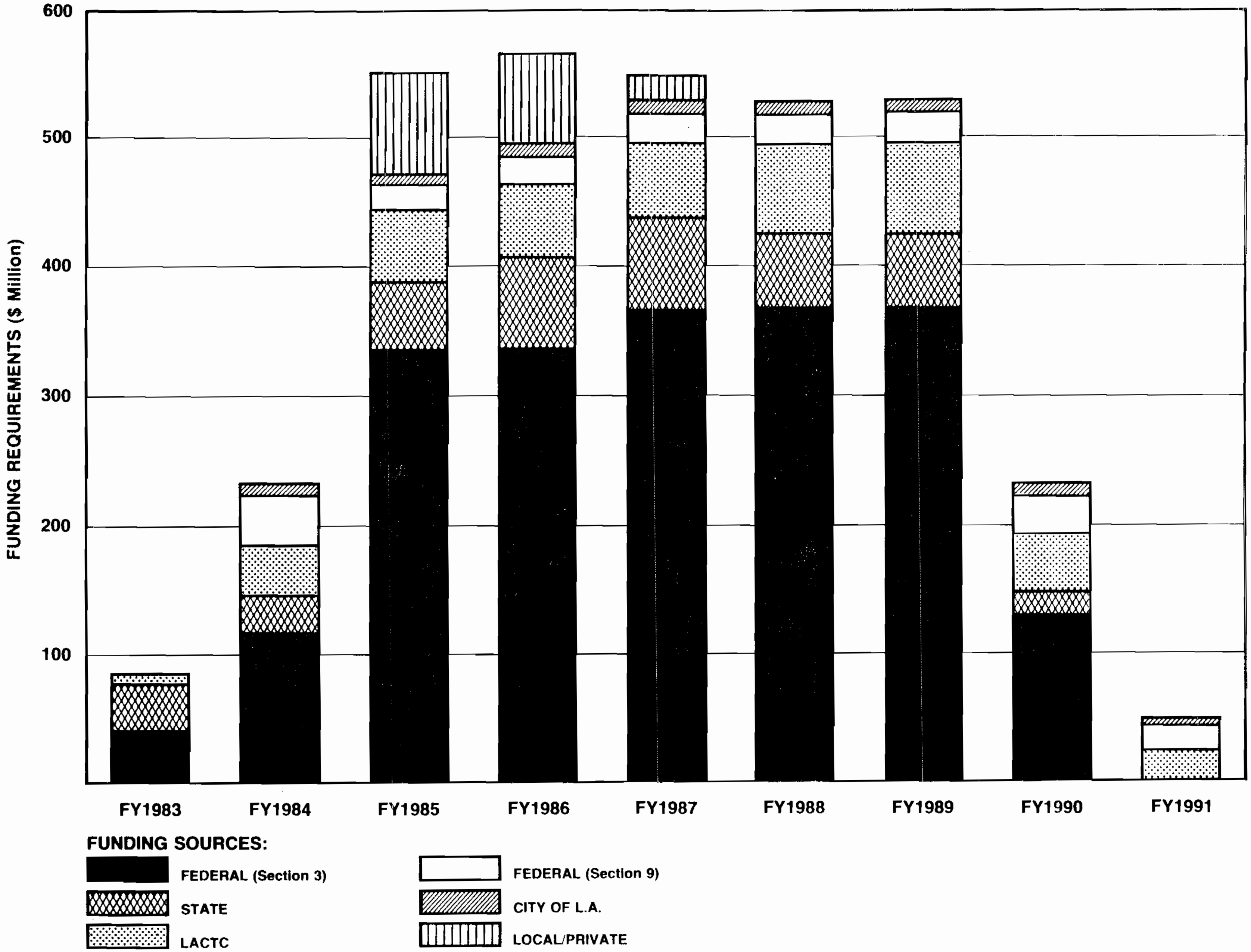

EXHIBIT 8
Anticipated Annual Commitment of Funds

1. PROJECT OVERVIEW

1. PROJECT OVERVIEW

This chapter presents an overview of the Metro Rail project, describing the events leading to the project's inception and the work undertaken in its initial phase; the procedures established to ensure the community's involvement in the project; and the project's overall goals and objectives. The discussion then turns to the just-completed stage of the project, preliminary engineering, and to the system design that has resulted from that effort.

BACKGROUND

The California State Legislature created the Southern California Rapid Transit District (SCRTD) in 1964 with a legislative mandate to design, construct, and operate a rapid transit system within the Los Angeles County area. To obtain the monies required to support this program, SCRTD attempted on three occasions to gain countywide voter approval for funding rapid transit through increases in local sales taxes. Finally, in June 1974, Proposition 5 was passed by a solid majority, allowing a portion of state gasoline taxes to be used for rapid transit development. This measure provided a local source of funds for SCRTD to begin its rail rapid transit development program in Los Angeles.

SCRTD also received federal funding in 1974 to evaluate 16 transit corridors in the Los Angeles metropolitan area. A Rapid Transit Advisory Committee (RTAC), composed of representatives of local and state agencies, guided this effort. The evaluations resulted in the identification of a rapid transit corridor that justified further development and evaluation.

Based on the results of the RTAC study, a Regional Transit Development Program was adopted by state and local jurisdictions. In September 1976, representatives of the City of Los Angeles, the California Department of Transportation (Caltrans), the Southern California Association of Governments, the County of Los Angeles, and SCRTD applied to the Urban Mass Transportation Administration (UMTA) for assistance in financing the Regional Transportation Development Program. Designed to focus on transportation problems in the Los Angeles area, this four-part program included improvements in the existing street system, freeway transit projects, a proposed downtown people mover system, and an evaluation of alternative transit solutions for the regional core of metropolitan Los Angeles. The program was immediately endorsed by the newly established Los Angeles County Transportation Commission in 1977.

Having received UMTA and Proposition 5 funds to evaluate transit corridors, in 1977 SCRTD began an in-depth analysis of 11 alternatives: a status quo alternative, five rail/bus alternatives, and five all-bus alternatives. The critical questions considered during the evaluation included:

- Which alternative would serve the largest number of people?
- Which corridor was experiencing the greatest surface traffic congestion without any plans for relief?
- Which alternative would reduce the greatest number of auto trips per day?
- Which corridor would best accommodate the city and county land use plans?
- Which corridor would have the most positive impact on local air quality and energy savings?
- Which alternative would offer the best opportunity for efficient operations?
- Which alternative would provide the greatest economic benefits to the Los Angeles metropolitan area?

Concurrently, a comprehensive environmental impact analysis was conducted to examine the effects of each of the alternatives on the affected communities. In September 1979, the SCRTD Board of Directors selected its preferred alternative--an 18-mile rapid transit line extending from the central business district through the Wilshire Boulevard area to Fairfax Avenue, and then north through Hollywood to North Hollywood.

The results of this analytical work were published in the final Alternatives Analysis/Environmental Impact Statement/Report (AA/EIS/EIR) and were submitted to UMTA for evaluation in April 1980. Two months later, SCRTD was allocated $12 million from UMTA and $3 million from local sources to begin the Metro Rail project. The just-completed phase of the project, called preliminary engineering, included additional environmental analysis and the basic work leading to final design and construction. UMTA noted that the Metro Rail project is one of the most carefully studied and thoroughly justified projects of its kind in the country.

COMMUNITY PARTICIPATION PROGRAM

An important factor in the development of the Metro Rail project has been regionwide public support. This broad-based support has been demonstrated on numerous occasions. Particularly impressive were the public hearings conducted in 1979 when business people, officials, organizations, and citizens from all areas of Los Angeles testified that this project was the one with which to begin rail rapid transit system development in the Los Angeles community.

As part of the process of designing and developing the rail system, the SCRTD Metro Rail project team has been involved with land use planning, service criteria, social issues, energy concerns, and environmental impact and aesthetic considerations. The project team recognized that designers and decision-makers must be responsive to the public's needs and desires.

Experience in other cities has highlighted the importance of the SCRTD Metro Rail project team's maintaining sensitivity to public concerns through a public participation process. An extensive Community Participation Program was established to meet this need. The purpose of the program, as adopted by the SCRTD Board of Directors, has been to provide a means for interested citizens of the Los Angeles area to interact with and provide input to the project team, city and county officials, and the Board of Directors on Metro Rail preliminary engineering issues and the related areas of planning and development.

The key element of the Community Participation Program has been the policy decision-making process, or milestone process. Through this mechanism, community participants have helped the project team make decisions on the 12 basic, interrelated points of development called milestones, providing input to the project on such topics as route selection, vehicle design, and cost estimation.

This process has not meant that the SCRTD Board of Directors and other involved local officials have relinquished their respective responsibilities where decisions are concerned. Rather, it has meant that important decisions have been made with the overall values, needs, and priorities of the community in mind. Since the greatest amount of public interest has been from those who live and work in the areas most directly affected by the Metro Rail project, the Community Participation Program has been structured to encourage and accommodate their participation.

The public milestone meetings have been held at two levels of organization: the sector level and the segment level. The sector level has constituted the basic organizational level, composed of six key geographical areas ("sectors") along the subway alignment. Most milestone reports have been presented to the public at this level through meetings held in each sector. Special organized groups have also been encouraged to participate at this level.

The segment level has formed the second level of community organization. At this second level, sector representatives have been grouped within three segments along the alignment (i.e., the central business district segment, the Wilshire segment, and the Fairfax/Hollywood/North Hollywood segment). Milestones dealing with issues that are not geographically specific have been presented at this level. Meetings have also been held in the San Gabriel Valley since some of the bus modifications at Union Station will affect bus service along the El Monte Busway.

Through the Community Participation Program, the public has had multiple opportunities to comment on the 12 Metro Rail milestones. As indicated in Table 1-1, the process has taken approximately 45 to 60 days for each milestone. The process for Milestone 12 began with the publication of the Preliminary Draft Report at the beginning of May 1983. This was followed by two rounds of meetings held at the sector level on May 16-19 and May 23-26, 1983. At the first round of meetings, the project team presented the issues, constraints, and assumptions involved in developing the system plan; at the second round, community participants were given additional opportunity to question or comment on that plan. Area residents had a third and final opportunity to comment on Milestone 12 at a public hearing convened by the SCRTD Board of Directors on June 27, 1983. The Board adopted Milestone 12 on July 14, 1983.

Although these public meetings and hearings concluded the Metro Rail milestone process, community participation is a long-range goal of SCRTD and will be actively solicited in the future. Organizations, support groups, advisory committees, and interested individuals will be encouraged to work with SCRTD on the project through the final design, construction, and operational phases. In addition, the joint effort between SCRTD and the community is expected to be repeated as system expansions are planned, thus ensuring a continuity of cooperation in the decades ahead.

METRO RAIL SYSTEM GOALS

SCRTD was given a mandate to "solve the transportation problems in the Southern California area and to provide the needed comprehensive mass rapid transportation system." In fulfilling its charter, SCRTD has enunciated a set of transportation-related goals and objectives. These goals and objectives range from broad statements of ideals and principles to specific plans.

To ensure that SCRTD's recommendations would be consistent with the needs of the public, the following goals were identified:

- Conservation of natural and cultural resources--Preserve open spaces, retard urbanization of agricultural land, and reduce air pollution and petroleum consumption.

- Land use and urban form--Guide regional urban development into a more structured form with evenly spaced, high-density centers linked by high-intensity transportation corridors.

TABLE 1-1
Timetable for Milestone Reviews

MILESTONE	COMMUNITY REVIEW SCHEDULE	SCRTD BOARD HEARING DATE
1. Preliminary System/ Operational Plan	March-April 1982	May 13, 1982
2. System Design Criteria	March-April 1982	May 13, 1982
3. Route Alignment	May-June 1982	July 22, 1982
4. Station Location	May-June 1982	July 22, 1982
5. Relocation Policy	June-July 1982	August 12, 1982
6. Development/Land Use	August-September 1982	November 17, 1982
7. Safety, Security, System Assurance	October-November 1982	November 10, 1982
8. Systems and Subsys-tems	November-December 1982	January 13, 1983
9. Supporting Services	January-February 1982	March 9, 1983
10. Fixed Facilities	February-March 1983	April 25, 1983
11. Cost Estimate	March-April 1983	May 11, 1983
12. System Plan	May-June 1983	June 27, 1983

- Conservation of the urban environment--Revitalize and develop, as much as possible, existing urban areas rather than urbanize new land.

- Social--Improve mobility of people and enhance access to employment and urban services.

- Transportation--Create a multimodal transportation system integrated with planned land use.

In the preliminary engineering effort, these broad regional transportation goals and objectives were used to develop more project-specific public goals and objectives to refine the route alignment and station location alternatives and system performance characteristics.

These public goals and objectives, derived through the involvement of the public in the Metro Rail Community Participation Program, are listed below:

- Improve mobility

    - Improve the level of mobility in the Los Angeles central business district/Wilshire/Hollywood/North Hollywood regional core area.

    - Integrate the corridor transit system with the other elements of the Regional Transit Development Plan to provide convenient regional access for all corridor residents.

    - Maintain and improve transportation system safety, dependability, comfort, and convenience for both users and nonusers.

    - Reduce travel time and cost.

- Provide cost-effective transit

    - Maximize system capital and operational cost-effectiveness in terms of passengers and passenger miles, over a foreseeable range of passenger volumes.

    - Minimize capital and operating cost requirements.

    - Minimize the need for public financial support.

- Support land development plans for transit land use planning

    - Complement regional and local transportation and urban land development goals.

- Achieve a land use pattern which encourages all components of the regional transit system--bus, Metro Rail, and light rail--to work effectively together and which allows for cost-effective growth and expansion.

- Achieve land use patterns at the regional and station area levels to encourage full use of the Metro Rail system during off-peak trips.

- Ensure that the optimum level of compatible development occurs at (or near) the Metro Rail stations, in a pedestrian environment conducive to attaining increased system ridership and cost-efficient operations.

- Continue to recognize the importance of community values and community participation in the transit planning process.

- Preserve the environment

  - Complement and support regional energy conservation and air quality goals.

  - Minimize displacement, disruption, disturbance, and noise at residential and employment areas in the regional core.

  - Reduce vehicle miles traveled on regional core surface streets to the extent possible.

  - Make the most efficient use of existing transportation energy resources and improve the ability of the transportation system to use alternative energy sources in the future.

- Implement joint development principles

  - Ensure that public and private developments at Metro Rail stations are compatible and are supportive of the transport function of the system.

  - Use joint private/public investments in public transit to ensure a stable, continuing source of funding for transit development.

- Develop value capture opportunities

  - Achieve an equitable distribution of the liabilities as well as the benefits of transit system development and operation.

  - Use value capture/benefit sharing mechanisms to enable the public to share in windfalls created by transit investments and to preclude the inequitable distribution of windfalls through speculation.

- Derive and sustain the highest level of revenues for the Metro Rail project without interfering with the private marketplace.

PRELIMINARY ENGINEERING

Preliminary engineering for a major public transit project such as Metro Rail has three primary functions or objectives:

- To identify and resolve major design and engineering issues. These include precise locations for alignment and stations; decisions on technology and associated subsystems; implementation schedules; construction methods; and similar features so that final design can proceed on a secure basis.

- To produce cost estimates that provide a reliable basis for major funding decisions by federal, state, and local officials.

- To provide a precise definition of the project so that a final environmental impact statement can be prepared. This includes detailed location and design data.

During the preliminary engineering phase of the Metro Rail project, approximately 30 percent of the final design has been completed. This effort provides a configuration for the final design, as described in the following section, as well as a reasonable basis for project cost estimates.

Simultaneous with the preliminary design work has been an extensive analysis of the possible environmental impacts of the Metro Rail project on the communities along its entire 18-mile route. As part of the environmental impact analysis and Milestones 3 and 4, alternative system alignments and station locations were considered. A comparative analysis screened alternative alignment segments and station locations that might improve upon the locally preferred alternative. Additional analyses in the Hollywood and North Hollywood areas further refined alignment and station locations in these communities.

The remainder of the environmental impact work assessed how the construction and operation of the Metro Rail project might affect key land use and socioeconomic characteristics, as well as natural and physical features, and evaluated possible ways to minimize any adverse effects. Two types of impact, short term and long term, were evaluated. The first type of impact will occur during the temporary construction period, and the second type will occur during Metro Rail's operations. Both direct and indirect effects were considered in the assessment. With direct effects, such as noise and vibration, there is an immediate connection between the Metro Rail system and its alteration of the environmental setting. By contrast, indirect effects occur later in time or farther removed in distance, such as the growth accommodated by Metro Rail and the subsequent economic and fiscal implications.

The analysis of impacts, as well as the selected measures for mitigating them, are documented in the Final Environmental Impact Report, published in November 1983 in compliance with state requirements, and the Final Environmental Impact Statement, published in December 1983 in compliance with federal requirements.

The completion of 30 percent of system design work, and the completion of preliminary cost estimation and all environmental impact analyses, have brought the preliminary engineering effort to its conclusion. This effort has seen SCRTD take all steps necessary to ensure that the Metro Rail system will comply with federal, state, and local requirements; will meet anticipated transportation demands; and will provide a safe, secure, and dependable means of travel for its users.

METRO RAIL SYSTEM DESCRIPTION

The Metro Rail line will be a conventional two-track, steel wheel, steel rail system. The initial segment will be approximately 18 miles long and will serve the central business district, Wilshire Boulevard, Fairfax, Hollywood, and North Hollywood areas. Metro Rail's route and station locations are shown in Figure 1-1 and on the map included at the end of this report.

The initial line is being designed with future line extensions in mind. Seven Metro Rail corridor extensions have been analyzed to estimate the effect of additional travel demand on the initial line. These corridors were presented in the Milestone 1 Report.

The ultimate regional system under consideration is a 150-mile rapid transit system, to be developed on an incremental basis. Different types of transit--light rail, bus-on-freeway, rail rapid transit--will be evaluated as each extension is planned. The most appropriate type will be selected, but in some cases, the system design will allow upgrading to other types of high-capacity transit as demand increases.

A basic policy of the SCRTD Board of Directors is that the Metro Rail project be designed with the flexibility to connect with any of the seven corridors and to accommodate increased patronage from additional future corridors. This policy ensures that the initial 18-mile system can accommodate line extensions without major cost or disruption to existing services.

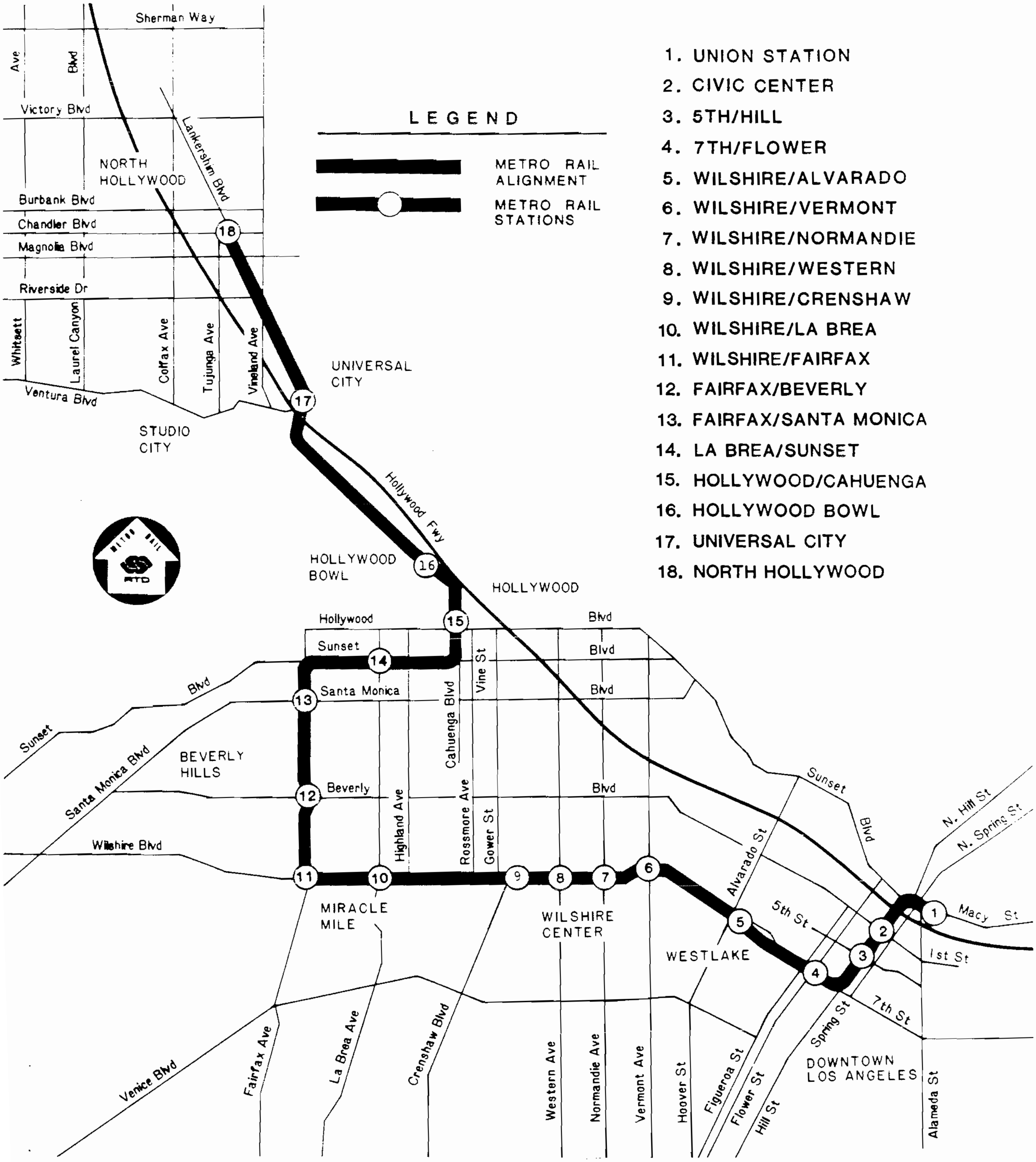

FIGURE 1-1
SCRTD Metro Rail Project
Route Alignment and Station Locations

The Metro Rail system can be described in terms of its four system elements: ways and structures, yard and shops, stations, and subsystems:

- Ways and structures--Ways and structures consist of the major fixed facilities of the system, including the tunnels and trackwork.

- Yard and shops--The main yard and shops constitute the facilities required to store and maintain Metro Rail transit vehicles and to provide maintenance to the system's physical plant and equipment.

- Stations--Stations provide riders access to the trains from the street level. Stations include stairs, escalators, and elevators; a platform area for boarding and leaving trains; and a mezzanine area for fare collection. The stations also provide space for such elements as train control equipment and ventilating equipment.

- Subsystems--The subsystems are the operating equipment portions of the system, such as the passenger vehicles, train control and communications equipment, traction power, and fare collection.

The passenger vehicle will be similar to those in use by modern U.S. rail rapid transit systems and will comfortably carry approximately 162 passengers at peak periods. Trains will consist of up to six passenger vehicles and will be run by one operator. Automatic devices will be provided for routine operating functions and to ensure safe operations.

The type of fare collection subsystem recommended for Metro Rail is designed to minimize evasion of fares and to provide change and tickets in a convenient and easy-to-use way. Depending on the specific station design and the volume of patrons, the location of the fare collection areas and the number of fare collection machines may vary from station to station.

The following chapters of this report describe each of these system elements in detail, following a discussion of the policies that will guide the final design and construction of the system.

2. METRO RAIL SYSTEM POLICIES

2. METRO RAIL SYSTEM POLICIES

During the course of the preliminary engineering effort on the Metro Rail project, a number of policy concepts have been formulated to provide direction for the project's activities. In previous milestone reports, some of these concepts have been addressed implicitly within the technical discussion of the report, while others have been presented as explicit statements of policy and have been adopted by the SCRTD Board of Directors. This chapter gathers these various policy concepts and enunciations into a consistent and formal set of policy statements. These statements comprehensively delineate the policies that will guide the final design and implementation of the Metro Rail system.

The development of these policies has taken place within the milestone process described in Chapter 1, in which the public has actively participated. Thus, the process is designed to ensure that SCRTD policies reflect the concerns of the community at large as well as the best judgment of the Board of Directors, the Metro Rail project staff, and elected officials. The ultimate responsibility for setting SCRTD policy nevertheless remains with the Board of Directors.

The statements of SCRTD policy presented in this chapter are discussed within three broad categories:

- Community-impact policies
- Land use and development policies
- Design and operation policies.

Within each category, specific policies are stated and underlying rationales and implementation measures are briefly described.

COMMUNITY-IMPACT POLICIES

The Metro Rail project is designed to benefit the community at large in the Los Angeles area. Therefore, it is of concern to the SCRTD Board of Directors that sensitivity be maintained to the public's interests, and that any negative impacts of the project on the citizens or the environment of the area be eliminated or mitigated to the greatest degree possible. To this end, policies have been formulated to govern:

- Community participation in the project
- Environmental impacts
- Real estate acquisition and relocation
- Utility relocation.

Each of these is discussed below.

Community Participation

> It is the policy of the SCRTD Board of Directors that citizen input shall be obtained in the Metro Rail project's planning and decision-making processes, to ensure that important decisions take into account the overall values, needs, and priorities of the community.

To implement this policy, the SCRTD Board of Directors has established an extensive Community Participation Program. This program is designed to provide maximum public awareness of, participation in, and support for decisions on the Metro Rail project. The program provides a means for identifying the transit needs and priorities of the community. By obtaining citizen participation, the program promotes the development of a Metro Rail system that will be of the greatest benefit to the greatest number of people and reduces the possibility of litigation, extensive plan revision, and major facility changes after construction begins.

Environmental Impacts

> It is the policy of the SCRTD Board of Directors that any undesirable environmental impacts of the Metro Rail project shall be identified and eliminated or mitigated in a manner that serves the best interest of the general population.

Evaluations of the environmental impacts of the Metro Rail project began with the project's inception and culminated in a detailed environmental impact statement and environmental impact report (EIS/EIR) identifying all significant impacts and their specific mitigation measures. The detailed EIS/EIR was published in draft form in June 1983, and a total of eight public hearings were held from July 18 through July 21, 1983, to obtain the comments of area residents. After revision to incorporate public comments, the Final EIR, responding to state requirements, was published and certified in November 1983; the Final EIS, responding to federal requirements, was published in December 1983.

The EIS and EIR evaluate the environmental effects of the Metro Rail project within 12 broad impact categories: transportation, land use and development, displacement, social and community impacts, safety and security, aesthetics, noise and vibration, air quality, energy, geology and hydrology, biological resources, and construction. It also considers the potential effects of the project on the area's cultural resources--its historic properties, parks and recreation areas, and archaeological and paleontological resources. For each category, the specific measures needed to eliminate or mitigate potential negative impacts are identified, and responsibility for implementing these measures is apportioned to SCRTD and/or other public agencies. In those cases where responsibility rests with other agencies, SCRTD will actively work with those agencies to help carry out the required mitigation measures.

Where responsibility for mitigation rests directly with SCRTD, specific design standards and construction techniques will be used to mitigate the environmental impact. Many of the EIS and EIR recommendations have in fact already been incorporated into the design of the Metro Rail project. For instance, to mitigate potential vibration impacts, the project will use special fasteners, ties, and/or trackbeds to ensure that ground-borne vibration will not be intrusive to occupants of buildings adjacent to the Metro Rail route. Similarly, the design of Metro Rail stations has already taken into account EIS and EIR recommendations concerning aesthetic values and patron safety and security. As an example, station design incorporates such security-related recommendations as the elimination of cul-de-sacs or long pedestrian tunnels leading from the street to the station lobby.

The temporary impacts of Metro Rail construction will be mitigated by various measures, including: (1) contractors will be required to control traffic during construction by following applicable City of Los Angeles manuals and specifications; (2) excavation and decking of arterial streets crossing the rail alignment will be phased so that the capacity of these streets is not unnecessarily reduced; (3) no designated major or secondary highway will be closed to vehicular or pedestrian traffic; and (4) local vehicular or pedestrian access to residences, businesses, or other establishments will not be precluded by the closing of any collector or local street or alley.

Right-of-Way Acquisition and Relocation

> It is the policy of the SCRTD Board of Directors that any persons displaced from their residences or business locations as a result of the acquisition of real property for Metro Rail purposes shall receive fair, uniform, and equitable treatment, and that such persons shall not suffer disproportionate injuries as a result of the Metro Rail project.

To implement this policy, the Board has adopted the following specific measures with regard to the appraisal, acquisition, and management of property and the relocation of citizens displaced by such acquisitions (see Milestone 5 Report):

- Appraisal
  - Real property will be appraised before the initiation of negotiations with an owner.

- The owner or his designated representative will be given an opportunity to accompany the appraiser during inspection of the property.

- The owner will be notified prior to negotiations as to the amount of just compensation established by SCRTD for the property to be acquired. In no event will this amount be less than the appraisal obtained by SCRTD.

- Any decrease or increase in the fair market value of real property prior to the date of valuation caused by the announcement of the Metro Rail project, other than that due to physical deterioration within the reasonable control of the owner, will be disregarded in determining compensation for the property.

- Appraisers will not give consideration to, nor include in their appraisals, any allowance for relocation assistance benefits.

- <u>Acquisition</u>

  - SCRTD will acquire all properties which are necessary for the implementation of the Metro Rail project. No acquisition will be undertaken until the SCRTD Board of Directors has passed a resolution which identifies specific parcels as part of the Metro Rail project and authorizes acquisition by the General Manager.

  - All such approved properties will be acquired in fee simple unless a lesser interest is determined to be in SCRTD's best interest and adequate control can be obtained to ensure the safe operation and construction of the Metro Rail project.

  - Subject to approval by the Board of Directors, advance acquisition will be made whenever practical to forestall anticipated appreciation from development or speculation, or to alleviate a hardship on the property owner resulting from SCRTD's interest in acquiring the property.

  - Every reasonable effort will be made to promptly acquire real property by negotiated purchase for the full amount of the approved just compensation.

  - SCRTD will not take an action which is coercive in nature to compel agreement on price.

  - When negotiations are initiated, the owner will be provided a written statement which sets forth the amount established as just compensation and the basis of the determination.

- If improvements or fixtures considered as realty are being separately acquired and the owner of the land involved disclaims all interest, an offer will be provided to the tenant for the improvements.

- The full amount of the approved just compensation will be paid to the property owner before SCRTD takes physical possession of the property or requires the property to be vacated by the property owner.

- SCRTD will compensate the owner for expenses necessarily incurred for recording fees, transfer taxes, and escrow fees related to conveying the real property.

- If the acquisition of part of a property will leave the owner with an uneconomic remnant, SCRTD will offer to acquire that remnant.

- Condemnation of real property interest by SCRTD will be pursued only after all reasonable efforts to obtain the required property by negotiation have been exhausted.

- Property management

  - All property rights acquired for purposes of constructing and operating the Metro Rail project will be managed by SCRTD.

  - SCRTD may permit an owner or tenant to occupy real property acquired on a rental basis for a short term or for a period subject to termination by SCRTD on short notice.

  - The owner of improvements or appurtenances on land being acquired will be allowed the option of retaining improvements or appurtenances at a retention value predetermined by SCRTD.

  - SCRTD will expeditiously move to inspect vacant property and to protect against vandalism, fire, and rodent infestation.

- Relocation

  - SCRTD will use its own facilities, personnel, and services to implement its relocation and acquisition programs.

  - To ensure that the public has adequate knowledge of the relocation program, SCRTD will present information and provide opportunity for discussion of relocation services and payments at public hearings, distribute relocation brochures, and provide adequate notice of the relocation assistance program.

- A relocation advisory program will be established to provide the maximum assistance possible to all persons required to relocate because of the Metro Rail project.

- Each displaced person will be provided written and verbal information which fully explains the relocation services and eligibility requirements for payments of replacement housing and moving expenses. Each displaced business will also be provided applicable information.

- No persons eligible for relocation payments and lawfully occupying real property will be required to move from a dwelling or business without notice in writing at least 90 days in advance of the intended vacate date.

- Any applicant for a relocation payment who is aggrieved by SCRTD's determination as to eligibility for payment or the amount of the relocation payment may appeal that determination to SCRTD.

- SCRTD will assure itself that decent, safe, and sanitary replacement dwellings will be available to displaced persons within a reasonable time prior to issuance of a notice to vacate.

Federal and state requirements for right-of-way acquisition and relocation are specified in:

- The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646

- Urban Mass Transportation Administration Circular 4530.1, March 21, 1978

- State of California Relocation Act, Government Code Section 7260 et seq.

- State of California Law of Eminent Domain, Code of Civil Procedure Section 1230.010 et seq.

SCRTD has formulated its policy and procedures to comply with these regulations.

Utility Relocation

It is the policy of the SCRTD Board of Directors that continuity of utility service to all utility users shall be maintained despite any utility relocation, replacement, or alteration necessitated by Metro Rail construction. SCRTD will provide adequate funds to achieve utility relocations without any interruption in service. Such funding shall be limited to that required to provide equivalent service, and not any improvement in service.

Construction activities on the Metro Rail project will require the facilities of many public and private utilities to be relocated (see Final EIS and EIR). The major utility owners that will be affected include:

- State of California
- County of Los Angeles
- City of Los Angeles
- Department of Water and Power
- Pacific Telephone & Telegraph Company
- Western Union Telegraph Company
- Southern California Edison Company
- Southern California Gas Company.

Continuity in the service of these utilities must be maintained to protect the health, safety, and welfare of occupants of residences and businesses adjacent to Metro Rail construction areas.

LAND USE AND DEVELOPMENT

The SCRTD Board of Directors has established several policies to guide land use and development (see Milestone 6 Report). These policies fall within four categories:

- Corridor-scale institutional framework
- Station area master planning
- Joint development
- Value capture.

Each of these is discussed in turn in the following sections.

Corridor-Scale Institutional Framework

It is the policy of the SCRTD Board of Directors that an orderly and effective corridor-scale joint development process shall be implemented in support of the Metro Rail project.

An effective corridor-scale institutional framework is a prerequisite to effective administration and implementation of equitable station area master plans. "Corridor scale" refers to the contiguous impact area of the Metro Rail system, covering not only the entire length of the system route, but also the entire breadth of the impact area along the route.

To establish a corridor-scale institutional framework, SCRTD will enter into cooperative agreements with other agencies. These agreements will establish a specialized entity to: (1) direct a comprehensive station area master planning process at each Metro Rail station; (2) package specific joint development projects; (3) negotiate appropriate and equitable value capture agreements and administer other joint development mechanisms; (4) provide ombudsman support services to facilitate joint development project implementation; and (5) monitor the implementation of the Metro Rail station master plans.

Specifically, the following measures will be taken to implement SCRTD's policy:

- SCRTD will enter into cooperative agreements with any or all of the following agencies--the Community Redevelopment Agency of the City of Los Angeles, the City of Los Angeles, and Los Angeles County--in order to carry out the station area master planning process and the Metro Rail joint development/value capture programs.

- SCRTD will secure arrangements with the City of Los Angeles and the County of Los Angeles, respectively, in order to review and comment on proposed land use changes, at both the regional and station area levels, which will affect short- and long-term Metro Rail system patronage.

- SCRTD will assume an active private/public co-venture position toward joint development/value capture in the implementation of the Metro Rail system. SCRTD will seek to attain and sustain the highest level of system operational revenue and return without interfering with the private marketplace, but adopting a capital leveraging position when necessary.

- Joint development planning undertaken by the station/corridor area master planning process will be closely integrated with the transit corridor specific plans prepared by the City of Los Angeles and the County of Los Angeles. The resulting plans will provide the flexibility sufficient to encourage, where appropriate, high-quality joint development and certainty regarding future land use patterns for residents of the planning areas.

This institutional framework is designed to provide a flexible, effective community-oriented planning process. Within this framework, the public and private sectors will work cooperatively in the planning, financing, and construction of development projects adjacent to, and integrated with, transportation facilities.

Station Area Master Planning

> It is the policy of the SCRTD Board of Directors that the specific content and form of the short- and long-term Metro Rail land use and development program shall be established through a comprehensive station area/corridor area master planning process. The station area/corridor master plans shall be formulated in a manner consistent with the existing general land use planning process and shall become the prevailing guide for all future land use development in these areas. The station area master plans shall build on the specific area plans now being developed by the Los Angeles City and County Planning Departments and shall be refined through major community and private sector input. The station area master plans shall be completed prior to the construction of the Metro Rail system and shall be fully coordinated with the final Metro Rail station design efforts.

Studies of other U.S. and Canadian regional rapid transit systems clearly indicate that the optimum level of station area development occurs when the public sector actively participates in the land use development process. A critical step both in protecting existing residential neighborhoods and in attracting new private investment is the establishment of "rules of the development process." A comprehensive and formally adopted master plan is the most effective means for establishing such rules. Consequently, a comprehensive station/corridor master planning process will be initiated for the Metro Rail joint development program.

Through a cooperative agreement with the Community Redevelopment Agency, SCRTD will use this flexible tool to plan all stations located in development areas. In station areas that cannot be designated as urban renewal districts, the specific area planning mechanism will be used.

Joint Development

> It is the policy of the SCRTD Board of Directors that an active "project packaging" approach to the joint development of Metro Rail station areas shall be adopted.

Experience in other U.S. and Canadian cities evaluated by SCRTD demonstrates that a laissez-faire approach or a development approach that relies solely on coordination is not adequate to ensure the optimum mix, staging, and composition of rapid transit station area development. Consequently, most U.S. public transportation authorities have in recent years instituted the more active "project packaging" approach to joint development. Case examples in the master planning process include New York, Atlanta, Miami, Houston, San Francisco, Philadelphia, Portland, and Washington, D.C.

"Project packaging" refers to the preparation of detailed proposals for specific real estate development projects. Such proposals contain all information necessary for public agencies and private sector investors to clearly identify their prospective roles, benefits, and liabilities. Project packaging therefore encompasses market and financial feasibility analyses; architectural planning and design; construction cost estimates; traffic and circulation assessments; land use policy analyses; site and improvement appraisals; and financial, construction, and operating plans.

This choice of approach is supported by the historical urban redevelopment experience of the City of Los Angeles and the economic development experience of Los Angeles County. To successfully package joint development, essentially five major areas of authority must be entrusted to the entity directing this process: (1) comprehensive planning and redevelopment coordination; (2) station facility and related transportation service design and location; (3) real estate project packaging resources and direction; (4) ombudsman support and interagency representation; and (5) financial leverage resources and value capture negotiation. Such authority will be provided through cooperative agreements between SCRTD and the Community Redevelopment Agency of Los Angeles, the City of Los Angeles, Los Angeles County, and other agencies, as required.

<u>Value Capture</u>

> It is the policy of the SCRTD Board of Directors that a sustainable level of value capture revenues shall be secured from public sector investment in the Metro Rail project, for the express purpose of supporting the system's ongoing operations and expansion.

"Value capture" describes a set of mechanisms that enable public interests to actively share in the monetary benefits accruing from the implementation of a regional rapid transit system. The benefits are secured or "captured" through negotiated agreements with private sector interests sponsoring projects that profit directly from the construction or operation of the system.

To implement the value capture policy, station cost-sharing agreements, connector fees, and land/air rights leasing will be directly negotiated by SCRTD with regard to existing and future development, physically or functionally linked to each Metro Rail station area. These agreements will be negotiated by SCRTD from an equitable and consistent set of pre-established principles. Full consideration will be given in defining the terms of these agreements to enhancing the feasibility of joint development projects during the critical first 5 years of commercial building and system operation.

The optimum level of station/vehicle advertising and station concession revenue will be sought while maintaining the highest quality amenities and pedestrian-oriented system, along with a consistently high level of patron security. All other viable fiscal approaches to value capture will actively be pursued by SCRTD for inclusion in the Metro Rail value capture program. These include: (1) tax increment financing; (2) benefit assessment districts; (3) employer contributions; (4) gasoline taxes; (5) transfer of development rights; and (6) assets speculation/ capital gains taxes.

The revenue objective for the Metro Rail value capture program will be to secure an annual cash flow stream at least equivalent to the capitalized 1982 costs of the Metro Rail station facilities. This is approximately equivalent to 25 percent of the total Metro Rail system capital costs. This level of private/public co-venture participation in the Metro Rail system is consistent with recently attained results and adopted value capture programs in other major U.S. metropolitan areas. In addition, the majority of ongoing station maintenance and security costs should be recovered through a successfully targeted and equitable value capture program.

This value capture policy fully takes account of recent private sector responses to the reduced prospect of federal funding in major U.S. metropolitan areas. In addition, because SCRTD will assume a positive and active role in joint development packaging in relation to individual Metro Rail station areas, the value capture program will in effect be a public/private co-venture. Both the public and private sectors will invest in the Metro Rail system, and equitable returns will be sought for both.

An additional consideration of the program is to enhance private sector returns through a joint development packaging process that fully coordinates station facility design with private development. The advertising and concession value capture policies have been formulated on the basis of the documented recent experience of other rapid transit system operators. The fiscal value capture mechanisms have been designed to fully conform with existing statutes as well as national and local precedents. In the case of the transfer-of-development-rights mechanism, special attention has been given to protecting existing homeowners and residential neighborhoods.

SYSTEM DESIGN AND OPERATIONS

This section discusses policies affecting the design and operation of the Metro Rail system in each of the following areas:

- Service levels
- Safety and security

- Cost-effectiveness considerations
- Integration of the Metro Rail system with other modes
- Stations
- Subsystems
- Future development.

Service Levels

> It is the policy of the SCRTD Board of Directors that transit mobility and accessibility shall be maximized within the Metro Rail corridor through the implementation of cost-effective levels of service and operating hours.

To implement this policy, the following standards have been established as the basis for the Metro Rail system design:

- Loading--To provide safe and comfortable passenger transportation, the loading standard for each Metro Rail car has been set at 162 passengers for peak periods. At off-peak times, the loading standard per car has been set at 90 passengers.

- Service frequency--To maintain the loading standards identified above, Metro Rail trains must operate frequently enough to prevent overcrowding in rail cars. However, when demand levels do not require frequent service to meet loading standards, a headway policy is needed to prevent unacceptably long times spent by passengers waiting to board trains. The following minimum train frequencies--or maximum headways--have been established:

  - Weekday peak period (6:30-9:00 A.M. and 3:30-6:30 P.M.)--A headway not greater than 6 minutes between trains will be maintained.

  - Weekday midday (approximately 9 A.M.-3:30 P.M.)--A headway not in excess of 7-1/2 minutes between trains will be maintained.

  - Evenings, weekends, holidays--A headway not greater than 15 minutes between trains will be maintained. Late-night service may be less frequent.

- Train size--The Metro Rail system will be designed to accommodate trains of a maximum length of six cars, with each car approximately 75 feet long. This train size will enable Metro Rail to handle peak passenger demand in the year 2000 with a time between trains of about 3-1/2 minutes. Six-car trains will also provide the capacity for 50 percent patronage growth beyond the year 2000 when operated at a headway of about 2-1/2 minutes between trains.

- Operating hours--The system should be capable of operating 24 hours a day, 7 days a week at the policy headway. Actual operating hours and late night service levels will be established by community needs and usage.

These standards are comparable to those applied by major U.S. rail transit authorities. They have been subjected to cost-effectiveness evaluations and analysis to ensure satisfaction of the expected passenger demand.

These standards will enable the Metro Rail system to handle not only the ridership expected during its early years of operation, but also the increases in ridership that are expected as the region and the system grow. In total, these standards determine the system's design capacity--the maximum number of peak-period passengers that Metro Rail will be able to accommodate through its most heavily traveled section.

Safety and Security

To ensure the safety and security of Metro Rail passengers, employees, facilities, and equipment, policies have been formulated concerning system safety, fire/life safety, security, and security enforcement (see Milestone 7 Report). Each of these is discussed below.

System Safety

> It is the policy of the SCRTD Board of Directors that safety shall be of primary importance throughout the development and implementation of the Metro Rail system, from preliminary engineering through revenue operations. All applicable codes and regulations, augmented by modern system safety engineering technology and design standards, shall be used to ensure that the system achieves a level of safety that equals or surpasses that of other rail rapid transit systems.

Safety considerations involve the identification of potential hazards and the prevention of accidents so that passengers and employees are not injured and transit system property is not damaged. In planning for a safe rail rapid transit system, the overall safety objective is to minimize, control, and eliminate hazards. To achieve this objective, SCRTD has developed a comprehensive system safety program plan for evaluating safety issues and implementing safety measures throughout the life of the Metro Rail project. The program plan emphasizes preventive measures over corrective ones, and therefore specifies methods for incorporating safety criteria into the design of the Metro Rail system.

The design criteria associated with the prevention of accidents in stations, aboard vehicles, and in other areas of the transit system place heavy emphasis on features to minimize the potential for accidents. These include such provisions as adequate lighting, walking surfaces constructed of nonslip materials, safe pedestrian access to station entrances, and fail-safe train control apparatus. Design criteria focusing primarily on protection of people and property include planning for adequate emergency exits, on-site electrical power supplies, appropriate alarm systems, and emergency communications systems.

In addition to these design requirements, the safety program plan specifies requirements for the structure of the safety management organization; mechanisms for identifying and assessing system safety hazards; and methods for eliminating, minimizing, or controlling those hazards throughout the Metro Rail project, from system design through construction and operation. To support these tasks, the experience of and analytical methods derived from other transit properties will be used by SCRTD.

Fire/Life Safety

> It is the policy of the SCRTD Board of Directors that special measures shall be taken for emergency preparedness on the Metro Rail system to ensure that fire/life safety levels will equal or surpass those of other rapid transit systems and meet the intent of local and state codes and standards.

A fire/life safety program plan has been developed by SCRTD to ensure that special emergency preparedness provisions for all types of major incidents (including fires, earthquakes, and other major disasters) are made throughout all phases of the Metro Rail project.

Fire/life safety provisions include design criteria for preventing, minimizing, or controlling emergency situations, as well as criteria to provide protection to people and property once an emergency actually occurs.

Preventive design considerations rely on the use of noncombustible, or low-combustion, materials wherever possible. In addition, the criteria emphasize the use of materials that produce low levels of smoke or toxic fumes. Preventive criteria include requirements for extensive fire sprinkler and standpipe installations; detecting devices for smoke, gas, and seismic activity; alarm systems; and adequate exits and other emergency provisions for safety walkways, exits to streets, and cross passages for safe egress to adjacent tunnels should a fire occur. Tunnel ventilation equipment is required to keep smoke and toxic fumes to safe levels until all passengers are evacuated.

Protective criteria include emergency plans and procedures for SCRTD personnel and local emergency response agencies. Periodic and extensive training drills will be developed and conducted by these various agencies to ensure a rapid and effective response to any emergency.

Security

> It is the policy of the SCRTD Board of Directors that modern security engineering standards and technology shall be used to ensure that the Metro Rail system achieves a level of security that equals or surpasses that of other rail rapid transit systems.

To implement this policy, a comprehensive security program plan has been developed for the Metro Rail system. The basic objective of the program plan is to protect Metro Rail passengers and employees from crime or the threat of crime and to protect system facilities and equipment from vandalism, theft, or disruption.

The security program plan defines the activities and responsibilities for security beginning with initial design and continuing through the construction and operation of the system. This plan emphasizes the incorporation of deterrent measures in system design, including provisions for open, well-lit parking areas, stations with clear visibility and open sight lines, and the use of vandal-resistant and graffiti-resistant materials for stations and vehicles.

In addition, the security program plan specifies significant requirements for the detection of crime once it occurs and for apprehending offenders. Provisions for the detection of crime include the obvious and extensive presence of transit police in the Metro Rail system, closed-circuit television coverage of station areas and other public areas of the system, emergency telephones in stations, and intrusion alarms in nonpublic areas and around fare equipment.

Provisions for the apprehension of offenders include measures to coordinate the law enforcement efforts of the SCRTD transit police, the Los Angeles City Police Department, and the Los Angeles County Sheriff's Department. Design criteria involving interagency law enforcement include extensive communications systems as well as detection and alarm apparatus.

Security Enforcement Policy

> It is the policy of the SCRTD Board of Directors that SCRTD transit police will have concurrent jurisdiction with local law-enforcement agencies and the medical examiner/coroner for Metro Rail property, but that the transit police will assume primary responsibility for policing all property owned or operated by SCRTD, including stations, vehicles, tunnels, and tracks.

The SCRTD transit police already have a recognized and established presence in Los Angeles and experience in policing a multijurisdictional transit operation. This background, together with the organizational ease with which this group can be trained in rail rapid transit characteristics, make the SCRTD transit police a logical choice for assuming the primary responsibility for policing the Metro Rail system. This choice is supported by the experience of comparable rail rapid transit systems in other U.S. cities.

SCRTD transit police currently have joint jurisdiction with local law-enforcement agencies for policing SCRTD buses. For example, under a current agreement with the LAPD, the transit police have primary responsibility for patrolling SCRTD buses, while the LAPD is responsible for conducting both preliminary and follow-up investigations of complex felony crimes, crimes of violence involving any weapon, and crimes involving the loss of property worth more than $1,000 that occur on SCRTD property.

Similar arrangements for Metro Rail would only be an extension of existing agreements between SCRTD and local agencies. However, because Metro Rail ridership levels are expected to be high, the number of security incidents may be sufficient to warrant the addition of an investigative capability to the transit police. Such would require changes to existing agreements. The Metro Rail Security Subcommittee is studying the issue of mutual-aid agreements, and the capability of the transit police to handle investigations of major crimes on SCRTD property will be assessed.

Cost-Effectiveness

> It is the policy of the SCRTD Board of Directors that the Metro Rail system shall maximize capital and operating cost-effectiveness in terms of costs per passengers carried and passenger miles traveled.

The principle of cost-effectiveness was inherent in the alternatives analysis that led to the selection of the preferred route and mode for the Metro Rail project. The policy of cost-effectiveness will be extended through the design and construction phases by implementation of the following:

- Minimization of capital costs consistent with maintaining a high level of ridership. This consideration places emphasis on attracting and maintaining ridership, and hence on providing service with functional utility and adequate safety and dependability.

- Assessment of capital and operating cost trade-offs in terms of life cycle costs. This requires that the added cost for capital equipment should have some payback over the life of the system in terms of reduced operating and maintenance costs. Conversely, some increase in annual costs may be appropriate to save on inordinately high capital expenditures.

- The use of design-and-construct-to-cost techniques. This method sets cost targets for system components and sections; monitors progress against the goal; and, if the expected cost is significantly higher than the target, requires redesign to reduce the cost. It is expected that value engineering techniques will be applied in all phases of the project to ensure the lowest possible system cost.

- The use of proven technology. This practice is fundamental to the Metro Rail design and will avoid the cost and schedule risks associated with unproven designs. The use of proven technology is particularly important where it improves labor productivity. Operating and maintenance labor represents on average approximately 65 percent of the annual operating costs of a transit system. Making use of proven technology to reduce labor costs, particularly in maintenance and operating areas, can thus provide significant cost savings.

Integration With Other Modes

To ensure that the Metro Rail system is effectively integrated with other modes of transportation, policies have been formulated to guide the development of the feeder bus system and the establishment and implementation of measures to minimize impacts on traffic flows. SCRTD policy concerning the system's integration with light rail vehicles is discussed at the end of this chapter in the future developments section.

Feeder Bus System

To carry out its fundamental charter to develop a cost-effective regional transit system providing convenient and affordable service to the greatest number of people, SCRTD shall establish an integrated Metro Rail and feeder bus system. It is the policy of the SCRTD Board of Directors that specific bus routes shall be modified to maximize rail traffic, but that the basic structure of the bus system shall be essentially maintained to ensure convenient service for those traveling on routes not served by Metro Rail.

The percentage of operating costs covered by passenger fares will be significantly higher for the Metro Rail system than it is for the bus system. Therefore, for cost-effectiveness considerations, the feeder bus system will be designed to maximize rail ridership.

The start of Metro Rail service will present an opportunity to save on bus operating costs by terminating bus routes at rail stations, rather than continuing to operate buses on lines paralleling the Metro Rail route. A competing concern is to avoid disruptions to large numbers of bus riders whose travel requirements will not be conveniently served by Metro Rail. Thus, there is an important trade-off between maximizing savings on bus operating costs and minimizing disruption to bus riders.

The recommended bus plan for the Metro Rail line takes into account these factors and represents the best balance between passenger convenience and savings in operating costs. The recommended bus plan is essentially the present bus system of routes and service levels, modified by a moderate amount of route terminations at rail stations and reductions in the frequencies of buses on routes parallel to the rail line (see Milestone 9 Report).

<u>Traffic Improvements</u>

It is the policy of the SCRTD Board of Directors that station design shall include measures to accommodate and facilitate traffic flows in the station vicinity, such as auto parking facilities and bus facilities. Such design elements shall be included in the capital cost of the station. SCRTD will also cooperate with the Los Angeles City Department of Transportation, which will be responsible for implementing other traffic mitigation measures.

Although Metro Rail will divert many auto users to transit and thus result in less overall traffic congestion in the regional core, traffic in areas adjacent to some Metro Rail stations is likely to increase. To minimize the adverse impacts on traffic circulation in these areas, automobile parking lots (park-and-ride facilities) will be provided at five stations and off-street auto pick-up and drop-off areas (kiss-and-ride facilities) and bus facilities will be provided at stations where traffic volumes are expected to be high.

At a number of stations, an estimated 15 percent or more of Metro Rail riders will arrive at or depart from the station by auto. At three stations (Union, Universal City, and North Hollywood Stations), the volume of passengers using auto as an access mode is projected at over 25 percent.

Measures to mitigate adverse traffic impacts at these three station areas and additional areas will be necessary. Some of these measures will be done by SCRTD as part of station construction and development, while others will be the responsibility of the Los Angeles City Department of Transportation. The Los Angeles City Department of Transportation has projected that 28 key intersections in the regional core will require mitigation measures as a result of Metro Rail, out of a total of 257 intersections that were studied.

Traffic volumes in these areas are projected to be at, near, or above the capacity of the intersections, and the volume-to-capacity ratio is expected to increase by at least 2 percent above existing levels. (At over half of the regional core's 76 most critical intersections, however, traffic conditions are expected to improve because of Metro Rail.)

Mitigation measures for adversely affected intersections might consist of one or more of the following:

- Increase the capacity of approach streets by restricting parking.
- Restripe the approach streets to provide an additional through lane and/or turn lane.
- Install left-turn restrictions/prohibitions.
- Add or revise traffic signal phases to accommodate the projected traffic pattern.
- Widen the intersection approaches.
- Establish reversible lanes, if the peak-period traffic is highly directional.

Street widening has been considered a realistic mitigation measure only at locations contiguous to station sites where property acquisition is contemplated and where cut-and-cover construction techniques will in any case require street reconstruction. Otherwise, the least restrictive measure that will completely mitigate the anticipated adverse impact generally has been or will be chosen. If an anticipated adverse impact cannot be completely mitigated, then the measure which will most effectively improve projected conditions at the intersection has been selected (see Final EIS and EIR).

Stations

SCRTD has formulated several policies which directly relate to Metro Rail stations. Policies have been established for advertising and concessions, artwork, parking for both automobiles and bicycles, station attendants, and restroom availability.

Advertising

> It is the policy of the SCRTD Board of Directors that stations shall use advertising to generate revenue, but only to the extent that the advertising does not interfere with the station's visual and design elements or patron convenience, safety, and security.

In formulating and carrying out the advertising program, several objectives were defined. Advertising should not interfere with the design elements of the station or with the ability of patrons to use the station. Most important, advertising should not inhibit station security surveillance in any way.

To maximize potential short- and long-term revenue returns from advertising, competitive bids will be used for all major contracts executed with private firms. Exclusive advertising agreements with private clients will be made when the circumstances ensure reliable, equitable, and profitable contractual terms.

As part of the advertising program, SCRTD will approve and support media type and placement so that maintenance costs can be minimized and allowance can be made for the possible future accommodation of the latest audiovisual technology. SCRTD is now monitoring audiovisual advertising media to determine their appropriateness for Metro Rail applications.

Concessions

> It is the policy of the SCRTD Board of Directors that station concessions shall be designed for patron safety and security, while still providing high-quality amenities and a source of revenue generation.

In keeping with the Board of Directors' focus on system safety and security, all food, beverage, and tobacco concessions will be excluded from Metro Rail stations. This will limit loitering, theft, and smoking-related fire hazards and should also help to keep the system's maintenance costs at a minimum.

Except for those Metro Rail stations where there are opportunities to develop retail concessions in areas connecting with station entranceways, SCRTD will pursue only "built in" mechanical retail concessions such as newspaper vending machines. Provision will be made for knock-out panels or second-level walkways to maximize the physical connection between Metro Rail station facilities and nearby commercial/retail developments.

During the final design of Metro Rail stations, SCRTD may also consider allowing the installation of "magic teller" bank outlets. These outlets could be located near the faregate area of stations.

Artwork

> It is the policy of the SCRTD Board of Directors that an artwork program shall be established to provide an individual identity for, and an aesthetic experience at, each station.

An artwork program is being established to respond to the Board's requirement for aesthetically pleasing art to be used for station identification. This program includes procedures for commissioning artwork and/or accepting donated artwork. A maximum of 0.5 percent of the estimated cost of the station structure will be budgeted at each station for commissioned artwork.

The acceptance or commissioning of artwork at each station will be guided by a committee composed of five permanent members and the architect for the particular station under consideration. The five permanent members will be appointed by the General Manager and will be eminent experts in art or art-related subjects. The architect for each station will be a voting member and technical adviser on artist selection and art review for his/her design assignment(s).

Parking

> It is the policy of the SCRTD Board of Directors that parking facilities for Metro Rail users shall be limited, given the costs of providing such facilities, traffic congestion considerations, and SCRTD's goal of promoting maximum bus and rail ridership. Parking facilities provided by Metro Rail shall be restricted to Metro Rail users. It is the intent of SCRTD that parking facilities shall be operationally self-sufficient, but that rates for parking shall not be so high as to discourage Metro Rail passengers from using the facilities. The Board of Directors will set parking rates and fees at a later date.

The cost of providing parking and related facilities for access to Metro Rail stations is extremely high. For this reason, bus access to Metro Rail stations will be promoted, and the number and size of auto parking facilities will be limited. Off-street parking for Metro Rail users will be provided only at those stations where there are high volumes of passengers having relatively long feeder/distribution trips. The Union Station, Wilshire/Fairfax, Fairfax/Beverly, Universal City, and North Hollywood Stations will have the highest priority for parking facilities.

To minimize the cost of these facilities, SCRTD will encourage public/private co-venture development. It will also require that parking revenues cover the operating costs of the parking facilities.

Bicycle Parking

> It is the policy of the SCRTD Board of Directors that those patrons arriving at Metro Rail stations on bicycles shall be accommodated to the extent feasible.*

To comply with the requests of citizens wishing to bicycle to Metro Rail stations, racks for bicycle parking will be provided at each Metro Rail station where land is available--that is, at all stations except for the Civic Center, 5th/Hill, 7th/Flower, Wilshire/Normandie, and Hollywood Bowl Stations. Bicycle parking facilities will be located in close proximity to station entrances, in an easily observable location.

The exact number of racks needed at each station cannot at present be accurately predicted. However, if a nominal number of racks is provided at each station, the degree of use can be observed and additional facilities can be provided if needed. It is possible that the additional facilities could be funded from fees charged for the use of the initial facilities.

Station Agents

> It is the policy of the SCRTD Board of Directors that Metro Rail stations shall be designed for centralized operation and shall not rely on full-time station

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* No decision has yet been made as to whether bicycles will be allowed on Metro Rail trains. Nothing in the system design will preclude bicycles from being carried on trains, but their transportation must not jeopardize the safety, comfort, or convenience of passengers. The SCRTD Board of Directors will establish a policy on bicycle transportation as part of the final system operating plan.

attendants. Station agents shall be provided at certain stations at certain times of the day when their presence is warranted. The determination of need shall be based upon patronage levels, security considerations, and the need for patron assistance.

Experience at other transit systems suggests that the Metro Rail system be designed without reliance on full-time personnel at stations. Experience also indicates, however, that station agents can perform many important functions cost-effectively and that they should be used on a selective basis. These functions are:

- Patron assistance
- Simple maintenance activities on fare collection equipment
- Deterrence of fare evasion, crime, and vandalism
- Assistance in emergency situations.

As the agent is expected to move around the station area and be highly visible to Metro Rail passengers, no agent's booth will be constructed in the stations, but a limited function control panel will be provided at fare collection areas. This will enable the station agent to communicate easily with the Central Control operation, although all station closed-circuit television monitoring, public address actions, and alarm system monitoring will be conducted by Central Control personnel. The Central Control operation will provide, in effect, full-time security surveillance and patron assistance.

Restrooms

It is the policy of the SCRTD Board of Directors that restroom facilities shall be provided at each station for Metro Rail staff use; these facilities shall be available for emergency use by the public at the discretion of Metro Rail personnel.

There is no requirement for public restrooms in transit facilities. In transit stations where such facilities have been provided, they have increased the initial capital cost of the stations and have required high levels of maintenance, with consequent impact on operating expenses. Such facilities are also difficult to monitor, and security and safety problems have occurred. Restroom facilities provided for Metro Rail personnel will therefore be equipped with remote-controlled door locking devices operable from Central Control and will be available for emergency use by the public.

It is believed that making restroom facilities available to the public on an emergency basis, at the discretion of Metro Rail personnel, will satisfy public needs while averting additional operation, maintenance, and security expenses.

Subsystems

This section discusses SCRTD's policies concerning two of Metro Rail's major subsystems--passenger vehicles and fare collection.

Passenger Vehicles

> It is the policy of the SCRTD Board of Directors that Metro Rail patrons shall be provided with an aesthetically pleasing passenger vehicle that will attract riders and provide a safe, comfortable, and dependable trip.

To this end, the passenger vehicle will have the following characteristics:

- A design using proven equipment that is generally available and a size that is similar to cars commonly in service in newer U.S. transit properties
- Stainless steel exterior carbody construction
- A comfortable, well-lighted interior designed for effective use of space that will meet loading standards
- Sufficient doors to allow rapid boarding and exiting
- Characteristics that meet all existing safety and security requirements, including fire-retardant materials, impact-resistant windows, etc.

Transit properties such as those in the metropolitan areas of Washington, San Francisco, Baltimore, Miami, and Atlanta have chosen 75-foot-long vehicles to meet their rapid transit needs. SCRTD vehicle subsystems have also been developed to meet the performance requirements of cars of this length. Thus, it will be possible to obtain proven, reliable rail rapid transit equipment. In addition, if a car is chosen that is similar to those being procured by other U.S. rail rapid transit systems, SCRTD may have the opportunity to realize significant cost savings. The size of the car order from SCRTD, in conjunction with car orders from other transit properties, should enable a vehicle supplier to benefit from economies of scale and thus reduce vehicle production costs.

Stainless steel has been chosen as an exterior material for reasons of durability and ease of cleaning and maintenance. Stainless steel is noncorrosive and will endure beyond the design life of the passenger vehicle. Even in the event of a fire, the carbody structure and skin may not sustain permanent damage. Stainless steel is the standard of New York City and is also being specified for new car orders in Philadelphia, Cleveland, Baltimore, Miami, Atlanta, and Houston.

The interior of the passenger vehicle will contain materials that are self-extinguishing, produce low levels of smoke emissions, and have minimal potential for generating toxic fumes. In addition, the vehicle's floor will provide resistance to flame penetration from undercar fires for a minimum of 1 hour.

The exterior design and interior layout, design, and appointments will be based on design studies and evaluation of alternatives. It is anticipated that the SCRTD Board of Directors will be involved in the final selection of interior and exterior designs. Preliminary studies have identified a need for three or four doors on each side of the car, but the final decision on the number of doors will be based on studies that consider boarding and exiting volumes, desired dwell times, and interior layouts.

Fare Collection

> It is the policy of the SCRTD Board of Directors that the Metro Rail system shall be designed to use an automated barrier fare collection approach. The fare collection equipment shall provide the Board of Directors with flexibility in setting and adjusting fare levels to meet future needs.

In evaluating fare collection subsystems, SCRTD had the overall objective of identifying an approach that not only ensures passengers pay the proper fare for their trips, but also provides SCRTD with flexibility in setting and adjusting those fares. Two basic alternatives--a barrier and a barrier-free approach--were evaluated on their ability to meet this objective, as well as on their cost and convenience to passengers.

The assessment indicated that both alternatives would provide a high degree of flexibility in setting and adjusting fares. The barrier-free approach would provide greater passenger convenience and incur lesser capital costs than the barrier alternative. Its advantages in these areas were, however, outweighed by its potential for fare evasion. Because no rail rapid transit system in North America has implemented a barrier-free collection method, there is a lack of data on which to estimate the potential magnitude of fare evasion. It is therefore impossible to accurately assess the level of inspection required to prevent fare evasion, the annual costs of operating the collection subsystem, and the impact of fare-evasion cases on the local court system.

Consequently, SCRTD has selected the barrier approach as that which best meets its overall objective of selecting a system that ensures that passengers pay the required fare and yet allows full flexibility in setting and adjusting those fares (see Milestone 8 Report).

Future Development

Future extensions to the Metro Rail system are contemplated, as is the implementation of new light rail transit lines. Accordingly, two policies have been formulated to guide the system design.

Future Metro Rail Extensions

> It is the policy of the SCRTD Board of Directors that the design of the Metro Rail system shall facilitate future rail extensions.

One of the primary objectives of establishing an integrated bus/rail transit system is to maximize operational efficiency, and in such a system, operating cost savings can be achieved when rail lines replace heavily patronized bus lines. However, any decision on future extensions to the system must be the result of a rigorous planning process similar to that followed for the system's initial line. Such a process must include careful evaluation of passenger demand, service considerations, and capital cost requirements, as well as potential operating cost savings.

Light Rail Provisions

> It is the policy of the SCRTD Board of Directors that light rail systems shall be considered for use in corridors where they could provide either increased service or reduced operating cost in comparison with bus operations. Opportunities for direct transfer from light rail to Metro Rail shall be sought where appropriate. Although light rail vehicles may use heavy rail trackways for shuttling or maintenance purposes, light rail and heavy rail operations shall not be combined for revenue service.

Cost savings can be realized by replacing some bus line-haul routes with light rail systems. Buses on these routes could be removed from service to reduce system costs, or could be reallocated to provide collection and distribution service for light rail lines.

3. METRO RAIL SYSTEM-LEVEL REQUIREMENTS

3. METRO RAIL SYSTEM-LEVEL REQUIREMENTS

The Metro Rail system represents the integration of many elements, including stations, ways and structures, and subsystems such as passenger vehicles, train control equipment, and fare collection devices. In the design of the system, certain criteria must be met that cut across all of these individual elements. These impose system-wide requirements on the project to provide:

- Convenient, rapid, and cost-effective transportation service through the year 2000 and beyond
- A comfortable environment
- Safety under both normal and emergency conditions
- Security
- Dependability
- The ability to operate satisfactorily in all likely environmental conditions.

These system-level requirements were defined in Milestone 1 and have been refined in analyses and discussions that have continued throughout the milestone process, including refinements to improve the system's cost-effectiveness. Since the publication of the Milestone 12 Preliminary Draft Report in May 1983, further modifications to Metro Rail's system-level requirements have occurred. These reflect the inclusion of two additional stations--Wilshire/Crenshaw and Hollywood Bowl--on the system route, as well as refinements to estimated patronage levels and system performance capabilities. Specifically, the changes include:

- A reduction in total projected patronage in the year 2000, from 376,400 to 364,000 riders per day, and concomitant changes in projected station boardings, link volumes, and peak-hour volumes
- A decrease in the peak-hour loading standard, from 170 to 162 passengers, to reflect refined estimates of vehicle capacity
- A decrease in maximum train speeds for normal operation, from 70 mph to 63 mph, and a refinement in peak-period dwell times, from 30 seconds at all stations to 35 seconds at downtown stations and 25 seconds at all other stations

- An increase in the estimated peak-period one-way trip time between Union Station and North Hollywood Station, from 32 minutes to 36-1/2 minutes

- A revision to minimum headway requirements from 2 to 2-1/2 minute headways, in response to revised ultimate demand conditions; and a consequent decrease in the ultimate size of the Metro Rail fleet, from 214 to 198 vehicles.

This chapter defines the refined Metro Rail system-level requirements. Details on each individual system element--ways and structures, stations, yard and shops, and subsystems--are discussed in subsequent chapters of this report.

TRANSPORTATION REQUIREMENTS

The first system-wide requirement imposed on the Metro Rail project is that it must be able to provide rapid and convenient service to passengers through the year 2000 and beyond. This section describes the levels of patronage projected for the Metro Rail system in the year 2000 and the characteristics of the service provided to meet those levels. These service characteristics include passenger vehicle loading standards; car, train, and fleet size; train frequency; travel time; and system operating hours. They specify the overall transportation requirements imposed on the system and establish a rational and dependable basis for Metro Rail planning and cost estimation.

In meeting these transportation requirements, the transit service provided by the system must be effective in terms of the cost per passenger carried and the cost per passenger mile traveled. To achieve this cost-effectiveness, the project will limit capital costs to the greatest degree possible consistent with maintaining a high level of ridership; however, opportunities to reduce long-term operating and maintenance costs through one-time capital expenditures will also receive careful scrutiny. In addition, the project will use proven technology and construction methods to reduce the risks of project delays and cost overruns; close monitoring of project schedules and costs will also reduce such risks.

Passenger Demand

The Southern California region, currently one of the largest metropolitan areas in the world, is expected to grow at a rapid rate into the next century. The Southern California Association of Governments (SCAG), which has the responsibility for planning in this region, adopted a projection in 1982 that indicated the area's population will grow to approximately 15 million people by the year 2000. The greatest increase in population is expected in the already densely populated regional core that Metro Rail is designed to serve. The travel patterns of people along the Metro

Rail corridor have been analyzed using a set of computerized models developed jointly by SCAG, Caltrans, and SCRTD. These models use the projected employment and population forecasts for the year 2000 from SCAG to estimate the number of trips that are likely to be made, their origins and destinations, and whether the trip will be taken by auto, bus, or Metro Rail. The results of the model predictions provide the patronage estimates that are the basis for developing Metro Rail's operating requirements.

An estimated 364,000 passengers are expected to enter the Metro Rail system each weekday in the year 2000. Figure 3-1 indicates the projected weekday patronage levels in the year 2000 at each of the 18 station sites along the Metro Rail route. As that figure shows, the most heavily used station will be at 5th and Hill Streets, where approximately 44,500 passengers are expected to enter the system each weekday. The Wilshire/Alvarado Station will also be heavily used, with 41,200 passenger boardings.

Figure 3-2 shows link volumes for the system--the maximum number of passengers who will travel on an average weekday in one direction between each station on the Metro Rail route. The heaviest traveled link will be that between the 7th/Flower and Wilshire/Alvarado Stations, where approximately 88,400 passengers are expected daily in each direction.

Projections indicate that Metro Rail ridership will be highest during the morning rush hour. Ridership during the peak 15 minutes of the morning rush hour is expected to account for approximately 28 percent of the levels projected for the entire peak hour. Figure 3-3 shows these peak 15-minute volumes for each link of the Metro Rail route. Again, the link between 7th/Flower and Wilshire/Alvarado is forecast to have the heaviest use, with an estimated 3,921 passengers traveling southbound on that segment in the peak 15 minutes.

Service Characteristics

To carry the projected level of passengers, a large (75 foot long), modern subway car will be used on the Metro Rail system. Loading standards have been established for the vehicle for both peak and off-peak hours. For peak hours, the vehicle loading standard has been set at 162 passengers. The space allowed to each passenger by this standard compares favorably with that in other rail transit systems and will permit satisfactory levels of comfort and movement. For off-peak hours, the loading standard has been set at 90 passengers.

To maintain the peak-period loading standard given the level of passenger demand projected for Metro Rail in the year 2000, it has been determined that trains of six cars will need to be operated on the system every 3-1/2 minutes during the peak 15 minutes of the morning and every 4 minutes during the peak 15 minutes of the evening. A six-car train is the maximum train

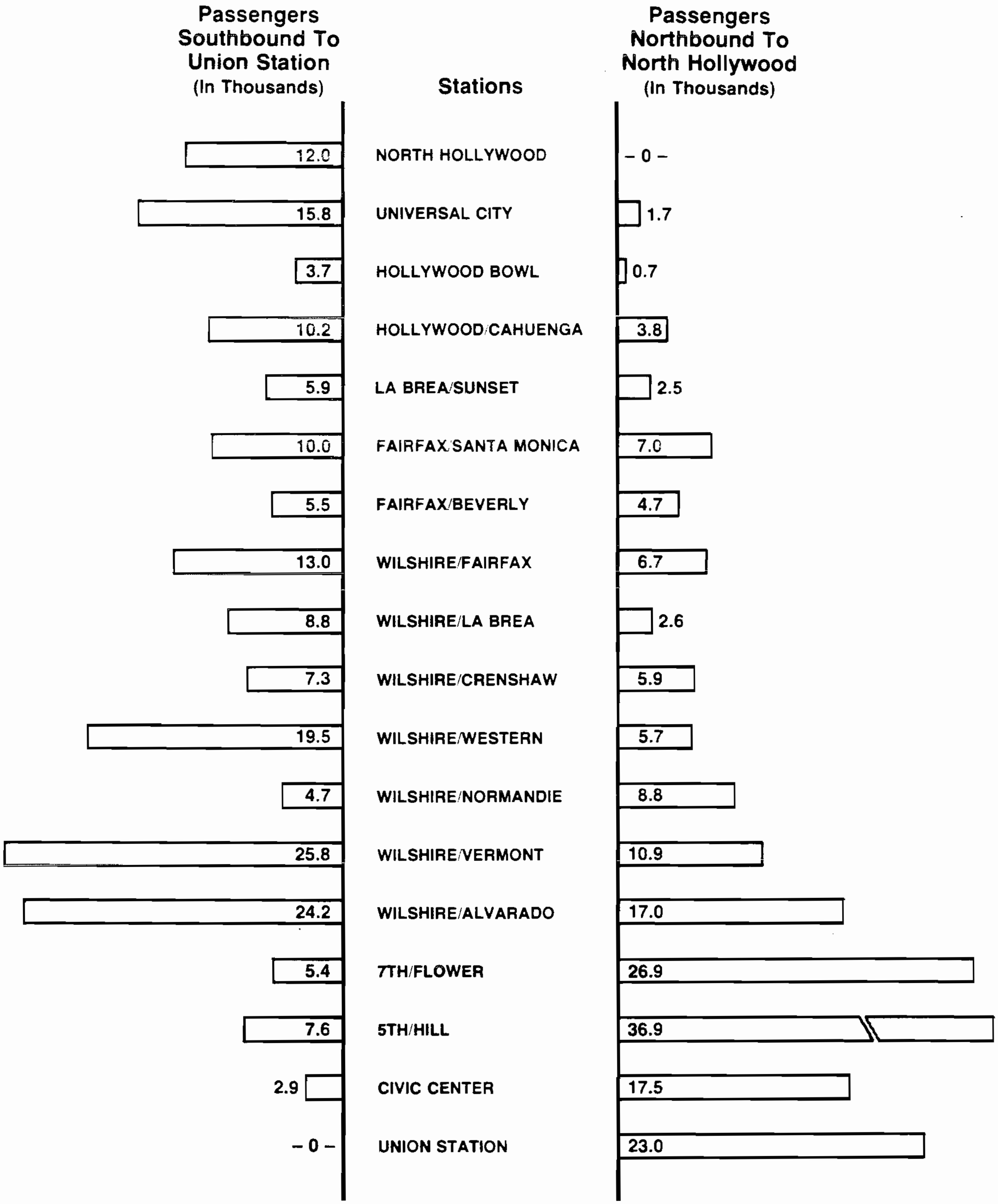

FIGURE 3-1
Daily Passenger Boardings by Station in the Year 2000

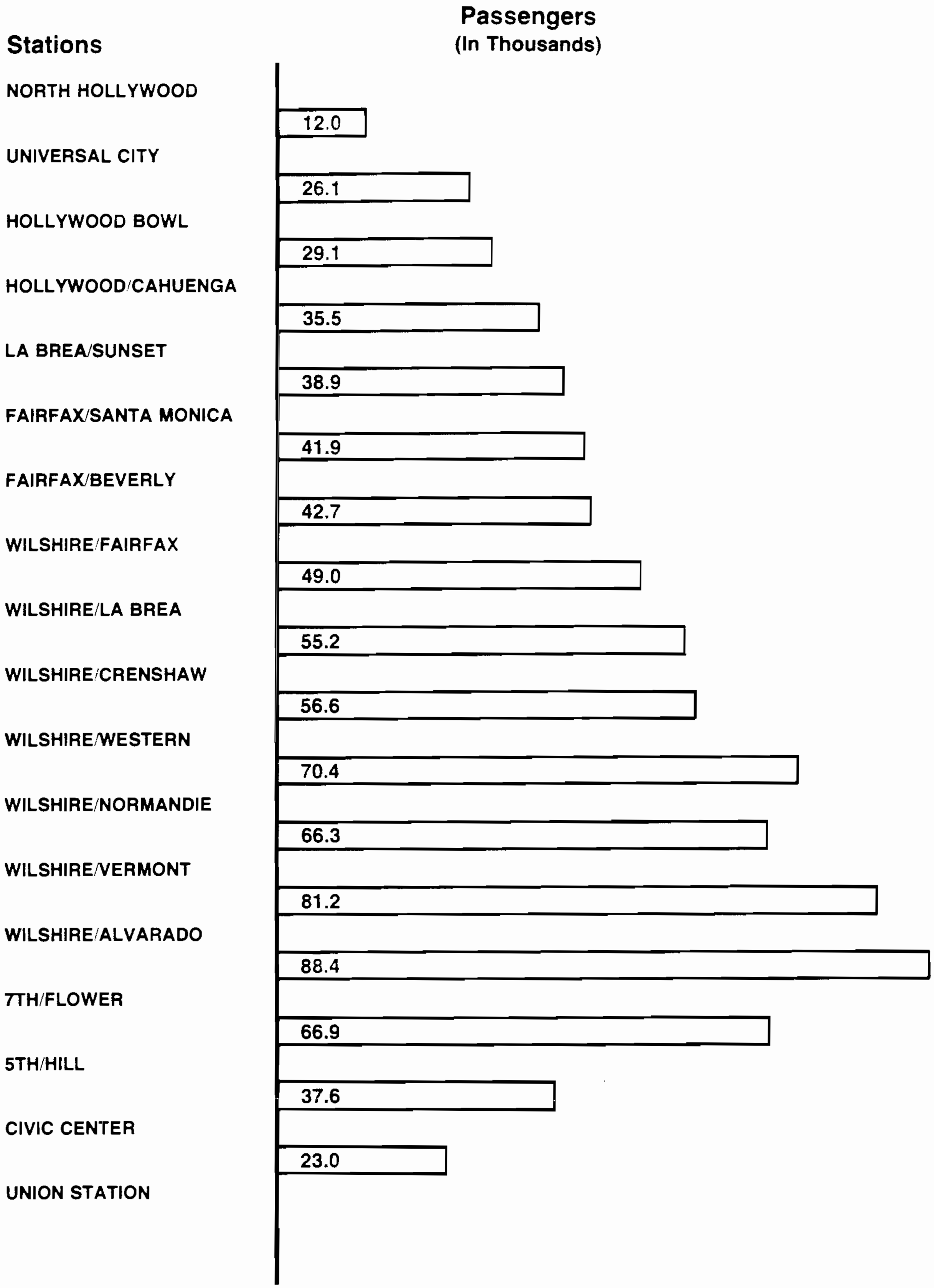

FIGURE 3-2
Average One-Directional Weekday Link Volumes in the Year 2000

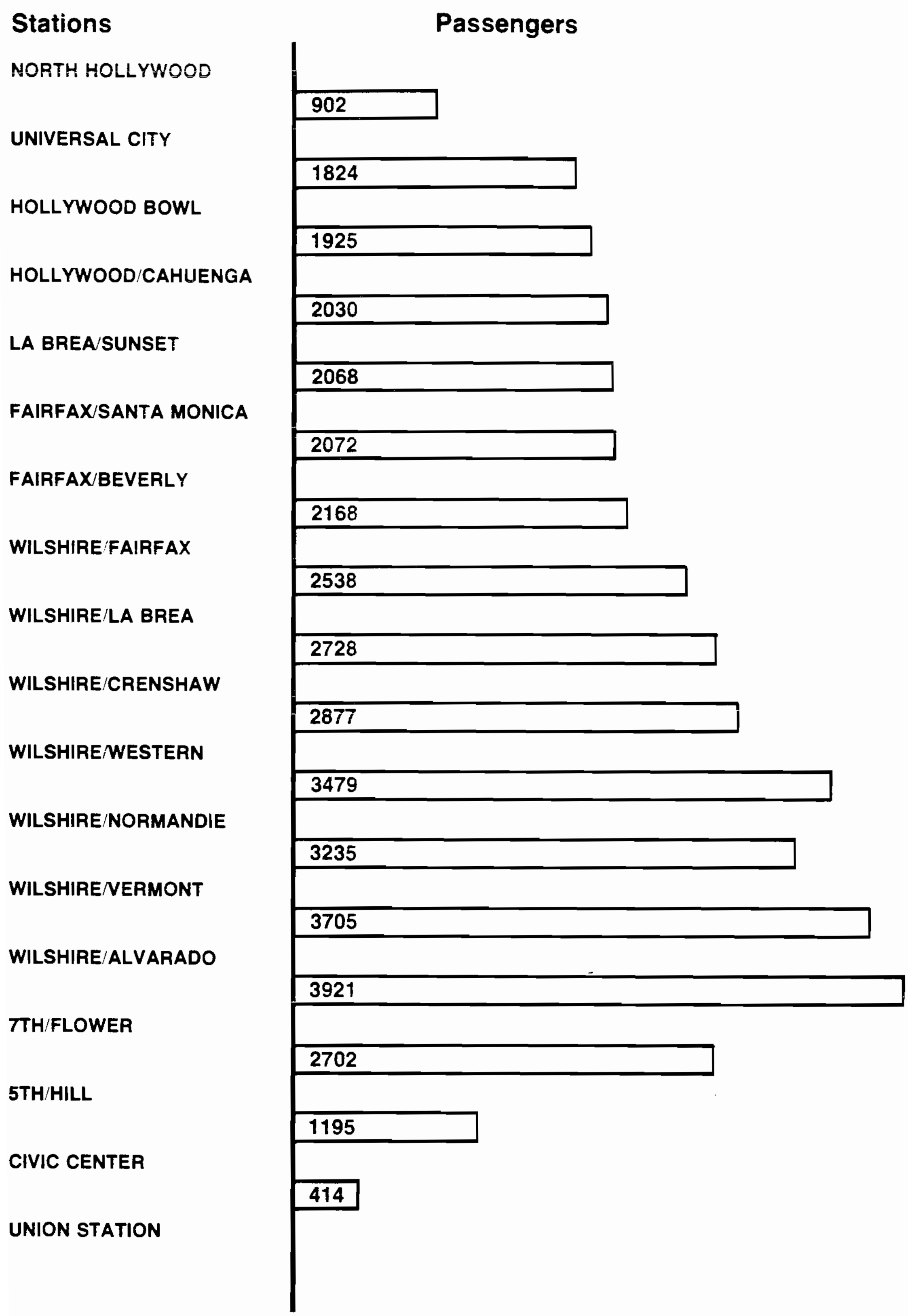

FIGURE 3-3
Projected Morning Peak 15-Minute Link Volumes,
Southbound to Union Station in the Year 2000

length established for the system and will carry an average of 972 passengers during peak periods.

At off-peak hours, train frequency and size will be adjusted to a level which minimizes operating costs, ensures the off-peak loading standard is maintained, and precludes excessive passenger waiting time. Table 3-1 summarizes the scheduled frequency of service and train sizes at various times.

As can be seen from Table 3-1, the hours established during preliminary engineering for the Metro Rail system are those from 5:30 A.M. to 1:30 A.M., a 20-hour operating day. These hours have been selected on the basis of an analysis of projected ridership, which indicated a small level of demand between 1:30 A.M. and 5:30 A.M. The assessment determined that bus service would provide a more cost-effective method of satisfying this low demand, and the preliminary engineering operating plan consequently specifies a 20-hour period. Track and tunnel maintenance are assumed to take place during this shutdown period.

This 20-hour operating period has been specified for the purposes of the preliminary engineering design and cost-estimating work. The system will have the capacity to operate 24 hours a day, and its actual operating hours will be determined near the start of revenue service. Should service be provided by the system between 1:30 and 5:30 A.M., the time between trains during this period may be longer than 15 minutes.

Another service characteristic of the system is the short total trip times that Metro Rail will provide; these trip times will be shorter than those of other modes. These short trip times will be accomplished by a number of measures, including the frequency of train operation specified above as well as station locations and designs that provide convenient and rapid access to pedestrians, autos, and buses. Because many of the system's passengers will arrive or depart from stations by bus, modifications to SCRTD's extensive bus system will be required to facilitate bus/rail transfers. These modifications will establish convenient transfer points and will provide an efficient and cost-effective integrated bus/rail transit system.

Another factor contributing to short trip times will be the rapid travel times attained by Metro Rail trains. These will result from such factors as high average train speeds (acceleration levels of 0 to 50 mph in 28 seconds and maximum train speeds of 63 mph under normal conditions and 70 mph for schedule recovery), low station dwell times, and station spacing and track design considerations.

An estimate has been made of the time required to travel the entire system route from the North Hollywood Station to Union Station (see Table 3-2). During peak periods, the one-way trip time is expected to be 36-1/2 minutes, assuming that trains stop at all stations, travel at a maximum speed of 63 mph, and have an

TABLE 3-1
Projected Frequency of Service
and Train Size, Year 2000

HOURS OF OPERATION	NUMBER OF TRAIN CARS	TIME BETWEEN TRAINS (MINUTES)
Weekdays		
Early Morning		
5:30 A.M. - 6:00 A.M.	6	15.0
6:00 A.M. - 6:30 A.M.	6	7.5
Peak Periods		
6:30 A.M. - 9:00 A.M.	6	3.5-6.0*
3:30 P.M. - 6:30 P.M.	6	4.0-6.0*
Midday		
9:00 A.M. - 3:30 P.M.	6	7.5
Evening		
6:30 P.M. - 7:30 P.M.	6	7.5
Night		
7:30 P.M. - 1:30 A.M.	4	15.0
Saturday		
Morning		
5:30 A.M. - 7:30 A.M.	4	15.0
Day		
7:30 A.M. - 7:30 P.M.	6	10.0
Evening		
7:30 P.M. - 1:30 A.M.	4	15.0
Sundays and Holidays		
All Day		
5:30 A.M. - 1:30 A.M.	4	15.0

*Service levels will be adjusted to meet demand. During the peak 15 minutes, headways will be 3.5 minutes in the morning and 4 minutes in the evening.

TABLE 3-2
Estimated Peak Hour Travel Time Between Stations (Minutes)

	NORTH HOLLYWOOD	UNIVERSAL CITY	HOLLYWOOD BOWL	HOLLYWOOD/CAHUENGA	LA BREA/SUNSET	FAIRFAX/SANTA MONICA	FAIRFAX/BEVERLY	WILSHIRE/FAIRFAX	WILSHIRE/LA BREA	WILSHIRE/CRENSHAW	WILSHIRE/WESTERN	WILSHIRE/NORMANDIE	WILSHIRE/VERMONT	WILSHIRE/ALVARADO	7TH/FLOWER	5TH/HILL	CIVIC CENTER
UNIVERSAL CITY	3.5																
HOLLYWOOD BOWL	7.0	3.5															
HOLLYWOOD/CAHUENGA	9.0	5.5	2.0														
LA BREA/SUNSET	11.5	8.0	4.5	2.5													
FAIRFAX/SANTA MONICA	14.0	10.5	7.0	5.0	2.5												
FAIRFAX/BEVERLY	16.0	12.5	9.0	7.0	4.5	2.0											
WILSHIRE/FAIRFAX	18.5	15.0	11.5	9.5	7.0	4.5	2.5										
WILSHIRE/LA BREA	20.0	16.5	13.0	11.0	8.5	6.0	4.0	1.5									
WILSHIRE/CRENSHAW	22.5	19.0	15.5	13.5	11.0	8.5	6.5	4.0	2.5								
WILSHIRE/WESTERN	24.0	20.5	17.0	15.0	12.5	10.0	8.0	5.5	4.0	1.5							
WILSHIRE/NORMANDIE	25.5	22.0	18.5	16.5	14.0	11.5	9.5	7.0	5.5	3.0	1.5						
WILSHIRE/VERMONT	27.5	24.0	20.5	18.5	16.0	13.5	11.5	9.0	7.5	5.0	3.5	2.0					
WILSHIRE/ALVARADO	29.5	26.0	22.5	20.5	18.0	15.5	13.5	11.0	9.5	7.0	5.5	4.0	2.0				
7TH/FLOWER	32.0	28.5	25.0	23.0	20.5	18.0	16.0	13.5	12.0	9.5	8.0	6.5	4.5	2.5			
5TH/HILL	33.5	30.0	26.5	24.5	22.0	19.5	17.5	15.0	13.5	11.0	9.5	8.0	6.0	4.0	1.5		
CIVIC CENTER	35.0	31.5	28.0	26.0	23.5	21.0	19.0	16.5	15.0	12.5	11.0	9.5	7.5	5.5	3.0	1.5	
UNION STATION	36.5	33.0	29.5	27.5	25.0	22.5	20.5	18.0	16.5	14.0	12.5	11.0	9.0	7.0	4.5	3.0	1.5

average station dwell time of 35 seconds at downtown stations and 25 seconds at all other stations. During off-peak periods, the one-way trip time will decline to 34 minutes because the station dwell times will be reduced to an average of 20 seconds or less. The turnaround time at terminal stations will be 3 minutes.

Given these operating standards, 108 vehicles will be required to serve Metro Rail's year 2000 passenger demand. To ensure that a fleet of this size will be available for revenue service, additional vehicles will be needed to account for maintenance and standby needs. Because it is expected that the availability of vehicles for service will be 88 percent, a fleet of 130 vehicles will be required by the system--108 vehicles for revenue service, 16 vehicles in maintenance, and 6 vehicles for standby service. This total represents a decrease of 10 vehicles from the fleet size specified in Milestone 1, a refinement designed to reduce Metro Rail costs without abridging the system's level of service.

Ultimate Capacity

Experience at other U.S. rail transit systems shows that subway ridership increases over time. Consequently, the Metro Rail system must be designed so that it can cope with a level of passenger demand that is significantly higher than that forecast for the year 2000. Patronage projection studies indicate the Metro Rail system should be designed for an ultimate capacity that is 50 percent greater than the estimated year 2000 demand. A 50 percent increase in peak 15-minute ridership levels results in a maximum link load of 5,882 riders, which will require trains to operate at 2-1/2 minute headways. Because the system is being designed with the capacity to operate at 2-minute headways, it will readily be able to handle the projected ultimate demand. At this ultimate demand level, a total of 198 passenger vehicles will be required: 162 for revenue service, 24 for maintenance spares, and 12 for terminal spares.

PASSENGER COMFORT

To attract and retain passengers, the Metro Rail system must provide not only rapid and convenient service, but also a comfortable physical and psychological environment. Metro Rail will provide that environment throughout the system by attention to:

- Aesthetics
- Heating, ventilating, and air conditioning
- Lighting
- Noise and vibration
- Provisions for the elderly, handicapped, and others requiring special-access measures.

Aesthetics

All components of the Metro Rail system--vehicles, stations, parking facilities--will be visually pleasing. The exterior of the vehicle will be constructed of corrosion-resistant materials, and distinctive markings will be provided. Passenger seats will be comfortable and will be constructed of durable, vandal-resistant materials.

The stations will be of a modern functional design and will be constructed of vandal-resistant and easily cleaned materials. Stations will be as open as possible to preserve a feeling of spaciousness. Visual interest will be provided at stations through varying site development, landscaping, entrances, colors and finishes selected from a group of approved alternatives, and artwork.

Heating, Ventilating, and Air Conditioning

Passenger vehicles will be provided with climate controls to ensure that their interior temperature and humidity remain within acceptable limits.

Stations will not initially be provided with air conditioning equipment. Experience at other transit systems has shown that ventilation in underground stations is sufficient to maintain temperature and humidity within acceptable limits. During rush hours, the platform temperature will be approximately 5^{o}F higher than the outside ambient temperature. As the system's ridership increases, Metro Rail stations may be retrofitted with air conditioning if temperature levels are found to exceed acceptable values. The stations will be designed to accept such retrofitting with minimum cost requirements and minor modifications to the ventilation system.

Normal ventilation in the Metro Rail tunnels will be provided by the piston action of trains, which will move air through the tunnels and up the ventilation shafts. Stations will be ventilated by fans that will draw outside air through the entrances and exhaust it through shafts connected to a ventilation system under the station platforms.

Lighting

The lighting on Metro Rail vehicles will provide sufficient illumination so that passengers can easily see to read; this approximates an intensity of 35 foot candles. The brightness ratio between the lamps and the ceilings and walls will be sufficient to minimize eye fatigue and eye strain. Lighting levels in stations and parking areas will also be high for passenger convenience, as well as for safety and security reasons.

Noise and Vibration

The sound level on Metro Rail vehicles and in stations will be typical of that experienced in other modern subway systems. In vehicles, the ambient noise level will be such that a passenger may speak to a neighbor without shouting. In stations, the ambient sound levels will be similar to those found in an average office, except when trains are arriving or departing.

The vehicles will employ an air suspension for excellent ride quality.

Special Access Provisions

The system design will generally conform to the requirements and guidelines of:

- U. S. General Services Administration, GSA Accessibility Standard, Federal Property Management Temporary Regulation D-66 (45 Fed. Reg. 67664-67666).
- APTA Guidelines for Design of Rapid Transit Facilities
- State of California Regulations for the Accommodation of the Disabled in Public Accommodations (California Administrative Code, Title 24, Parts 2, 3, and 5).

The system will be designed to enable elderly and handicapped people to use it unaided, except in unusual cases. Important system and emergency information will be presented not only on easily readable signs but also by touch or audibly. In passenger vehicles, other special access measures include such examples as designated priority seating and the provision of space for wheelchair patrons that is out of the normal flow of traffic, although easily accessible by wheelchair movement. In stations, a partial list of special-access measures includes the provision of elevators, elevator buttons and intercoms at a level within reach of wheelchair patrons, and special fare gates for persons requiring special access.

SAFETY

Assuring the safety of passengers is of paramount importance at all levels of the Metro Rail system and during all phases of the project, from preliminary engineering through revenue service. A comprehensive safety program is being implemented by SCRTD to ensure that the safety levels of the system meet or exceed those of other modern U.S. rail rapid transit systems.

The system safety program plan presents the activities, analyses, and management controls which ensure that:

- Safety considerations compatible with system requirements are incorporated into the designs of all system elements.

- Potential hazards associated with each system element are identified and then eliminated or minimized.

- The safety philosophy emphasizes preventive measures over corrective measures to eliminate unsafe conditions.

- Historical safety data generated by the newer transit properties are analyzed and used to support the safety program.

To comply with the Metro Rail system safety plan, the system design will incorporate features that minimize the potential for accidents. A partial listing of safety features that will be incorporated within the design of stations, vehicles, and train control for Metro Rail includes the following:

- Stations

  - Station designs that provide safe access, by minimizing hazards to pedestrians from crossing bus and auto access routes

  - Clear and distinct signs that facilitate a smooth passenger flow

  - Platform edge materials that are different in color and texture from the main platform area

  - Refuge areas under the platform for use in the event a person falls onto the track when a train is approaching

  - Nonslip walking surfaces in station areas

  - Warning system to alert patrons to train arrivals.

- Vehicles

  - Safety interlocks to prevent vehicles from moving while doors are open

  - Flexible door edges to allow trapped clothing or other articles to be withdrawn

  - Warning signals when doors are about to close

  - End doors for emergency evacuation

  - Wide doors for smooth passenger flow

- Fail-safe designs for all safety-related onboard equipment

- Intercom apparatus to permit passengers to communicate with the train operator.

- <u>Train Control</u>

  - Continuous monitoring of tracks for presence and location of trains to prevent actions that could result in collision or derailment

  - Maintenance of train separation

  - Overspeed protection

  - Fail-safe design.

<u>FIRE/LIFE SAFETY</u>

Special consideration is being given in the Metro Rail system to emergency preparedness with respect to fires or other major disasters. A comprehensive fire/life safety program is being implemented by SCRTD to ensure that the system's fire/life safety levels meet or exceed those of other transit systems. Like the general safety program, the fire/life safety program specifies activities, analyses, and management controls to be undertaken throughout the life of the system. These include ensuring that fire/life safety considerations, compatible with system requirements, are incorporated into subsystem designs, and that potential hazards are identified and then eliminated or minimized. In addition to such hazard analyses, specialized assessments required by the fire/life safety program include:

- <u>Acceptable materials list</u>--Compiling acceptable fire/life safety performance standards for materials to be used in the vehicles, guideways (the portion of the transit system that carries trains between tunnels), or other transit-related facilities.

- <u>Passenger exit calculations</u>--Determining the volume of passengers that may need to be evacuated through tunnels, loading platforms, stairs/elevators/escalators, and station exits so that exit capacity requirements can be accounted for in the design of all structures.

- <u>Fire-test planning</u>--Developing requirements for testing critical system areas and materials under simulated fire scenarios.

Selected examples of the fire/life safety criteria that will be incorporated into the design of the Metro Rail system include the following:

- <u>Stations</u>

  - Structural materials will be noncombustible, as will those used for finish and trim.

  - Passenger and ancillary areas will be separated by fire-resistant construction.

  - Emergency ventilation will protect patrons and employees from smoke and toxic gases.

  - Electrical conduits and cableways will be fire-resistant.

  - Exits will be sufficient to handle the greater than normal numbers of passengers who may be required to evacuate the station under emergency conditions.

  - Emergency power and emergency lighting will be provided for safety functions.

  - Fire protection will include alarm systems, automatic sprinkler systems, standpipes, hose outlets, portable fire extinguishers, and emergency telephones.

- <u>Guideways</u>

  - Noncombustible construction materials will be used.

  - Emergency ventilation systems will be incorporated to remove smoke and toxic fumes.

  - A protective coverboard will be installed over the third rail.

  - The service walkway in tunnels will provide an emergency egress path; frequent cross passages will be constructed between the twin tunnels, with fire doors, emergency telephones, and power trip stations.

  - Wet standpipes will be installed throughout the guideways, and portable fire extinguishers will be located at cross passages.

- <u>Passenger vehicles</u>

  - Vehicle materials will be selected that limit smoke and toxic-fume emissions.

  - A fire-resistant floor will separate undercar equipment from the passenger compartment.

- Doors will be located at the ends of each car for emergency exiting; interior and exterior manual door releases will be provided on side doors.

- Emergency power will be provided for lights and other critical safety functions.

- Fire extinguishers will be carried in each vehicle.

Detailed plans and procedures will be developed to handle the range of possible emergencies the transit system may experience. These will identify such information as types of emergencies, the responsibilities and authorities of various agencies, the operation of command posts, and emergency communications requirements to be undertaken. SCRTD operational staff and security forces, the fire departments of Los Angeles City and County, and other emergency agencies will participate in training and emergency preparedness drills.

SECURITY

To ensure a secure environment for Metro Rail passengers, a system-wide security program plan has been developed that emphasizes:

- Deterrence of criminal activity--The prevention of crime is a major emphasis of system design.

- Detection of criminal activity--Detection of criminal activity is a primary function of transit police, employees, and surveillance systems. Both police patrols and closed-circuit television (CCTV) must be obvious and efficient.

- Apprehension of criminals--Once criminal activity is detected, response time is critical. Catching an offender "in the act" serves notice to the public that crime will not be tolerated.

The SCRTD transit police will have an expanded responsibility for rail rapid transit system law enforcement. The SCRTD transit police have an established presence and are experienced in policing transit operations in Los Angeles. Cooperative agreements for bus operations exist between the SCRTD transit police, the Los Angeles County Sheriff's Department, and the Los Angeles City Police Department. These agreements will be expanded to cover Metro Rail operations. In addition, the size of the transit police force will be increased to cover Metro Rail operations, and training will be provided for those involved in Metro Rail duty.

Examples of the security features that will be provided in the Metro Rail system include the following:

- Electronic surveillance will be provided by closed-circuit television (CCTV) so that Central Control can monitor the stations.

- Station sites will be well lighted to ensure good visibility at all times.

- All areas will be as open as possible to provide good visibility.

- Construction and finishing materials will be graffiti- and vandal-resistant.

- Emergency telephones will be provided in each station.

- Passenger vehicle communications will be provided for patrons on board vehicles to enable them to communicate with the train operator.

- A passenger security zone will be provided on each platform. This area will have a high level of CCTV surveillance to ensure the security of patrons during hours of low patronage.

- Central Control personnel will have direct means of communication with law enforcement and transit security forces.

DEPENDABILITY

All elements of the Metro Rail system will be dependable. That is:

- The equipment will be reliable.

- The equipment will be readily restored to service when a failure occurs.

- All components will be high-quality products to avoid high failure rates.

- The trains will operate on time.

A fundamental tenet of the system design is that only proven technology will be employed. In applying this principle, SCRTD is able to draw upon the vast amount of experience which has been gained by other transit systems in the areas of reliability, maintainability, and quality control.

A systems assurance program plan is being implemented that details the tasks and activities which SCRTD will perform in designing, constructing, testing, and operating a dependable, reliable, and maintainable rail rapid transit system. To ensure major emphasis on systems assurance during the engineering and design phase, the following activities will be conducted:

- Mathematical models will be developed to predict the reliability of major components and subsystems. The use of these models will aid in predicting the reliability of the total system.
- The reliability, maintainability, and warranty clauses of other rail rapid transit systems, in conjunction with the results experienced by those systems, will be analyzed to develop appropriate requirements for Metro Rail contracts.
- Requirements will be prepared describing the management, design, quality control, manufacturing, and testing procedures that will be used to ensure that products manufactured and/or constructed for the Metro Rail project will meet the specified quality standards. These requirements will be incorporated into construction and supplier contracts.
- The information gathered in the above-listed tasks will be used to analyze the design and products which are produced for the Metro Rail system. This process will ensure that each contractor is complying with SCRTD requirements.

To ensure that Metro Rail trains run on time, failure management strategies will be employed. These strategies entail:

- The application of redundant components in those system elements which have a high impact on system dependability and safety.
- Provisions for safely operating around failures, such as:
  - Manual operation to override the automatic operating mode
  - The ability of one train to push or pull another which has stalled
  - The ability to temporarily store empty trains on pocket tracks
  - The ability to operate on a single track around blockages.

OPERATING ENVIRONMENT

The Metro Rail system must be capable of operating in a wide variety of climatic conditions, which may include pronounced differences in temperature, humidity, cloud cover, fog, rain, and sunshine. These differences are related to the distance from, and the elevation above, the Pacific Ocean. As a result, elements of the Metro Rail system will be exposed to significant differences in ambient environment, both at the surface and at locations along the transit corridor route. Although the trains will operate in tunnels, they will be stored in an outdoor yard, so the equipment must cope with all of the conditions shown in Table 3-3.

Seismic Conditions

A special concern for those in the Los Angeles area is the possibility of seismic activity. There are sound and stringently enforced city, county, and state earthquake construction codes, which have been strengthened since the 1971 San Fernando earthquake. In designing and constructing the Metro Rail system, the staff and their seismic consultants will apply the most recent criteria and requirements and will meet or exceed earthquake safety standards set forth in applicable codes and regulations.

Those portions of the Metro Rail system not adequately covered by existing structural codes will be designed to special seismic criteria that consider the exposure of the public to significant earthquake hazards. These special criteria will exceed minimum structural design code requirements and will apply to such elements as stations and tunnels. The special earthquake criteria are classified at two levels of severity: operating design earthquake (ODE) and maximum design earthquake (MDE).

An ODE is defined as an earthquake event which has a probability of occurring once every several hundred years. Such an event can reasonably be expected to occur during the 100-year facility design life. The probability that this level of event will occur is on the order of 40 percent during the life of the facility.

An MDE is defined as an earthquake event which has a probability of occurring once every several thousand years. Such an event has a small probability of occurrence during the facility's life. This probability is on the order of 5 percent or less.

The severity of earthquakes is measured by the Richter scale. The Richter scale is logarithmic; therefore, an increase in magnitude from 5 to 6 indicates 10 times the difference in the force generated by the earthquake. Earthquake forces encountered by Metro Rail facilities will depend on a number of factors, principally the distance from the epicenter, the type of earth conditions both between the epicenter and the system and surrounding a particular facility, and the magnitude of the earthquake. An MDE would be caused by a magnitude 7 earthquake on the Malibu-Santa Monica Fault because of its close proximity to Metro Rail facilities. An ODE could be caused by earthquakes ranging in magnitude from 5.5 to 6.5, depending on the distance

TABLE 3-3
System Ambient Conditions

	LOS ANGELES (CIVIC CENTER)	NORTH HOLLYWOOD	METRO RAIL TUNNEL
Temperature Range (^{o}F)	23-110	21-111	23-105
Humidity Range (%)	40-100	31-100	40-100
Rainfall (max. inches/hour)	4	4	--
Wind (steady state gusts, max. miles per hour)	30-50	30-50	--
Hail/Snow	Trace	Trace	--
Air Quality:			
Particulate (average mg/m^3)	.14	.14	.17
O_3 (max. PPM)	.29	.35	--
NO_x (max. PPM)	.44	.35	--
SO_x (max. PPM)	.037	.028	--
CO (max. PPM)	19	29	--
Solar Radiation (max. $BTUH/ft^2$)	275	275	--

to the epicenter. There are a number of faults in the region which could be the source of such events.

The system will be designed to continue normal operations, although performance may be temporarily degraded, given the level of ground shaking caused by an ODE event. At the level of ground shaking caused by an MDE event, the system design will ensure that critical items required to maintain public safety and to prevent catastrophic failure and loss of life will continue to function.

Subsurface Oil and Gas

Portions of the Metro Rail tunnel and station sites will be located in areas that may contain subsurface combustible gases, principally methane and traces of hydrogen sulfide. Combustible gases may be present in significant volumes and at pressures which may present a hazard during Metro Rail construction and subsequent operations unless proper design measures are taken. The relative likelihood of the presence of gas along the Metro Rail alignment is shown in Figure 3-4, classified as follows:

- Nongassy--There is little likelihood gas will be encountered during construction of the tunnel.

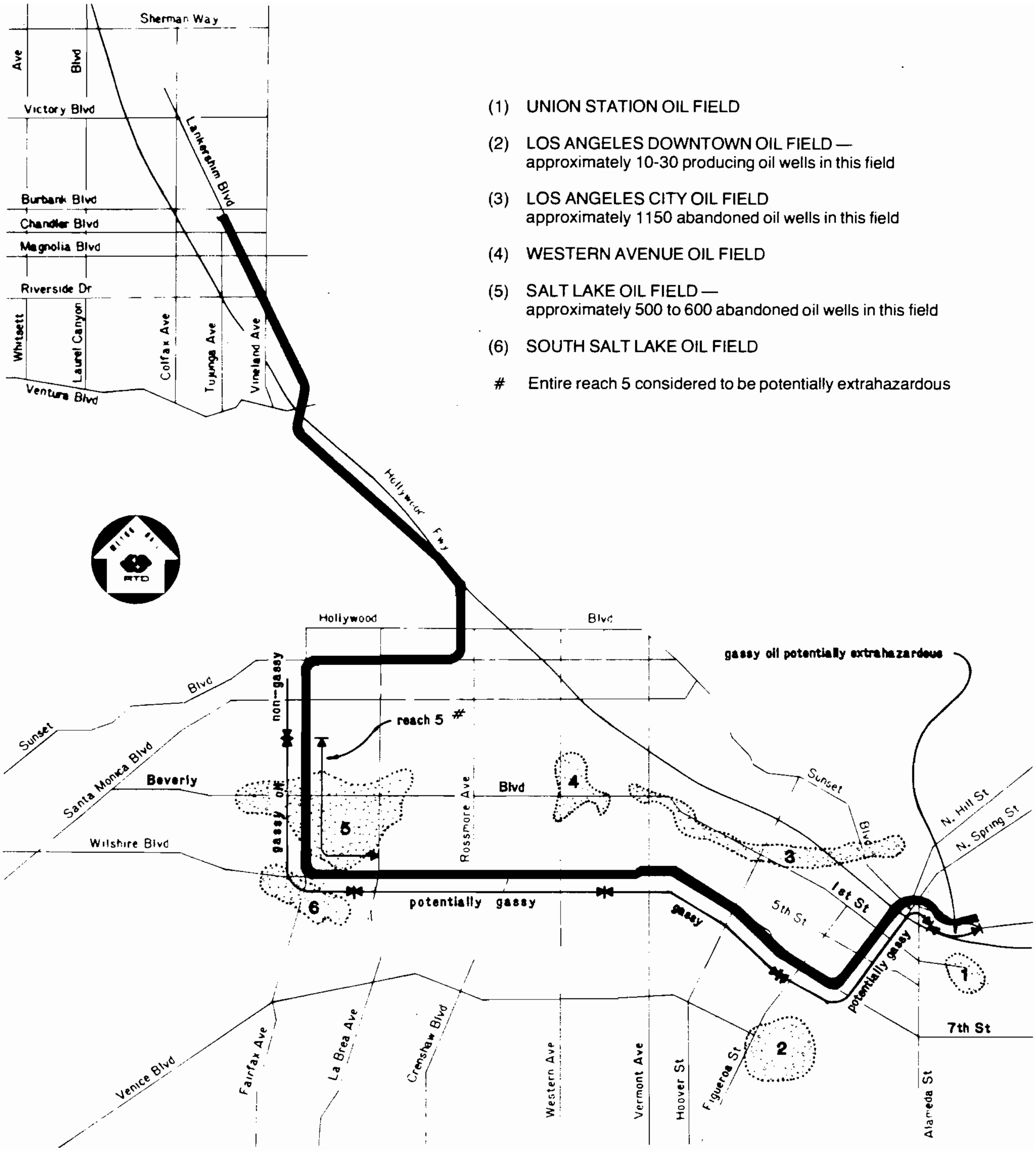

FIGURE 3-4
Classification of Potential Subsurface Gas Hazards Along the Metro Rail Alignment

- Potentially gassy--There is a possibility of encountering flammable gas or hydrocarbons.

- Gassy--Gas is likely to be encountered.

- Extrahazardous--There is serious danger to the safety of employees.

Specific construction or safety measures will be required to preclude the presence of gas from affecting the Metro Rail system. Methods include sealed tunnel liners in gassy areas, gas detectors and alarm systems, and automatic tunnel ventilators.

Electrical Interference

Special care will be taken with the design of Metro Rail equipment to prevent electrical interference with other equipment. Filters, shielding, or other suppression techniques will be used to prevent interference with such equipment as commercial telephone systems, television sets, radios, computer installations, medical electronic equipment, and other electronic equipment along the route. Similarly, Metro Rail electronics equipment will be designed or protected so it may operate in the normal urban environment. Radio transmitters and other equipment generating electromagnetic radiation will meet applicable Federal Communications Commission regulations.

4. WAYS AND STRUCTURES

4. WAYS AND STRUCTURES

This chapter discusses the location and alignment of Metro Rail's tunnels and stations; describes the design and interior features of the tunnels, such as liners, tracks, and ventilation; describes the system's electric power substations and Central Control facility; and finally summarizes the methods planned for construction of these fixed facilities.

These system elements have been the subject of extensive analysis and public discussion. Alternative alignments and station locations were examined in the Community Participation Program for Milestones 3 and 4, and further public comment was obtained and refinements achieved through the Hollywood and North Hollywood special studies. In Milestone 10, station locations were refined, and the design of the system's fixed facilities and the methods to be used in their construction were described.

Several additional changes to these elements have been made since the publication of the Milestone 12 Preliminary Draft Report. The alignment has been modified by the addition of two stations--Wilshire/Crenshaw and Hollywood Bowl--and the relocation of the Wilshire/Fairfax Station to an off-street site on May Company property in the northeast quadrant of the Wilshire/Fairfax intersection. Certain of the fixed facilities described in this chapter have also been modified:

- The crossover track formerly planned for the east end of the Wilshire/La Brea Station has been transferred to the east end of the Wilshire/Crenshaw Station.

- The traction power substation previously planned for a mid-line location on Wilshire Boulevard has been transferred to the Wilshire/Crenshaw Station site; similarly, the traction power substation planned for a mid-line location to the north of the Hollywood Bowl has been transferred to the Hollywood Bowl Station site.

- The mid-line traction power substation between the Universal City and North Hollywood Stations has been deleted.

- A number of traction power substations have been relocated to below-ground sites; all traction power substations will now be below ground except for the substation at La Brea/Sunset and the mid-line substation between Hollywood Bowl and Universal City, which will remain above ground.

- The mid-line ventilation shaft between the Wilshire/Fairfax and Fairfax/Beverly Stations has been deleted.

The contents of this chapter have been revised to reflect these changes. The continuing process of refinement has been guided by the principle of responsiveness to community needs; the objective of providing a safe, fast, dependable transit system; and the policy of achieving a cost-effective design.

ALIGNMENT

The horizontal alignment of the Metro Rail system refers to the location of the route relative to streets and surface features; vertical alignment refers to the depth of the tunnel below the surface. Both are illustrated on the map which is included at the end of this report.

In this section, each of the four major segments of the horizontal route alignment is briefly described. These segments, which correspond to the planned construction phases of the Metro Rail system, are:

- Union Station to Wilshire/Vermont Station
- Wilshire/Vermont Station to Fairfax/Beverly Station
- Fairfax/Beverly Station to Hollywood/Cahuenga Station
- Hollywood/Cahuenga Station to North Hollywood Station.

Union Station to Wilshire/Vermont Station

This segment of the route alignment (see Figure 4-1) begins at the Metro Rail main yard adjacent to the Los Angeles River, extends to the Union Station site, and then runs generally northwest under Macy Street. Leaving the Macy Street right-of-way,

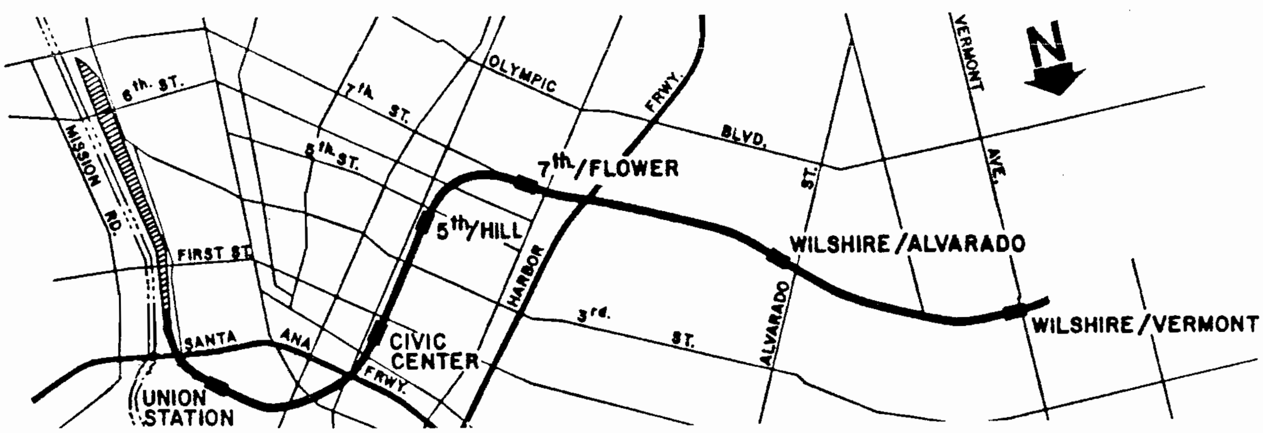

FIGURE 4-1
Alignment from Yard and Union Station
to Wilshire/Vermont Station

the alignment next curves west and southwest to Hill Street at Temple Street, continuing under Hill Street to the Civic Center Station northeast of 1st Street. The alignment continues to run southwest to the 5th/Hill Station between 4th and 5th Streets. Just before 6th Street, the alignment begins to curve west to 7th Street at Grand Avenue and proceeds under 7th Street to the 7th/Flower Station. The alignment remains under 7th Street until Burlington Avenue, where it enters an off-street alignment between 7th Street and Wilshire Boulevard to reach the Wilshire/Alvarado Station.

Passing under the lake in MacArthur Park, the alignment runs to Wilshire Boulevard at Parkview Street, then runs under Wilshire to Hoover Street. The alignment then continues northwest, entering an off-street alignment to reach the off-street Wilshire/Vermont Station mid-block between Wilshire and 6th Street.

Wilshire/Vermont Station to Fairfax/Beverly Station

From the Wilshire/Vermont Station, the alignment curves south under the Wilshire Boulevard and Alexandria Avenue intersection (see Figure 4-2). From that point, the alignment continues west under Wilshire Boulevard; stations are located just east of Wilshire and Normandie and at Wilshire and Western, Wilshire and Crenshaw, and Wilshire and La Brea.

The line continues west under Wilshire Boulevard to a point beyond the Los Angeles County Museum of Art, where it begins to curve to the northwest to reach the Wilshire/Fairfax Station. The line continues to curve to the northwest, crossing under Fairfax Avenue, and then curves back to the northeast until, at a point north of 4th Street, it enters an off-street alignment to the east of Fairfax to reach the Fairfax/Beverly Station.

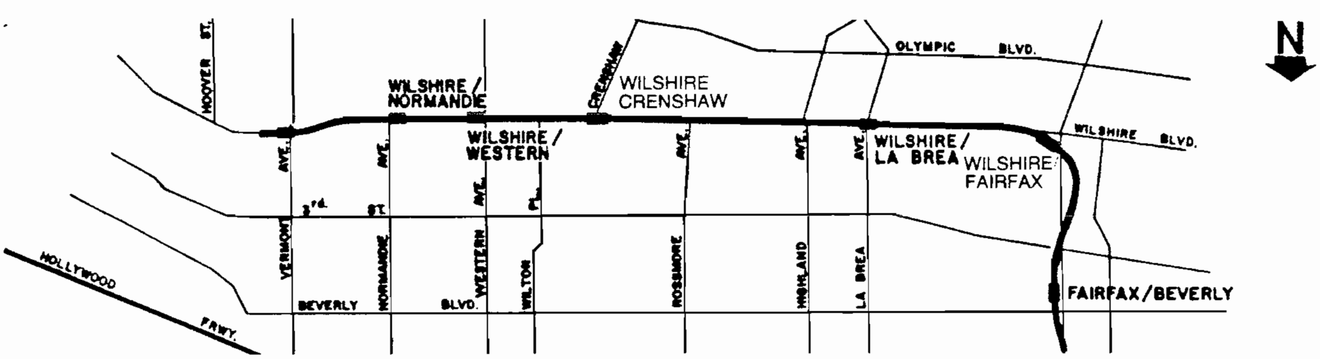

FIGURE 4-2
Alignment from Wilshire/Vermont Station
to Fairfax/Beverly Station

Fairfax/Beverly Station to Hollywood/Cahuenga Station

From the Fairfax/Beverly Station, the alignment curves back to Fairfax Avenue north of Oakwood Avenue, and then continues north under Fairfax to the Fairfax/Santa Monica Station (see Figure 4-3). The alignment proceeds under Fairfax until, north of Fountain Avenue, it curves east to run under Sunset Boulevard to the La Brea/Sunset Station. It continues east under Sunset to Hudson Avenue, where it curves north to an off-street alignment west of Cahuenga Boulevard to reach the Hollywood/Cahuenga Station.

FIGURE 4-3
Alignment from Fairfax/Beverly Station
to Hollywood/Cahuenga Station

Hollywood/Cahuenga Station to North Hollywood Station

From the Hollywood/Cahuenga Station, the line curves west to run under the Hollywood Freeway, leaving the freeway right-of-way near Highland Avenue to reach the Hollywood Bowl Station (see Figure 4-4). The alignment then proceeds under the Santa Monica

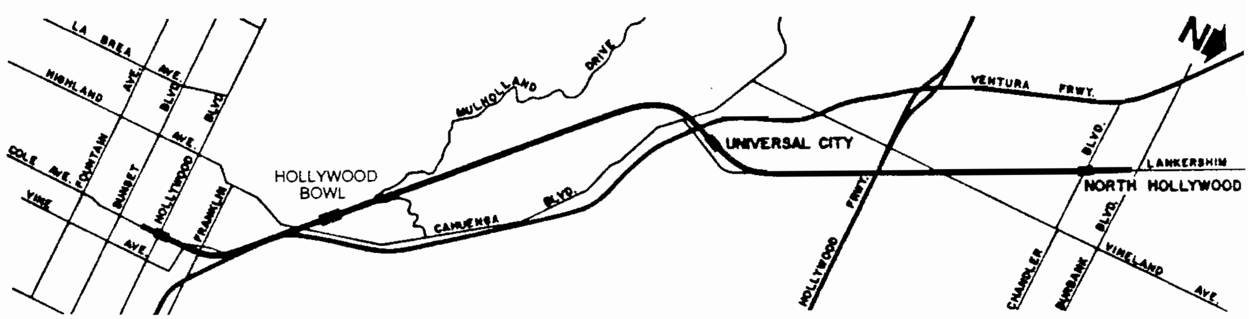

FIGURE 4-4
Alignment from Hollywood/Cahuenga Station
to North Hollywood Station

Mountains to the Universal City Station and curves under Lankershim Boulevard near the Los Angeles River, continuing north to the North Hollywood Station, centered under Lankershim at the Chandler Boulevard right-of-way.

TUNNELS

The Metro Rail alignment will be constructed in twin tunnels. This section describes the interior features of these tunnels, including the tunnel cross section and tunnel liners for bored tunnel sections; the design of crossovers and pocket tracks; trackwork, including special designs for noise and vibration reduction; and tunnel ventilation.

Tunnel Cross Section and Liners

Most of the subway line will be constructed by underground tunneling techniques. The most cost-effective approach is to use twin tunnels, one for each track, rather than a single large tunnel.

It is expected that these tunnels will be constructed using tunnel boring machines which will generate a circular cross section. The required diameter of the tunnel is determined by the size of the passenger vehicle, the trackbed construction, the width of the walkway, the minimum clearances required for the passenger vehicle traveling at high speed, and construction tolerances. On the Metro Rail project, the largest clearance requirement will occur when the 75-foot-long car must travel around the minimum radius curve (1,000 feet) with maximum banking; a tunnel internal diameter of 17 feet 6 inches will be required to meet these conditions.

Since most of the tunneling on the project will be through soft soil or fractured rock, the tunnels will be constructed using a circular shield which supports the ground until a permanent liner can be installed immediately behind the shield. The tunnel liner will be made of precast concrete in the form of circular rings between 3 and 4 feet wide. Each ring will be composed of five to seven segments, all of which will be bolted together. Figure 4-5 shows the interior of a typical tunnel with a segmented liner.

As rings are installed, the space between the rings and tunnel walls will be filled with cement grout injected under pressure through holes in the rings. The tunnel liner rings must be watertight to prevent leakage of ground water into the tunnels; rubber gaskets between segments will be used to maintain a watertight seal. The liner segment joints will also be caulked after installation for additional protection against water. Because the segmented liner cannot be relied on to remain gas tight, an additional thin welded steel liner may be installed

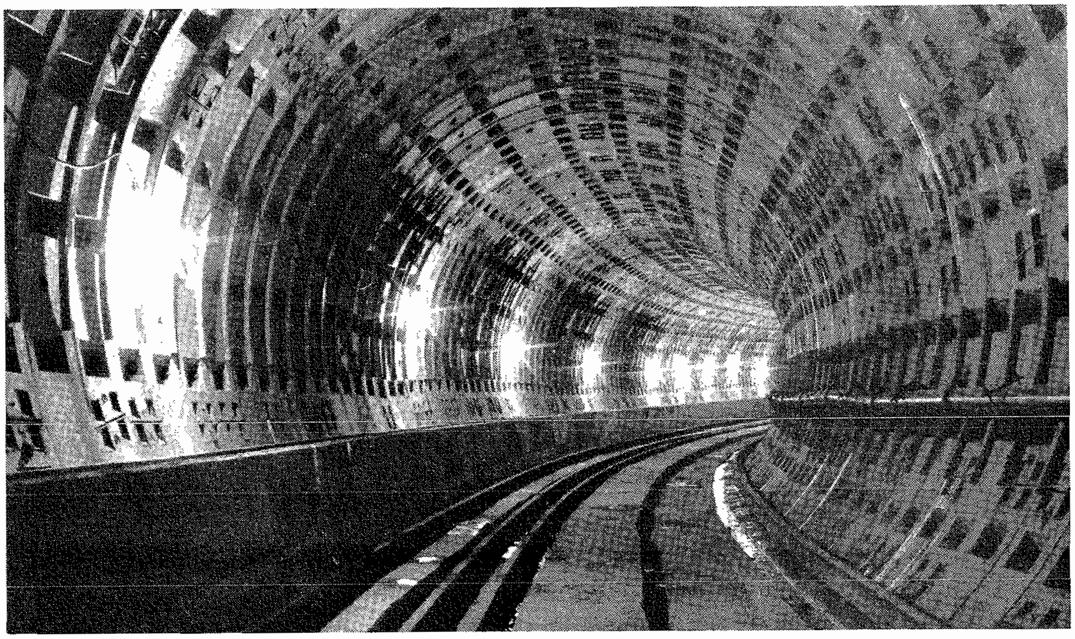

FIGURE 4-5
Typical Tunnel Cross Section

inside to form a gas-tight membrane in areas where subsurface methane gas may be present.

For tunnels running through the rock of the Santa Monica Mountains, a concrete tunnel liner which would be cast in place after the tunnels have been excavated may be used as an alternative to tunnel liners.

Crossover and Pocket Tracks

Because Metro Rail will operate on a two-way track system, with one track for each direction of travel, provisions will be needed to allow trains to cross over to the opposite track. These crossovers will be required for special operations such as bypassing a stalled train or closing down a section of track for maintenance, and for the turnback of trains at each end of the line or at intermediate points. The automatic train control subsystem will prevent trains from moving to or through the crossovers unless it is safe. Crossover tracks will be constructed along the Metro Rail line at the locations shown in Figure 4-6. All crossovers will be constructed adjacent to stations as part of station cut-and-cover construction. Figure 4-7 illustrates a typical double crossover track to be used on Metro Rail, including the position of the traction power third rail.

In addition to these crossover tracks, a pocket track will be constructed on the system at the Hollywood/Cahuenga Station. As

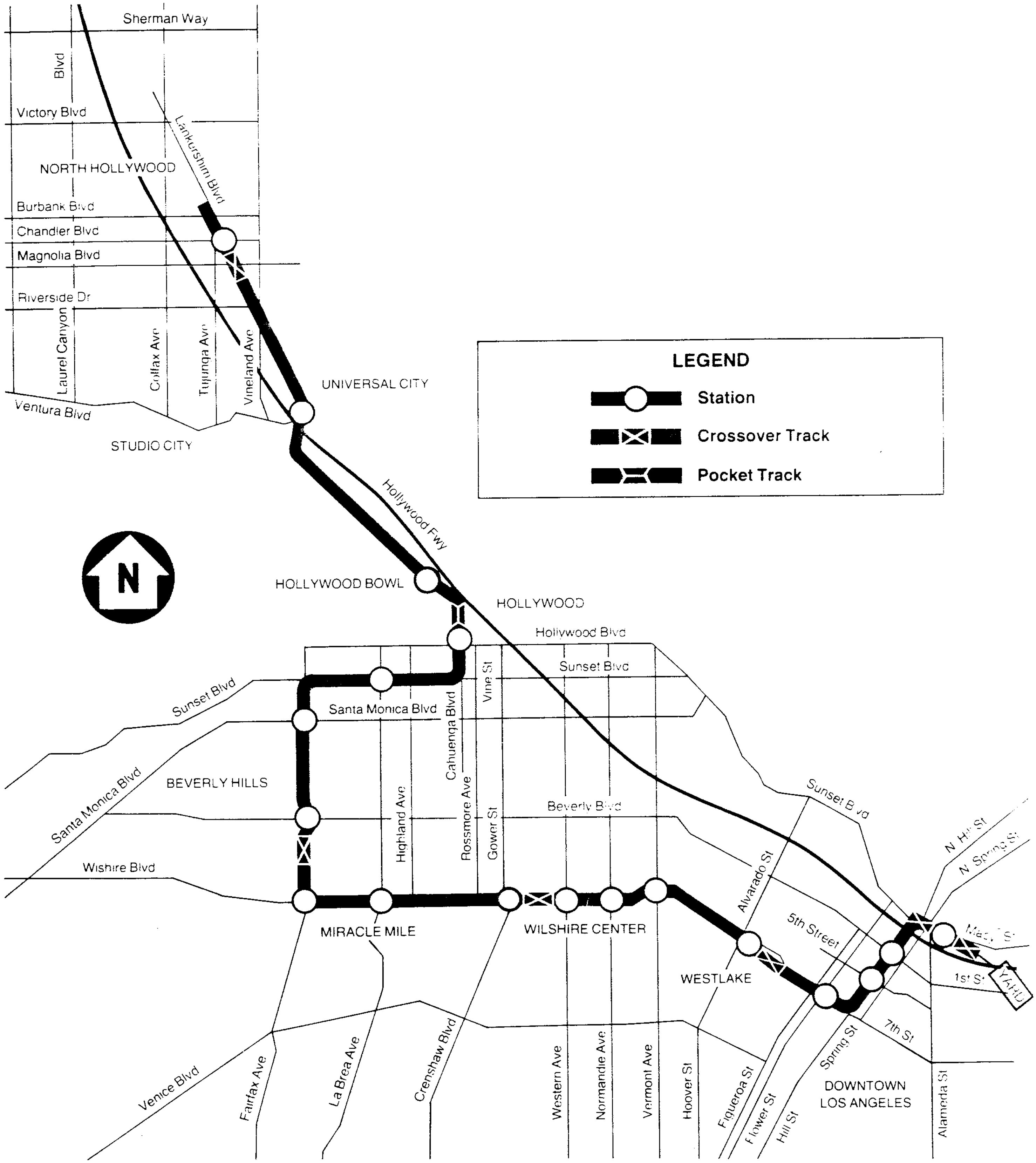

FIGURE 4-6
Location of Pocket and Crossover Tracks

illustrated in Figure 4-8, a pocket track is a split crossover with a separate track between the two main lines. The center track will be of sufficient length to store a six-car train without inhibiting trains operating on either adjacent main line track.

Trackwork

Metro Rail will use a standard 4 foot, 8-1/2 inch gauge, 115 pound-per-yard conventional rail. All rails in the line will be continuous, with welded joints to reduce noise, vibration, and track and wheel maintenance.

The rails will be laid with a transition spiral from straight section to curves to maintain a smooth ride into the curves. The

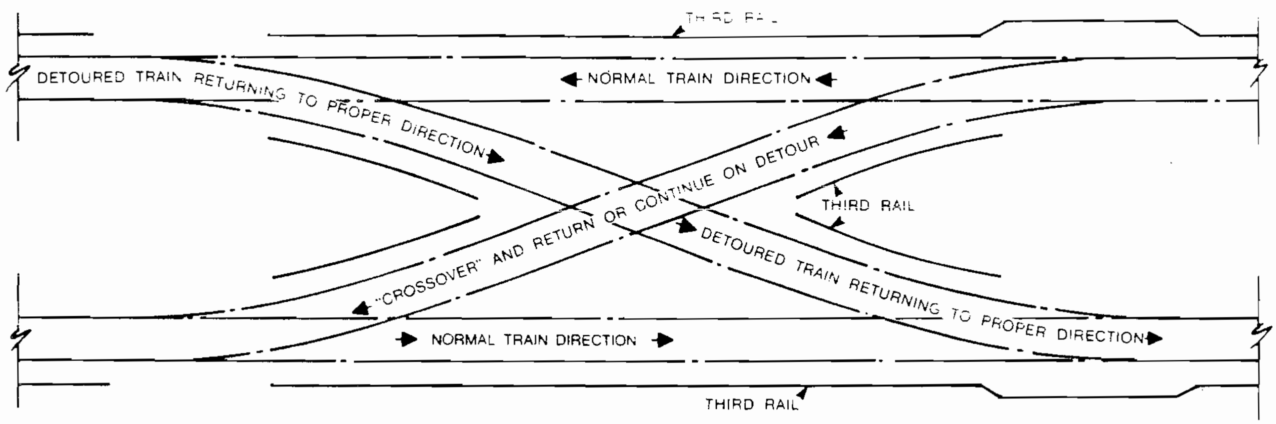

FIGURE 4-7
Typical Double Crossover

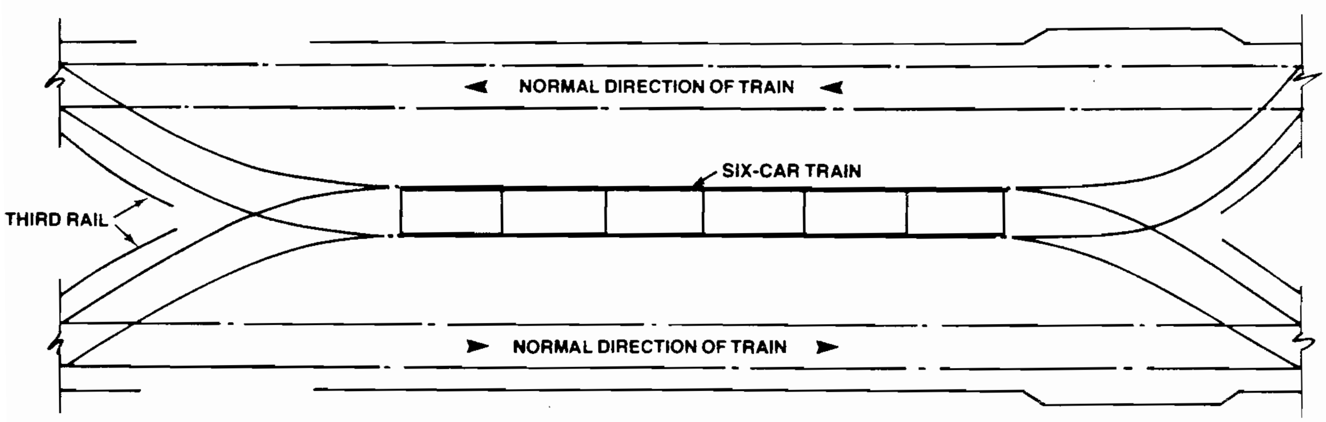

FIGURE 4-8
Typical Pocket Track

curve sections themselves will be banked or superelevated to reduce the lateral force which occurs on curves. This banking will serve not only to maintain ride quality but also to increase allowable train speed. A superelevated track section is shown in Figure 4-9. A maximum 4-inch difference between the inner and outer rail will be used on superelevated sections. This superelevation and a minimum radius on curves of 1,000 feet will allow a comfortable ride at 45 mph.

The method used to attach rails to a tunnel floor affects the levels of noise and vibration transmitted by a transit system. Older underground rail rapid transit systems have created low-level ground-borne vibration and noise which are transmitted from the subway structure to adjacent buildings. This vibration is generally perceived in nearby buildings as a low pitched rumbling or a slight shaking.

To reduce such ground-borne noise and vibration, special attachment techniques have been developed, including resilient rail fasteners, resiliently supported ties, and floating slab trackbeds. Measurements at operating transit systems indicate that resiliently supported ties can reduce vibration levels by 50 to 70 percent, and floating slab trackbeds can provide large reductions of 80 to 90 percent. These techniques, illustrated in Figures 4-10 through 4-12, will be applied to the Metro Rail system.

The final selection of noise and vibration attenuation techniques and their application at specific locations along the Metro Rail route will be accomplished during the detailed design activities. Generally, resiliently supported ties will be required along much of the route through the central business district, along Wilshire Boulevard, through Hollywood, and at several sites in North Hollywood. Specially designed floating slabs will be required at sites near churches, schools, hospitals, rest homes,

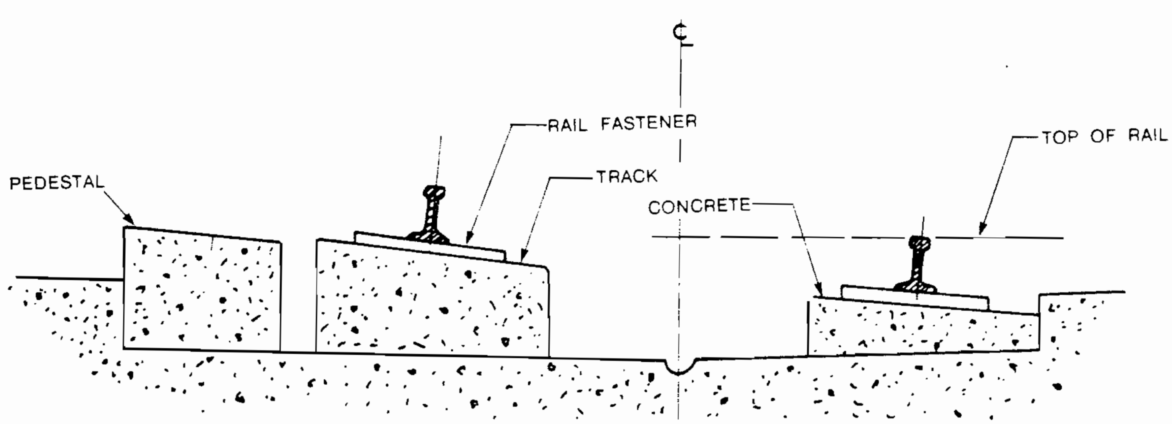

FIGURE 4-9
Curved Track with Superelevation

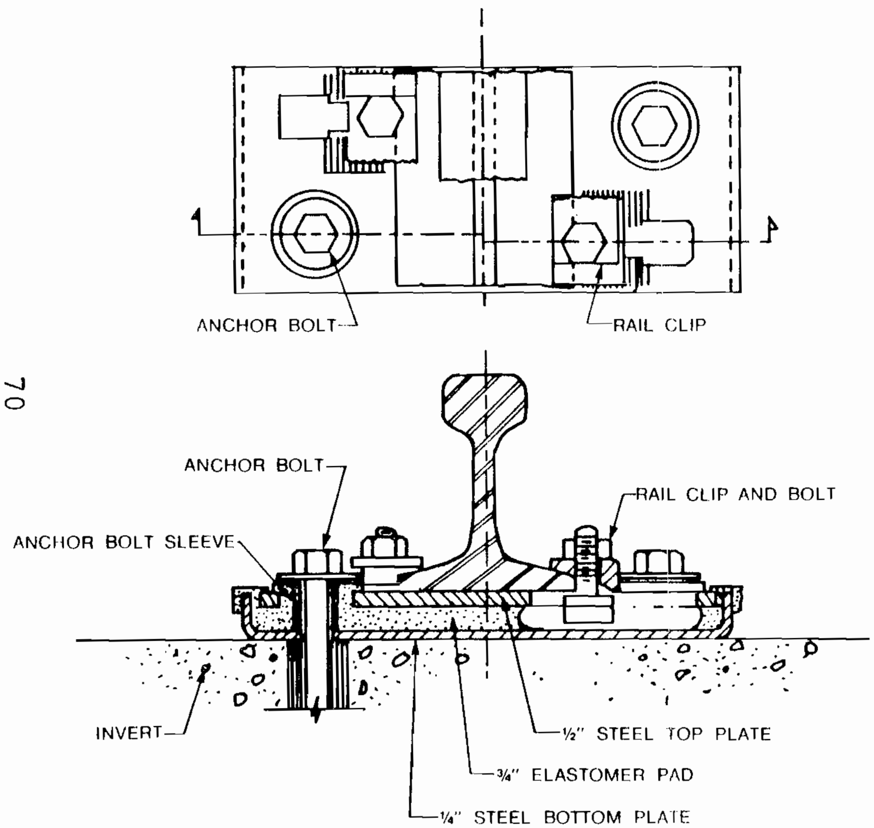

FIGURE 4-10
Typical Resilient Rail Fastener

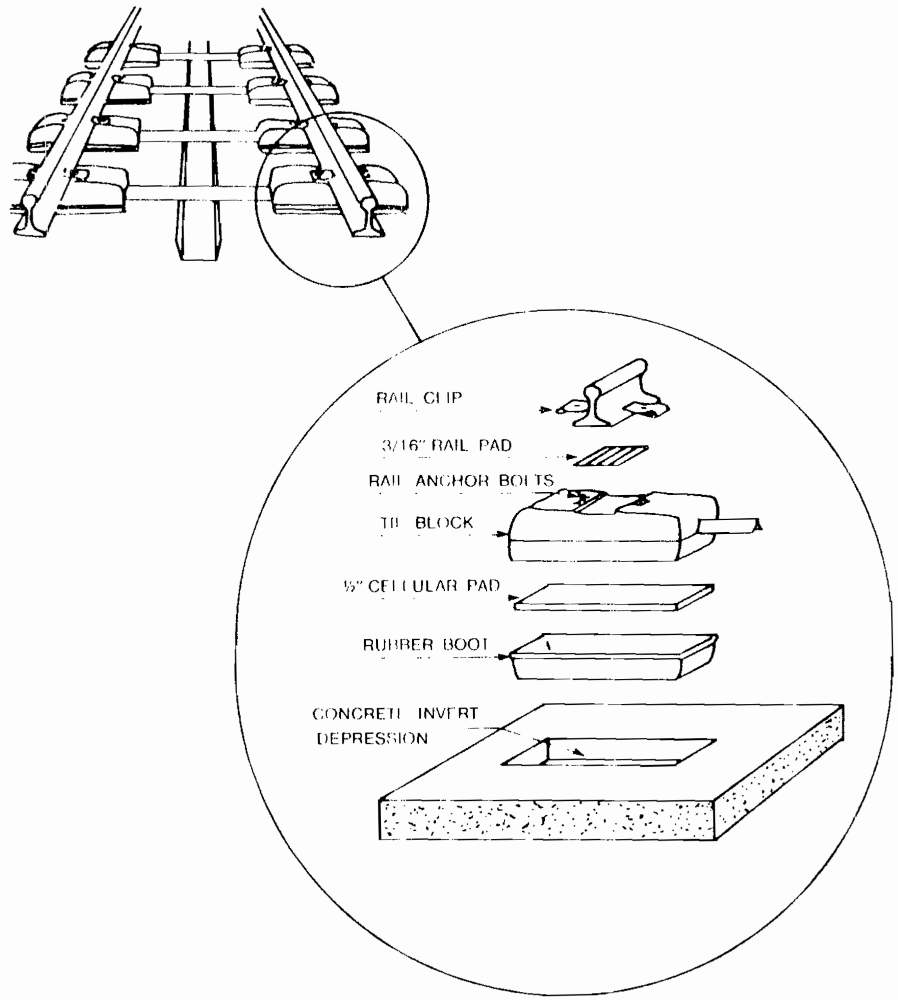

FIGURE 4-11
Typical Resiliently Supported Rail Ties

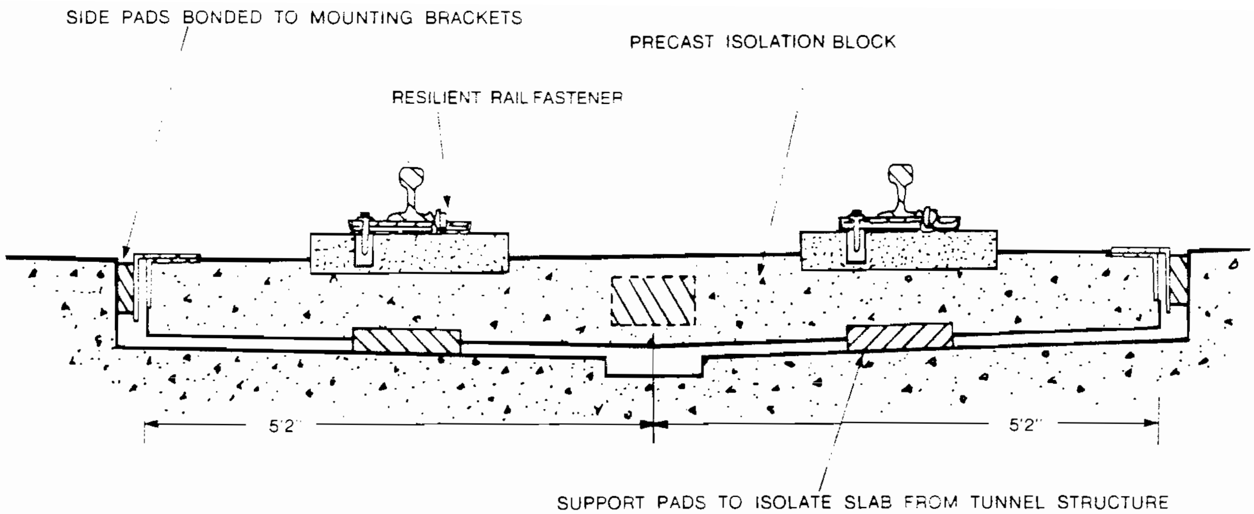

FIGURE 4-12
Typical Floating Slab Track Support System

and theaters to ensure that noise and vibration are not transmitted to these areas.

Tunnel Ventilation

There are three important aspects of tunnel ventilation: to provide fresh air and remove heat generated by the trains; to eliminate pressure pulses in the station generated as the train moves through the tunnel; and to provide emergency ventilation of smoke and toxic fumes caused by fires.

Tunnels will be ventilated through shafts located at each station site and also between certain stations. Normal tunnel ventilation will be provided by the piston effect of the train traveling through the tunnel, with the movement of the train acting to push air out of the ventilation shaft ahead of it and draw air from the ventilation shaft behind it. The temperature and freshness of the air in the tunnels will be maintained by dampers controlling the amount of external air being drawn in. The ventilation shafts will be of sufficient size and will be located close enough to stations to ensure that pressure pulses from the trains do not reach people within the station.

Each ventilation shaft outlet will require an area of approximately 200 square feet. The surface structure for these ventilation shafts will be designed to integrate successfully with the surrounding neighborhood. If an outlet can be located on the sidewalk area, it will be covered with a closely spaced steel grating. Outlets located in open areas out of the public way will be incorporated within low planters or will be raised, chimney-like structures up to 10 to 12 feet high. Fans and other ventilation equipment will be located below the surface within station ancillary spaces or, for mid-line ventilation shafts, will generally be housed in a separate below-surface structure. There will be four mid-line ventilation shafts on the Metro Rail alignment: one between the Wilshire/Crenshaw and Wilshire/La Brea Stations, two in the Santa Monica Mountains between the Hollywood Bowl and Universal City Stations, and one between the Universal City and North Hollywood Stations. (See the map included at the end of this report.)

When necessary, normal tunnel ventilation will be augmented by forced ventilation. This emergency ventilation will be provided by large bidirectional fans located in emergency fan rooms at each end of a station. During an emergency, these fans will work in pairs, with the fans at one station pulling in fresh air and the fans at the opposite end of the tunnel expelling the smoke from the tunnel. For instance, if a fire were to start in a stalled vehicle, the emergency fans would be operated at the stations in front of and behind the vehicle. The fans at the closest station would draw a stream of fresh air in toward the vehicle, creating an evacuation route for passengers, while the emergency fans at the other station would draw the smoke from the tunnel and exhaust it away from the passengers.

OTHER FIXED FACILITIES

In addition to the system's tunnels and trackwork, the ways and structures of the Metro Rail system include the electric power substations needed to supply power to the system, and the system's Central Control facility. Each of these fixed facilities is discussed below.

Power Substations

Electric power to operate the Metro Rail system will be received at 23 power substations located along the line as required to provide distribution of power (see Figure 4-13). Of these power substations, 18 will include traction power equipment--the equipment necessary to convert conventional alternating current to the direct current required by rail rapid transit trains--in addition to the auxiliary power equipment needed to operate the system's stations, yard and shops, and other facilities and equipment. One traction power substation will be located at the main yard and 17 will be located along the transit route. Of those on the transit route, all will be located below surface level except for two, one at the La Brea/Sunset Station and one mid-line between the Hollywood Bowl and Universal City Stations. These substations will be housed in above-ground structures approximately 50 feet by 160 feet by 18 feet in size and designed to be compatible with the area in which they are located.

The remaining five power substations will contain only auxiliary power equipment. Two of these will be located below surface level within the structures of the 5th/Hill and Wilshire/ Normandie Stations. Three will be housed in above ground

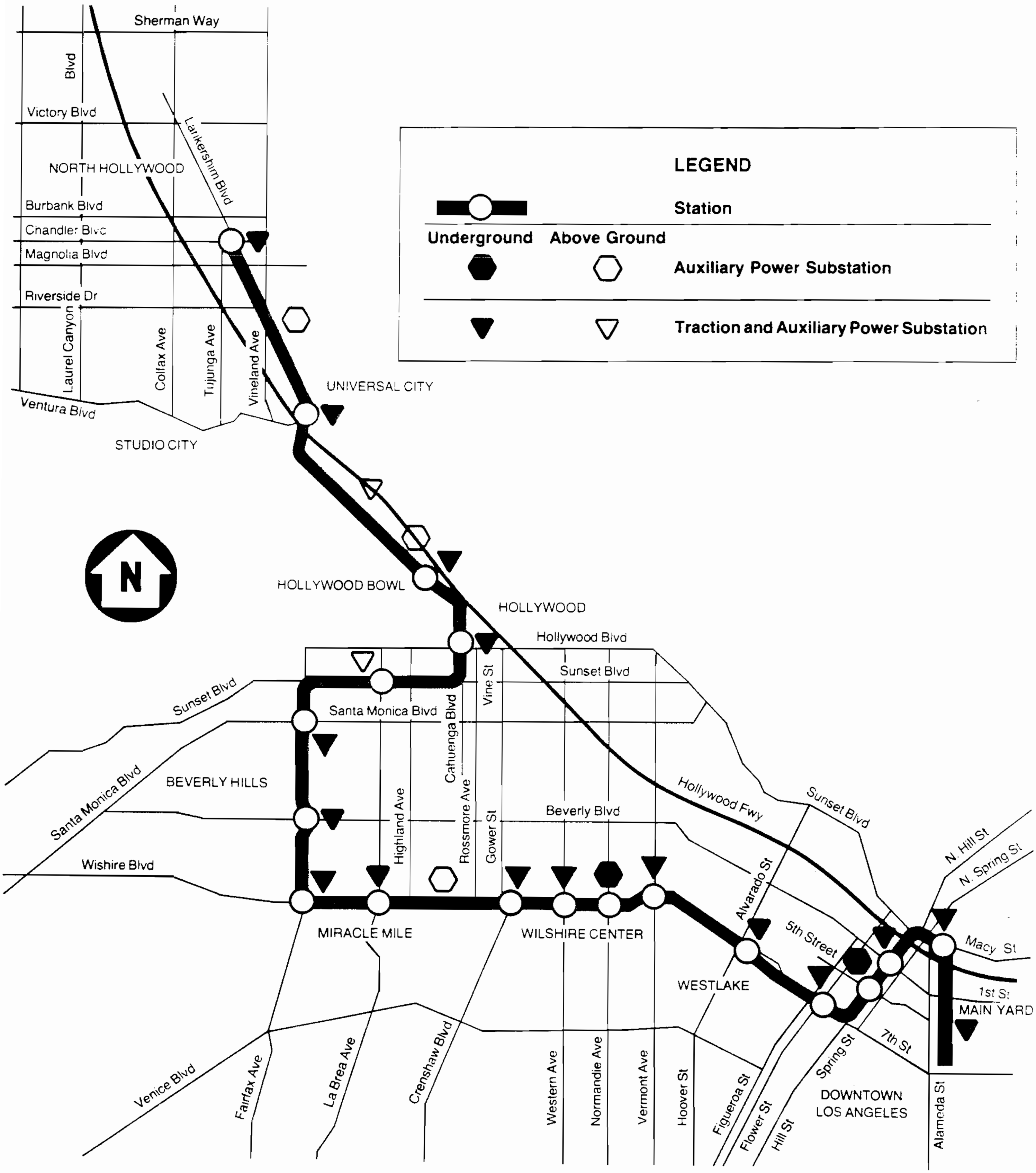

FIGURE 4-13
Location of Electric Power Substations

structures approximately 50 feet by 80 feet by 18 feet in size, and will be located at the site of the mid-line ventilation shafts on Wilshire Boulevard, north of Hollywood Bowl, and between the Universal and North Hollywood Stations.

Central Control Facility

The Central Control facility will be the nerve center of the Metro Rail system. All revenue service operations will be coordinated from this facility; Metro Rail security forces will be directed from this location; and television surveillance of stations will be monitored here.

The Central Control facility will be a conventional building located near the east entrance of Metro Rail's Union Station. It will house an operations and communications center, a surveillance and security center, and a data processing room.

CONSTRUCTION METHODS

To construct the Metro Rail project's subway line sections and other underground fixed facilities, SCRTD has selected two general methods: the cut-and-cover method of construction will be used for pocket and crossover tracks, substations, ventilation facilities, and stations, and bored tunneling techniques will be used for subway line sections. These methods have been selected for cost considerations and for their potential for minimizing disruption to the community during Metro Rail construction. Within the construction requirements imposed by these methods, contractors will be allowed to select the techniques and sequence of activities that enable them to submit the best bid.

Cut-and-Cover Construction

Stations, pocket and crossover tracks, and mid-line ventilation shafts will be constructed using cut-and-cover methods. This construction technique requires that portions of streets and adjacent surface areas be blocked off for a short time for initial excavation. Immediately after excavation, the area will be decked over and full excavation will take place underneath the decking. This construction method will cause some temporary surface disruptions but, because it will allow stations to be constructed close to the surface, it will be less costly than other alternatives.

Cut-and-cover construction will be accomplished in a series of stages designed both for efficiency and minimum surface disruption. Before construction begins, the station design and construction requirements will be carefully reviewed. Detailed plans for each step of the process will be developed that identify requirements for utility relocation or temporary support; vehicle and pedestrian control plans; and designs of underpinnings or protection for buildings located close to the excavation, as well as sheeting and bracing wall designs for the excavation itself.

The first construction stage will involve the underpinning of certain buildings (see Figure 4-14) and the drilling of holes for soldier piles to be used as part of the sheeting (see Figure 4-15). This initial excavation work will generally take place at the sidewalk or edge of the street, as shown in Figure 4-16. During this work the contractor will occupy only one side of the street. After the line of soldier piles has been installed, the contractor will begin excavating in the street area to a depth of 8 to 10 feet. This initial excavation will uncover utilities and allow them to be supported or temporarily relocated. Any permanent rerouting will also be accomplished at this time. Utility work will cause no significant interruption in service.

Large pieces of timber called lagging will be placed between the soldier piles to support the soil as the excavation proceeds. The excavation will be quickly decked over with heavy timbers, and traffic will be rerouted over the decked area while the same activities are accomplished on the other side of the street.

Once the decking is installed and the utilities supported, construction will move to the next stage, excavation of the full station box. Below the decking, heavy equipment will be used to move earth to a central pick-up point. On the surface, the contractor's equipment will be located to one side, allowing traffic to use other lanes of the street. Subsurface and surface activities of this stage of construction are shown in Figure 4-17.

If a station is to be used as the beginning of a bored tunnel, the tunnel boring machine will be placed in the prepared end of the excavation and boring will be started. Generally, the boring machine will be removed at the opposite end of the tunnel.

Construction of the station structure will begin with the pouring of the base slab or invert. Work will then proceed in side walls and upper level floors until all station structural elements are complete (see Figure 4-18).

The final construction stage will entail the removal of the decking in sections and backfilling over the station structure. After backfilling is completed on one side of the street, the street will be paved and sidewalks will be restored. Traffic will then be routed over the new pavement, and the backfilling and surface restoration will be repeated on the opposite side of the street (see Figure 4-19). Completion of the station interior will take place through the normal station entrances with minimal surface disruption.

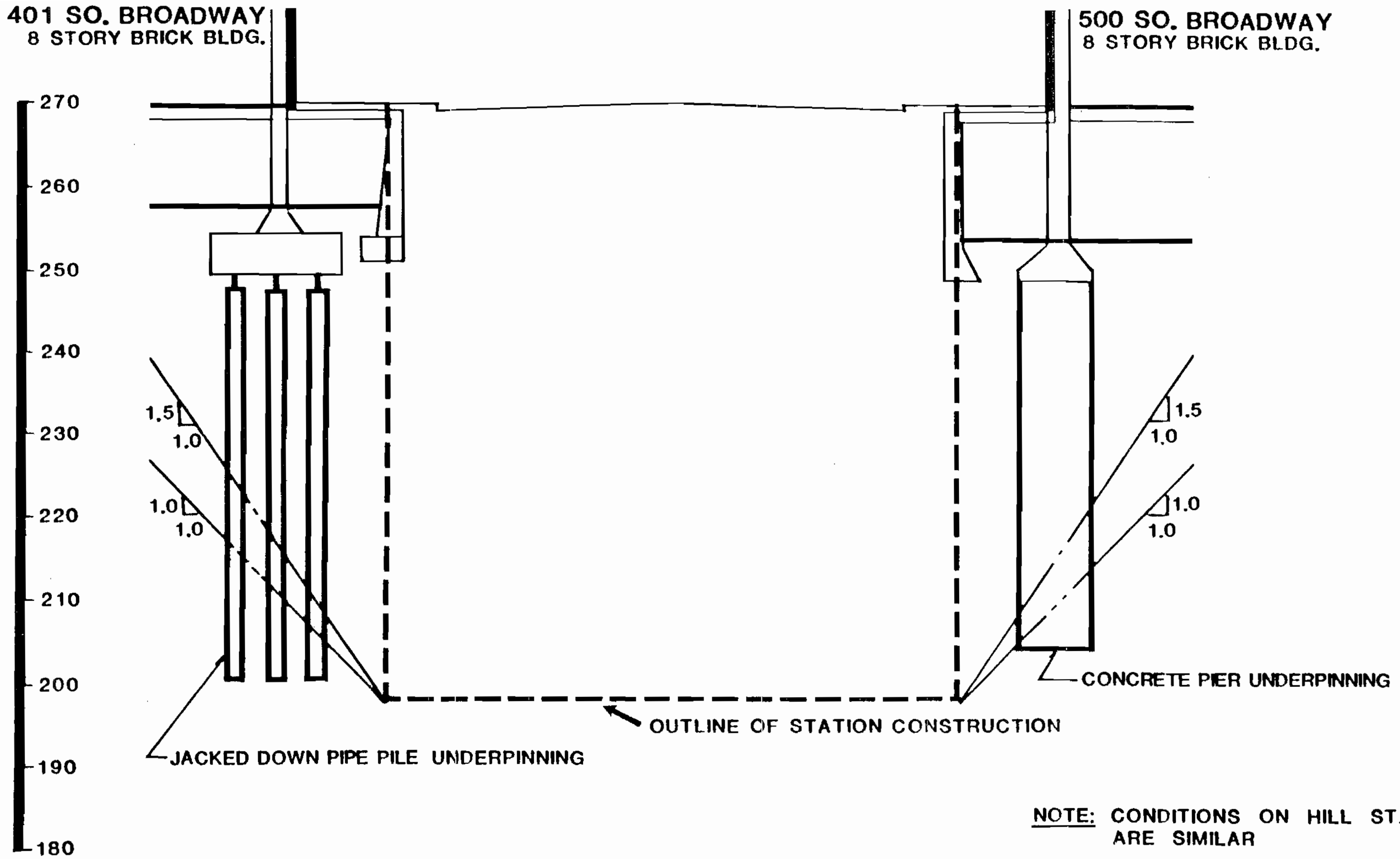

FIGURE 4-14
Methods of Underpinning

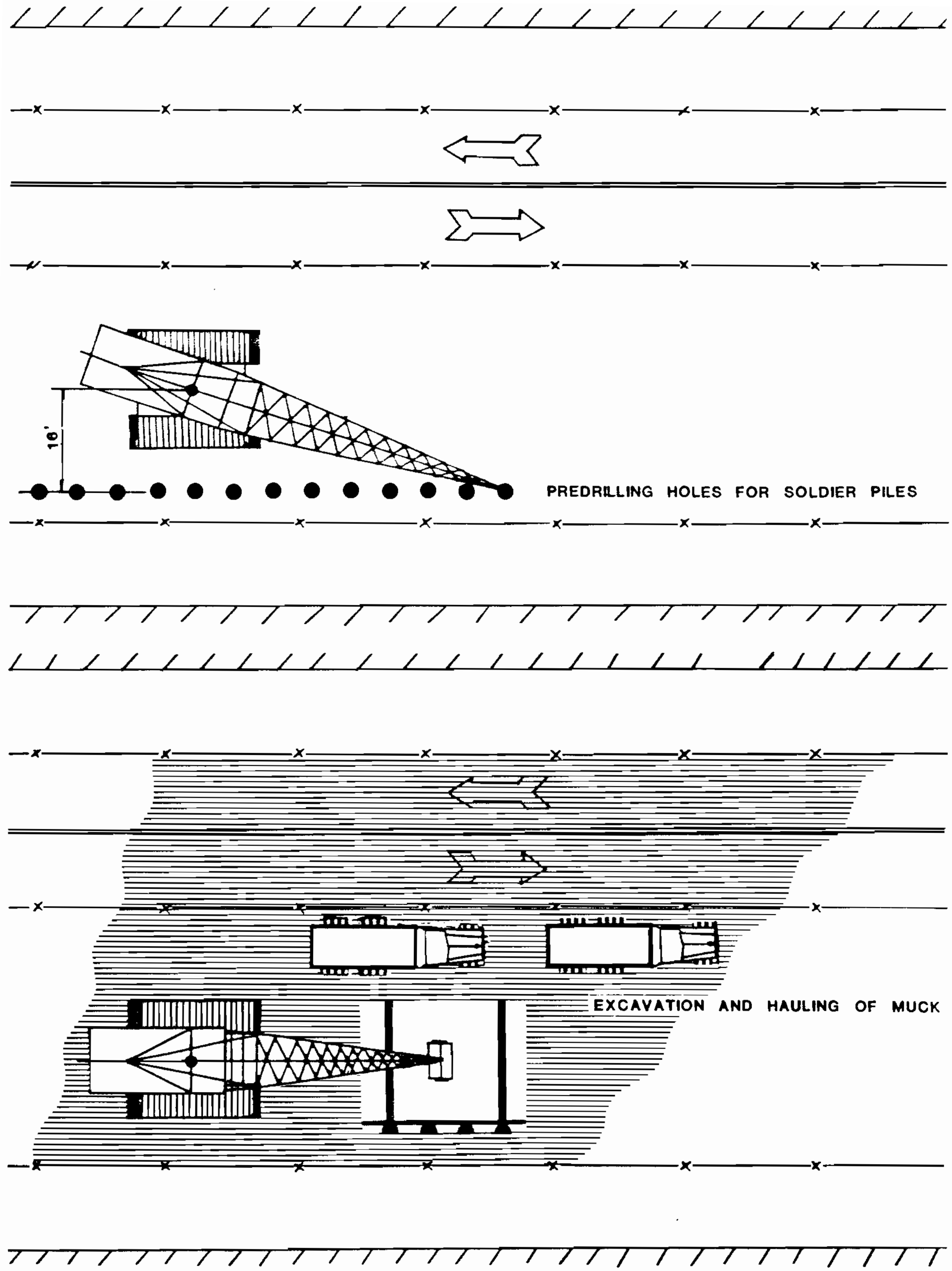

FIGURE 4-15
Contractor's Surface Options

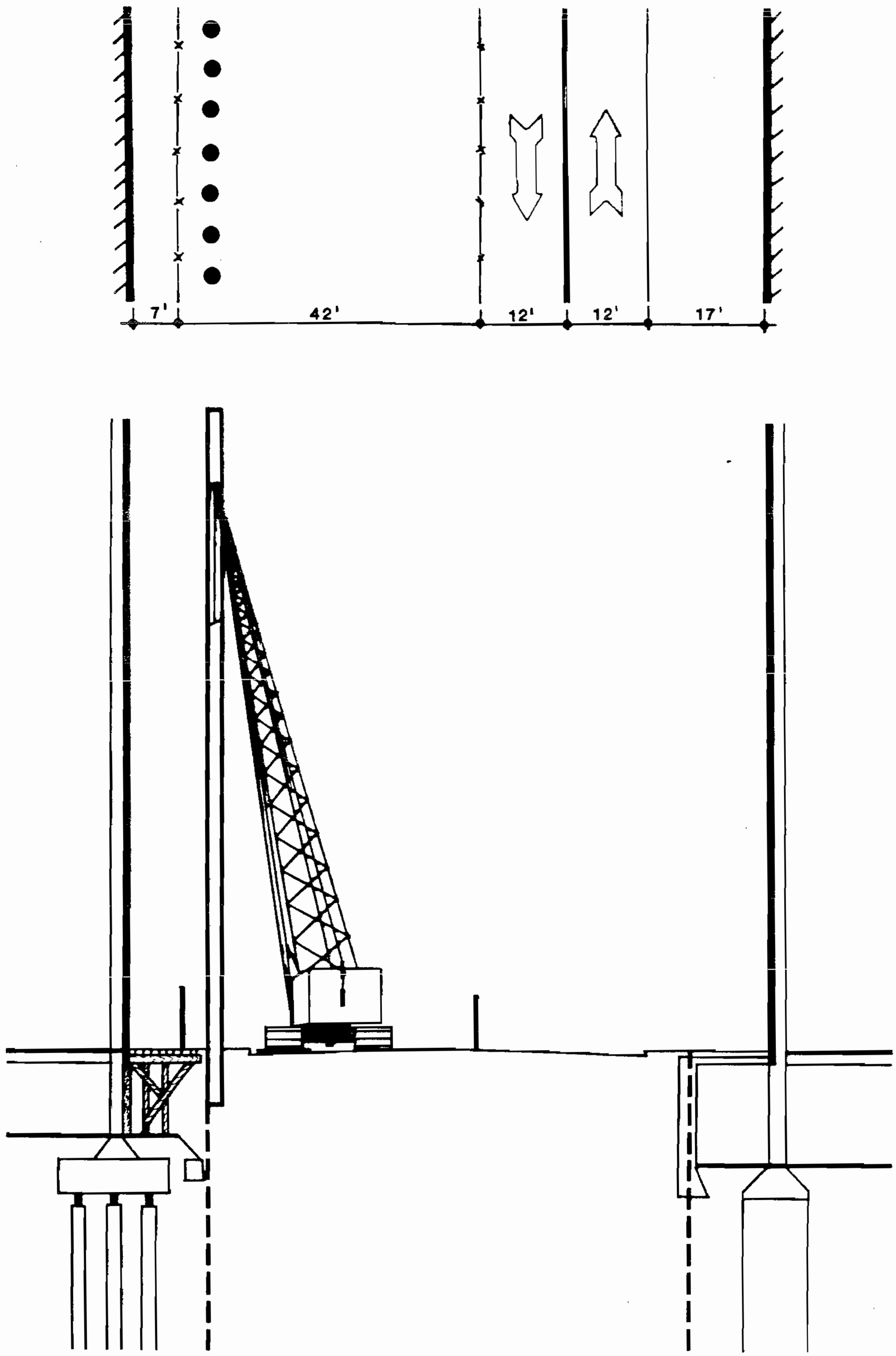

FIGURE 4-16
Sheeting Installation

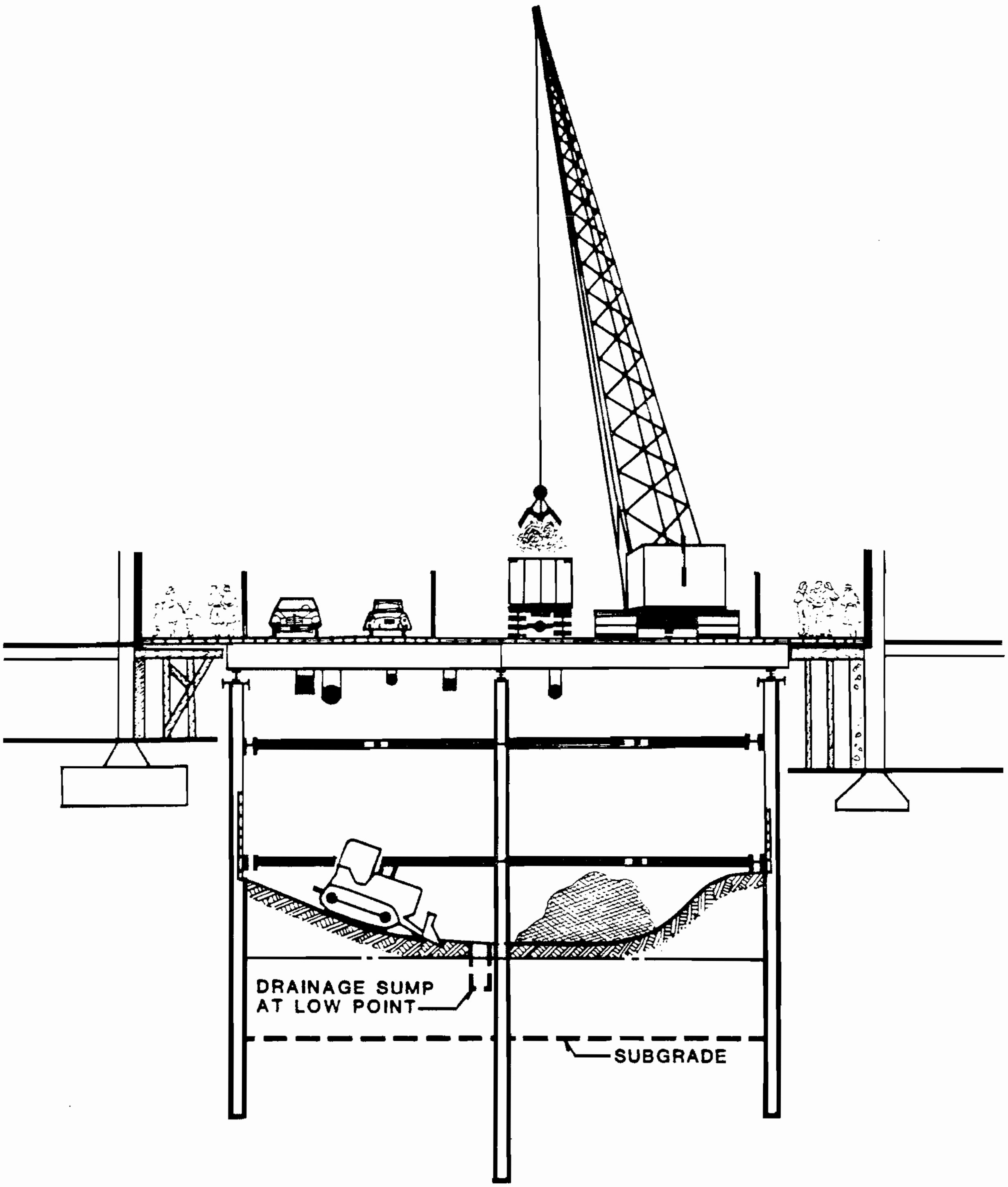

FIGURE 4-17
Excavation and Bracing

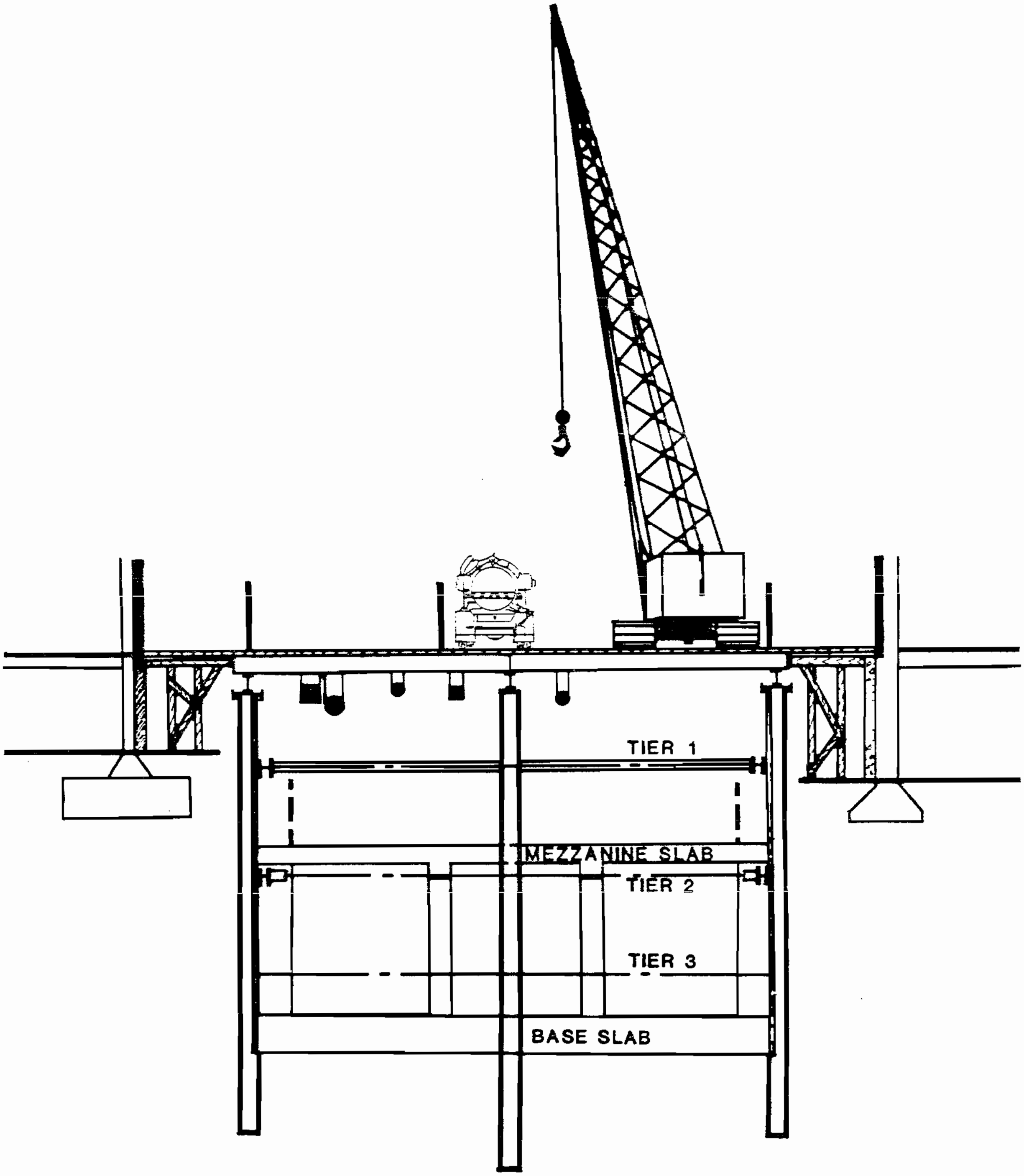

FIGURE 4-18
Structure Installation and Bracing Removal

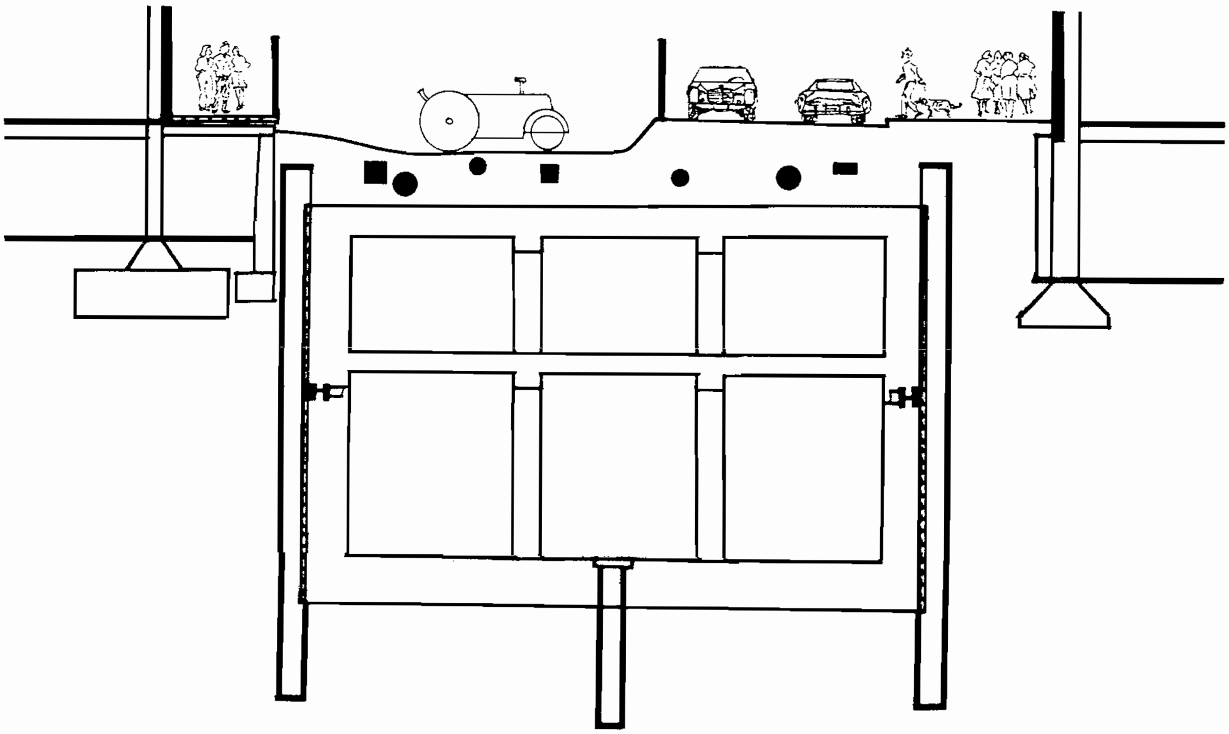

FIGURE 4-19
Backfilling and Surface Restoration

Tunneling Methods

Most of the subway line sections between stations will be constructed using tunneling techniques. The tunnels will be excavated by boring below the surface, and the excavated material will be removed at the adjacent station site.

These tunneling techniques have significantly less effect on street usage, surface features, and utilities than cut-and-cover construction methods. Utility lines will be located at points above the tunnel. Surface features will be affected only at access points.

The method of tunneling depends largely on the type of material in which the tunnel is being cut. In soft ground, the tunnel machine can use a circular cutter that excavates across the full tunnel diameter as the machine rotates. Figure 4-20 illustrates this type of machine. The face of the excavating machine has rows of large teeth which scrape against the tunnel face, breaking away the ground. A circular shield directly behind the cutter head supports the tunnel wall until the liner can be installed behind the shield. The boring machine is moved forward by a group of hydraulic jacks. These jacks push between the installed liner and boring machine, forcing the machine forward.

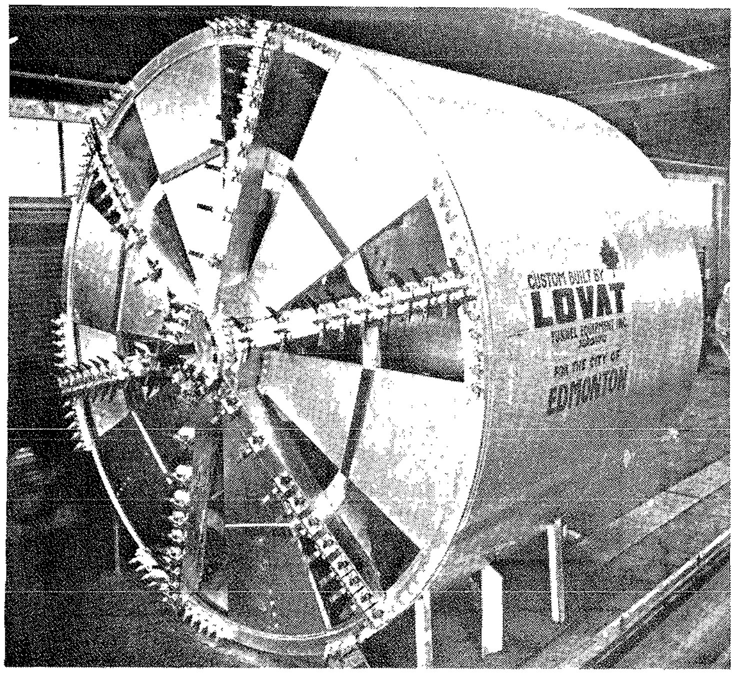

FIGURE 4-20
Soft-Ground Tunnel Borer

The excavated soil is removed through the center of the shield and carried to the tunnel portal by a small mine train. In good ground conditions, a boring machine may average 50 feet per day.

An alternative soft ground tunneling machine uses a digging arm that excavates at the tunnel face. The arm digs back and forth across the face to remove material. As with the boring machine, the tunnel wall is supported by a steel shield until the liner sections are installed. The excavated material is dropped from the digger arm into a conveyor system that transports it to the rear of the shield and into a mine train.

The tunnel through the hard rock of the Santa Monica Mountains can be dug using a tunnel boring machine similar to the one shown in Figure 4-21. The hard rock machine cuts the full face of the tunnel as the head rotates in a manner similar to the soft ground tunneling machine. The machine face is equipped with small rollers or cutters that grind away the rock as the face rotates. In hard rock where the tunnel is self-supporting, the boring machine does not require a shield; however, a shield may be needed in sections with broken rock. The machine uses feet and arms that are forced against the tunnel wall to hold it in place. An internal jacking mechanism moves the boring machine forward. Tunnel dust is kept down by water sprays or vacuum systems. The excavated material is removed through a conveyor to a mining train in the rear. A rate of advance of approximately 50 feet per day can be attained by a tunnel boring machine in hard rock.

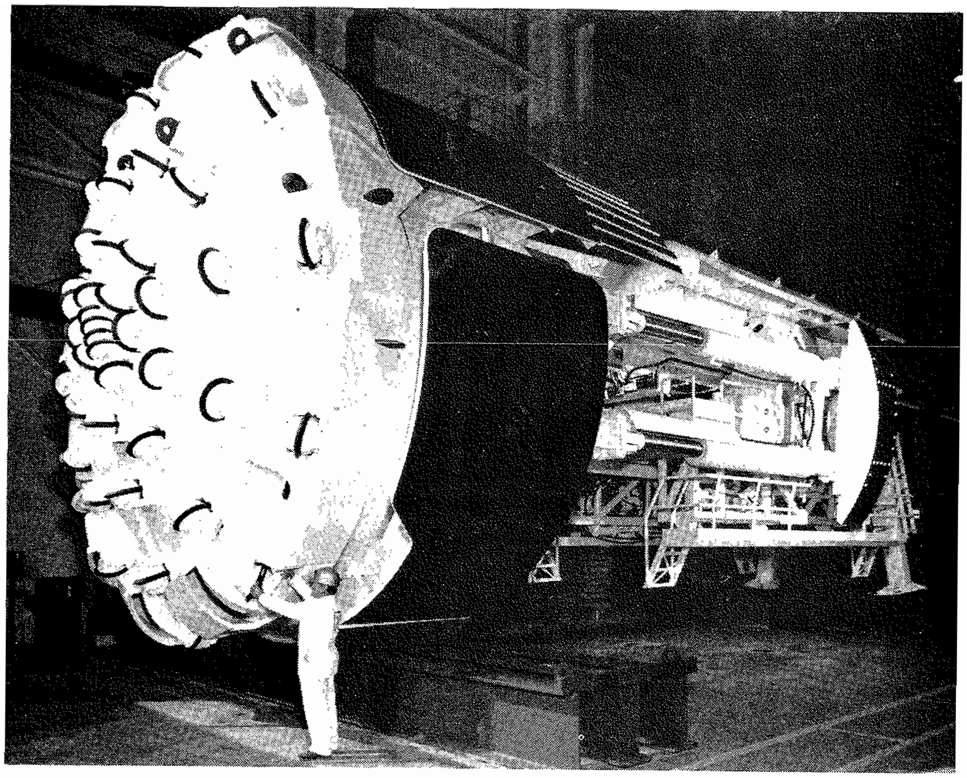

FIGURE 4-21
Hard-Rock Tunnel Borer

An alternative to the tunnel boring machine in hard rock is the conventional drill and blast method. In this technique, a series of holes are drilled in the tunnel face, and an explosive charge is packed in and set off. The broken rock is then removed by machinery and placed on a mine train. An average rate of advance for the drill and blast technique is 40 feet per day. This type of excavation will be used for the Metro Rail system only in unusual conditions.

Muck Disposal

Material excavated from the tunnel, called muck, will be removed from the face of the tunnel by a small mining train to the adjacent cut-and-cover excavation site. A small area of the cover will have an opening to the surface; the muck will be hoisted out through this opening and loaded into trucks for disposal.

Material haul routes and traffic control plans will be developed by the tunnel contractor to minimize traffic disruptions. These route and traffic plans will meet city traffic, noise, and other code requirements, and must be approved by the city.

5. STATION DESIGN AND DESCRIPTIONS

5. STATION DESIGN AND DESCRIPTIONS

This chapter describes the sites and designs of the Metro Rail stations that will serve transit passengers within the Los Angeles regional core. General station locations were defined primarily as a result of the Milestones 3 and 4 Community Participation Program and extensive analyses and discussions of such factors as cost, service, and environmental considerations. Station sites and designs were refined and presented to the public during the Milestone 10 meetings. Following these meetings, the plans were modified to reflect public input and to improve the system's cost-effectiveness.

Since the publication of the Milestone 12 Preliminary Draft Report in May 1983, a number of further refinements to station siting and design have occurred. The changes include the addition of two stations to the system, at Wilshire/Crenshaw and at Hollywood Bowl,* raising the total number to 18 stations along the initial line:

- In the central business district--at Union Station, Civic Center, 5th/Hill, and 7th/Flower
- Along Wilshire Boulevard--at Alvarado, Vermont, Normandie, Western, Crenshaw, La Brea, and Fairfax
- On Fairfax Avenue--at Beverly and Santa Monica
- On the Hollywood/North Hollywood route--at La Brea/Sunset, Hollywood/Cahuenga, Hollywood Bowl, Universal City, and North Hollywood.

At several of these locations, station sites or designs have been modified for cost, service, or environmental reasons. Key changes include the following:

- The 7th/Flower Station has been reconfigured to accommodate an interface with a light rail line that may be built on Flower Street. The site of the station box has been shifted slightly to the east to center it on the Flower Street axis, and the station will have a continuous mezzanine with knock-out panels at the Flower Street axis to facilitate a connection with the potential light rail line.

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*The SCRTD Board of Directors has directed the design of the Hollywood Bowl Station to be carried to a 50 percent level of completion, the cost of the station to be excluded from the project's federal grant application, and other public and private sources of funds to be sought to enable the station's design and construction to be completed within the current project implementation schedule.

- The Wilshire/Fairfax Station site has been moved to an off-street location to the north and east of the intersection of Wilshire and Fairfax Boulevards. This site was selected both to minimize environmental impacts in the Hancock Park/La Brea Tar Pits area and to take advantage of a significant joint public/private development opportunity. To minimize the length of line and thereby reduce cost, the station has been designed with stacked side platforms rather than a center platform. Separate entrances and mezzanines at either end of the station will provide access to both platforms. The bus terminal previously planned for the Wilshire/Fairfax Station has been deleted, but bus pull-off lanes will be constructed on each of the four sides of the site.

- The design of the Wilshire/Alvarado Station has been changed to include two entrances oriented to Alvarado Street, rather than the single entrance previously specified, and a center rather than an end mezzanine.

- The Wilshire/Vermont Station has been reconfigured to include an entrance on the west side of Vermont, with an adjacent bus pull-off lane, in addition to the planned entrance on the east side of Vermont.

- At the Wilshire/La Brea Station, the entrance has been reoriented to parallel the Wilshire rather than the La Brea axis, and the crossover track formerly planned for this location has been relocated adjacent to the Wilshire/Crenshaw Station.

- The Hollywood/Cahuenga Station has been modified to have a center mezzanine rather than two end mezzanines.

- The bus terminal formerly planned for the east side of the Union Station site has been deleted.

- All traction power substations located at station sites will be below ground, with the exception of the substation at La Brea/Sunset.

These revisions have been incorporated into the station descriptions contained in this chapter and in the preliminary site plans, or "footprint" drawings, that indicate basic surface and station features at each station location. These station descriptions are preceded by a discussion of the general design approach for stations.

DESIGN APPROACH

The general approach taken to Metro rail station design emphasizes the use of standardized architectural elements for all stations to establish an identity for the system as a whole. Within these limits, however, each station will be allowed to develop a somewhat individual appearance through the use of such elements as varying site development, landscaping, entrances, finish materials, artwork, and color.

Standardization of station design is emphasized for two main reasons. First, standardization of such elements as fare collection areas, platform areas, and signs will reduce confusion and enable passengers to move easily throughout the Metro Rail system. Equally important, standardization will minimize the costs required to construct, operate, and maintain the stations.

The application of this approach to station design is described below, first with regard to general architectural features and then with regard to functional station components. Figure 5-1 illustrates the general features of a Metro Rail station.

General Architectural Features

This section describes the approach taken in station design for such features as landscaping, artwork, signs and graphics, concessions and advertising, materials and finishes, lighting, and communications.

Landscaping

Landscape work at Metro Rail stations has as its basic objectives: (1) ensuring that pavements and surfaces are safe for pedestrians; (2) creating a pleasant appearance; (3) coordinating proper grading and drainage; and (4) providing irrigation where it is required. In addition, landscaping must be consistent with the security requirements of the Metro Rail system, and installation and maintenance costs must be minimized.

To meet these goals, landscaping criteria have been developed which provide station designers with basic landscaping requirements and with methods for meeting those requirements. These criteria establish specific plant and material uses and an approved group of design devices from which station designers may choose.

Artwork

To help provide stations with an individual community identity and visual interest, an artwork program is being established. This program contains procedures for both the acceptance of donated artwork and the commissioning of artwork by SCRTD. A maximum of 0.5 percent of the estimated cost of station structure will be budgeted for artwork at each station.

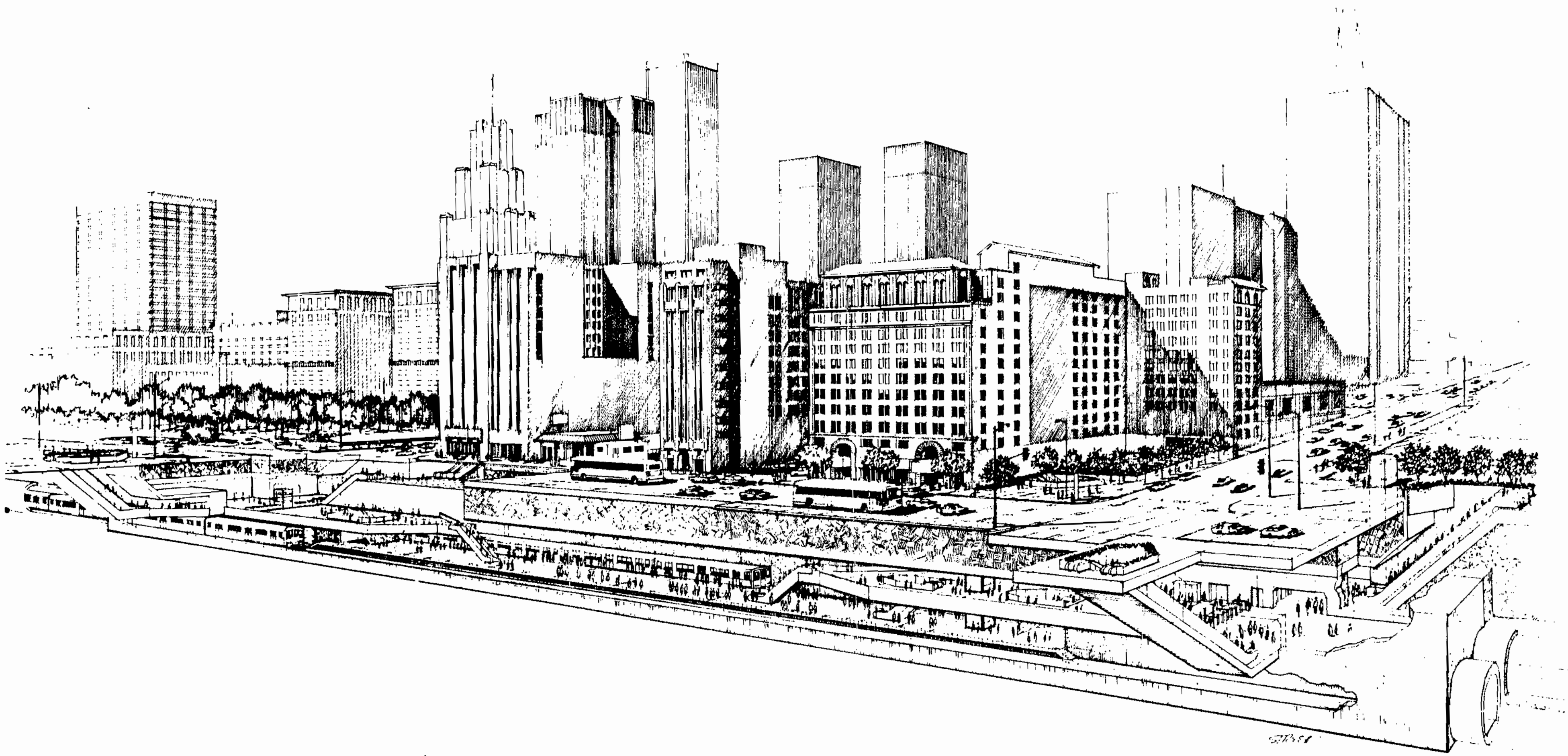


FIGURE 5-1
General Station Features

The acceptance or commissioning of artwork will be guided at each station by a committee composed of five permanent members and the architect for the particular station under consideration. The five permanent members will be appointed by the General Manager and will be eminent experts in art or art-related subjects. The architect for each station will be a voting member and technical adviser for artist selection and art review for his/her design assignment(s). The artwork at each station will be in keeping with local characteristics and may include sculpture, mosaics, wall paintings, etc.

Signs and Graphics

The design and location of signs and graphics will be uniform throughout the Metro Rail system. Signs will be held to the minimum required for effective guidance of Metro Rail passengers. The message on each sign will be simple, clear, and concise.

Signs will have precedence over artwork and advertising with regard to their location and prominence. In addition, because of the importance of their messages, certain signs will have priority over others. Examples of high-priority signs include those directing passengers to normal and emergency exits. This priority may be indicated by differences in size, color, or location.

Concessions/Advertising

Mechanical retail concessions, such as newspaper vending machines, may be located on the mezzanine level of the stations. In addition, retail concessions will be considered for those areas which connect with station entranceways. No tobacco, food, or beverage concessions will be permitted within the stations.

Advertising will be allowed in the stations on a carefully controlled basis. Advertising will be designed so that it does not conflict with directional or safety signs and graphics, and does not inhibit station security surveillance.

Material and Finishes

Final selection of construction materials will be determined during the next phase of design. A limited group of materials and finishes will be selected from which station designers may choose. All construction materials and finishes will be durable, graffiti- and vandal-resistant, and easily cleaned.

Interior colors will be predominantly light in tone to aid in maintaining high illumination levels, but with sufficient contrast and accents to provide visual interest and to conceal minor soiling. Preferred textures will be smooth rather than rough for ease in cleaning.

Lighting

High levels of illumination will be provided in the public areas of Metro Rail stations. Standardized lighting fixtures will be used throughout the system, although the placement of the fixtures may vary from station to station. Lighting will be direct rather than indirect. A battery-powered emergency lighting system will provide sufficient light for safe exiting of passengers if normal power fails.

Communications

For passenger security and convenience, all Metro Rail stations will include an intercom system, a public address system, closed circuit television monitors, and emergency telephones.

To enable passengers in the stations to communicate with the Central Control facility, intercoms will be installed on platforms, at elevator entrances, in fare collection areas, and outside of the restrooms. A public address system which will be accessible to Central Control operators and station employees will be used to convey information throughout the station.

For station security and safety reasons, a closed circuit television system, monitored by Central Control personnel, will be used for surveillance of station platforms and mezzanine areas. In addition, emergency telephones located in each station will enable passengers to directly contact SCRTD transit police.

Functional Components

This section discusses the major functional components of Metro Rail's stations, beginning with parking facilities, station entrances, stairways/escalators/elevators, and concluding with station platforms and equipment spaces.

Station Access Facilities

The highest priority in station design has been given to pedestrian access. In addition, facilities for auto, bus, and bicycle access will be provided at various stations. Park-and-ride facilities are currently planned for five Metro Rail stations: Union Station, Wilshire/Fairfax, Fairfax/Beverly, Universal City, and North Hollywood. Consideration will be given to the construction of parking structures at some later date.

Facilities for autos to drop off or pick up passengers--called "kiss-and-ride" facilities--will be provided at Union, Wilshire/Alvarado, Wilshire/Vermont, Fairfax/Beverly, Hollywood/Cahuenga, Universal City, and North Hollywood Stations.

Bus access to Metro Rail has been emphasized over auto access in the design of Metro Rail facilities. In line with this approach, provisions will be made that range from new bus pull-off lanes on existing streets to complete bus terminals with bus bays, turnarounds, and layover areas.

Off-street bus facilities will be provided at six stations: Wilshire/Vermont, Wilshire/Western, Wilshire/Crenshaw, Hollywood/Cahuenga, Universal City, and North Hollywood. In addition, new bus pull-off lanes will be constructed at the Civic Center, Wilshire/Alvarado, Wilshire/Vermont, Wilshire/Normandie, Wilshire/Western, Wilshire/Crenshaw, Wilshire/La Brea, Wilshire/Fairfax, Fairfax/Beverly, Fairfax/Santa Monica, and North Hollywood Stations.

A limited number of racks for bicycle parking will initially be provided at all the stations except the Civic Center, 5th/Hill, 7th/Flower, Wilshire/Normandie, and Hollywood Bowl Stations. If the level of demand warrants, consideration will be given to increasing the number of bicycle parking spaces. The bicycle racks will be located close to station entrances in a highly visible area. Table 5-1 summarizes these station access features.

Station Entrances

Plaza-type entrances and entrances within existing or planned developments have been incorporated into the Metro Rail station design. These off-street entrances have been planned to relate to business and urban activities as well as to serve their transit function. Although entrances at all stations will meet the general requirements, they may vary in number and in location relative to the station platform because of differences in projected patronage levels, pedestrian flows, mode of passenger arrival at stations, and site-specific considerations. For example, it has been determined that patronage levels will support the construction of entrances and mezzanines at both ends of a station primarily within the central business district, and double-ended stations will consequently be provided at the Union, Civic Center, and 5th/Hill Stations. (The 7th/Flower Station will have a continuous mezzanine which patrons will be able to access from either end of the station.) For site-specific reasons, the Wilshire/Fairfax and North Hollywood Stations will also be double-ended.

TABLE 5-1
Summary Of Station Access Features

STATION	Auto Facilities		Bus Facilities		Bicycle
	Park-and-Ride	Kiss-and-Ride	Terminals	Pull-Offs	Parking
Union Station	●	●			●
Civic Center				●	
5th/Hill					
7th/Flower					
Wilshire/Alvarado		●		●	●
Wilshire/Vermont		●	●	●	●
Wilshire/Normandie				●	
Wilshire/Western			●	●	●
Wilshire/Crenshaw			●	●	●
Wilshire/La Brea				●	●
Wilshire/Fairfax	●			●	●
Fairfax/Beverly	●	●		●	●
Fairfax/Santa Monica				●	●
La Brea/Sunset					●
Hollywood/Cahuenga		●	●		●
Hollywood Bowl					
Universal City	●	●	●		●
North Hollywood	●	●	●	●	●

The orientation of station entrances--that is, whether the entrance parallels, runs perpendicular to, or is set at some other angle to the major street--has been determined by a number of factors. These include the existence of underground utility lines, anticipated pedestrian flows, the location of bus stops, and the potential for future development of the site.

Elevators/Escalators/Stairs

Stair and escalator requirements have been determined on the basis of projected station use for the year 2000 during the peak 15 minutes of a day. The number of stairs and escalators incorporated in each station will allow detraining peak-period passengers to leave the platform before the next train arrives and will permit uncongested movement of passengers throughout the station. Additional stairways will be provided at the station platforms to permit rapid evacuation of the station during any emergency.

Elevators connecting the street and mezzanine levels, and the mezzanine and platform levels, will be installed to make the system fully accessible to the elderly, handicapped, and others requiring special access provisions.

Mezzanine

The mezzanine area provides a transition between the station entrance and the train platform and will contain fare vending and collection equipment, signs, and telephones. The configuration of the mezzanine area will be determined by patronage levels and the number and location of the station entrances.

The portion of the mezzanine that a patron enters prior to fare collection is termed the "free" area, and that portion after fare collection is termed the "paid" area. A limited function control panel for station agents will be located at the fare collection area of mezzanines to allow agents to communicate easily with the Central Control operation.

Platforms

A center platform configuration--a single platform with tracks on either side--will be installed in all Metro Rail stations except the Wilshire/Fairfax Station, which will have side platforms, one stacked over the other. The center platform configuration, illustrated in Figure 5-2, enables patrons to make directional decisions on the platform and thus facilitates their use of the system. Also, costs are typically lower for stations with center platforms than for those with side platforms. Metro Rail station platforms will be 450 feet long to accommodate trains consisting of six 75-foot-long cars.

FIGURE 5-2
Typical Metro Rail Center Platform

Equipment Space

Many different service and equipment rooms are required to support the operation of a rail rapid transit system. Substantial station space is needed for mechanical and electrical equipment or components, including auxiliary power distribution rooms, fan rooms, and traction power substations at some locations. The design of these equipment spaces will be standardized as much as possible to minimize capital, operating, and maintenance costs. Their location will vary somewhat from station to station, given site-specific considerations. Most frequently, however, the equipment spaces will be located at track level beyond the platforms and/or at the mezzanine level beyond the public space.

STATION DESCRIPTIONS

Union Station

Metro Rail's Union Station will be located under the passenger loading platforms of the Los Angeles Union Passenger Terminal (LAUPT) (see Figure 5-3). This site is at the edge of the downtown core near the Civic Center and Little Tokyo, and is adjacent to El Pueblo de Los Angeles State Historic Park, a major tourist attraction.

The station site is bounded by Alameda Street on the west, Macy Street on the north, Vignes Street on the east, and the Santa Ana Freeway on the south. Located within this area are the Union Station Terminal Building (a historic landmark), administrative offices, surface parking, tracks, and an underutilized area east of the tracks.

Continental Trailways and Amtrak services operate from LAUPT, and local RTD buses use the north end of the terminal as a bus stop and turnaround. The State Department of Transportation (Caltrans) has planned an extension of the El Monte Busway, which will provide a bus stop on the southwest corner of the LAUPT site for express buses serving the San Gabriel Valley. Under a joint-powers agreement between Caltrans and the City of Los Angeles, a condemnation action has been filed to acquire the LAUPT site. In a separate action, Caltrans is pursuing acquisition of a small portion of the LAUPT site to accommodate the proposed extension of the El Monte Busway.

Union Station will be the initial station on Metro Rail's alignment. Passengers walking to the station will come primarily from the downtown area to the west of the site. Auto and bus patrons will be arriving mainly from suburban areas to the north and east. Given these passenger arrival characteristics and the relatively high projected levels of patronage, the station will have an entrance and mezzanine at each end of the platform. Ancillary space and a double crossover track will be located at

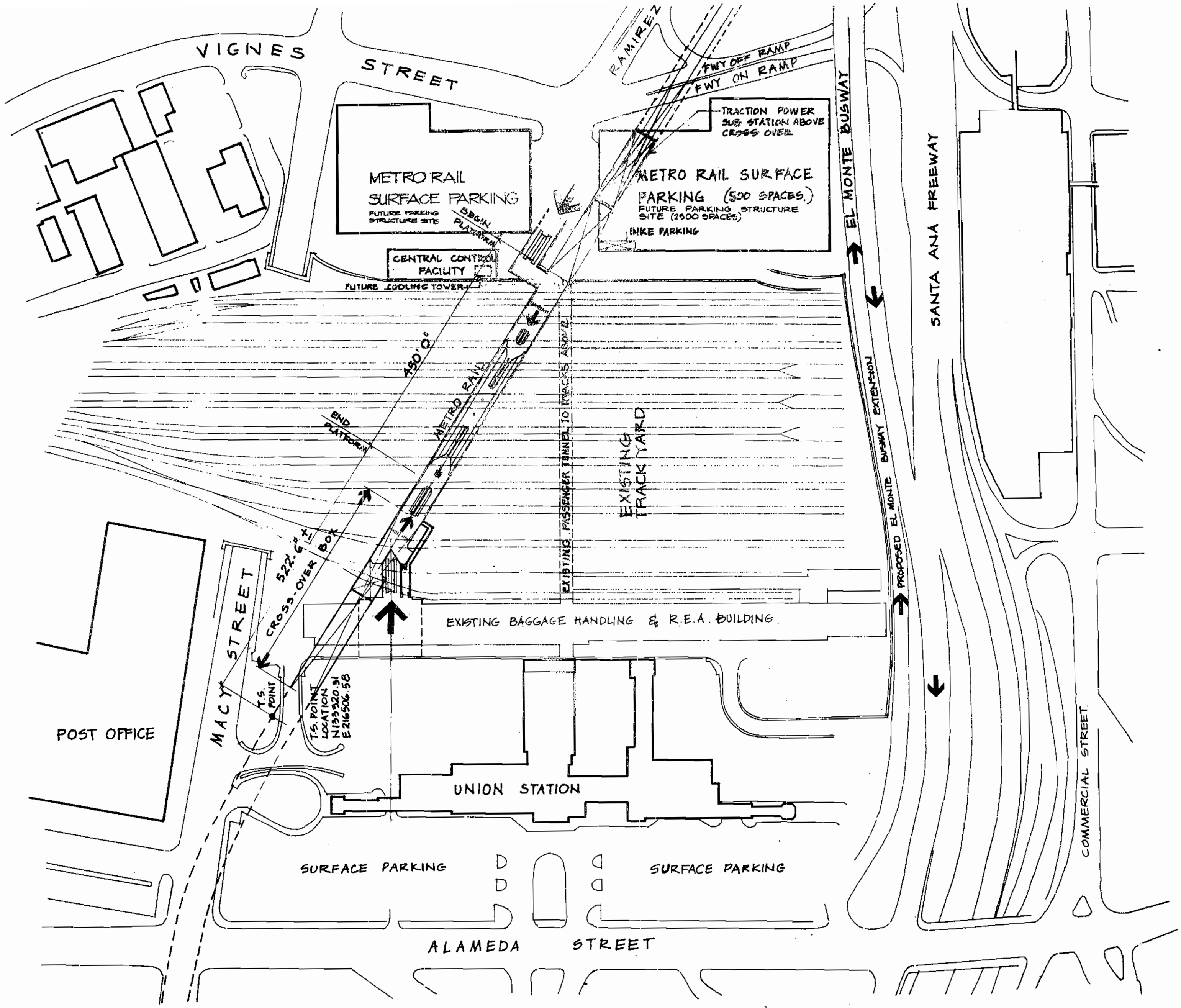


FIGURE 5-3
Union Station

each end of the station. At the east end, a traction power substation will be sited below grade over the crossover track.

The Central Control facility for the Metro Rail system will be located near the east entrance to the station. Parking will also be located near the east station entrance. Initially, 500 parking spaces will be provided in a surface park-and-ride area. Construction of a parking structure having spaces for 2,500 autos will be considered at a later date. The small demand for kiss-and-ride parking at this station will be accommodated either on surface streets or in a portion of the parking area.

Civic Center Station

The Civic Center Station will be located under Hill Street between Temple and 1st Streets (see Figure 5-4). Various federal, state, county, and city office buildings are located in the vicinity, including the County Courthouse, Hall of Records, County Law Library, City Hall, Hall of Administration, State Office Building, Criminal Courts, and the Hall of Justice. The Civic Center Mall immediately to the west of Hill Street, and the Court of Flags to the east, create a major axis which extends from the Water and Power Building and the Music Center to City Hall.

The southwest corner of 1st and Hill Streets is undeveloped and is owned, in part, by Los Angeles County. Plans for a large mixed-use development project on this site, including theaters and office, residential, and commercial buildings, have been announced by the Music Center's Performing Arts Council in conjunction with the Community Redevelopment Agency.

A significant number of bus-rail transfers are expected to occur at the Civic Center Station. Bus access will be provided by two bus pull-off lanes: one will be on the west side of Hill Street, immediately to the south of 1st Street; the other will be on the east side of Hill Street adjacent to the Court of Flags. The functional plan for this station site does not call for park-and-ride or kiss-and-ride facilities, as most patrons are expected to arrive at the station either on foot or by bus. All station entrances will be located to facilitate pedestrian traffic flow patterns, but at the same time the design will have a minimum adverse impact on public land.

In response to the relatively high patronage levels projected for this station and the expected patterns of pedestrian flow, the Civic Center Station has been planned with entrances and mezzanines at each end of the platform. At the south end of the station, an entrance will be located at the southwest corner of 1st and Hill Streets; provision will also be made for possible future construction of an entrance at the northeast corner of that intersection. At the north end of the station, an entrance will be located adjacent to the Court of Flags and will be designed to enhance this public park space.

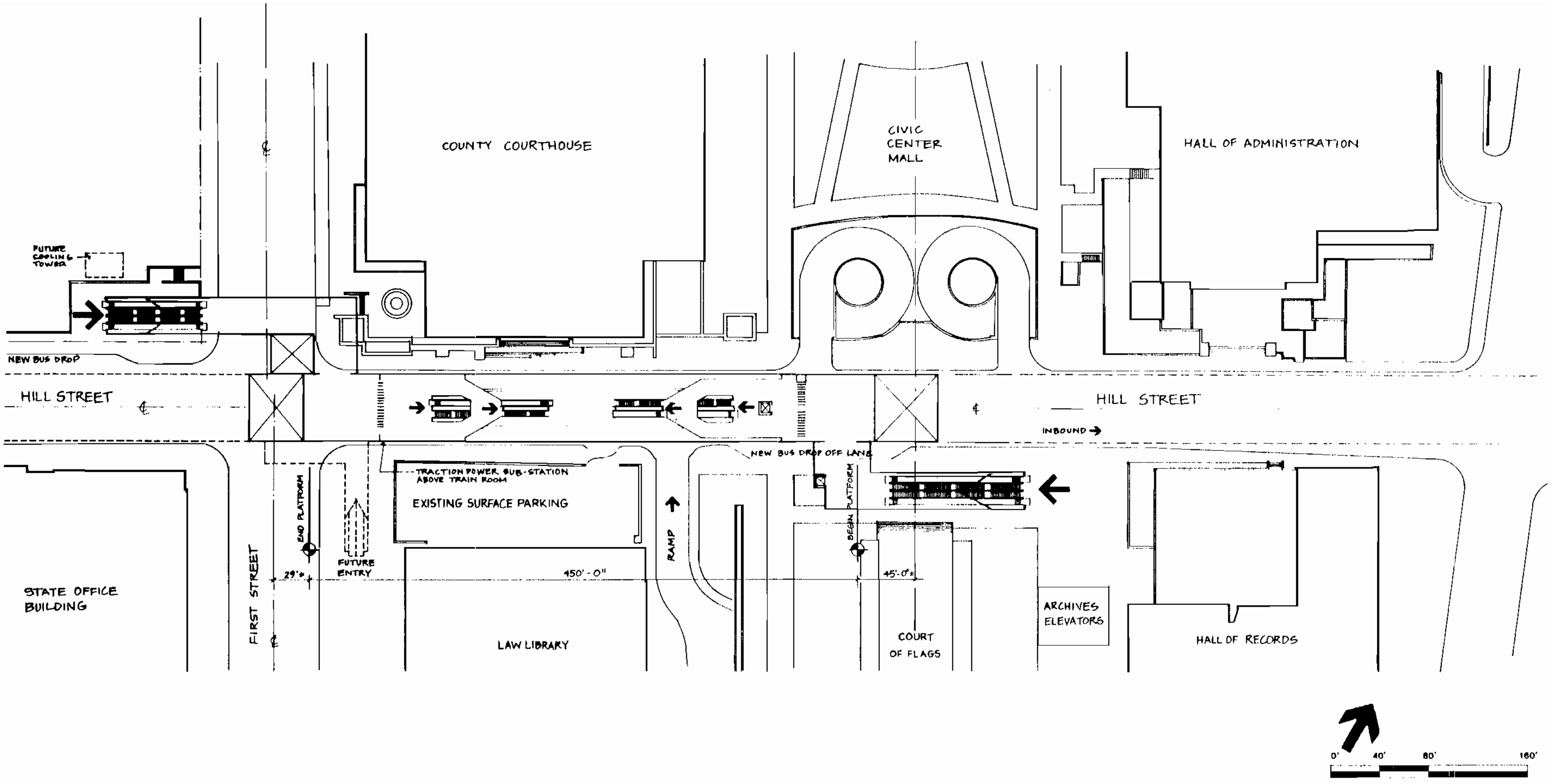


FIGURE 5-4
Civic Center Station

A traction power substation will be located over the train room, and ancillary space will be provided at the mezzanine and platform levels at each end of the station.

5th/Hill Station

The 5th/Hill Station will be located under Hill Street between 4th and 5th Streets (see Figure 5-5). The surrounding area contains the International Jewelry Center, the Grand Central Market, the Biltmore Hotel, and many retail, commercial, and office buildings. Pershing Square Park is at the south end of the station site. Several major new developments are proposed for this area including California Plaza, a $1.2 billion mixed-use development on the northwest corner of 4th and Hill Streets, and an expansion of the International Jewelry Center on the southeast corner of 5th and Hill Streets.

The primary concern with regard to the 5th/Hill Station is that the entrances be oriented to pedestrian flow and also be designed to accommodate future development. The major bus transfer point for the station will be at the intersection of 5th and Hill Streets. Three corners of this intersection are fully developed, a factor which increases the complexity of locating entrances. The 4th and Hill Street end of the station will serve pedestrians from east of Hill Street and from the proposed California Plaza. In addition, the Community Redevelopment Agency is promoting a pedestrian link between Hill Street and a proposed pedestrian plaza above Hope Street and Grand Avenue. Pedestrian flow to the north station entrances will increase when these developments are completed.

This station has the highest levels of patronage projected for the system, and consequently has been planned with entrances and mezzanines at each end of the station. At the intersection of 4th and Hill Streets, two entrances are planned, one on the northwest corner to serve the proposed California Plaza and pedestrian traffic from the west, and the other located on the northeast corner to serve pedestrian traffic from the east and north. Both sites are undeveloped, but projects have been proposed for them. Final orientation of entrances may be modified to permit the integration of the entrances with such future development.

Two entrances are also proposed for the intersection of 5th and Hill Streets. An entrance at 401 West 5th Street on the northwest corner will require careful design to protect and enhance the commercial viability of the building's ground floor. The site of the entrance on the southeast corner, adjacent to the International Jewelry Center, is presently a parking lot but is expected to house an expansion of the Jewelry Center. This entrance will be oriented parallel to 5th Street to accommodate the pedestrian flow from Broadway and Spring Street. However, orientation of the entrance may be changed to permit its integration with future development. The station design will

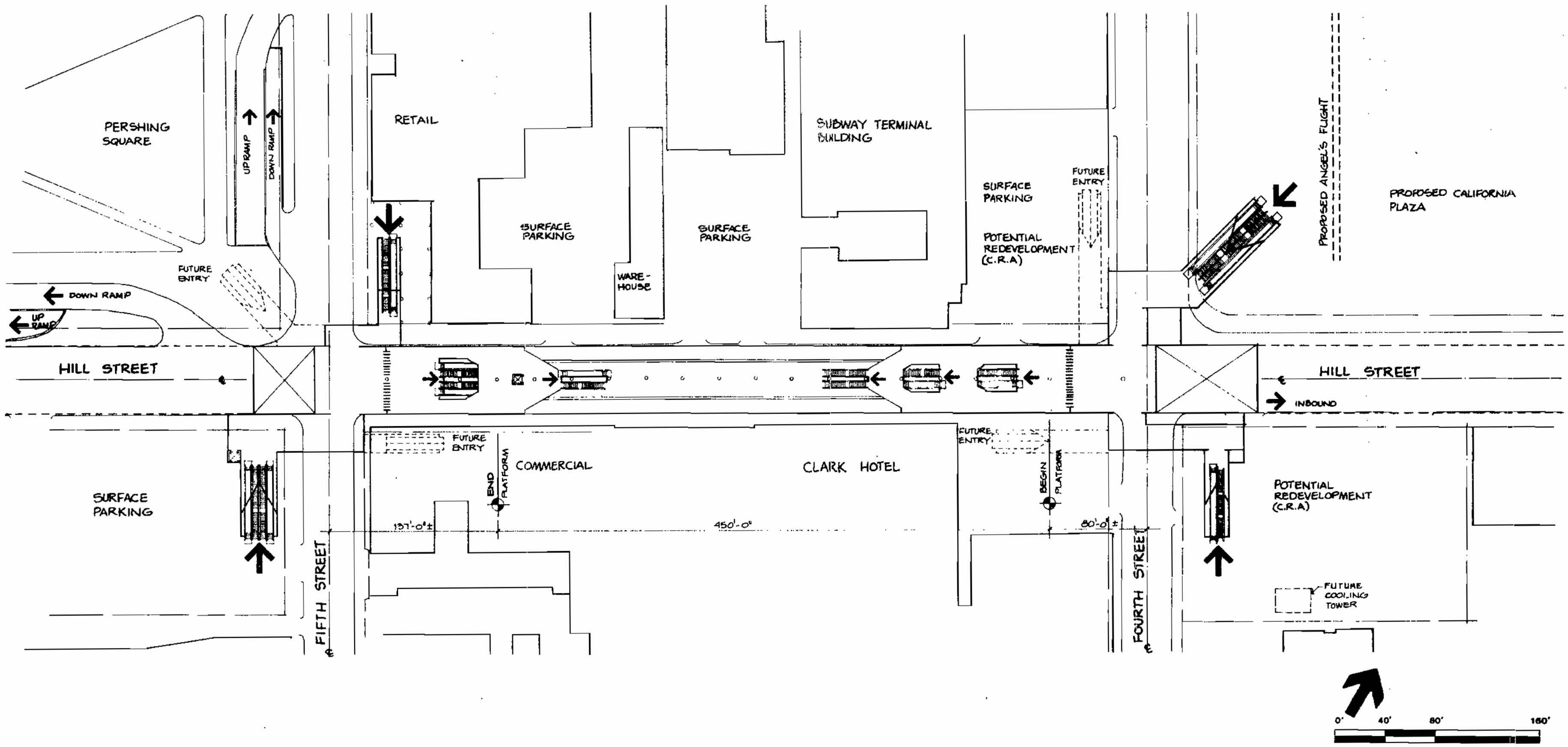


FIGURE 5-5
5th/Hill Station

accommodate future construction of additional station entrances, so that an entrance on each corner of the intersections of 4th and Hill and 5th and Hill will be possible.

Ancillary space will be provided at each end of the station. No traction power substation will be required at this site.

7th/Flower Station

The 7th/Flower Station will be located under 7th Street between Hope and Figueroa Streets (see Figure 5-6). Within the central business district, 7th Street is a major auto, bus, and pedestrian artery. Land uses in the station area include high-rise office towers, street-level retail and commercial space, department stores, and restaurants. Significant centers of activity in the vicinity of the station site include the First Interstate Tower, J.W. Robinson's department store, ARCO Plaza, the Hilton Hotel, Barker Brothers, and the Broadway Plaza. The immediate area contains little undeveloped land, with the exception of the southwest corner of 7th and Figueroa Streets. This will be the site of the Pacific Plaza, now under construction, which will provide over 3 million square feet of office and commercial/retail space. Three historic landmarks are located near the intersection of 7th and Figueroa Streets--the Barker Brothers Building, Fine Arts Building, and Engine Company No. 28.

In response to the moderately high patronage levels projected for this location, entrances have been planned at each end of the station, connecting to a continuous mezzanine. At the west end, an entrance will be constructed on the northeast corner of the intersection of 7th and Figueroa Streets. This will be the primary station entrance. At the east end, a second entrance to the station will be constructed in the corner of the Central Bank Building at the intersection of 7th and Hope Streets. This entrance will be designed to have a minimal impact on the building's commercial space.

The construction of additional station entrances in the future will be possible. At the west end, an entrance from the proposed Pacific Plaza to the station could be constructed. In addition, entrances from the garden level of the Broadway Plaza and from the northeast and southeast corners of 7th and Hope Streets are possible at some future time.

Station ancillary space will be located at each end of the station platform. A traction power substation will be located below the entrance on the northeast corner of 7th and Figueroa Streets. No special provisions for autos or buses are planned for this station.

The design of the 7th/Flower Station has been influenced by the possibility that a light rail line may be built on Flower Street, with a station between Wilshire Boulevard and 7th Street. To accommodate a future interface between Metro Rail and such a

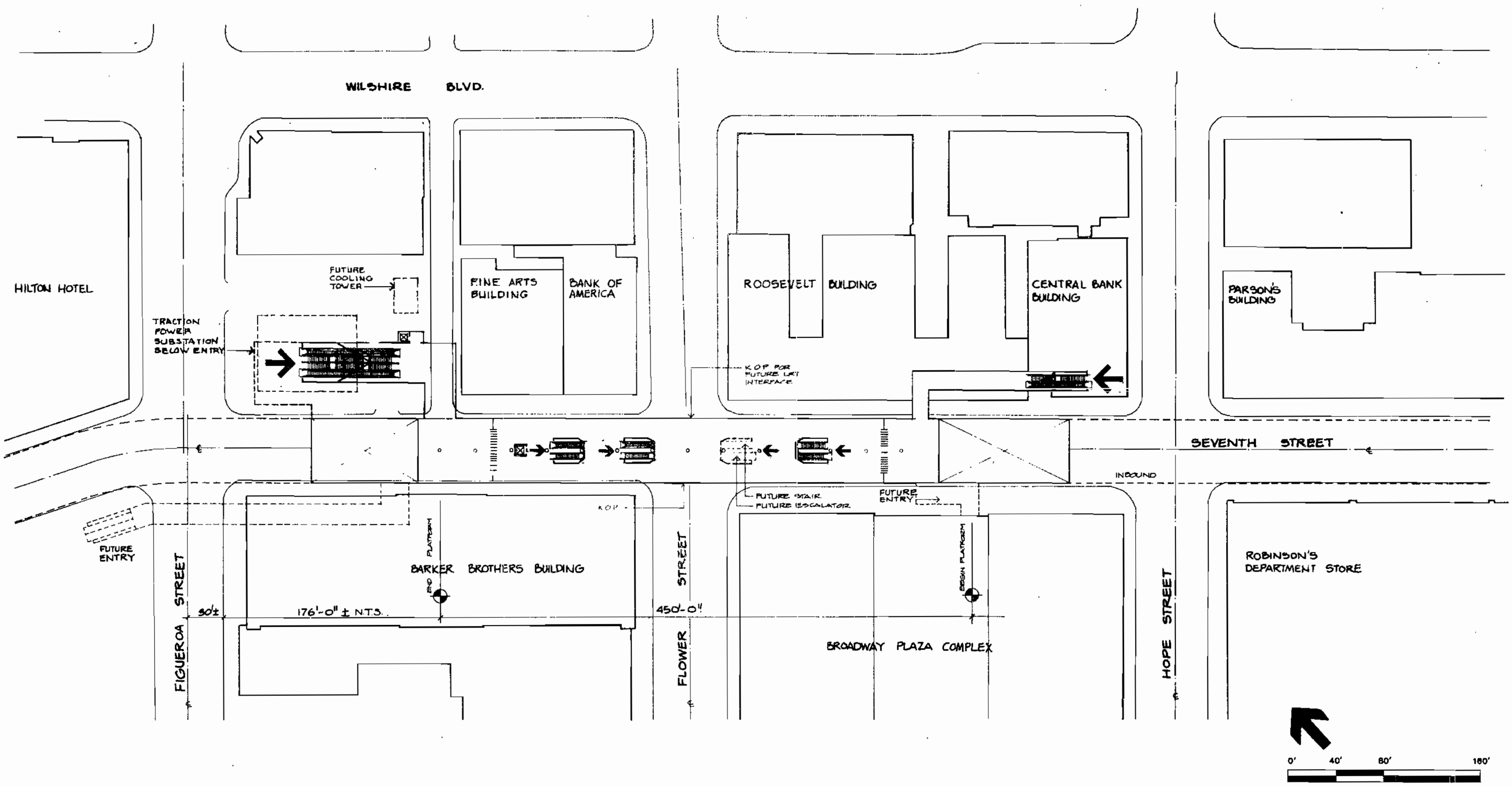


FIGURE 5-6
7th/Flower Station

light rail line, the 7th/Flower Station will be centered on the Flower Street axis and will incorporate a continuous mezzanine with knock-out panels at the Flower Street axis.

Wilshire/Alvarado Station

The Wilshire/Alvarado Station will be located off-street in the middle of the block between 7th Street and Wilshire Boulevard (see Figure 5-7). Extending from Bonnie Brae to Alvarado Streets, this station is located in the Westlake area. MacArthur Park, a heavily used public space, is just across from the station site. Along Alvarado and 7th Streets are low-rise retail buildings, and several mid-rise office buildings are located on Wilshire Boulevard. The center of the block is primarily devoted to parking.

Because the station will be constructed by the cut-and-cover method, the mid-block area will need to be acquired and cleared. After construction of the station is completed, this site could be available for new development. Consideration may thus be given to creating a mall or pedestrian pathway from Alvarado Street to Westlake Avenue.

Patronage is projected to be moderately high at this station. A significant number of passengers are expected to transfer to Metro Rail from buses operating on Alvarado Street. To facilitate such transfers, a bus pull-off lane is planned for the east side of Alvarado Street in front of the station. No park-and-ride facility will be constructed; however, a kiss-and-ride facility will be provided on the west side of Westlake Avenue.

The station will have two entrances, located adjacent to Alvarado Street at the west end of the station and connecting to a center mezzanine. Ancillary space will be provided at each end of the station, and a double crossover track will be located at the station's east end. A traction power substation will be located below grade over the crossover track.

Wilshire/Vermont Station

The Wilshire/Vermont Station will be located off-street in the middle of the block between Wilshire Boulevard and 6th Street, spanning Vermont Avenue (see Figure 5-8). The block facings in the immediate area of the station consist primarily of offices and retail establishments. Development along Wilshire Boulevard includes some high-rise structures; low-rise development predominates along the north-south streets. The surrounding area is primarily residential. Structures between the station site and Wilshire Boulevard consist of a branch of the Bank of America, located on the northeast corner of the intersection of Wilshire and Vermont, and a service station on the northwest corner. Bullock's Wilshire, a historic landmark, is located nearby. The mid-block area is primarily used for parking.

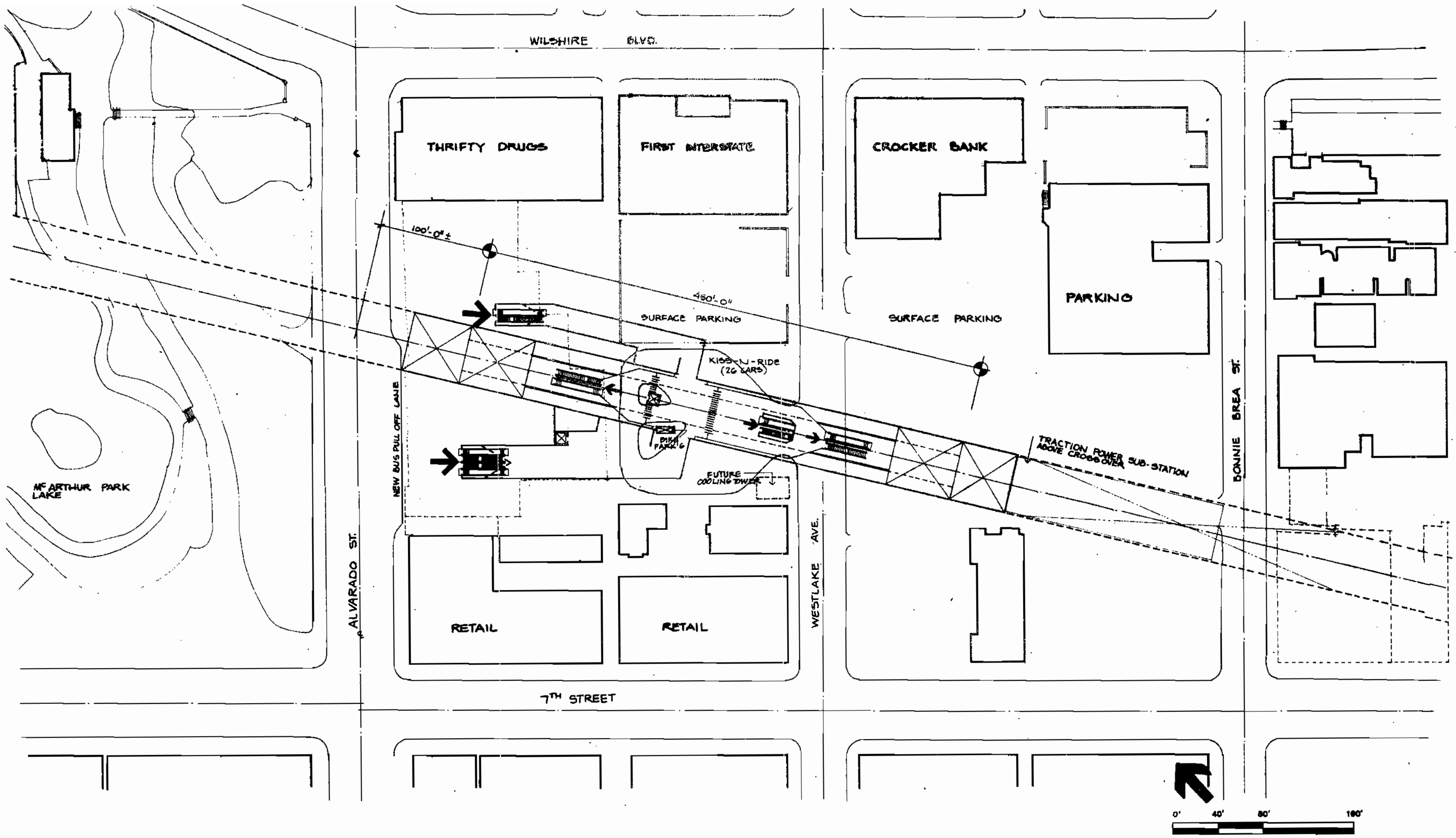


FIGURE 5-7
Wilshire/Alvarado Station

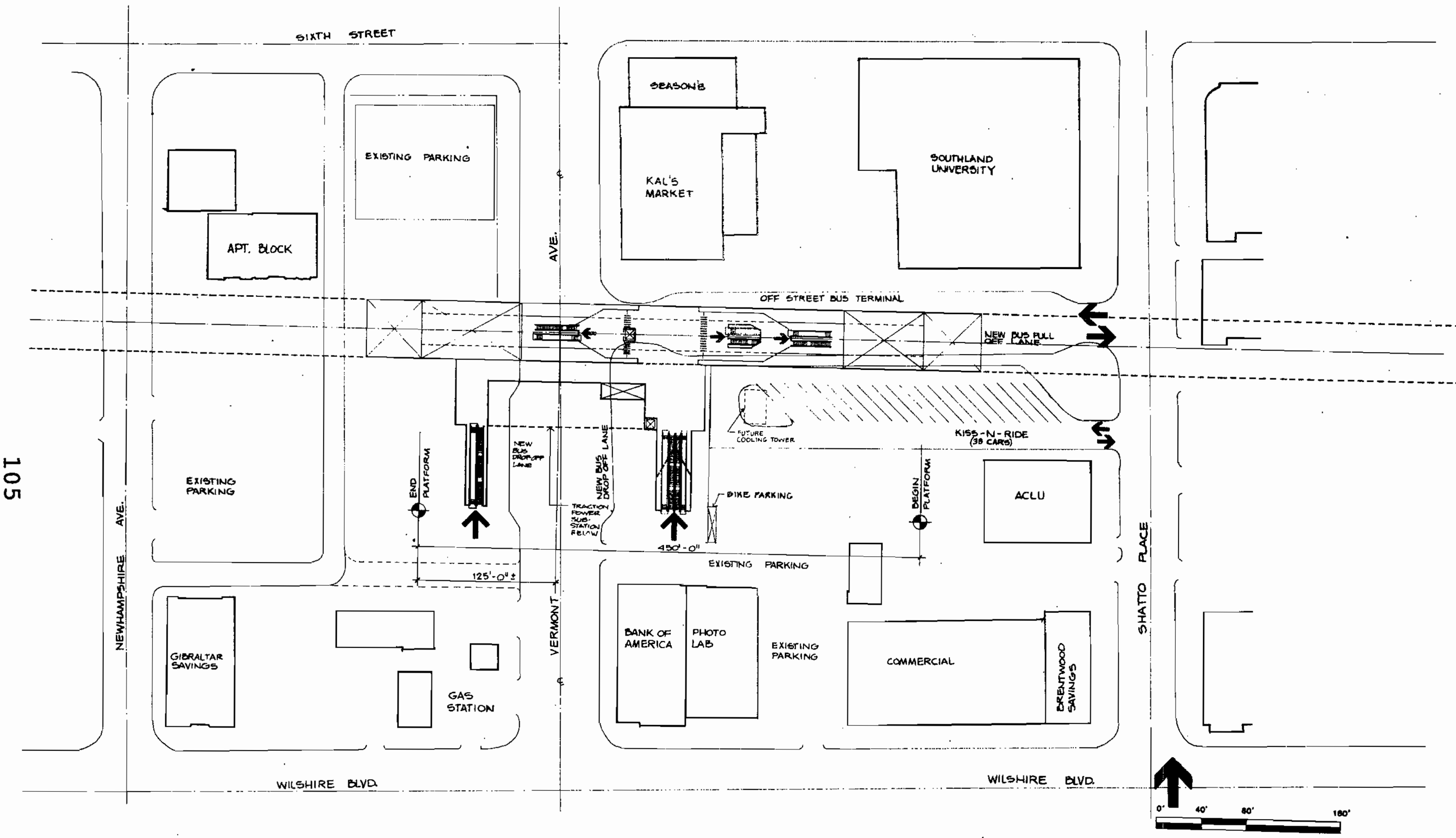


FIGURE 5-8
Wilshire/Vermont Station

The station is planned with two entrances, one on each side of Vermont Avenue. The entrances, which will lead to a center mezzanine, will be oriented toward Wilshire Boulevard, the direction of the major pedestrian flow. The location of the station entrances will offer strong potential for future adjacent and air-rights development. A traction power substation will be located below grade between the station entrances.

A major consideration in the site design for this station is the transit interface between bus and Metro Rail. The Vermont bus lines serving this station location have patronage levels that are among the highest in the city. Some buses will terminate their routes at this location, while others will continue in service after picking up or dropping off passengers. All buses continuing in service will load and unload in bus pull-off lanes located on each side of Vermont Avenue, each adjacent to a station entrance. Bays to provide space for terminating buses to park between trips will be located off-street just north of the east station entrance. A small kiss-and-ride parking area will also be constructed.

Wilshire/Normandie Station

The Wilshire/Normandie Station will be located under Wilshire Boulevard between Ardmore and Normandie Streets (see Figure 5-9). A number of high-rise office buildings and two major hotels are located along Wilshire Boulevard near the station location. The Wilshire Hyatt Hotel is immediately adjacent to the station site, and the Ambassador Hotel is one block away. The Ambassador Hotel, the Wilshire Christian Church on the northeast corner of Wilshire and Normandie, and the Brown Derby are all historic landmarks in the station vicinity. The areas to the north and south of Wilshire Boulevard are residential.

Several sites on Wilshire Boulevard are being considered for new development. An 18-story office building is planned for the site adjacent to the Glendale Federal Bank, and the owners of the Ambassador Hotel may develop the area in front of the hotel. There have also been plans for developing the Brown Derby site.

Irolo Street next to the Glendale Federal Bank is little used and may be vacated by the city, which will entail closing the street and giving up the right-of-way.

Major utilities which pass through the intersection of Normandie Street and Wilshire Boulevard limit the opportunity to locate a station entrance to the east of Normandie Street. West of Normandie Street, the right-of-way of Irolo Street offers the opportunity to locate the required entrance on public land not needed for other transportation purposes. The entrance to the station will therefore be on Irolo Street, but close to Normandie to facilitate bus transfers and pedestrian access. To the greatest degree possible, the entrance will be designed and located to complement the proposed development on the adjacent

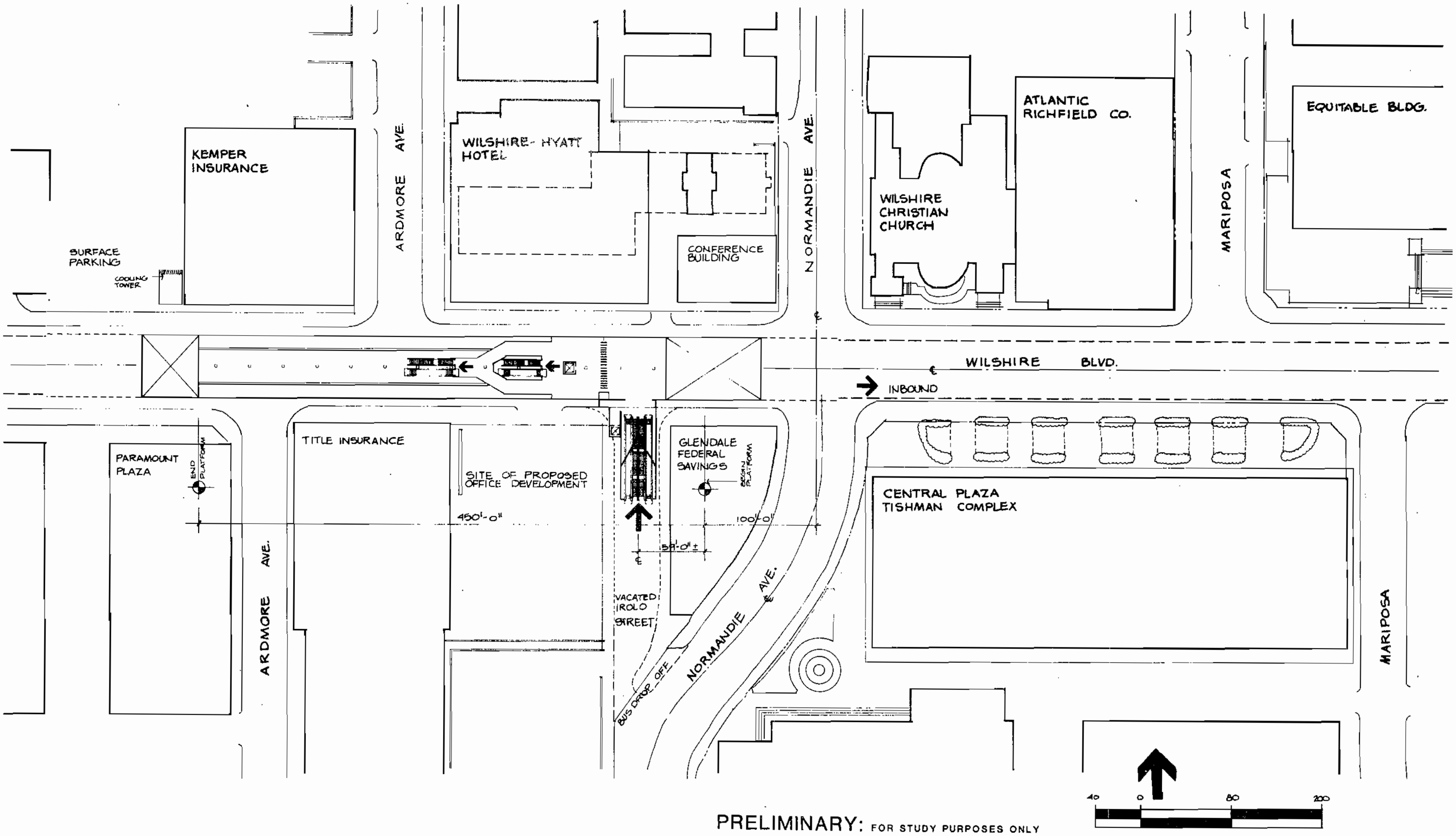


FIGURE 5-9
Wilshire/Normandie Station

site. To improve the flow of street traffic on Normandie and to be convenient for passengers transferring from buses to Metro Rail, southbound buses will need a pull-off lane near the intersection of Normandie and Irolo Streets.

The feasibility of locating a station entrance in the Hyatt Conference Center on the northwest corner of Normandie and Wilshire was investigated. It was found that such an entrance would be difficult to design and expensive to construct; it nevertheless remains an option for future development.

Ancillary space will be provided at each end of the station. A traction power substation will not be required at this location.

Wilshire/Western Station

The Wilshire/Western Station will be located under Wilshire Boulevard between Western Avenue and Oxford Street (see Figure 5-10). This area is on the western edge of a high-rise office segment of the Wilshire corridor. The other major streets have low- to medium-rise mixed-use buildings. The remainder of the surrounding area is residential. All four corners of the intersection of Wilshire and Western are developed. A historic landmark, the Wiltern Theater, is located on the southeast corner and is undergoing renovation. A Union Bank building is on the southwest corner; the Pierce National Life Insurance Building is on the northwest corner; and a Thrifty Drug Store is on the northeast corner adjacent to the McKinley Building, another historic landmark.

All corners of the Wilshire/Western intersection were investigated as potential entrance locations. The northeast corner, occupied by the smallest existing structure, is the proposed location of the single entrance planned for this station, primarily because of the cost and difficulty of construction at the other three corners. This station entrance will be parallel to Western Avenue to facilitate future site development and will lead to a center mezzanine. This configuration will permit an entrance to be constructed into the Union Bank building in the future if needed to meet patronage requirements or if provided by another entity.

A relatively high volume of bus-rail transfers are expected; therefore, bus pull-off lanes on each side of Western Avenue north of Wilshire are planned. Some bus lines will terminate at this station and will need turnaround or layover facilities. To facilitate bus operations, a bus-only right-of-way connecting Western Avenue to Oxford Street is proposed. This proposed right-of-way will be sufficiently wide to have one parking lane and one passing or through lane.

Ancillary space will be located at each end of the station, and the required traction power substation will be located beneath the station entrance.

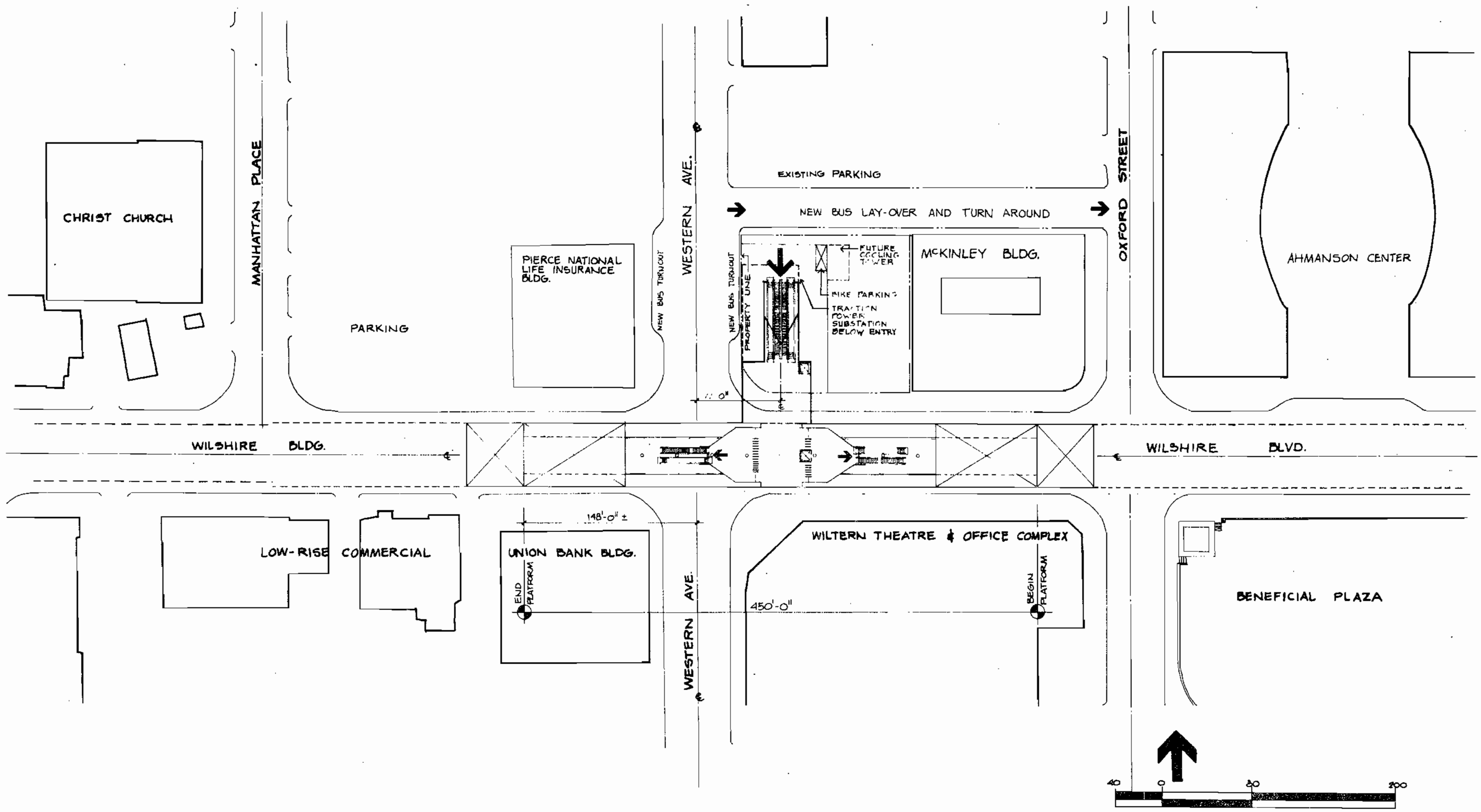


FIGURE 5-10
Wilshire/Western Station

Wilshire/Crenshaw Station

The Wilshire/Crenshaw Station will be located under Wilshire between Lorraine Boulevard and Bronson Avenue (see Figure 5-11). The surrounding land use is primarily low-density housing with apartments and commercial office buildings on Wilshire Boulevard in the vicinity of the station. A 140,000-square-feet office building is under construction on the northwest corner of Wilshire and Lorraine.

Two bus lines will terminate at the Wilshire/Crenshaw Station, creating a need for an off-street bus turnaround with layover and boarding bays. The site dimensions will be adequate to accommodate such a facility and still provide space to construct walls and planted berms to adequately buffer the site from the surrounding residential area. The site will be bounded on the south by an existing wall adjacent to the first existing structure south of Wilshire Boulevard. This wall will be renovated or reconstructed and extended to Lorraine Boulevard. A 10-foot-wide planting berm will be constructed along the north side of the wall. A bus platform island, paved and landscaped with raised planted berm areas, will be constructed, and the station entrance will be located in this island. Four bus loading and drop-off bays, two on each side of the island, and two bus layover positions will be provided. The proposed design will thus minimize bus-auto conflicts while providing an attractive addition to the community.

This station, which is projected to have moderate patronage levels, will have a single entrance leading to a center mezzanine. A double crossover track will be located at the east end of the station. A traction power substation will be constructed over this crossover track. Ancillary space will be provided at each end of the station.

Wilshire/La Brea Station

The Wilshire/La Brea Station will be located under Wilshire Boulevard between Detroit Street and Sycamore Avenue (see Figure 5-12). The surrounding area along Wilshire Boulevard contains mostly low-rise commercial and retail developments, with the exception of the medium-rise Mutual of Omaha Building. This historic landmark is located on the northeast corner of the intersection of Wilshire and La Brea. The areas to the north and south of Wilshire Boulevard are residential. Although few major destination points, public spaces, or attractions presently exist at this location, the many underutilized parcels of land in the vicinity of the station site increase the potential for new development.

Given the moderate patronage levels projected for this station, only one entrance and mezzanine will be required. As the northwest corner of the Wilshire/La Brea intersection is the least developed, it is proposed as the entrance location. The site is

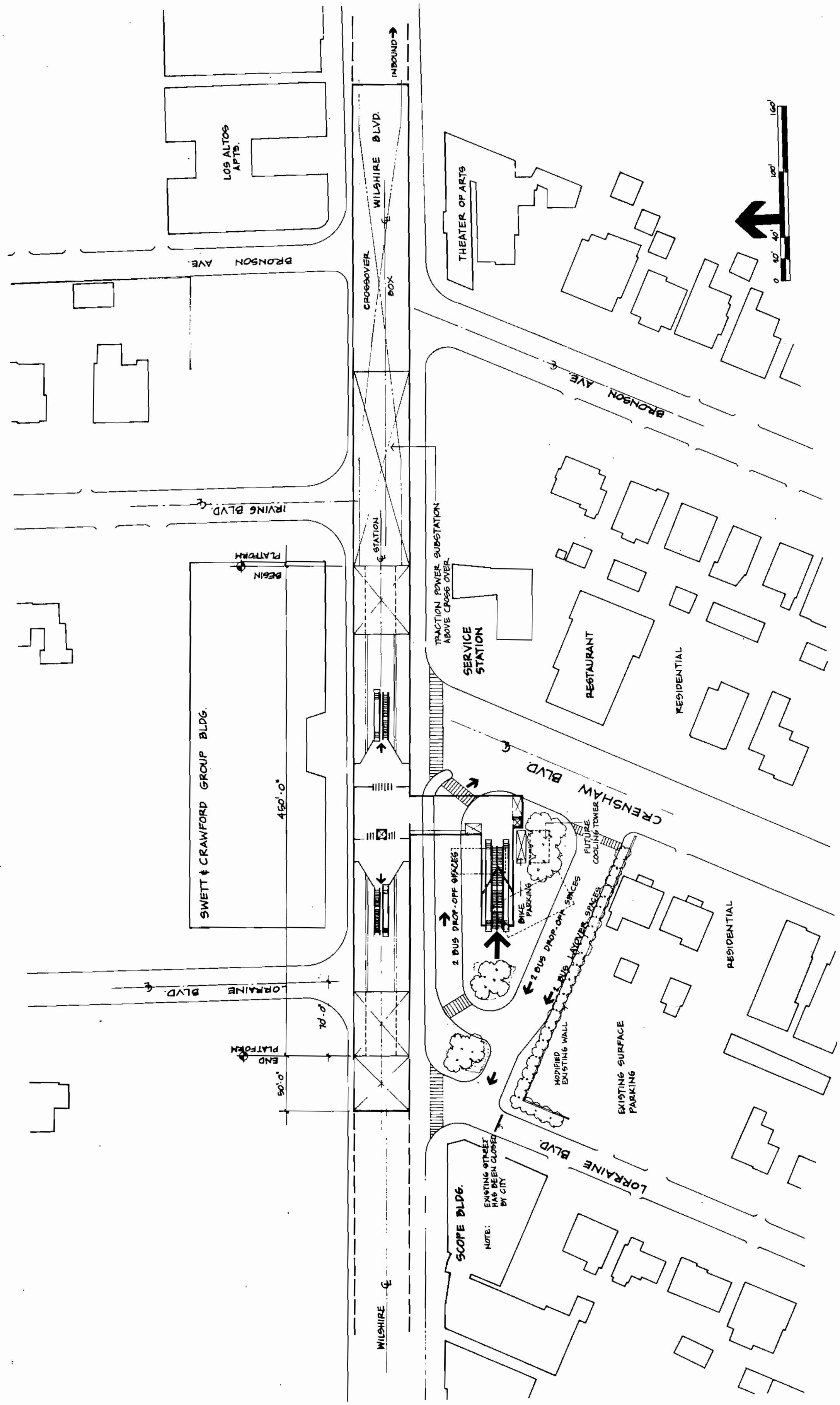


FIGURE 5-11
Wilshire/Crenshaw Station

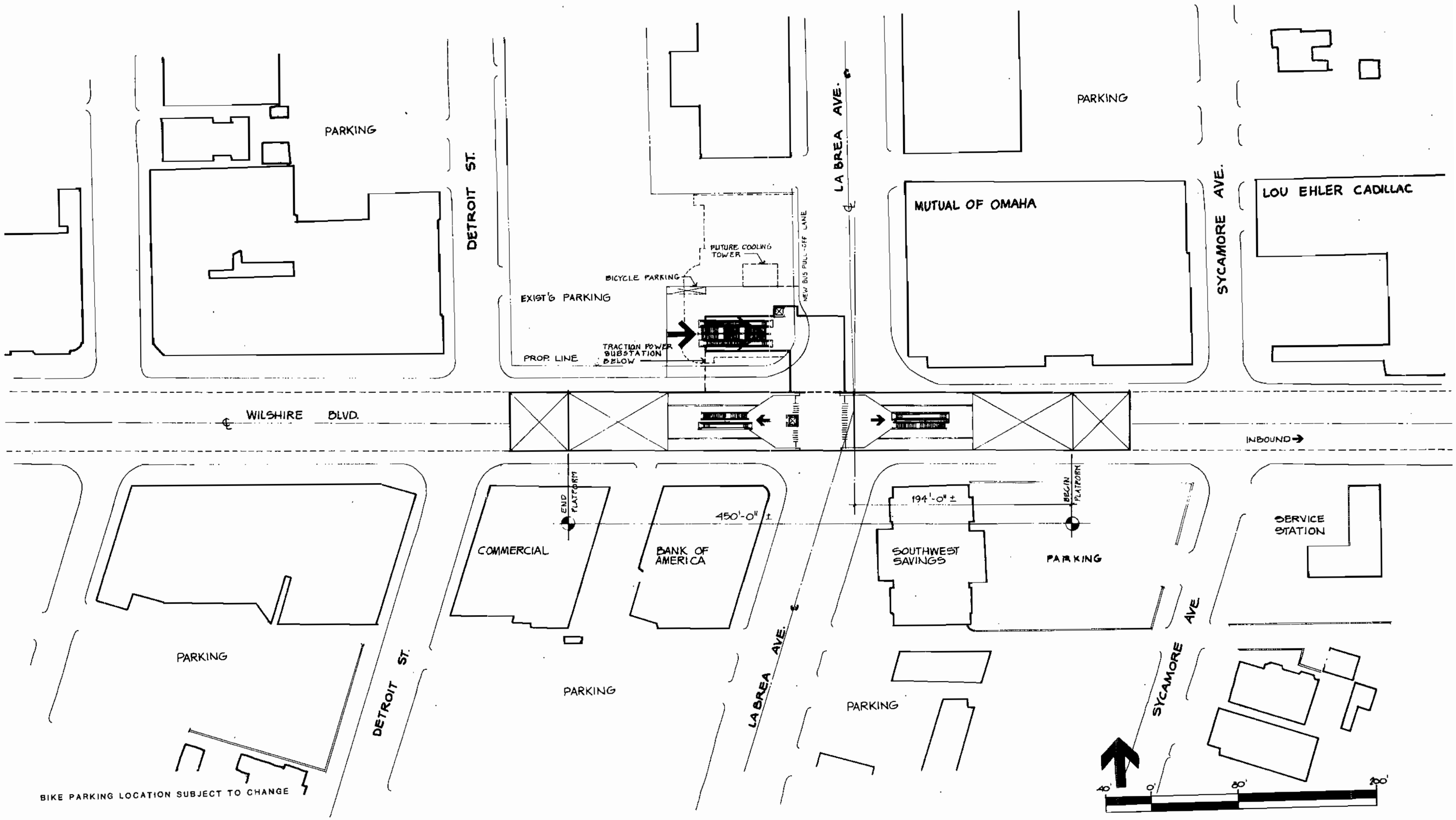


FIGURE 5-12
Wilshire/La Brea Station

occupied by low-rise commercial structures and surface parking. The entrnce will be parallel to Wilshire Boulevard and will lead to a center mezzanine. A bus pull-off lane is proposed for the west side of La Brea Avenue adjacent to the station entrance.

Ancillary space will be provided at each end of the station, and a traction power substation will be constructed below the station entrance.

Wilshire/Fairfax Station

The Wilshire/Fairfax Station will be located at an off-street site to the north and east of the intersection of Wilshire Boulevard and Fairfax Avenue (see Figure 5-13). The surrounding area is heavily residential and also contains such major public attractions as the Los Angeles County Museum of Art, the Rancho La Brea Tar Pits, and the Page Museum of Natural History. The residential areas comprise high-rise, multi-family, and single-family housing.

The Wilshire/Fairfax Station will be located under property currently owned and occupied by the May Company. In October 1983, SCRTD and the May Company concluded an agreement for joint development of the site, under the terms of which the May Company will provide the property interests and other considerations necessary to construct the station and allow its functional use. The May Company is currently preparing alternative development plans for the site; these will probably involve both above- and below-ground shopping areas and connections to the station.

As the westernmost station on the Wilshire corridor, the Wilshire/Fairfax Station will be a major reception point for patrons arriving by auto and bus from the south and west. Metro Rail parking for 175 autos will be available in a new parking structure to be constructed by the May Company, and bus pull-off lanes will be provided on all four sides of the site.

The station will have an entrance and mezzanine at each end, with one entrance oriented to the northwest and the other to the southeast. In order to minimize the length of the rail alignment, the station will not have a center platform but will instead have two side platforms, one stacked over the other. Ancillary space will be provided at each end of the station, and a traction power substation will be located at the mezzanine level at the northeast end of the station. The station has been designed to permit the construction of extensions of Metro Rail to the west at some future date.

Fairfax/Beverly Station

The Fairfax/Beverly Station will be located off-street on a north-south axis about 100 feet east of and parallel to Fairfax Avenue (see Figure 5-14). The north end of the station will be located just south of Beverly Boulevard. The proposed station

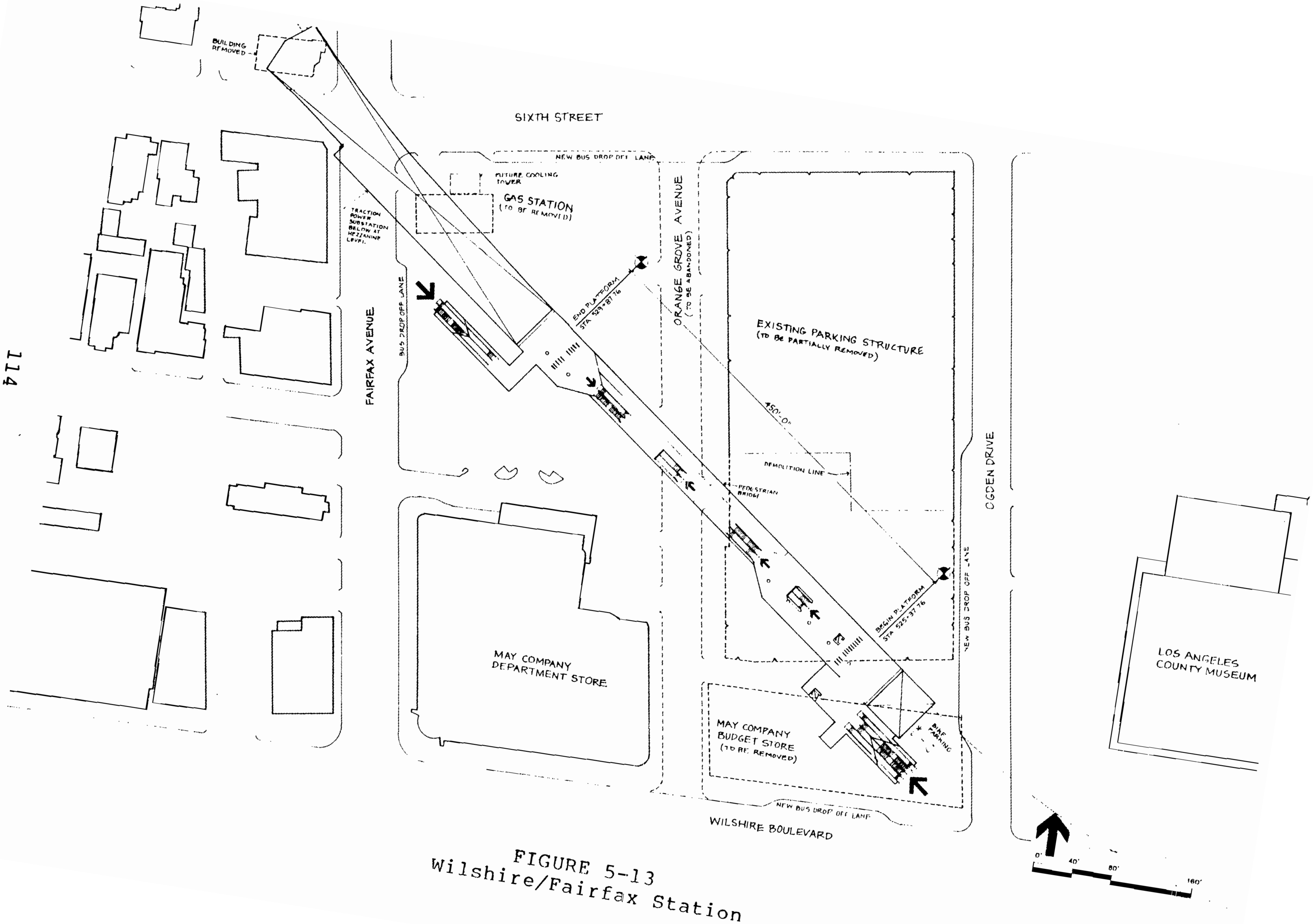


FIGURE 5-13
Wilshire/Fairfax Station

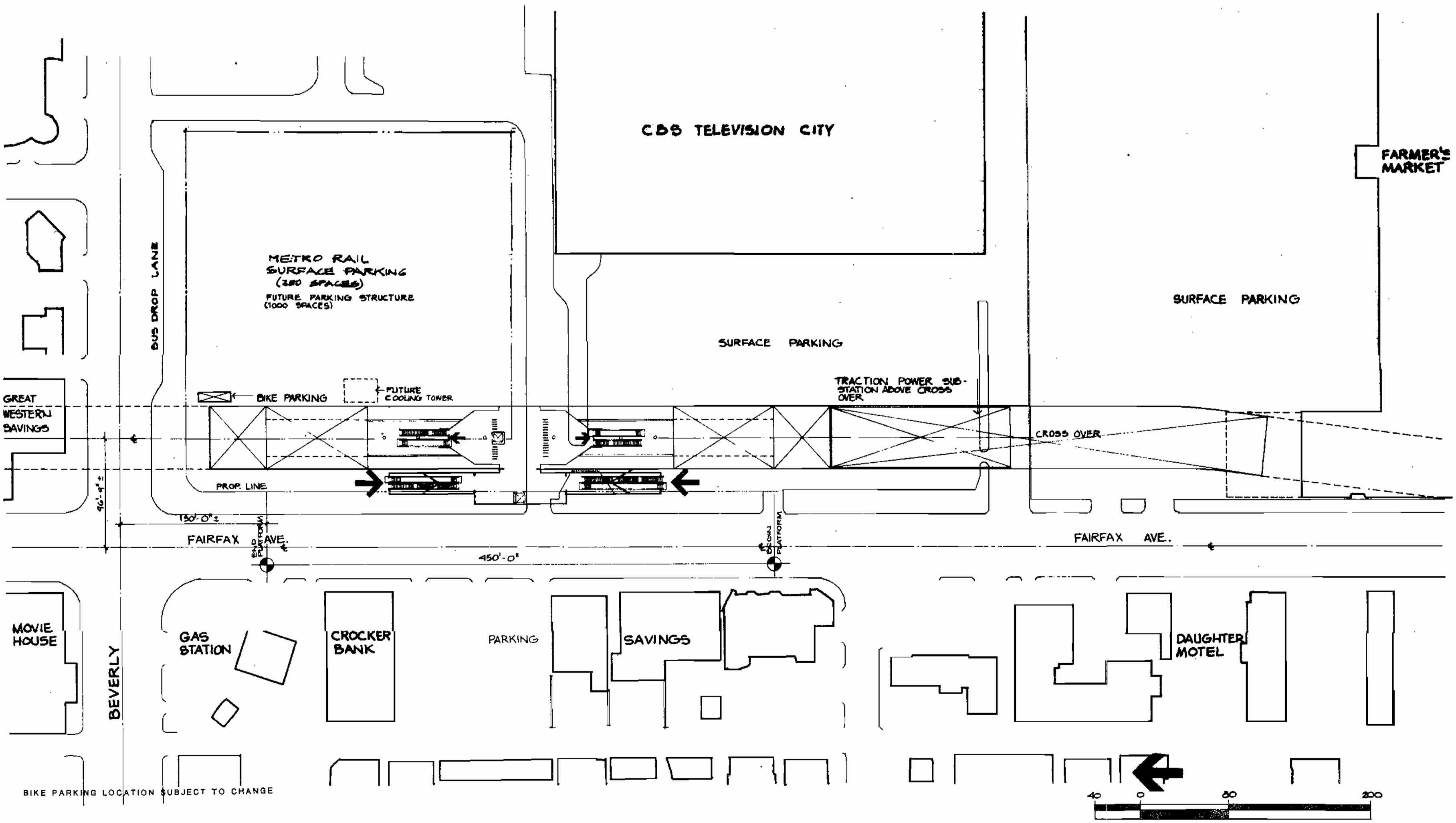


FIGURE 5-14
Fairfax/Beverly Station

site is currently a parking lot for CBS Television City. At the south end of the station is the Farmers Market, a historic landmark and major tourist and retail attraction. Other land use in the area includes retail, commercial, and mixed-use development along Fairfax and Beverly, with an immediate shift to residential housing on other streets. West of the station, the area is primarily low-density, single-family residences; to the east are medium- and high-density apartments. Pedestrian activity is high throughout the area, particularly during the day.

The station is planned with two entrances, each parallel to Fairfax, one oriented to Beverly and the other to the south. The two entrances will provide access to a single center mezzanine. Ancillary space will be provided at each end of the station. A double crossover track will be located at the south end of the station, and a traction power substation will be constructed above the crossover track.

A bus pull-off lane will be located on the south side of Beverly Boulevard just east of Fairfax for bus lines serving Beverly and for a possible neighborhood shuttle bus. A Metro Rail parking area will be located adjacent to the bus pull-off lane. Initially, space for 250 autos will be provided in a surface park-and-ride area, which will also handle the demand for kiss-and-ride parking. Construction of a parking structure with space for 1,000 autos will be considered at a future date.

Fairfax/Santa Monica Station

The Fairfax/Santa Monica Station will be located under Fairfax Avenue between Romaine and Norton Streets (see Figure 5-15). The areas off the major streets are primarily residential, while the major streets have primarily low-rise, storefront retail and small neighborhood shopping centers.

Most patrons will arrive at the station either on foot or by bus. Buses will primarily arrive from and depart to the west, and some routes will terminate at the station. The planned single entrance to this station will be located at the southwest corner of the intersection of Fairfax and Santa Monica, and bus pull-off lanes will be located on the north and south sides of Santa Monica. Locating the entrance on this corner will require demolition of existing commercial buildings. However, the resulting clear area will enhance the development potential of the site. Construction of additional station entrances will be possible on the other corners of Fairfax and Santa Monica if warranted in the future.

A single center mezzanine will provide sufficient space for the projected moderate patronage demand. Ancillary space will be provided at each end of the station, and a traction power substation will be located below grade over the ancillary space at the north end of the station.

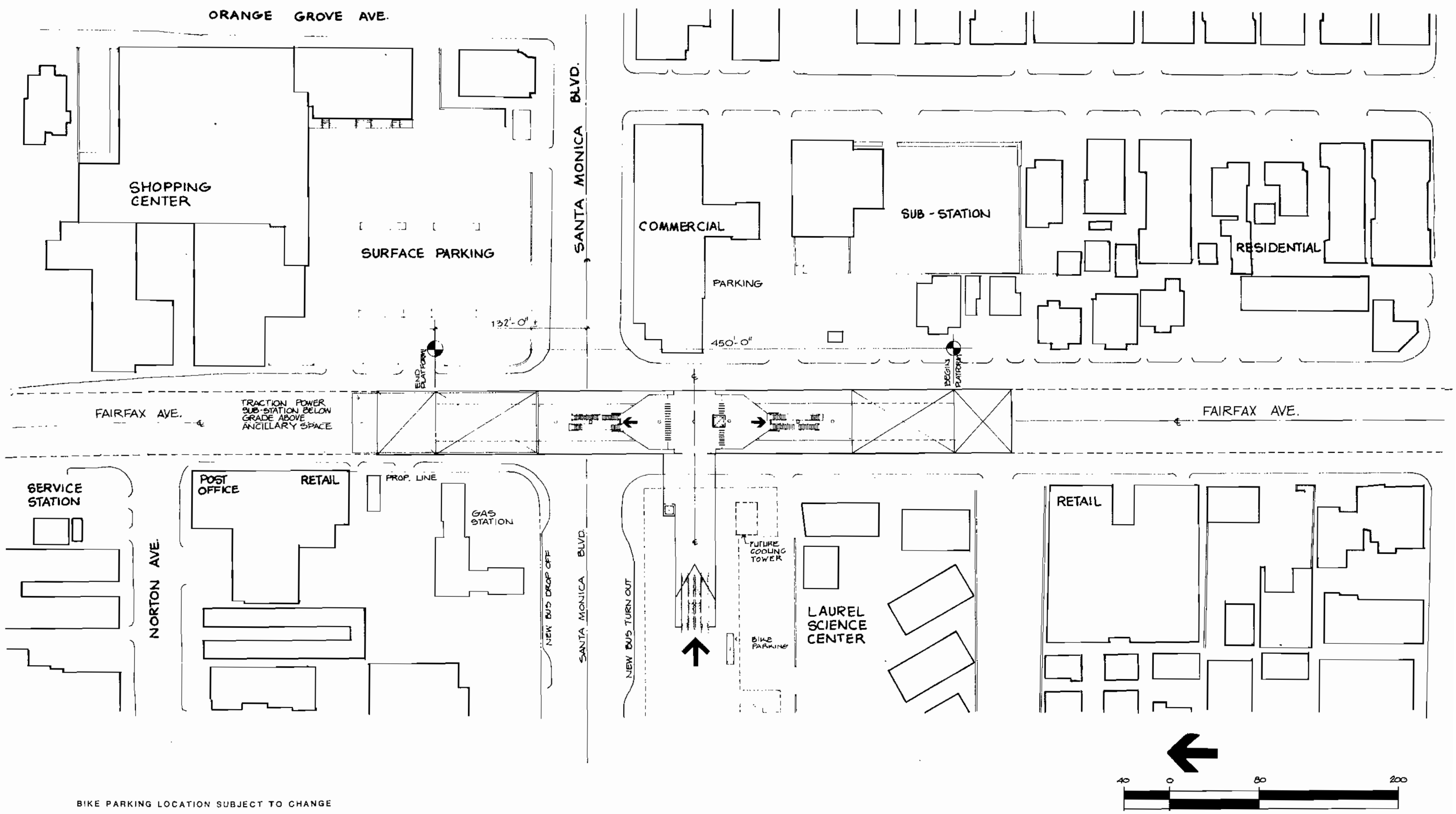


FIGURE 5-15
Fairfax/Santa Monica Station

La Brea/Sunset Station

The La Brea/Sunset Station will be located under Sunset Boulevard between Formosa and La Brea Avenues (see Figure 5-16). The station area is characterized by mixed-use development. The major streets, Sunset and La Brea, have low-rise commercial facilities. The residential areas in the vicinity of the major streets are primarily single-family homes. Hollywood High School is located nearby. A Safeway Supermarket is located on the southeast corner of La Brea and Sunset; service stations are on the southwest and northeast corners; and a Tiny Naylor's Restaurant is on the northwest corner.

The expected level of patronage at this station is among the lowest on the system. The station will therefore have a single mezzanine and a single entrance, to be located on the southwest corner of the intersection of Sunset and La Brea. Construction of the entrance will require removal of an existing service station, but the site will have enhanced development potential.

Ancillary space will be located at each end of the station. The required traction power substation will be located at ground level immediately to the south of the station entrance.

Hollywood/Cahuenga Station

The Hollywood/Cahuenga Station will be located off-street on a north-south alignment along the west side of Cahuenga Boulevard between Hollywood Boulevard and Yucca Street (see Figure 5-17). The station area is in the commercial center of Hollywood. Along Hollywood Boulevard there are low- and medium-rise commercial developments, with theaters, restaurants, and other places of entertainment. The Hollywood Pacific Theater and other vintage buildings are located nearby. A mixture of commercial and retail buildings is located on Cahuenga Boulevard. Moderate- to high-density residential areas are located north of Hollywood Boulevard and west of Cahuenga.

In addition to passengers whose destination is the station area, many users of this station will transfer to buses running on Hollywood Boulevard. Some bus lines will terminate at the station, and others will continue in service. Given the expected levels of pedestrian and bus movements, the station has been planned with two entrances, connecting to a center mezzanine. The entrances will be located on the northwest and southwest corners of Hollywood and Cahuenga. An area immediately to the south of the station is planned as a bus turnaround and layover area. A 99-space kiss-and-ride facility will be located at the southwest corner of Cahuenga Boulevard and Yucca Street.

A pocket track will be located at the north end of the station. Both the station and the pocket track will be constructed by the cut-and-cover method, necessitating the removal of most of the existing structures on the west side of Cahuenga Boulevard

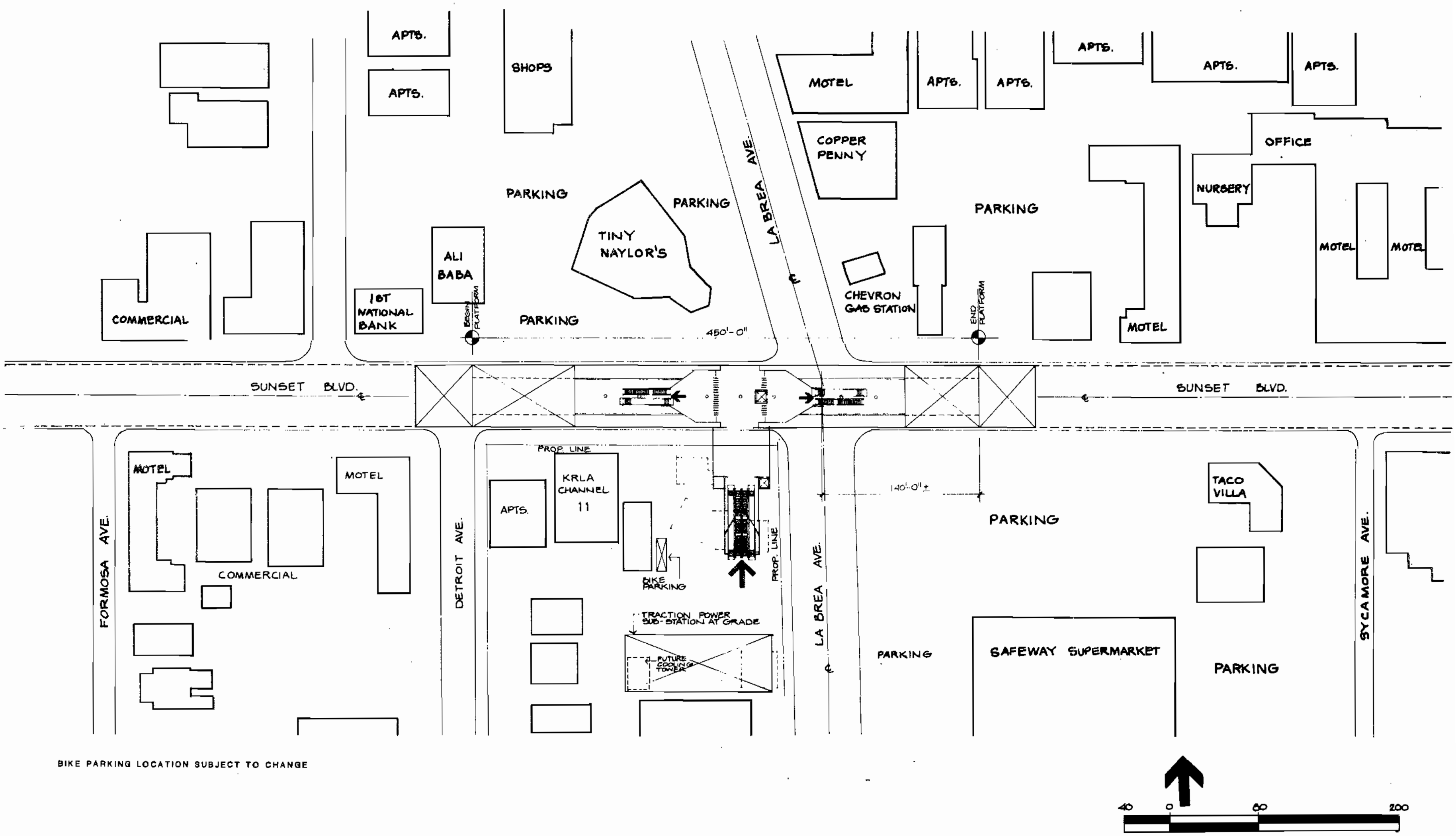


FIGURE 5-16
La Brea/Sunset Station

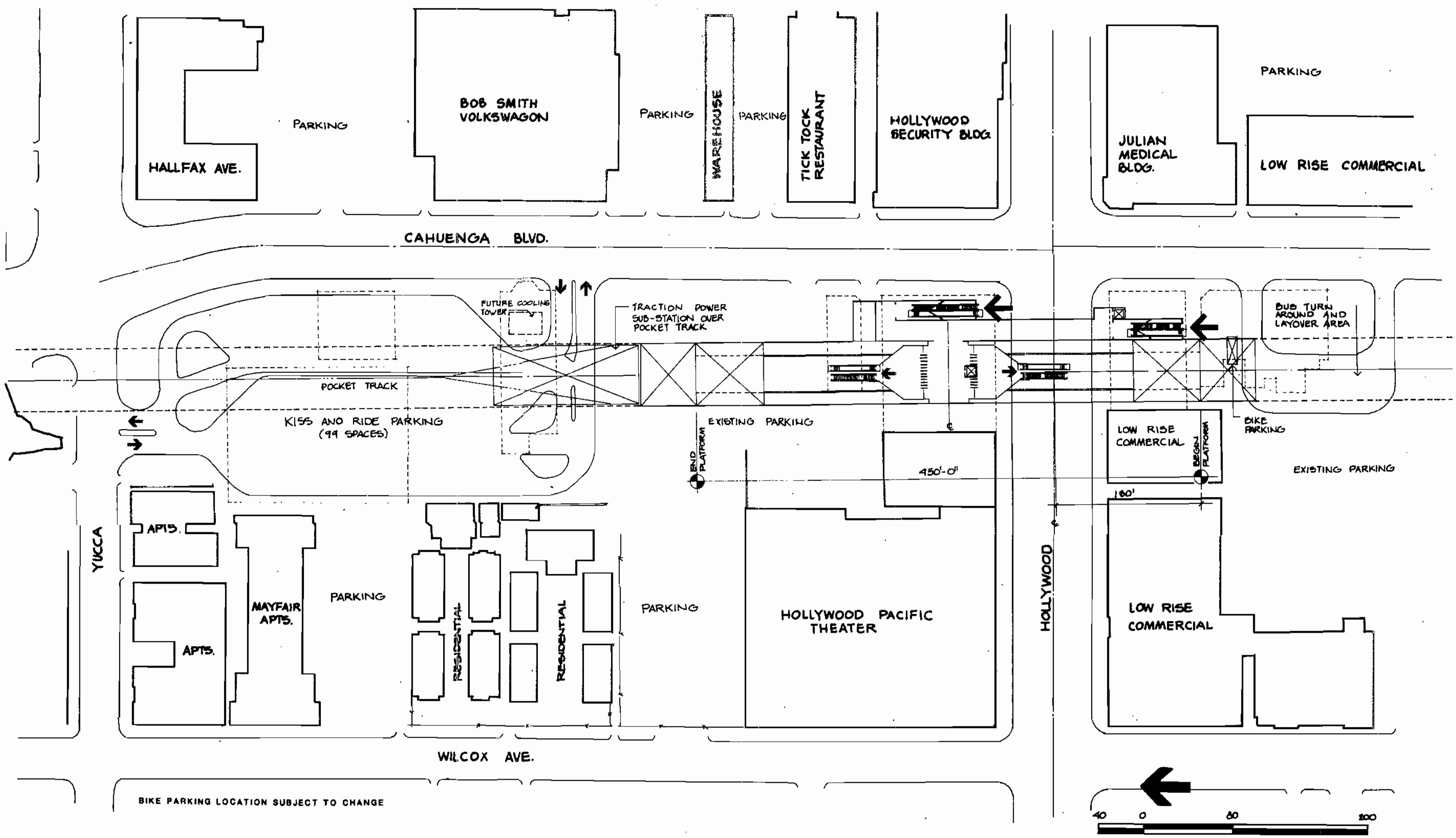


FIGURE 5-17
Hollywood/Cahuenga Station

between Hollywood and Yucca. The area adjacent to the station entrances will be available for new development after station construction is complete. The off-street location of the station will reduce construction-related impacts that normally hinder traffic.

Ancillary space will be provided at each end of the station, and a traction power substation will be located below grade over the pocket track.

Hollywood Bowl Station

The Hollywood Bowl--an open-air amphitheater--is a major entertainment center attracting large audiences for performances presented during an 11-week season. In the 1982 season, 77 performances were given, with a total attendance of 715,000 persons. The Ford Theater, a sister facility to the Hollywood Bowl, is located on the east side of the Hollywood Freeway. Attendance at Ford Theater performances totaled 52,000 in 1982. The area to the north of the Hollywood Bowl is Los Angeles County parkland. The surrounding developed areas are a mix of low- and medium-density residential land uses.

Although patronage for the Hollywood Bowl Station (see Figure 5-18) is expected to be the lowest on the system, the peak-hour patronage during Bowl events may be quite high. Because it would be very expensive to construct a station with sufficient space below ground to hold peak-period crowds, it is planned that admission into the at-grade station entrance will be manually metered after performances to prevent overload of the mezzanine and platform.

For the convenience of transit patrons, the station entrance will be located close to the entrance to the Bowl, adjacent to the ticket offices. The entrance will be oriented to have the least conflict with the pedestrian flow of non-Metro Rail users and will connect to a center mezzanine. Passengers will be able to access the station platform from either end of the mezzanine, a configuration that both maximizes the passenger-handling capacity of the mezzanine and promotes a more even distribution of passengers along the platform. Ancillary space will be provided at each end of the station, and a traction power substation will be located below grade over the ancillary space at the north end of the station.

Because the provision of transit-related park-and-ride, kiss-and-ride, and bus facilities might conflict with the use of the area for Bowl activities, none is presently planned.

(In accordance with the decision of the SCRTD Board of Directors, the design of the Hollywood Bowl Station will continue until it reaches a 50 percent level of completion, but remaining design work and construction will be deferred pending the identification of a source of construction funds.)

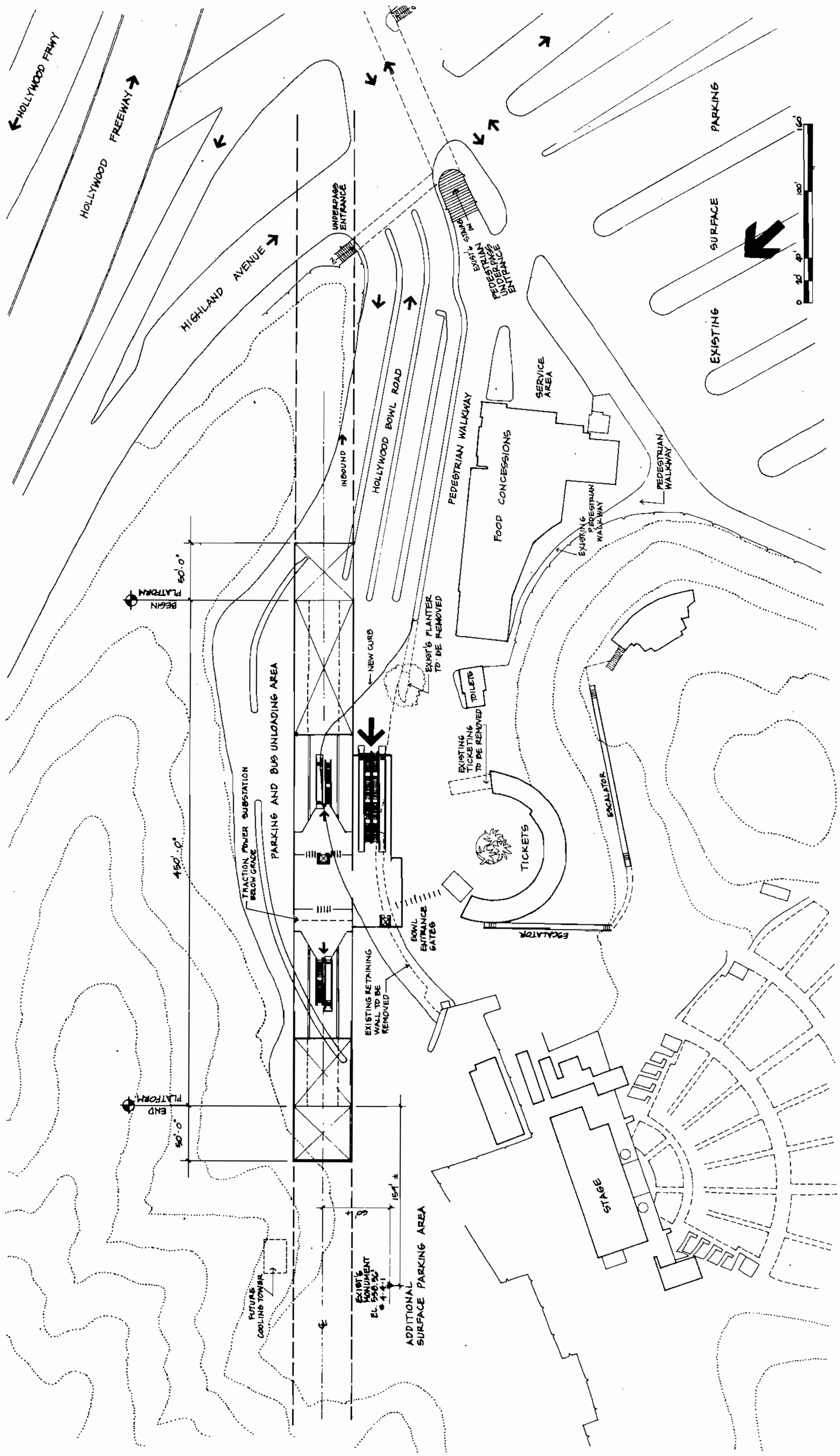


FIGURE 5-18
Hollywood Bowl Station

Universal City Station

The Universal City Station will be located off-street in an area bounded by Lankershim Boulevard on the east, Universal Place on the south, and Bluffside Drive on the west and north (see Figures 5-19 and 5-20). MCA World Headquarters and Universal Studios are located immediately to the east. Areas to the west are either residential or parkland. The Campo de Cahuenga, a historic landmark park, is located within the station site boundaries. The Hewlett-Packard Company, which currently occupies a facility in the station area, is relocating to a new facility at the corner of Magnolia and Lankershim. A 36-story, 700,000-square-foot office building, headquarters for the Getty Oil Corporation, is under construction on the east side of Lankershim adjacent to the Hollywood Freeway.

The plan for the station site includes a surface parking area with 425 spaces; a 39-space kiss-and-ride area; and a bus terminal with boarding locations for seven buses and layover capacity for ten buses. (Construction of a parking structure will be considered at a future date, with plans calling for a future maximum of 2,500 parking spaces as a total for all sites in the station area.) Vehicular access to the site will be enhanced by construction of an overpass over the Hollywood Freeway connecting the station site to Vineland Avenue. This will involve a new street parallel to, but separate from, Bluffside Drive on the north side of the freeway. Universal Place will become a one-way northbound street. Retaining the integrity of the Campo de Cahuenga will be of special concern. All structures in the station area other than the Campo de Cahuenga will be removed. The areas around the station entrance and vehicular access areas will be landscaped to provide a parklike setting and enhance the surrounding neighborhood. The landscaping will include setbacks, berms, and appropriate plantings.

The existing SCRTD park-and-ride lot west of the Hollywood Freeway and the site between the new access road and Ventura Boulevard, east of Vineland Avenue, will provide 750 additional surface parking spaces. Buses using the new road to arrive at or depart from the station will pick up and discharge patrons at these surface lots, thus providing a shuttle service to the station.

The single entrance planned for this station will serve both the bus terminal and the parking area. Ancillary space will be provided at each end of the station, and a traction power substation will be located below grade over the train room.

North Hollywood Station

The North Hollywood Station will be located under Lankershim Boulevard spanning Chandler Boulevard (see Figure 5-21). The area around the station has a mixture of land uses. The Burbank Line of the Southern Pacific Railroad runs within the wide median

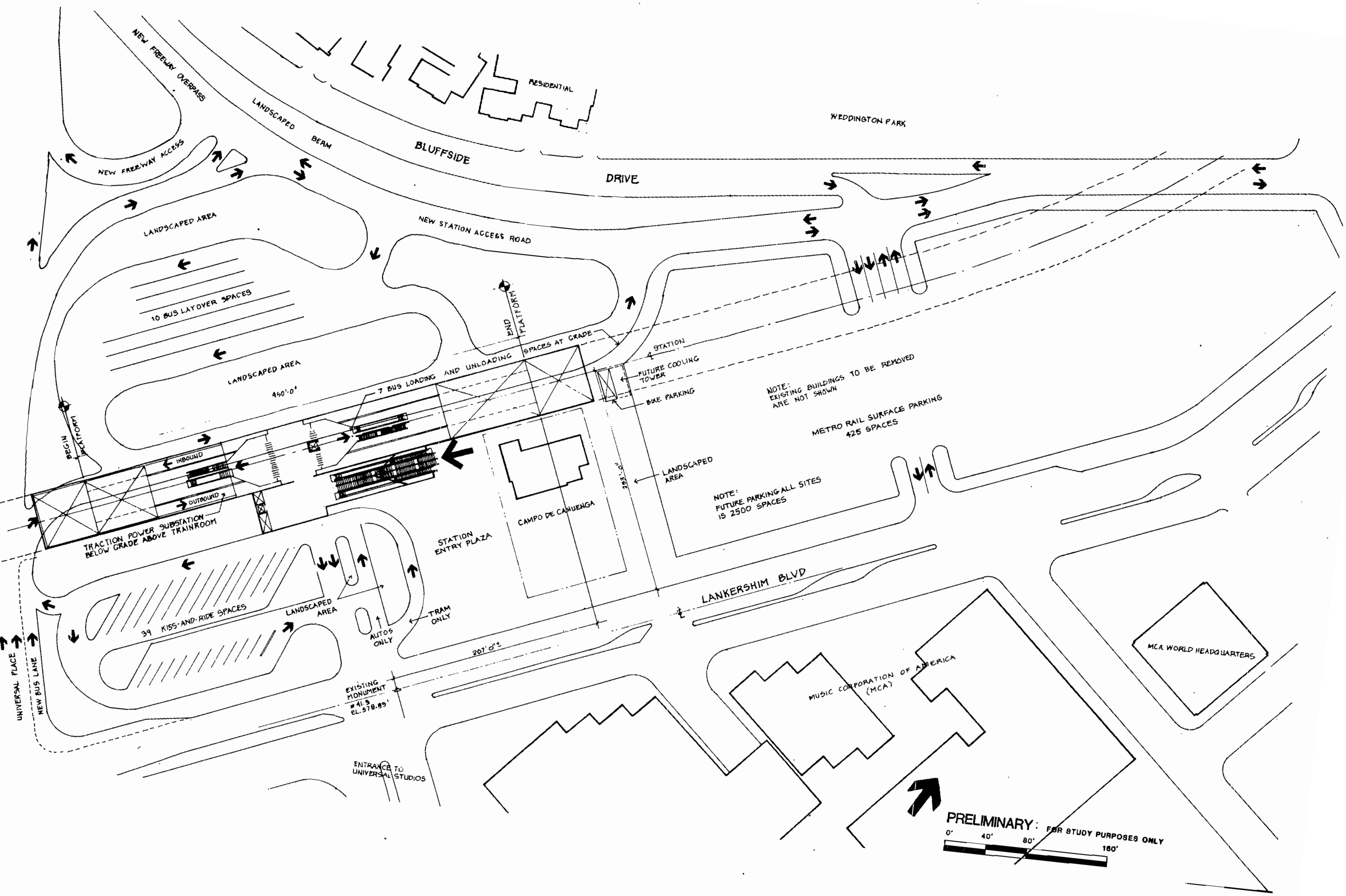


FIGURE 5-19
Universal City Station

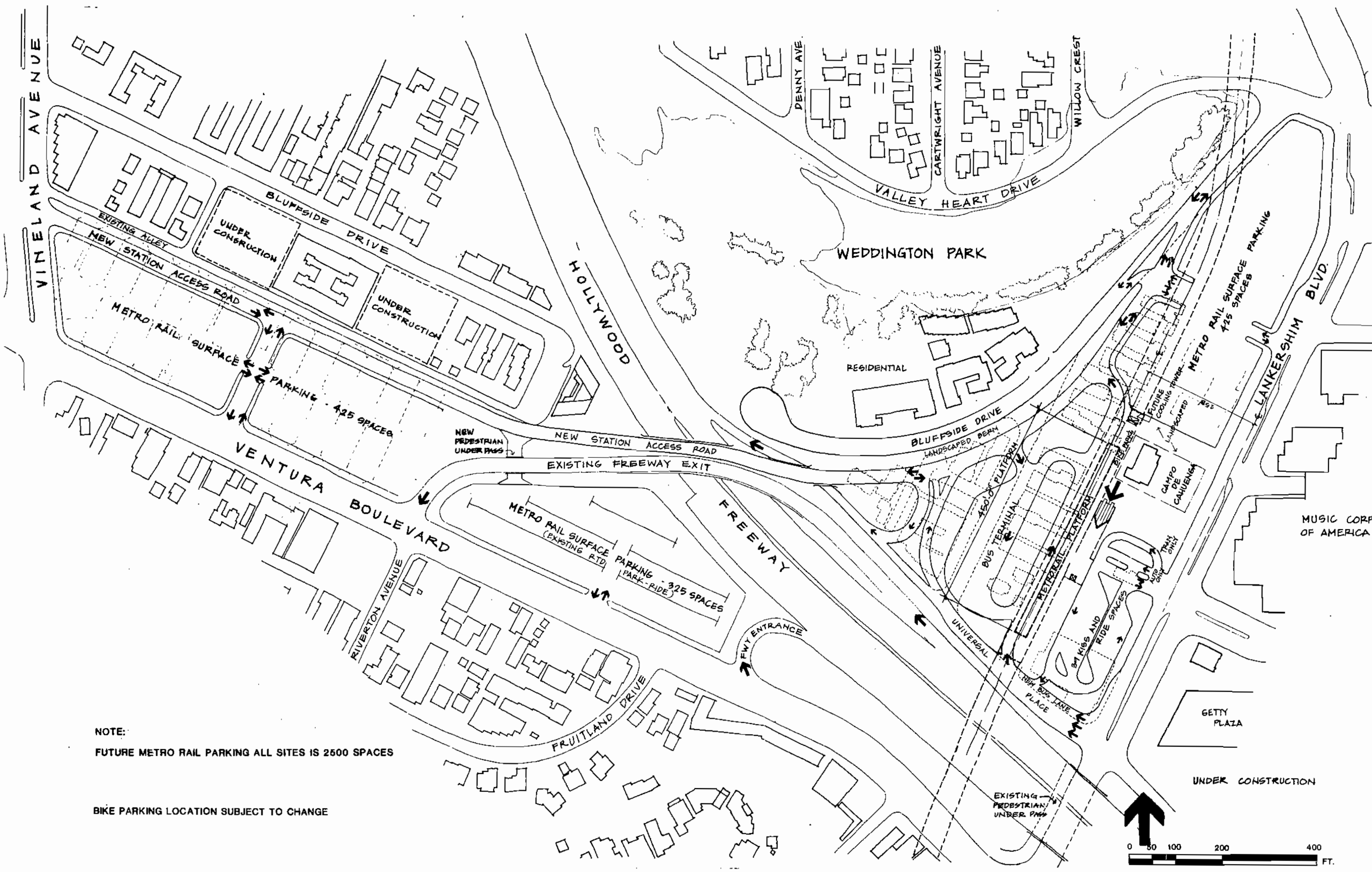


FIGURE 5-20
Universal City Station - Overall Site Development

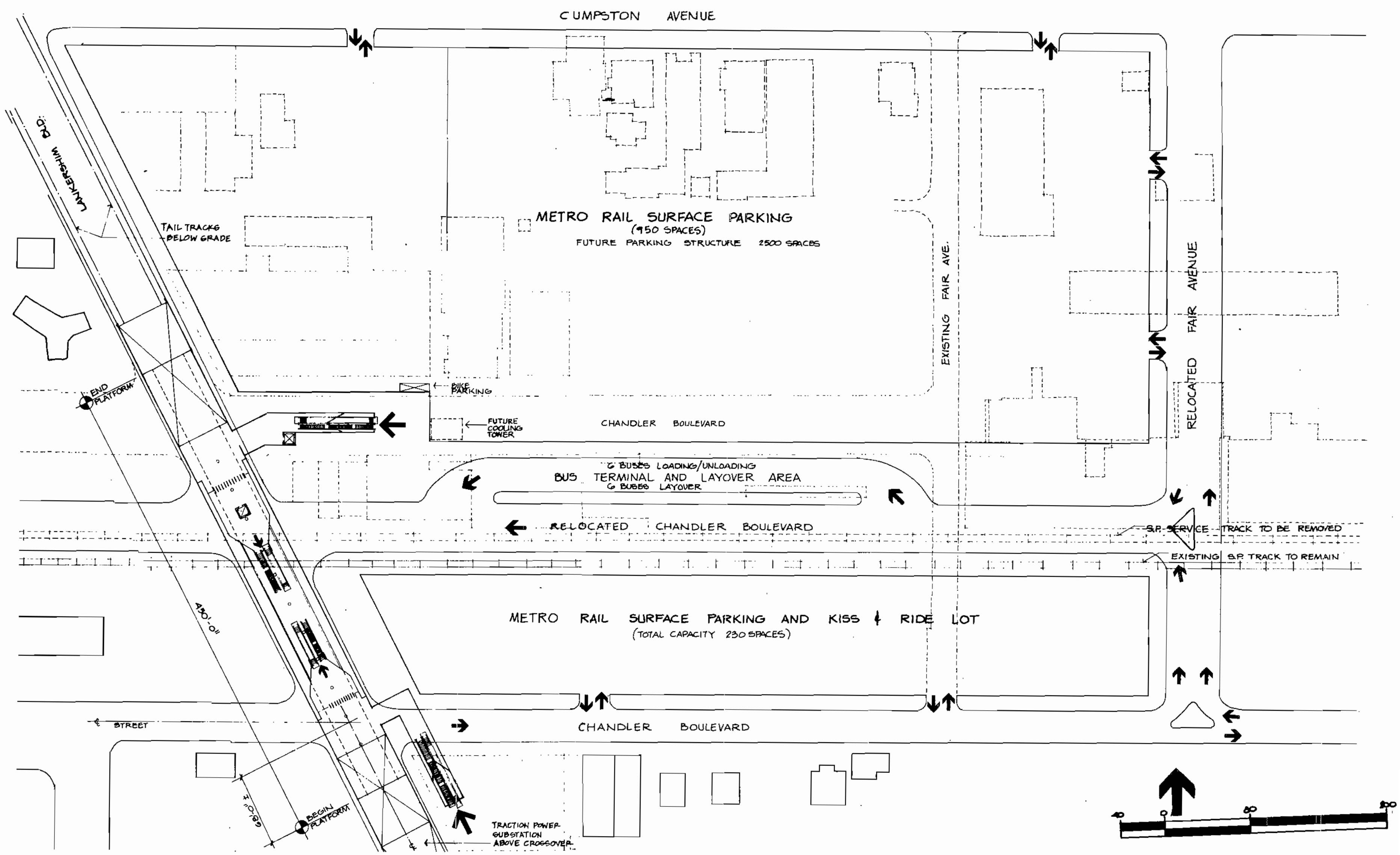


FIGURE 5-21
North Hollywood Station

divider of Chandler Boulevard. Auto dealerships are located along Lankershim to the north. Low-rise commercial/retail space predominates along Lankershim Boulevard to the south. The area along Chandler is used for industry and warehousing. An office/ warehouse facility extending westward from Tujunga along the north side of Chandler was recently completed. A number of buildings of historical and architectural interest are located in this immediate area. The station lies within the boundaries of the North Hollywood Redevelopment Area. The first three phases of redevelopment are planned for the area south of Chandler and east of Lankershim. Land use to the north and east of the station is residential.

The plan for the station site includes surface parking for 1,180 autos, with possible future construction of a 2,500-space parking structure. The main parking site will be bounded by Fair and Cumpston Avenues and Lankershim and Chandler Boulevards. To accommodate this parking area, Fair Avenue will be relocated to the east, and the North Chandler right-of-way will be relocated to the south. The future parking structure will be set back to permit commercial/retail development along Lankershim. A bus terminal facility, including a layover area, will be located on the north side of the relocated North Chandler Boulevard. A 230-space park-and-ride and kiss-and-ride facility will be located in the median between the Southern Pacific tracks and the South Chandler right-of-way.

To serve both the development area and the surface parking area, the station has been planned with two entrances and two mezzanines. One entrance will be located to the northeast of the intersection of Lankershim and the relocated North Chandler right-of-way; the other entrance will be located on the southeast corner of the intersection of Lankershim and the South Chandler right-of-way. The design of the station will permit additional entrances to be constructed in the future on the west side of Lankershim.

A double crossover track will be located at the south end of the station, and two tail tracks will be constructed at the north end. The station, tail tracks, and crossover track areas will all be constructed by the cut-and-cover method. A traction power substation will be located below grade over the crossover track.

6. MAIN YARD AND SHOPS

6. MAIN YARD AND SHOPS

The main yard and shops comprise the facilities required to store, clean, and maintain Metro Rail transit vehicles and to provide maintenance to the system's physical plant and equipment. These storage and maintenance facilities, which are illustrated in Figure 6-1, will be located east of the central business district of Los Angeles on a site of approximately 40 acres. The site will extend from the Santa Ana Freeway on the north to about 1,100 feet south of the 6th Street Bridge, and will be bounded on the east by the Los Angeles River and on the west by Santa Fe Avenue (see Figure 6-2).

Transit vehicles will enter the main yard from Metro Rail's Union Station. The main body of the yard will consist of the storage yard for Metro Rail transit vehicles. Other facilities at the yard will include a main shop building for vehicle maintenance, vehicle cleaning and washing facilities, and a maintenance-of-way shop. The Milestone 10 Report presented detailed information on the layout and facilities of the main yard and shops; these have been refined slightly for cost-reduction reasons, as follows:

- The capacity of the storage yard has been reduced from 214 to 170 vehicles.

- The capacity of the service and inspection area of the main shop has been reduced from 18 to 16 vehicles.

The yard and shops area will nevertheless remain able to accommodate the fleet of vehicles needed to operate the 18-mile Metro Rail system at maximum capacity, now estimated at 198 vehicles. The storage area for 170 vehicles will be supplemented by the tail tracks and station at North Hollywood, which will be used to store an estimated 24 vehicles. Some of the 198 vehicles will be in maintenance and thus will not require storage; an estimated maximum of 24 vehicles will be in maintenance at any one time, and the main shop retains sufficient capacity to handle this demand.

STORAGE YARD

The storage yard will contain tracks for various train operation functions, including train make-up, dispatch to and receipt from revenue service, and train and vehicle storage. This yard will also provide for the movement of trains to and from the various maintenance and cleaning facilities.

There will be a Metro Rail-Santa Fe Railway connecting track at the south end of the yard. This track will provide a direct rail connection between the national railroad network and Metro Rail.

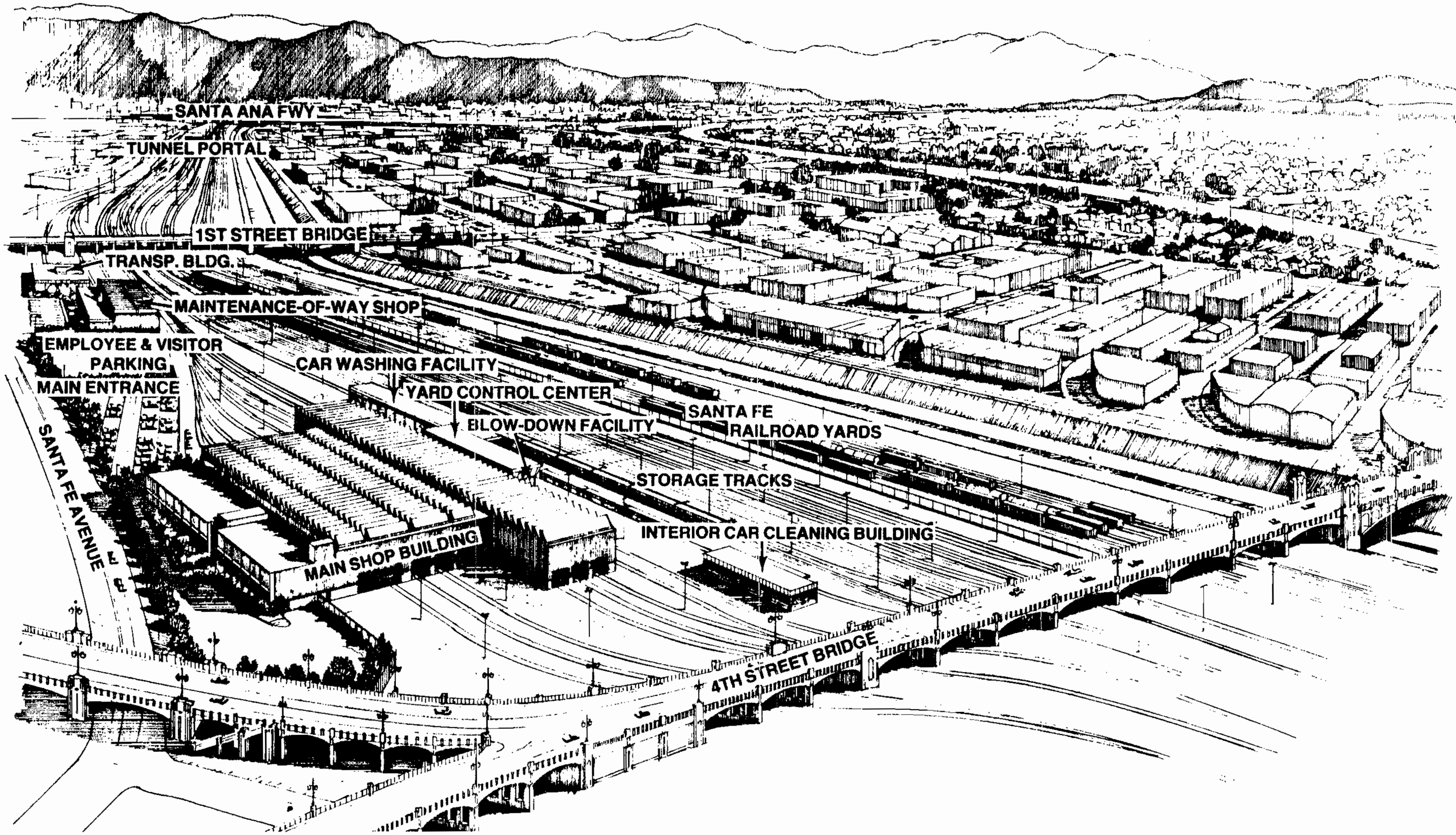


FIGURE 6-1
Northeast View of Main Yard and Shops

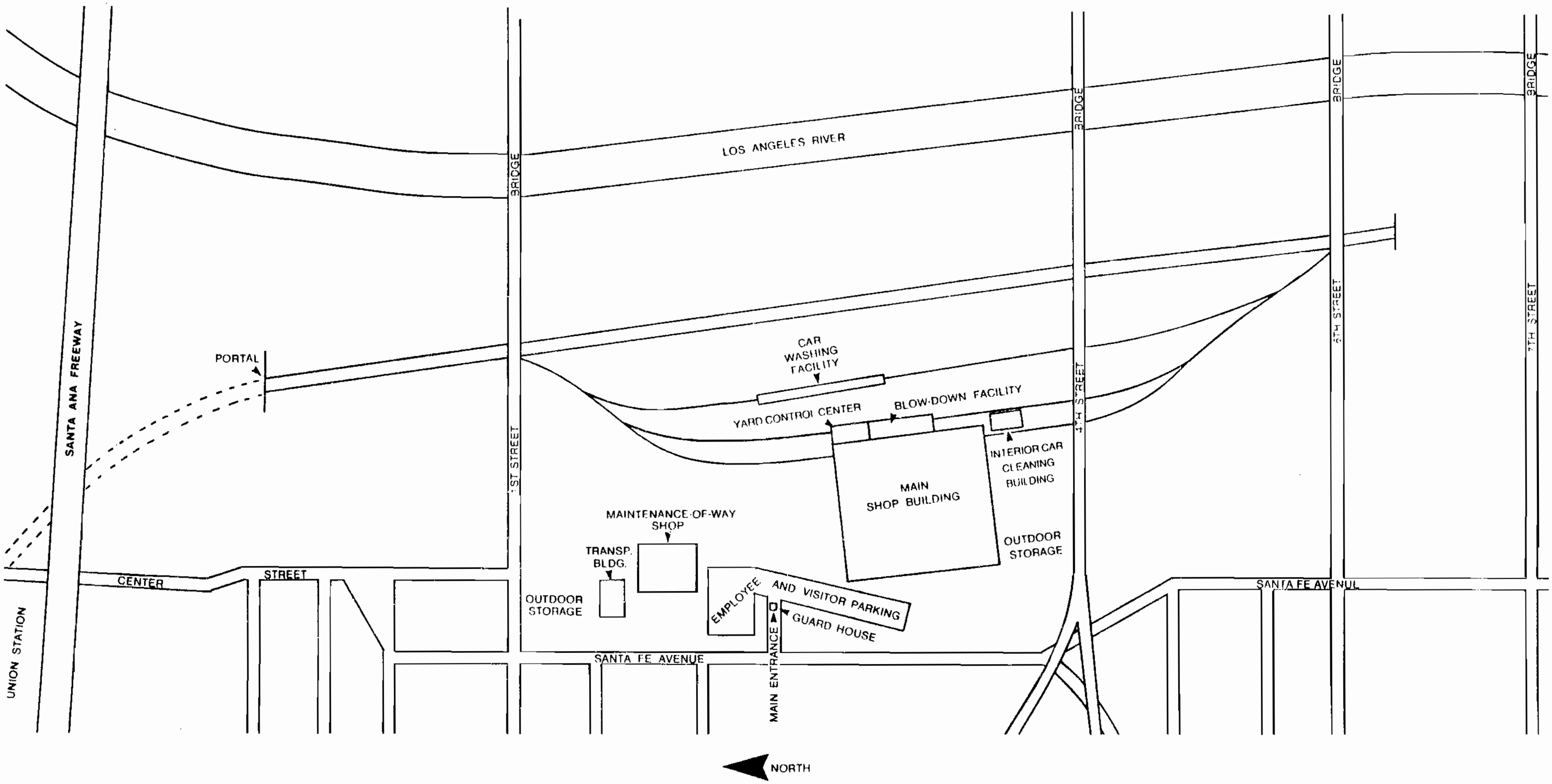


FIGURE 6-2
Yard and Shop Facilities

It is expected that the system's passenger vehicles will be delivered from the manufacturer over this track.

The yard will include 10 storage tracks, providing a total yard capacity of approximately 170 vehicles. The spacing between each set of tracks will alternate from 14 feet to 19 feet to provide easy access to the vehicles. Transit vehicles will be able to enter the storage yard from either end to facilitate train movement.

MAIN SHOP BUILDING

The largest facility within the Metro Rail yard will be the main shop building, where vehicle maintenance will take place. This will be a single structure with separate areas designated for routine service and inspections of Metro Rail cars and for heavy repairs to the vehicles, as indicated in Figure 6-3. Routine service and inspection functions will be relatively short-term activities, such as safety inspection, lubrication, light bulb replacement, filter and brake pad changes, and light repairs. Heavy repair functions will involve longer term operations, such as major equipment overhauls, wheel grinding and trueing, and damage repairs.

Rail access will be provided at either end of the main shop building. Four tracks will run through the building's service and inspection shop, each with space for four vehicles. A single pit will run under all four tracks to provide access for undercar work, and a raised walkway will span the pit.

Three tracks will run through the building's heavy repair shop; of these, two will each have repair space for four vehicles, and one will have repair space for two vehicles and a wheel-trueing area for two vehicles. This area will be equipped with overhead cranes for removal of trucks and heavy equipment, and hydraulic hoists for undercar work.

The main shop building will also contain shops for servicing, testing, and repairing assemblies, modules, and components of the vehicles as well as of fare collection, traction power, train control, and communications equipment. In addition, inspections of new parts will take place in these shops. The building will also contain office and administrative areas, employee facilities, and equipment and component stores.

Adjacent to the main shop building will be a track through the blow-down facility. In the blow-down pit, the underside of passenger vehicles will be cleaned with compressed air before the vehicles are brought into the main shop building. The pit will be sheltered and equipped with a means of collecting airborne particles before they escape.

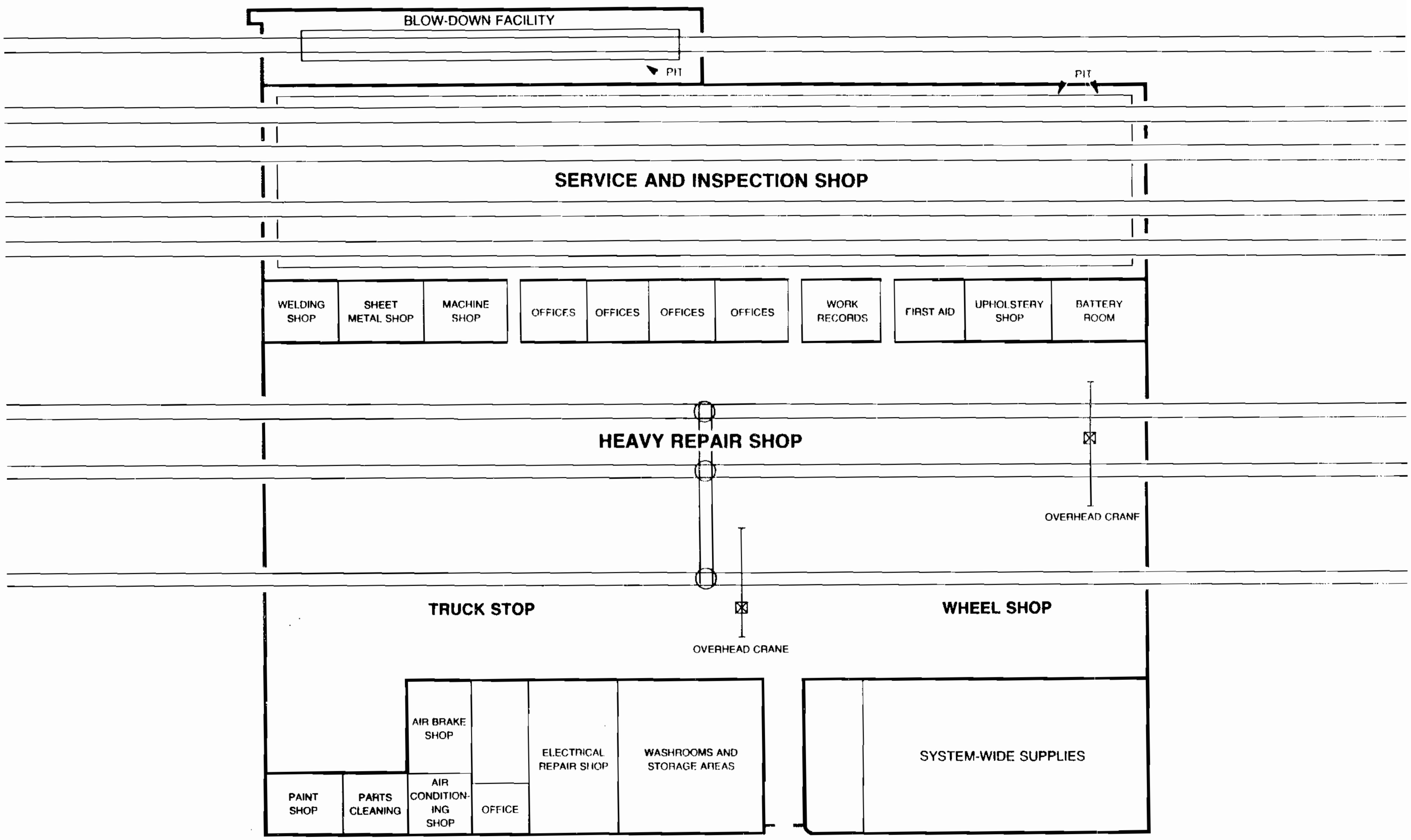


FIGURE 6-3
General Facility Layout--Main Shop Building

The yard control tower will be located above the blow-down facility, adjacent to the main shop building. This tower will be used to supervise and control train operations to, from, and within the yard area.

VEHICLE CLEANING FACILITIES

The yard and shops area will contain facilities for cleaning the exteriors and interiors of the passenger vehicles. Exterior vehicle washing will be conducted in an enclosed area located so that a train leaving the washer can proceed directly to the storage yard. This car washing facility will include equipment for the control and treatment of waste water to preserve the environment.

The interior car cleaning building will be located adjacent to the storage tracks. This will be a small, single-level industrial-type building containing storage and equipment rooms as well as office and employee facilities, and will support interior car cleaning activities in the storage yard.

MAINTENANCE-OF-WAY SHOP

The maintenance-of-way shop will be a single-story, industrial-type building containing repair and carpentry shops, equipment and component stores, employee facilities, and office and administrative areas. This facility will serve as a base for personnel responsible for maintaining the fixed facilities and the trackwork (the track structure and hardware) of the Metro Rail system. Such work will generally be performed along the line, requiring personnel to travel to the site to perform the maintenance activities. Most of the tools, equipment, and material needed for this work will be stored within the shop.

The shop will also provide a limited capability for testing such items as track switch machines, contact rail apparatus, and station and building equipment. In addition, the shop will contain provisions for maintenance and repair of auxiliary and surface vehicles.

A section of the shop will be dedicated to the repair of surface vehicles, such as patrol cars, pick-up trucks, etc.

MAINTENANCE EQUIPMENT

To support the Metro Rail system's repair and maintenance functions, as well as such other activities as security work, a variety of equipment will be needed. This maintenance and support equipment falls into four major categories:

- Auxiliary vehicles
- Support vehicles
- Fixed machinery/equipment
- Portable tools and test equipment.

Auxiliary vehicles normally ride on the rails in performing such functions as tunnel cleaning and maintenance; rerailing of vehicles; rail grinding; and towing. Metro Rail's auxiliary vehicles will include such items as locomotives, self-propelled cranes, and flat cars. These vehicles will be stored in the Metro Rail yard on the track adjacent to the maintenance-of-way shop. Further details on auxiliary vehicles are given in Chapter 7 of this report.

Support vehicles for Metro Rail's operations will include automobiles, golf-cart type personnel carriers, forklift trucks, and cranes. Vans and pick-up trucks will also be provided, some of which may be equipped with devices for use on the tracks.

Maintenance machinery/equipment which will be permanently mounted or installed in the main shop building will include:

- Overhead cranes--to lift major components
- Truck turntables--to realign trucks off of main tracks
- Wheel trueing machine--to restore wheel profiles after wear
- Wheel press and axle lathe--for remounting wheels
- Truck hoists
- Passenger vehicle hoists.

In addition, a wide range of portable tools and testing devices will be required for the maintenance of vehicles and facilities. This equipment will vary in size from small hand tools to large portable jacks used to lift transit cars, and in cost and complexity will range from screwdrivers to oscilloscopes.

7. SUBSYSTEMS

7. SUBSYSTEMS

The term "subsystem" refers to the electrical, electronic, and mechanical equipment required for operation of the Metro Rail system. The major Metro Rail subsystems are:

- Passenger vehicles
- Automatic train control
- Communications
- Electric power
- Fare collection
- Auxiliary vehicles.

Many of these subsystems are integral parts of other subsystems or of other system elements; for example, passenger vehicles and train control equipment are interdependent, while fare collection equipment is housed in and influences the design of stations. However, because of the complexity and importance of the subsystems, they are most easily considered as separate items, and in this chapter each is discussed individually.

The recommended configurations for each subsystem were developed from discussions and analyses of alternatives conducted as part of the Milestone 8 process. Further refinements to the subsystems have resulted principally in a reduction in the level of automatic train operations and a concomitant increase in the train operator's control. As an example, it is now planned that Metro Rail train operators will open and close passenger vehicle doors. These changes will provide savings in project costs but will have no significant effect on the speed, capacity, or safety of the system.

PASSENGER VEHICLES

The passenger vehicle of the Metro Rail system will be a heavy rail type of car, similar to those used in Washington, D.C., Atlanta, and Baltimore and planned for use in Miami. SCRTD will thus make maximum use of the experience gained by other rail transit operators in selecting a car to meet Metro Rail performance requirements. Figure 7-1 provides an exterior view of a passenger vehicle similar to that which will be used on the Metro Rail system.

Major components of the passenger vehicle include subsystems discussed in subsequent sections of this chapter, such as communications equipment and Automatic Train Control equipment.

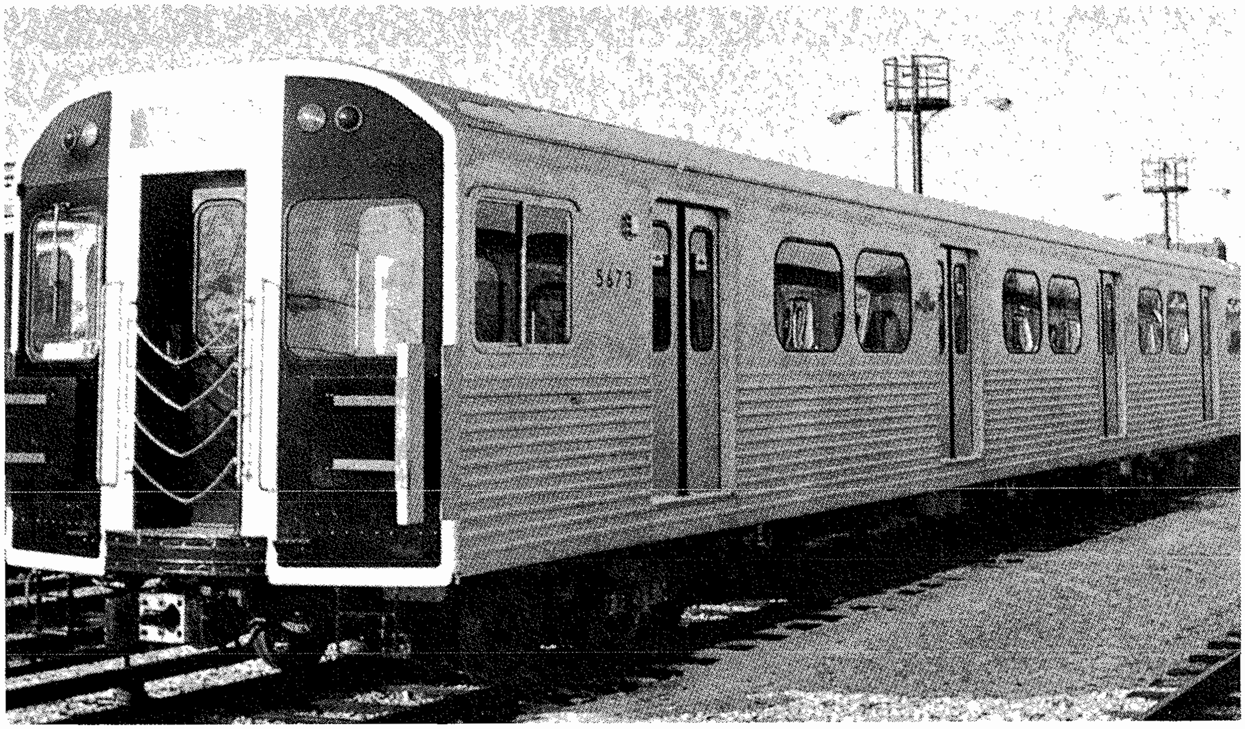


FIGURE 7-1
Typical Rail Transit Passenger Vehicle

In this section, the discussion focuses on the planned configuration of the passenger vehicle with regard to carbody, operator's cab, doors, couplers, trucks, propulsion equipment, friction brakes, auxiliary electrical power, and miscellaneous equipment.

Carbody

Stainless steel will be used in conjunction with plastics and other lightweight materials to achieve an aesthetically pleasing, fire-resistant, quiet, adequately strong structure of efficient design. The basic seating arrangement, standard for all vehicles, will ensure maximum comfort as well as efficient utilization of space. Throughout the vehicle, stanchions and handholds will be provided for the safety and convenience of passengers. Space will be provided for wheelchair patrons that is easily accessible but out of the flow of normal traffic. Priority seating for the elderly and handicapped will also be designated. Figure 7-2 shows the interior of a vehicle similar to the configuration that will be used on Metro Rail passenger cars.

Nominal vehicle dimensions will be 75 feet long, 12 feet high, and 10-1/2 feet wide. The basic operating unit will be a dependent pair of cars coupled together, with an operator's cab located at each end of the pair. The first car of this pair, known as the A-car, will contain an air compressor but will lack batteries and related equipment. The second, or B-car, will

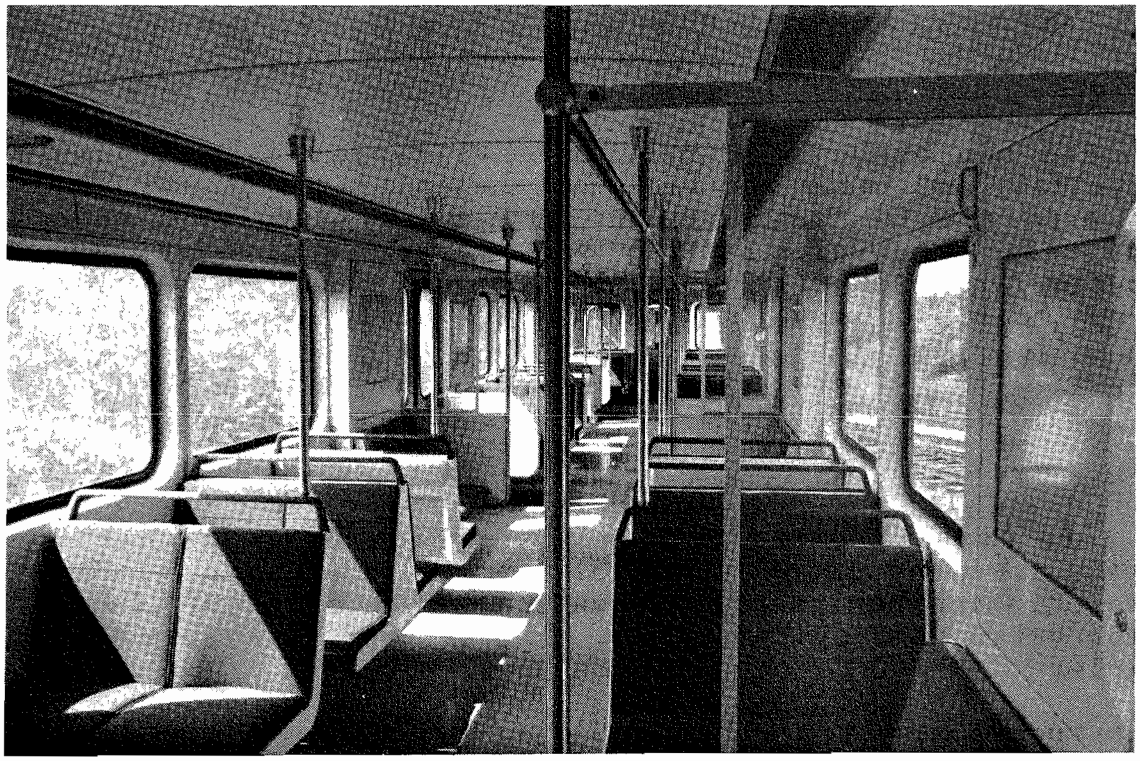


FIGURE 7-2
Typical Passenger Vehicle Interior

contain batteries but will lack an air compressor. Complete trains will operate in consists of one, two, or three dependent pairs.

Operator's Cab

Each operator's cab will contain an operator's console, communications equipment, various electrical controls, and annunciators that will display subsystem status. Functions essential to train operation will be initiated by an operator in the train's lead cab. All other operator's cabs on a train will remain locked for security.

Passenger Doors and Door Operation

Each side of the passenger vehicle will be equipped with three or four sliding doors that part in the middle and are sufficiently wide to enable rapid and orderly boarding or exiting of passengers. The precise number of doors per side will be determined during final design based on studies of patron loading times. The vehicle doors will be electrically powered and will be controlled from the cab by the train operator. The doors will be designed so that they will not open while the train is moving; if they are forced open, the train will automatically stop. Internal and external emergency releases will be provided for doors.

Couplers

Couplers and associated structure will provide a mechanical, electrical, and pneumatic linkage between passenger vehicles, and will also act to cushion minor impacts by recoiling under the load. The couplers at the end of each dependent pair of passenger vehicles will be able to be released both from within the operator's cab and from outside the vehicle.

An electrical connector in the coupler system will allow control and communication signals to be transmitted throughout the train.

Trucks

The term "truck" describes an assemblage of four wheels, two axles, two propulsion traction motors, two power collection shoes, braking equipment, suspension, and the supporting frame. In the Metro Rail system, there will be two trucks per passenger vehicle.

The suspension system will consist of air springs. Load-leveling equipment will maintain a constant floor height in the passenger vehicle so that the vehicle's floor will match the height of the station platform regardless of passenger load. The load-leveling equipment will also supply load information to the traction and braking systems so that acceleration and braking can be maintained at required levels.

Propulsion

Each truck of the passenger vehicle will be equipped with two direct current traction motors which will allow a fully loaded train to accelerate at 3 mph per second and achieve maximum train speeds of 70 mph. In addition, the size of the motors will enable a fully loaded train to tow or push another fully loaded train which has stalled on the tracks.

The current to the motors will be regulated by a series direct current chopper. This type of motor control has demonstrated energy efficiency characteristics and accuracy of control that are superior to those of alternative control methods. The chopper control will provide a smooth and continuous tractive effort and will enable the traction motors to operate as generators to provide electrical braking capabilities. Electrical braking will be either regenerative, in which energy is returned to the power system during braking, or resistive, in which energy is dissipated in a grid of braking resistors carried on the vehicle.

Friction Brakes

Electrical braking will provide the primary type of braking on Metro Rail vehicles. However, at speeds below about 5 mph, electrical braking will not be available, and pneumatically actuated disc brakes will be required to supplement the electrical braking equipment. The balance between electrical and pneumatic braking will be automatically controlled to provide a smooth stop. Air for the pneumatic disc brakes will be supplied by a compressor located in the A-car of a dependent pair.

Auxiliary Electrical Power

An auxiliary electrical power supply on passenger vehicles will provide power to operate car lighting, controls, and communications equipment. There will be two types of auxiliary power: high voltage, taken directly from the traction power contact rail, and low voltage, generated by a motor-alternator group or a static inverter.

The high voltage power source will supply larger loads such as electrical heating, air conditioning compressor motors, and the air compressor motor. The low voltage source will supply small equipment such as door operators, lighting, train control, and communications. A set of batteries will provide a back-up low voltage source in the event of a power failure.

Miscellaneous Equipment

As previously described in Chapter 3, the Metro Rail passenger vehicles will contain equipment to ensure the comfort and convenience of the system's passengers, including lighting and heating, ventilating, and air conditioning equipment. The passenger vehicle's lighting will provide adequate illumination for ease of reading (approximately 35 foot-candles at the reading plane), and emergency lighting equipment will ensure safe levels of illumination in the event of a temporary outage of the main power supply. The heating, ventilating, and air conditioning equipment will maintain reasonable levels of passenger comfort by responding to changes in tunnel temperatures and passenger loads. For passenger safety, all vehicles will carry portable fire extinguishers in the passenger area and a first aid kit in the operator's cab.

AUTOMATIC TRAIN CONTROL

Safe, rapid movement of trains on the Metro Rail system will be ensured by the use of an Automatic Train Control (ATC) subsystem. The ATC subsystem will enable Metro Rail trains to operate at closer headways and with more reliable schedules than would be possible if the system were to rely only on operators and wayside signals.

The term "automatic" is used here in a general sense only. The safety-related functions of the subsystem will be fully automatic, requiring no intervention by a train operator or Central Control. Some operating and supervisory functions will also be automatic, while others will be controlled by the train operator or by Central Control. These automatic and manual functions are identified in this section.

Functions

The ATC subsystem, illustrated in Figure 7-3, will provide three main functions: the automatic train protection (ATP) function will enforce train safety; the automatic train operation (ATO) function will control train movements; and the automatic train supervision (ATS) function will direct train operations on the Metro Rail main line and in the yard. Each is described below.

Automatic Train Protection

Automatic train protection (ATP) is based on a knowledge of each train's location on the system and when it is safe for a train to proceed. Detection of train locations will be accomplished on the Metro Rail system by monitoring the tracks in sections or blocks ranging in length up to approximately a thousand feet. When a train enters one of these sections or blocks, the steel wheels and axle will complete an electric circuit between the two rails. The completed circuit or shunt will cause a vital or fail-safe relay to open, indicating that the block is occupied. Train movement will be controlled by various logic functions, all of which will be fully automatic, including:

- Monitoring safe train separation by preventing a train from approaching within less than a safe stopping distance of another train

- Determining the maximum safe speed for each train, considering civil speed limits and the position of other trains on the same track

- Transmitting a signal to indicate to each train operator the speed limit which the train may not exceed

- Providing broken rail detection by arranging track circuit components such that a broken rail interrupts transmission of the speed limit signal to the train

- Enforcing speed limits by commanding the brakes to apply whenever a train exceeds the safe speed limit

- Applying emergency brakes whenever safe train stopping does not occur

- Preventing a train operator from opening vehicle doors unless the train is stopped, and preventing the train from moving when vehicle doors are open

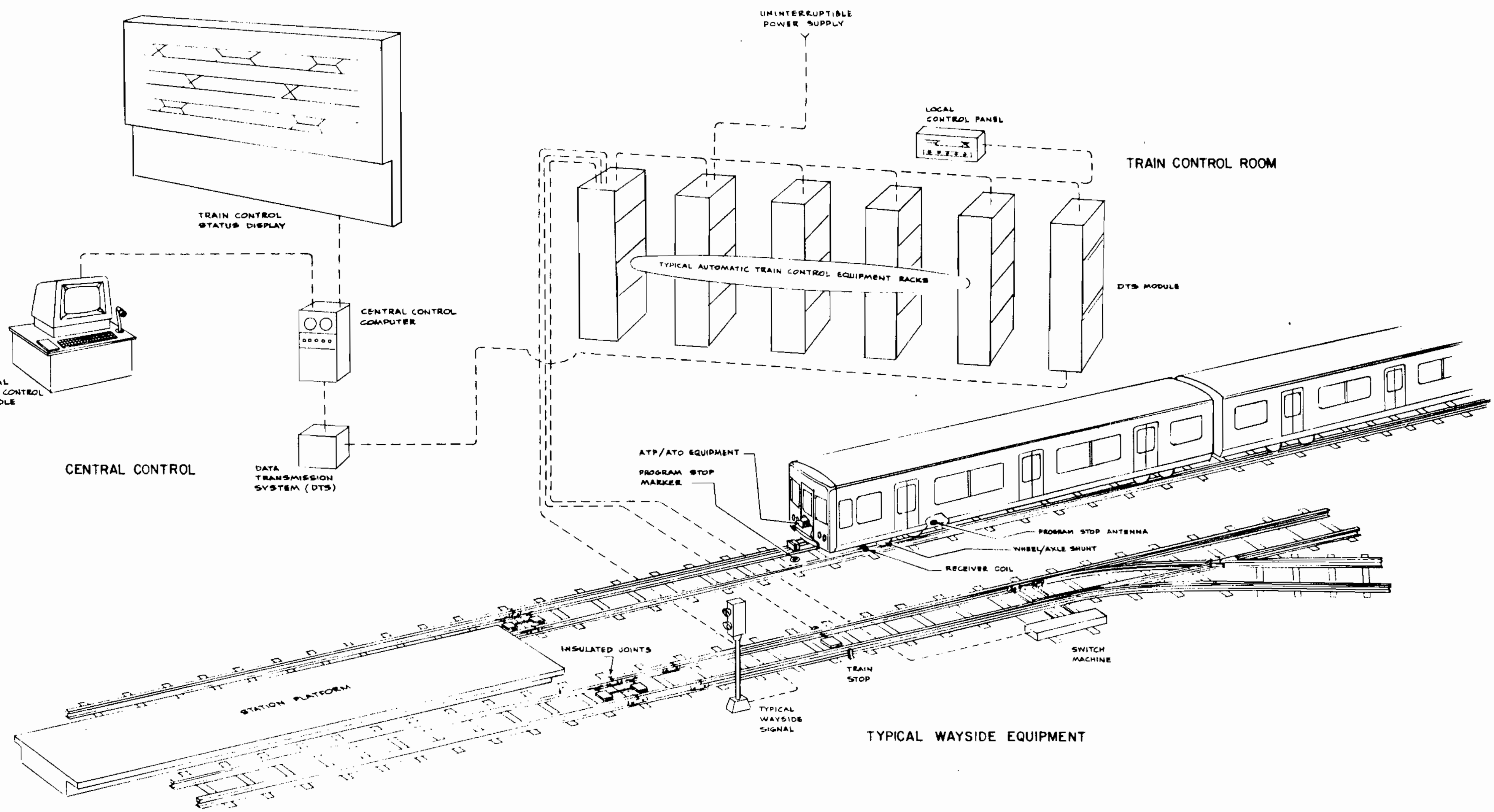


FIGURE 7-3
Automatic Train Control Subsystem

- Providing protection against unintentional train movement or rollback.

Automatic Train Operation

The automatic train operation (ATO) function will control the manual or automatic mode of operations, regulate train speeds, and control programmed entry and stopping of trains at stations. Train operators will control the operation of passenger vehicle doors, train dwell times in station, and train departure. Specifically, the ATO functions will include:

- Setting controls in the automatic operating mode

- Maintaining proper train speeds

- Ensuring trains stop at the desired location in stations

- Providing speedometer readings to train operators.

Train operation information such as speed adjustments and station stopping profiles will be provided to the equipment on board the train. These signals will be relayed from the wayside to the control equipment on the train through a data communications link. Information about the train, such as its speed and performance, will be sent back through the same link.

Automatic Train Supervision

The automatic train supervision (ATS) function is designed to maintain intended train headways and schedules and to minimize the effects of train delays on the system's operating schedule. The ATS functions will include:

- Modifying train operating speeds and/or acceleration rates

- Providing train identification and destination information for use at Central Control

- Controlling whether trains stop at or bypass a particular station

- Controlling train routing and movement at turnbacks

- Monitoring and displaying train movements and routing at Central Control

- Displaying alarms at Central Control and in the train operator's cab.

Vehicle ATS functions will be performed by equipment on the trains, with a data communications link transferring information to the wayside. All wayside data will be collected at the train control rooms in each station and will then be transmitted to Central Control by the communications subsystem, described in a subsequent section of this chapter.

Equipment

To enable Central Control to monitor and control the operation of the Metro Rail system, the Central Control facility will contain the following ATC-related equipment: train control consoles, a status display panel, the Central Control computer, and associated data transmission equipment. The Central Control computer, as part of the communications subsystem, will receive data about train and station equipment operations from the station train control rooms; it will then either process the information for display on the display panel or operator's cathode ray tube (CRT) or will store the information for later recall.

The display panel, illustrated in Figure 7-3, will provide current operating information including the actual locations of trains and their direction of movement, the position of track switches throughout the system, the status of traction power, and various alarm functions. The train control operator will have a keyboard and CRT which can be used to control train operations by changing routes at track switch locations, by adjusting the schedule, or by adding or removing trains from the system. The CRT will provide additional information on operations, schedules, status, and train identification.

The Central Control portion of the ATC subsystem will be designed so that, if there is a disruption in either the equipment or the data transmission link, the system may continue to operate automatically or be controlled manually from the train control rooms located at Metro Rail stations.

In addition to the display and control equipment located in Central Control, ATC equipment will be located along Metro Rail's wayside, in the station control room, and on the passenger vehicles.

The wayside equipment will include block track circuits, antennas, track switch controller circuits and indicators, wayside signal lights, and station stopping apparatus. This equipment will provide position information and will relay information to and from the trains.

Within the station train control rooms will be the fail-safe vital relay logic controlling the ATP function, as well as equipment for the ATO and ATS. Information from these functions will then be retransmitted to Central Control over the data transmission system. All equipment within the train control room will function automatically or by remote control from Central Control.

Local control panels will be provided as a back-up in the event of loss of communication with Central Control.

The vehicles will contain relays and logic circuits to control the traction motors, brakes, and doors. In addition, the operator's console will contain the speedometer and speed limit readout and control mode switch. A tachometer and antenna will be mounted under the vehicle.

Fail-Safe Design and System Safety

The Automatic Train Control subsystem will be designed to provide absolute assurance that any malfunction affecting safety will cause the subsystem to revert to a status known to be safe. The following design considerations apply:

- The ATC subsystem will conform to the safety requirements of Signal Manual of Recommended Practices of the Association of American Railroads, and to the relevant requirements of the California Public Utilities Commission.

- The ATP will be designed to be fail-safe, independent of other ATP functions.

- All ATC equipment will be designed and constructed so that no single failure or resulting failure will allow a train to respond unsafely. Equipment failures which affect train safety will be self-detecting. Failures which affect safety will be annunciated by fail-safe means, or by stopping the train, or by imposing a speed limit that is known to be safe. Equipment failures that are not self-detecting will be unable to cause an unsafe condition, even given combined equipment failures.

The ATC subsystem will be designed so that it can continue to operate in the event that failures occur in equipment that is not safety related, although operations will probably be at some reduced level of performance.

COMMUNICATIONS

The principal functions of the Metro Rail communications subsystem will include:

- Providing accurate and rapid transfer of information between equipment and operating personnel to ensure orderly system operations and rapid, well-informed responses to service disruptions or incidents

- Providing communications equipment in the passenger stations and vehicles for security, emergencies, and passenger assistance

- Providing management of operations, security, and maintenance activities

- Providing emergency communications with local authorities and agencies.

The equipment for the communications subsystem will be located in the Metro Rail Central Control facility and in stations, vehicles, tunnels, and other work locations. This equipment will fall into eight major categories: radio, telephone, public address, fire and security, closed-circuit television, intercom, data transmission, and cable transmission equipment. The integration of the equipment is illustrated in Figure 7-4.

Radio Service

For train, yard, and maintenance operations and for emergency communications, the Metro Rail communications subsystem will include radio service providing two-way voice communication over six channels. This radio service will also accommodate City and County fire department radio channels to ensure prompt response during any possible emergency.

Portable radios will be used for most radio communications. Antenna lines in the tunnels and stations will allow for transmission and reception throughout underground portions of the Metro Rail system. In addition, a one-way paging system will be available to operations and maintenance personnel.

Telephone Service

The Metro Rail telephone system will provide three separate telephone services: the administrative telephone (ATEL) service, the maintenance telephone (MTEL) service, and the emergency telephone (ETEL) service. At many locations, all three will be served through a single instrument. The telephone system will use a digital electronic private automatic branch exchange (EPABX) which will allow station-to-station dialing within SCRTD as well as dial access to outside telephone company lines.

To support the management, administration, and operation of the Metro Rail system, ATEL instruments will be placed in offices, station mezzanines and equipment rooms, maintenance shops, tunnel cross passages, and other locations that will frequently be used by Metro Rail personnel.

MTEL service will have lines separate from those of ATEL to allow for direct communication between maintenance personnel. The number of MTEL lines will be minimized by the use of party lines. Instruments and telephone jacks will be housed in locations where maintenance work will frequently occur, such as shops, equipment rooms, substations, and tunnels.

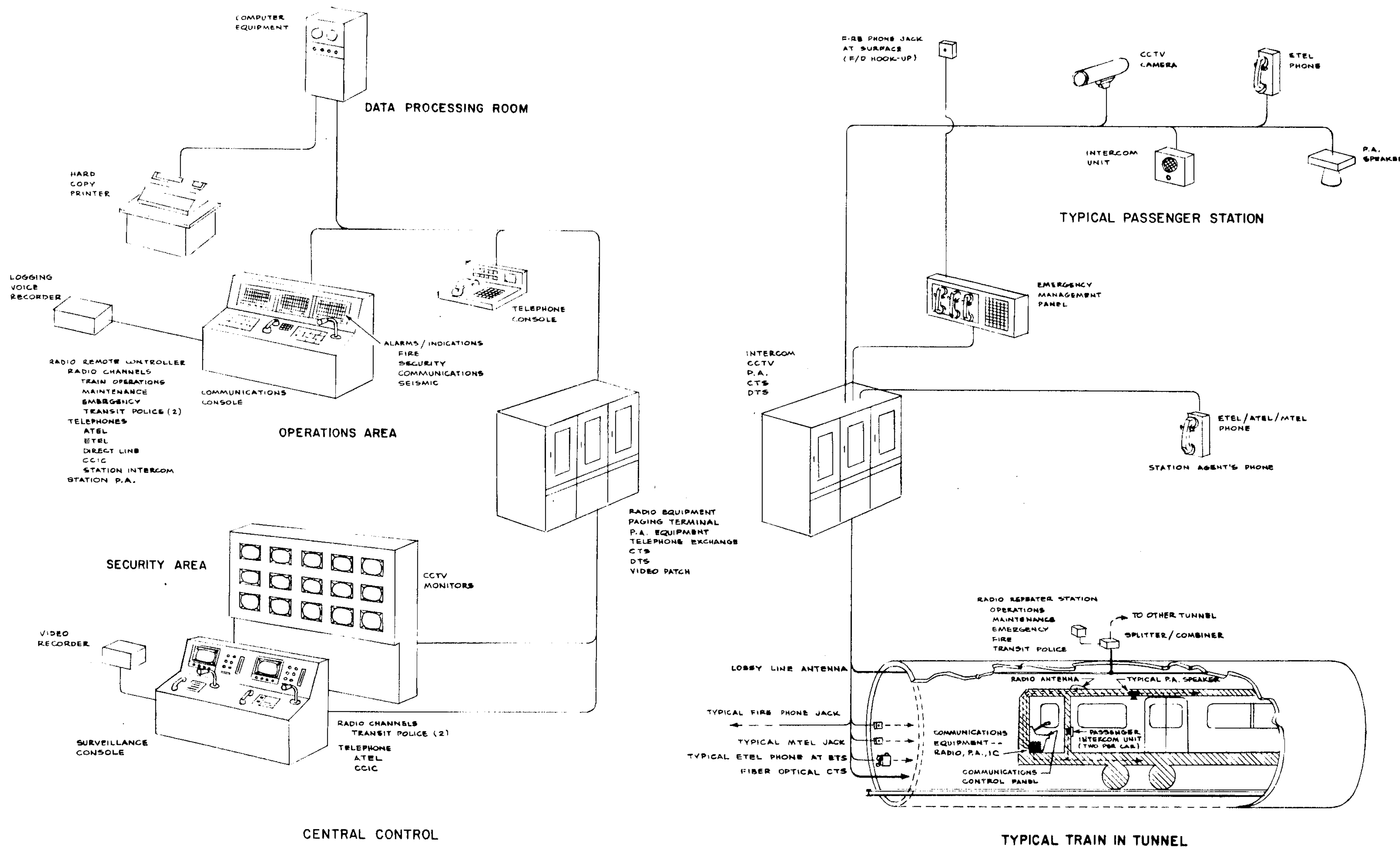


FIGURE 7-4
Communications Subsystem

ETEL service will provide direct automatic signaling to Central Control when the handset of a telephone instrument is lifted or a button is pressed. Failure of any ETEL line will be indicated by an automatic alarm so that repairs can be made immediately. Emergency telephones will be available in key locations in the public areas of stations and in equipment areas. Other emergency telephones will be located in the emergency cross passages of tunnels and at all traction power emergency shut-off stations. All emergency calls will be automatically recorded at Central Control.

Public Address Service

Public address (PA) systems will be located in each Metro Rail station and inside each passenger vehicle. An additional PA system will serve the yard and shop areas. These PA systems, consisting of microphones, amplifiers, and speakers, will provide a means of delivering announcements and emergency instructions to Metro Rail patrons and SCRTD personnel.

Announcements to passengers within Metro Rail cars may be made by the train operator or by Central Control personnel. Public announcements in stations may originate from Central Control or may be made by a station agent from a station's patron assistance area.

Fire and Security Service

Fire and security logic control equipment, emergency management panels, fire and intrusion detectors, radio relay stations, and a dedicated fire telephone (FTEL) jack system will compose the Metro Rail fire and security communications service. Equipment at Central Control will monitor and control the fire and security equipment.

Control equipment will also be located in passenger stations; displays and controls will be provided on the emergency management panels located at each station. These panels will be for use by fire department personnel in investigating or handling emergencies. The emergency management panel will contain controls for ventilation and other station equipment, two FTEL handsets, a combined ATEL/MTEL/ETEL instrument, and a station public address system microphone. One FTEL handset will connect to a line running through both tunnels to the next upline station; the other, to a line running through both tunnels to the next downline station. One line will also connect to a jack at street level. The FTEL lines will be used for tactical communications between fire department personnel in the stations, in the tunnel sections between stations, and on the street.

Closed-Circuit Television Service

Closed-circuit television (CCTV) cameras and associated equipment will be used to monitor various portions of each Metro Rail station, such as fare gates, ticket vending areas, and station platforms. These cameras will be linked to the security area of Central Control, where TV monitors and video recorders will be located.

Intercom Service

Intercoms will be installed at several locations within each station (e.g., near fare gates, on platforms, and within elevators) to enable Metro Rail patrons to communicate directly with Central Control. These devices will be activated when a button is pressed, signaling the Central Control facility. A similar intercom will be installed in each passenger vehicle to enable passengers to contact the train operator.

Data Transmission Service

The data transmission service (DTS) will furnish the Central Control computer with information gathered from alarms and signal equipment. Such data will include: traction power alarm and control signals; ATC alarm, indication, and control signals; mechanical equipment and auxiliary power alarm information; fire alarm signals; tunnel ventilation alarm indication and control signals; security and intrusion alarm signals; communications alarms information; CCTV control signals; information from electrical and mechanical equipment status-indication alarms, such as fire, gas, and earthquake detectors, and fare collection data.

These data will be transmitted to Central Control via the cable transmission service described below.

Cable Transmission Service

Using fiber optics transmission techniques, the cable transmission service (CTS) will run through the Metro Rail tunnels to provide for the interconnection of all communications between stations, Central Control, traction power substations, and other facilities. The CTS will carry telephone services, remote signals for satellite transmitter/receiver operation, CCTV service, and specified remote controls.

ELECTRIC POWER

The Metro Rail electric power subsystem will convert the high voltage power received from utility companies to the correct voltage and type of electricity needed to operate the system's trains, stations, yard and shops, tunnel ventilating equipment, and other machinery. The electric power subsystem will also include equipment to distribute and control power. In addition, the electric power subsystem will provide standby power for the operation of those subsystems and equipment items considered essential for the safety of the public.

The Metro Rail electric power subsystem, which is illustrated in Figure 7-5, will comprise the following:

- Utility company service equipment
- Primary electrical distribution, at 34,500 or 16,000 volts alternating current
- Traction power, at 750 volts direct current
- Auxiliary power for stations, tunnels, and elsewhere, at 480 volts and 208/120 volts alternating current
- Standby power equipment and batteries
- Controls and protective equipment.

Each of these is discussed in turn below.

Utility Company Service

Power to operate the trains, stations, yard and shops, and other facilities and equipment will be received from the Los Angeles Department of Water and Power or the Southern California Edison Company at 23 Metro Rail power substations located along the line as required to provide distribution of power. Of these substations, 18 will include traction and auxiliary power equipment; the remaining 5 will contain only auxiliary power equipment.

Whenever possible, each of the power substations will receive power from two separate high voltage feeders originating from separate utility company substations. This will minimize the possibility of power outages affecting system operation.

At each service point, the incoming feeders will terminate at a service meter and switching devices. Only one of the two feeders will supply power at a given time. Automatic transfer from the operating feeder to the standby feeder will be accomplished by the utility incoming switching devices.

Primary Power Distribution

At Metro Rail traction power substations, incoming power from the utility service feeders will be divided between the traction power equipment and the auxiliary power equipment. At the remaining power substations, utility power will be converted directly to auxiliary power.

Traction Power

Traction power equipment will provide 750 volts of direct current to the system's third rail sections. Separate circuits will feed power to the third rail from the traction power substations at

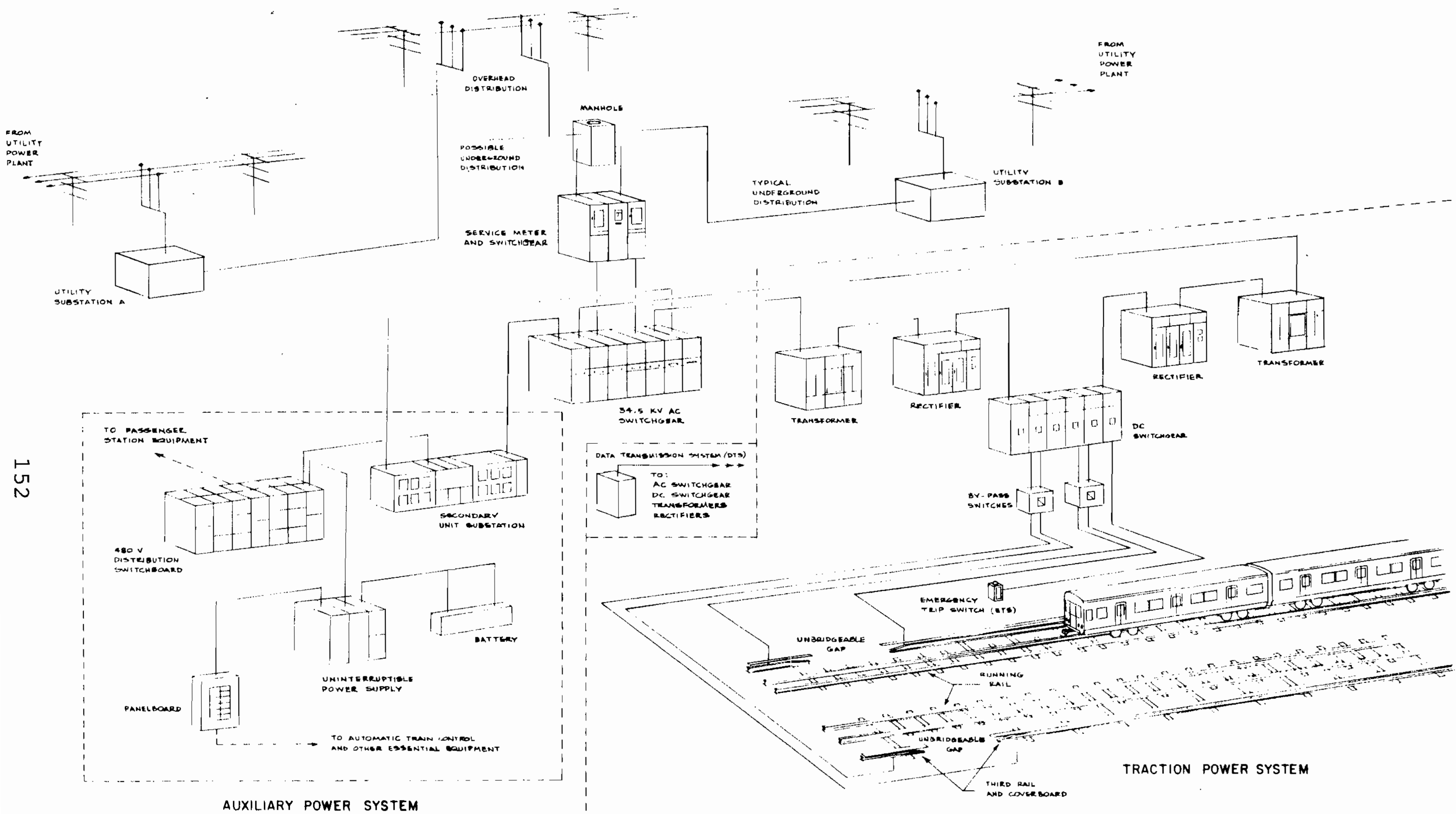


FIGURE 7-5
Electric Power Subsystem

each end of the section, so that loss of output from any one substation will not shut down train operations.

The passenger vehicles will obtain power for the traction motors and auxiliary equipment from the collector shoes which will slide along the third rail. The third rail will be divided into sections, each with separate power controls, to enable sections of the third rail to be isolated in the event of an emergency or when maintenance is required. The power circuit will be completed through the running rails.

Power to the third rail will normally be controlled from the Central Control facility. Emergency trip stations will be provided at station platform ends and at every cross passage in the tunnels so that traction power can be turned off locally in an emergency. The location of these stations will be indicated by a blue light, and they are consequently often referred to as "blue light stations."

Auxiliary Power

Auxiliary power equipment will provide electricity for station operation, including power for lighting, ventilation fans, and other station equipment.

For each station, this auxiliary power equipment will consist of transformers, 480 volt alternating current distribution switchboards located at opposite ends of each passenger station, and necessary distribution feeders and equipment. The substation transformers will each be of a sufficient size to carry the entire load for a station, so that one transformer can be taken out of service for maintenance without curtailing station operation.

Standby Power

A battery-supported, uninterruptible power supply (UPS) will provide standby power to ensure that essential equipment on the Metro Rail system continues to operate during emergency periods when utility power is not available. This standby power source will provide power for ATC equipment, alarms, communications, and emergency lighting, but will not power the passenger vehicles or ventilating equipment.

Controls and Protective Equipment

All equipment located in Metro Rail passenger stations will be designed to function without the aid of an attendant. Automatic controls and circuit breakers will regulate operation and switching functions; these will be linked by remote control to the supervisory monitoring and control system located at the Central Control facility.

FARE COLLECTION

The Metro Rail system will have a fare collection subsystem of the automatic barrier type, with fare gates equipped with machines to read encoded tickets and passes (see Figure 7-6).

This section describes the equipment that will be included in the Metro Rail fare collection subsystem and then discusses the types of fares the subsystem will be designed to handle.

Equipment

The fare collection subsystem will include fare gates, ticket vending equipment, change machines, and add-fare machines which will be located on the mezzanines of Metro Rail stations. The number of gates and ticket vending and related machines to be installed in each station will be determined on the basis of peak-period patronage projections at the station.

A console at the Central Control facility will indicate the status, and permit the control, of the fare collection equipment at each station. The intercom connection will allow passengers needing assistance to communicate directly with Central Control personnel.

The computer at the Central Control facility will possess data links to the fare collection equipment. This will permit the accumulation of data on patronage, revenues, and maintenance histories of fare collection equipment items.

Fare Gates

An array of fare gates will define the line between the free and paid areas of the mezzanines of Metro Rail passenger stations; these gates will provide the means of entrance and exit for passengers. Upon the insertion of a valid ticket or pass, the gates will release to permit the passenger to enter and will then return the ticket or pass to the passenger. A swinging door gate, wide enough to accommodate a wheelchair, will be provided for use by the handicapped.

In a fare system based on distance traveled, passengers must use a fare gate for exiting as well as entering. Exit gates will be of the same type as entrance gates, and all gates will be clearly marked so that passengers can easily discern which are for entrance or exit. Exit gates will print a transfer designation on the ticket for a passenger wishing to transfer to an SCRTD bus, as described subsequently in the discussion of Metro Rail fares.

Emergency Exit Gates

To ensure that passengers will be able to safely evacuate from Metro Rail stations in an emergency, exit means other

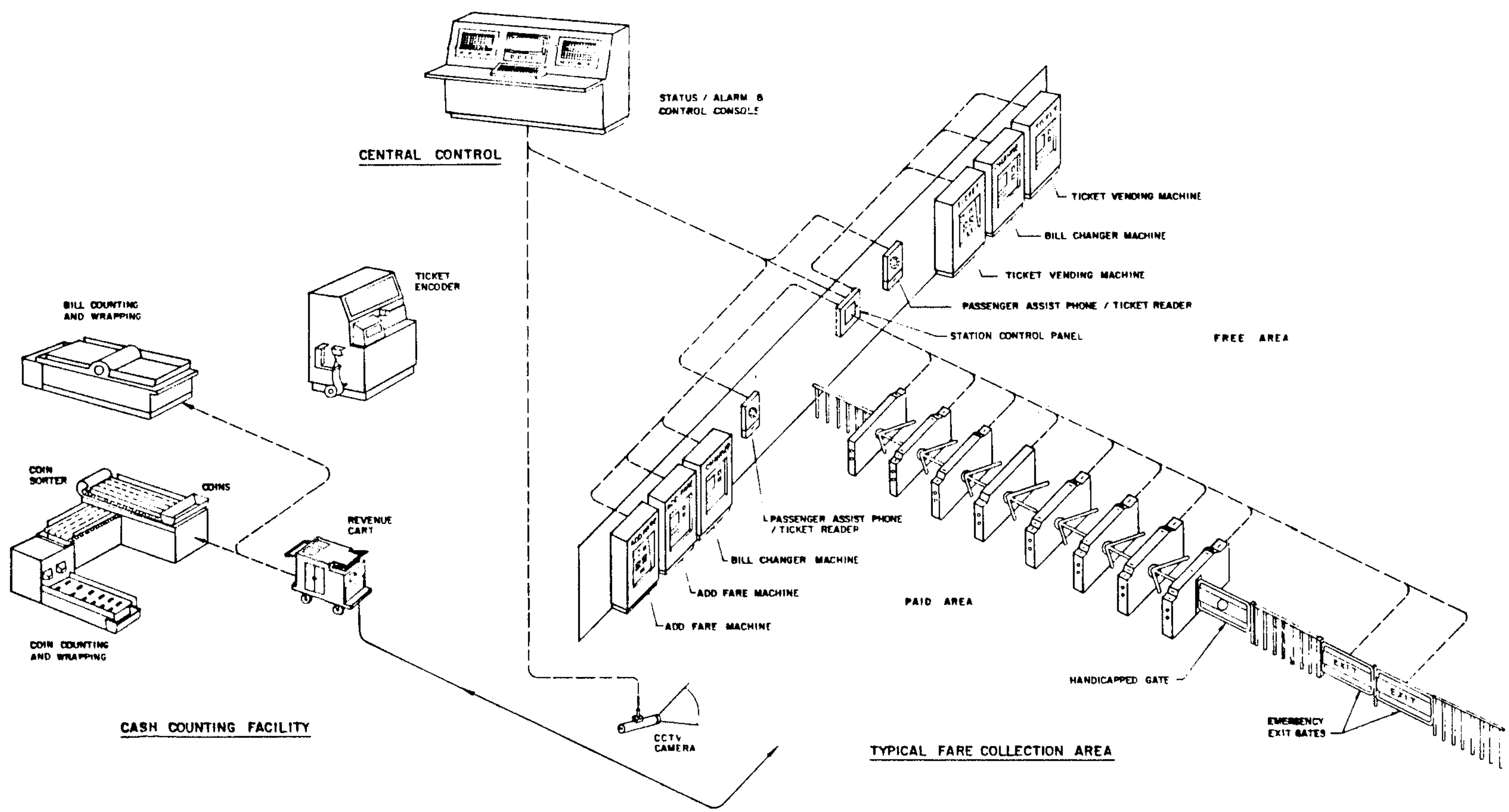


FIGURE 7-6
Fare Collection Subsystem

than the fare gates will be necessary. This additional exit capacity will be provided by swinging-door type gates which feature emergency-release hardware operable from the paid area of the mezzanine.

Ticket Vending Equipment

Metro Rail passengers will purchase single-trip tickets in the free area of station mezzanines from ticket vending machines. Tickets of various values for different trip lengths will be able to be purchased, and the ticket vending machine will return appropriate change after coins have been inserted. The vending machine will be able to accommodate discounts on the purchase of a single-ride ticket if a transfer from an SCRTD bus or possible light rail vehicle is inserted into the unit. The machines will also accommodate the purchase of tickets that include transfers to SCRTD buses or light rail lines.

Change Machines

Change machines will be located in the free area of station mezzanines near the ticket vending equipment, and in the paid area near the fare gates. These machines will dispense coins in exchange for U.S. $1 and $5 bills for use in the ticket vending and add-fare machines.

Add-Fare Machines

In the paid area of each station, add-fare machines will permit patrons to increase the value of their tickets. This would be necessary, for instance, if the ticket used to enter the system was of minimum value and the trip taken was of greater value than the worth of the ticket. These machines will indicate the amount to be added to the original ticket and will give change once a patron has inserted coins and a ticket into the machine.

Types of Fares

The Metro Rail fare collection subsystem will be designed to handle various tickets, passes, and transfers, including single-trip tickets, multi-trip tickets, monthly passes, reduced-fare monthly passes, and transfers to or from light rail vehicles or buses.

Single-Trip Tickets

Passengers making a single trip on Metro Rail will purchase tickets from a ticket vending machine at the station of origin. This ticket will contain information concerning entry and exit through the Metro Rail system fare gates. After inserting the ticket into an entry fare gate console, the passenger will proceed through the gate and retrieve the ticket for use on exit. To leave the Metro Rail system, the passenger will insert the ticket in an exit fare gate console and will then proceed through the fare gate. The ticket will not be returned.

Multi-Trip Tickets

Multi-trip tickets will be able to be purchased from SCRTD sales outlets and will be valid for travel on Metro Rail, SCRTD bus lines, and possible light rail lines. To ride the Metro Rail system, a passenger will insert the multi-trip ticket into the fare gate console when entering and exiting a station; in this respect, the procedure will be identical to that for the single-trip ticket. The multi-trip ticket, however, will be returned to the passenger after each use until there is no value remaining on the ticket. At that time, the ticket will be captured by the exit gate.

To allow multi-trip tickets to be used on buses or light rail vehicles as well as on Metro Rail, the validity of the ticket must be able to be checked visually or by a machine on board the bus or light rail vehicle.

Monthly Passes

Patrons using SCRTD buses and Metro Rail on a regular basis will be able to purchase a pass, valid for a specified time period, at an SCRTD sales outlet. The pass will be used in the same way as multi-trip Metro Rail tickets. The pass will also allow a passenger to board a bus or travel on a light rail vehicle.

Reduced-Fare Monthly Passes

Patrons eligible for reduced-fare travel on Metro Rail will be able to purchase special passes from SCRTD sales outlets. Like the monthly passes, these passes will be valid only for a specified time period. Use of the reduced-fare passes will be identical to that of the monthly passes.

Transfers

Passengers making single trips on Metro Rail which begin with a bus ride will, upon boarding the bus, obtain a machine-readable bus-to-rail transfer card from the bus operator. To transfer to Metro Rail, a passenger will insert the transfer card into the Metro Rail ticket vending machine to receive credit for the fare paid on the bus.

Machine-readable transfers from light rail vehicles will either be dispensed by agents at designated stations or will be provided onboard the light rail vehicle by the operator or a dispensing machine.

Passengers wishing to transfer from Metro Rail to SCRTD buses will simply press a transfer button on the ticket vending machine when purchasing a Metro Rail single-trip ticket. When the passenger exits the Metro Rail system, the exit gate console will print the time and date on the ticket before returning it to the passenger. The ticket will then be turned over to a bus operator if the passenger is boarding an SCRTD bus, or will be shown to a fare inspector if the passenger is boarding a light rail vehicle. (Current plans for the light rail transit system call for self-service fare collection with inspectors to prevent fare evasion.)

Revenue Collection

Revenues will be collected daily from each Metro Rail station in revenue carts containing compartments to hold change hoppers, locked money bags, and ticket stock. These carts will be used to transport the revenue through the station to street level. Revenues will be transported between Metro Rail stations and the SCRTD revenue processing facility by armored truck.

AUXILIARY VEHICLES

The Metro Rail system will require various secondary, or auxiliary, vehicles to perform such miscellaneous work functions as tunnel cleaning and maintenance; the rerailing of passenger vehicles; emergency water pumping; rail grinding; and the towing of maintenance and passenger vehicles. The types of auxiliary vehicles that will perform these functions include:

- Locomotives
- Self-propelled cranes
- Small on/off rail car movers
- Emergency pumping equipment
- Rail grinding equipment
- Tunnel cleaning/maintenance vehicles
- Flatcars
- Passenger vehicle rerailing equipment.

Locomotive

A locomotive will be used to move heavy loads in the Metro Rail yard or main line areas. The locomotive will haul passenger vehicles on SCRTD property whenever third rail traction power is not available or when a train is disabled. The locomotive will also be able to haul flatcars and work crews needed to perform maintenance tasks to any location along tracks. Figure 7-7 illustrates such a locomotive.

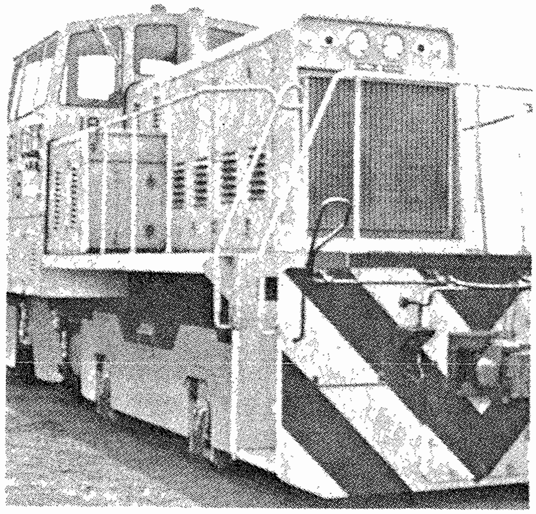


FIGURE 7-7
Auxiliary Vehicle--Locomotive

Self-Propelled Crane

A diesel-powered crane will be used to lift heavy items such as rail sections, special trackwork, and other bulky pieces of equipment. The crane will have a low profile to enable it to be used in tunnels or at grade, where the crane boom will be able to rotate to lift trackside items.

Small On/Off Rail Car Mover

A diesel-powered vehicle will be used to move Metro Rail passenger vehicles and other rail vehicles at relatively low speeds within the yard and shops. The car mover will operate on conventional rubber tires to allow movement around the yard by road for maximum efficiency. When rail operation is required, small steel wheels will be lowered onto the tracks and the vehicle will then be propelled by the rubber tires riding on the steel rails. A standard vehicle coupler will be mounted on the car mover to permit easy towing of the passenger vehicles.

Emergency Pumping Equipment

A diesel-generator-driven pump will be required to assist existing sump pumps in the event of unusual flooding in tunnels or the failure of a sump pump. The equipment will be transported by other auxiliary vehicles.

Rail Grinding Equipment

Rail grinding equipment will be used for surface grinding of rails, for shaping newly installed or repaired trackwork, and for removing corrugations and uneven areas. The grinding action will be accomplished by multiple grinder stones, mounted on a special rail vehicle and powered by a diesel generator. The slow and precise track speed needed for this work will be achieved through the use of a locomotive.

Tunnel Cleaning/Maintenance Vehicle

Tunnel cleaning/maintenance vehicles will travel on the rails to clean tunnel surfaces. Washing equipment and associated reservoirs will be mounted on cars which are either self-propelled or towed by a locomotive. Crews will manually operate the vehicles in the tunnels while directing high pressure cleaner/water sprays at the tunnel walls. Vacuum equipment used to remove dust and other debris may be mounted on an on/off rail vehicle.

Flatcars

Flatcars will be used to haul heavy and lengthy equipment such as rails and special trackwork, and to transport crews and maintenance equipment to work locations along the tunnel corridor. The flatcars will be hauled by locomotive.

Passenger Vehicle Rerailing Equipment

To rerail passenger vehicles, mechanical and hydraulic jacking equipment will be required. This equipment will be moved to a derailment site by small vehicles.

8. ESTIMATED COSTS, SCHEDULE, AND FUNDING

8. ESTIMATED COSTS, SCHEDULE, AND FUNDING

A primary objective of the preliminary engineering effort for the Metro Rail project has been to develop system cost estimates that provide a reliable basis for major funding decisions by federal, state, and local officials. Such estimates are presented in this chapter for the system's capital costs--costs associated with design, procurement, installation, and construction--and for the annual operating and maintenance costs the system is likely to incur. The chapter also includes an implementation schedule for the final design and construction phases of the project, and indicates the estimated annual level of funding required to accomplish that schedule.

The projections in this chapter have been based on the results of the preliminary engineering effort which has carried the system design to approximately 30 percent of its final detail. The projections have been revised to reflect the addition of the Wilshire/Crenshaw Station to the Metro Rail system; the costs of the Hollywood Bowl Station, although included in the estimated year 2000 operating and maintenance costs of the system, have been excluded from the projected capital cost and funding requirements contained in this chapter. This approach to the Hollywood Bowl Station is in accordance with the decision of the SCRTD Board of Directors to carry the design of that station to a 50 percent level of completion, to exclude its capital cost from the project's federal grant application, and to seek other private and public sources of funds to enable the station's design and construction to be completed within the current project implementation schedule.

Cost estimation, like design, is an ongoing process. Therefore, as the system design becomes more detailed and definitive in subsequent stages of the project, more refined estimates of cost will be developed. Nevertheless, the estimates contained in this chapter reflect all major design features of the Metro Rail system and serve as reliable indicators of likely system cost. They have been validated in separate checks by three independent engineering firms.

CAPITAL COSTS

Capital costs encompass all costs associated with design/procurement/construction contracts and include all direct and indirect costs, contractor profits, and other related expenses. The estimation of these costs began with individual assessments of the direct costs to procure, install, or construct the system's fixed facilities and subsystems, defined as follows:

- Guideways--Costs to construct twinbore tunnels with boring machines and finish with precast concrete tunnel liners

- Stations--Costs of the station shell (essentially a concrete box structure), architectural finishes, mechanical equipment, auxiliary power equipment, heating and ventilation equipment, fire protection, plumbing, and site development

- Utilities--Costs to relocate, replace, or support utilities in place during construction, or to protect existing utility systems by other means in construction areas

- Parking--Costs associated with providing park-and-ride facilities at selected station locations

- Central Control building--Costs to construct a conventional building on a site near Union Station to serve as the nerve center of the Metro Rail system

- Main yard and shops--Costs to provide the vehicle storage yard and tracks, main shop building and all necessary equipment, maintenance-of-way shop, vehicle cleaning facilities, yard control tower, operations administration facility, and tracks connecting the yard to the main line

- Trackwork--Costs for all structures and hardware necessary to support the rail transit vehicles as they operate over the guideway, including steel running rails, sub-ballast, ballast, cross ties, and mounting hardware

- Train control--Costs for the subsystems necessary to perform automatic train protection (ATP), automatic train operation (ATO), and automatic train supervision (ATS)

- Communications--Costs for all telephone, radio, data transmission, cable transmission, public address, and closed-circuit television (CCTV) communication systems within the Metro Rail project

- Traction power--Costs necessary to provide electric power to run the trains along the Metro Rail route

- Fare collection--Costs necessary to provide for automatic self-service fare collection

- Passenger vehicles--Costs of the electrically powered, air-conditioned rail transit passenger vehicles

- Auxiliary vehicles--Costs of utility vehicles necessary to operate and maintain the transit system.

For each of these, direct costs were estimated essentially by determining the quantity of the specific item or material to be used in the Metro Rail project, and then multiplying that quantity by the appropriate cost of a unit of the material or item. Quantities were developed based on the specifications of preliminary engineering drawings. Unit costs were determined in one of three ways:

- Averaging of direct quotes from suppliers or contractors
- Developing unit costs from a detailed analysis of labor, material, and equipment requirements
- Using data derived from established construction cost manuals, adjusted for the Los Angeles area.

Once the direct cost of each fixed facility or subsystem was determined, its indirect costs (reflecting contractors' overhead and profit) were estimated. The direct and indirect cost estimates were then combined to generate a capital cost estimate for each fixed facility and subsystem. The sum of these estimated capital costs basically produced the estimated capital cost for the system as a whole. However, to fully develop the overall system estimate, several other cost items had to be accounted for:

- Design contingency--An allowance to cover design uncertainties to be resolved during later design stages, set at 15 percent for fixed facilities and 10 percent for subsystems
- Right-of-way--Direct project costs to acquire real estate needed for Metro Rail construction, based on right-of-way requirements developed by consultants for SCRTD
- Design and construction management--The costs to provide for project design and procurement and management during construction, estimated at 13 percent for fixed facilities and 10 percent for subsystems
- Agency--The money SCRTD must pay staff personnel for project management and administration, estimated at 5 percent of total project cost
- Insurance--The cost to insure facilities and contractors during construction, including those for Workers' Compensation, General Liability, and Builders' Risk, which typically add between 4.5 and 5.0 percent to the cost of a project.

The sum of all of the cost elements described above equals the estimated capital cost for the transit system as a whole.

This process was followed to estimate the capital cost not only of the Metro Rail system's 18-mile initial line, but also of the 9.8-mile "minimum operable segment" of that line. The latter represents the minimum-distance segment of the system that can provide reasonable service levels and operational capability. Its identification is required by the Urban Mass Transportation Administration. For Metro Rail, it has been defined as extending from Union Station to the Fairfax/Beverly Station and includes the main yard and shops.

Table 8-1 provides the results of the estimating process. As the table shows, capital costs will total an estimated $2.4 billion for the 18-mile initial Metro Rail line, and an estimated $1.5 billion for the minimum operable segment, expressed in first-quarter 1983 dollars.

To assess the reasonableness of the estimation results, the Metro Rail capital cost estimate was compared with capital costs incurred by other U.S. rail rapid transit systems. Figure 8-1 indicates the comparative costs on a route mile basis. The figure also indicates the extent of each system accounted for by subway routes; this is an important consideration in the comparison, given that the costs to construct subway lines are significantly higher than those for surface or aerial routes. When this factor is taken into account, the capital costs for the Metro Rail project appear to be reasonably dependable estimates in light of the experience of other transit systems.

Construction of the Metro Rail system is scheduled to begin in June 1984, with revenue service commencing on the minimum operable segment in February 1990 and on the full 18-mile system in November 1990, as discussed in a subsequent section of this chapter. To take account of the cost inflation that will occur over time, estimated capital costs were escalated at a 7 percent rate to the midpoint of each design and construction contract. As Table 8-1 indicates, this produced a capital cost estimate of $3.3 billion for the full 18-mile Metro Rail system.

The 7 percent rate was chosen on the basis of UMTA guidelines and historical construction cost indices published in the Engineering News Record, and is considered an appropriate rate for planning purposes. However, this rate must be considered only as a guide, for escalation is volatile and variations will almost certainly occur in any given year.

OPERATING AND MAINTENANCE COSTS

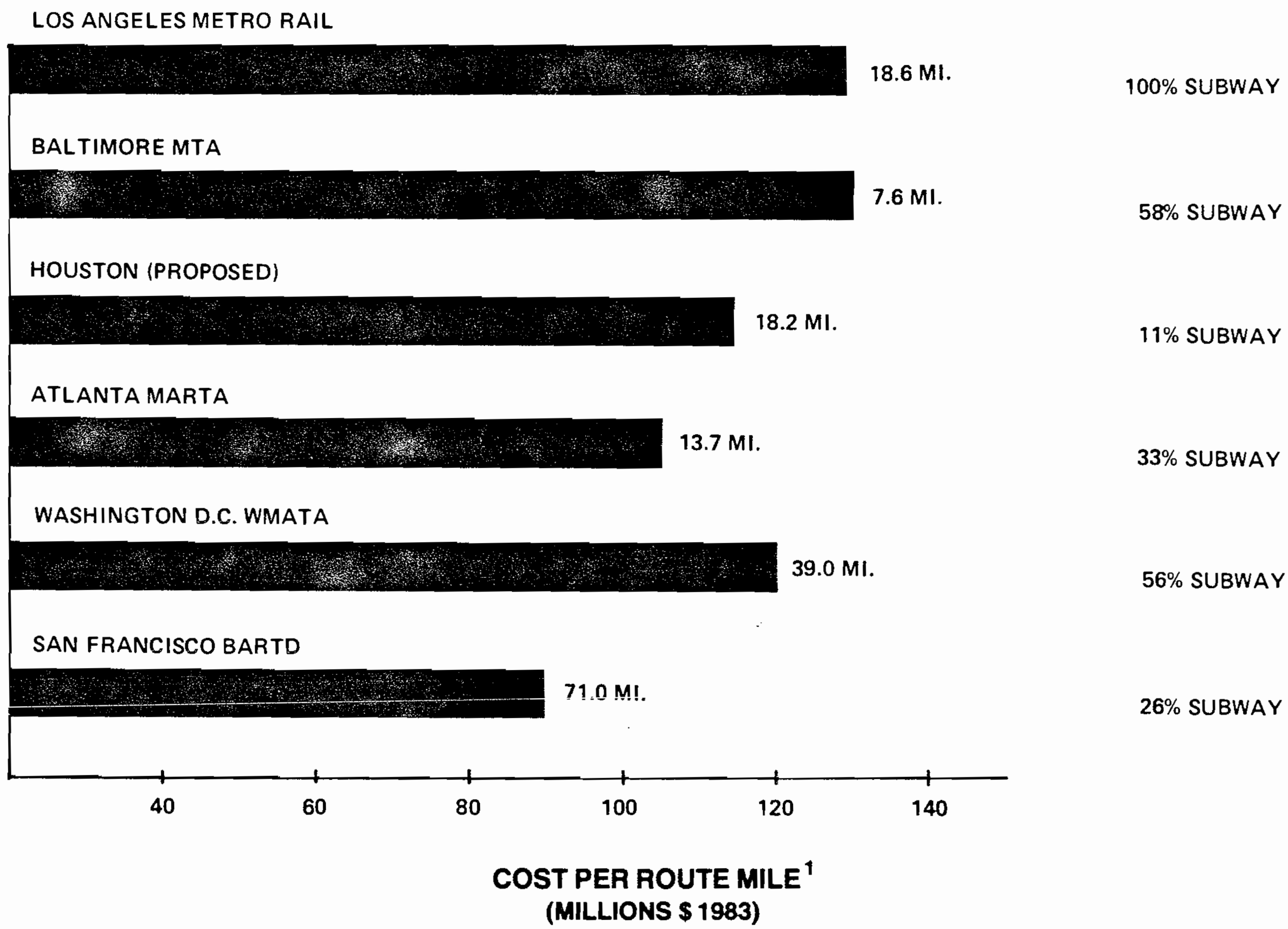
Operating and maintenance (O/M) costs are those incurred in the day-to-day operation of a transit system and are estimated on a total annual cost basis. They include labor, material, and other expenses required to operate, maintain, and manage the system.

To project such costs for the Metro Rail system, individual cost estimates were prepared for each major O/M activity and for the liability expenses (for personal injury, property damage, etc.)

TABLE 8-1
Estimated Capital Costs of the Metro Rail System
(1st Quarter 1983 Prices)

COST ELEMENT	ESTIMATED COST: TOTAL SYSTEM	ESTIMATED COST: MINIMUM OPERABLE SEGMENT
Fixed Facilities and Subsystems		
Guideways	$ 524,500,000	$ 278,000,000
Stations*	669,700,000	471,600,000
Utilities	26,300,000	17,600,000
Parking	9,000,000	3,100,000
Central Control Building	1,500,000	1,500,000
Main Yard and Shops	40,000,000	40,000,000
Trackwork	79,100,000	51,500,000
Train Control	57,000,000	36,200,000
Communications	21,700,000	16,700,000
Traction Power	38,100,000	21,700,000
Fare Collection	18,400,000	15,400,000
Passenger Vehicles	130,000,000	74,000,000
Auxiliary Vehicles	1,300,000	1,300,000
Subtotal	$1,616,600,000	$1,028,600,000
Design Contingency (15% for fixed facilities; 10% for subsystems)	229,200,000	146,000,000
Right-of-Way	176,000,000	118,000,000
Design and Construct. Mgmt. (13% for fixed facilities; 10% for subsystems)	231,200,000	147,200,000
Agency	80,800,000	53,100,000
Insurance	77,500,000	51,000,000
TOTAL CAPITAL COST	$2,411,300,000	$1,543,900,000
TOTAL CAPITAL COST Escalated at 7% to Midpoint of Each Design/Construction Contract	$3,309,000,000	$2,133,500,000

*Includes costs of pocket and crossover tracks.



[1] All costs have been inflated to 1983 dollars using construction cost indices supplied by *Engineering News Record* and individual properties. The primary source for each cost estimate is as follows:

Baltimore MTA (BRRTS): Telephone interview with the construction manager of BRRTS.

Houston: Telephone conversation with Houston Transit Consultants, the general project consultant.

Atlanta (MARTA): MARTA status report prepared for Mr. Richard Gallagher, Manager and Chief Engineer, SCRTD, November 30, 1979.

Washington, D.C. (WMATA): Construction cost quoted in Los Angeles *Times*, November 14, 1979.

San Francisco (BARTD): U.S. Department of Transportation, *BART's First Five Years: Transportation and Travel Impacts*, DOT-P-30-79-08, April 1979.

FIGURE 8-1
Comparison of Capital Costs of Metro Rail and Other Transit Systems

the system is likely to incur. The estimates were developed on the basis of key statistics (e.g., annual vehicle miles and vehicle hours) contained in the projected operating plan for Metro Rail in the year 2000, and the estimated resources required to operate the system at the planned level.

Costs were estimated for each of the following major O/M activities of the Metro Rail system:

- Operations--Costs of management, train operations, control center, stations, and security functions, including all labor, material, and miscellaneous expenditures necessary to operate the transit system

- Vehicle maintenance--Costs of all management, service, inspection and cleaning, heavy repair, component repair, and maintenance support functions, including all labor, material, parts, lubricants, and miscellaneous expenses necessary to maintain transit vehicles in a safe and reliable condition

- Ways and structures maintenance--Costs of all management, personnel, material, parts, and supplies needed to maintain track, structures, stations, shops, offices, and other facilities in a manner that will permit safe, comfortable, and efficient operations

- Subsystems operation and maintenance--Costs of all management, personnel, material, parts, and equipment needed to maintain the traction power, train control, fare collection, and communication subsystems, and all costs of the electric power required to run the transit vehicles

- General administration--Costs of the additional SCRTD administration required as a result of Metro Rail operations. This includes the labor cost associated with additional requirements for general management, planning and marketing, operational and safety training, customer relations, administrative management, and finance functions.

The estimation of costs for each of these activities involved two major cost components: labor costs associated with Metro Rail personnel (salaries, wages, and benefits), and the costs of material and other expenses (replacement parts, supplies, electric power, subcontracted activities, miscellaneous requirements). Labor costs were developed by: (1) estimating the number of personnel required at each skill level (operators, mechanics, administrative personnel, etc.); (2) establishing pay scales for each skill level on the basis of SCRTD's current scales in its bus operations, and then assigning a pay rate to each employee; (3) multiplying pay rates by personnel requirements to arrive at salary and wage totals; and (4) estimating fringe benefits on the basis of the estimate of total wages and salaries. These assessments were based on a variety of data, including detailed operating and maintenance procedures and annual budgets from other operating systems.

Costs of material and other expenses for each activity were developed by estimating the annual costs of electric power, parts, supplies, etc. Electric power costs were developed from engineering estimates of power consumption for trains, stations, yard and shops, and other facilities, multiplied by the unit cost of electricity. Expenses for major vehicle parts, such as wheels and brakes, were estimated on the basis of part replacement intervals and unit costs from BARTD (San Francisco), WMATA (Washington, D.C.), and other sources. For other expenses, such as supplies and miscellaneous parts, costs were based on the current experience of representative rail rapid transit systems.

The estimate of Metro Rail's annual liability expense includes the costs of personal injury, property damage, other liability expenses, and insurance coverage. It was developed on the basis of current SCRTD liability expenses, increased in a direct relationship to total projected Metro Rail employees and passengers in the year 2000.

The results of this estimating process are given in Table 8-2, which provides estimated O/M costs for each major Metro Rail activity as well as for the overall system. As with capital costs, these estimates have been developed both for the full 18-mile system and for the minimum operable segment. For the full system, O/M costs are estimated at $48.5 million per year; for the minimum operable segment, at $31.9 million per year.

As Table 8-2 indicates, subsystem costs will account for the largest single component of total system O/M costs, and are estimated at approximately $19.5 million per year for the full 18-mile segment. A significant portion of these costs is accounted for by expenditures on electric power, which are estimated to run $9.9 million annually.

The estimate of $48.5 million for total annual Metro Rail O/M costs breaks down into an estimated cost per passenger of $0.45; this compares with a cost per passenger forecast at $0.62 for combined bus/rail operations. The cost per passenger mile for Metro Rail is estimated at about $0.10, derived by dividing average cost per passenger by the projected average trip length for system passengers. Cost per passenger mile for combined bus/rail operations is projected at $0.18.

IMPLEMENTATION SCHEDULE

The implementation schedule for the final design and construction phases of the Metro Rail project is illustrated in Figure 8-2.

TABLE 8-2
Estimated Annual Operating and Maintenance Costs
of the Metro Rail System
(1983 Dollars)

COST ELEMENT	ESTIMATED COSTS TOTAL SYSTEM	MINIMUM OPERABLE SEGMENT
Operations	$ 9,735,702	$ 6,893,289
Vehicle Maintenance	8,307,436	4,963,710
Ways and Structures Maintenance	5,066,852	3,744,578
Subsystems Operation and Maintenance:		
Electric Power	9,877,500	5,551,649
Other	9,663,448	6,767,050
Subtotal	19,540,948	12,318,699
General Administration	3,956,042	2,765,204
Liability	1,900,000	1,254,992
TOTAL OPERATING AND MAINTENANCE COSTS	$48,506,980	$31,940,472

As indicated, construction is expected to occur in four overlapping phases:

- A-1 - Union Station to Wilshire/Vermont
- A-2 - Wilshire/Vermont to Fairfax/Beverly
- A-3 - Fairfax/Beverly to Hollywood Freeway
- A-4 - Hollywood Freeway to North Hollywood.

Phases A1 and A2 constitute the minimum operable segment, which is projected to be ready for revenue service by February 1990. The total 18-mile system is projected to be ready for revenue service by November 1990.

This schedule for the Metro Rail project, while ambitious, appears reasonable in comparison with the experience of other recently constructed rail rapid transit systems. In Baltimore, the 7.6-mile first-phase system entered final design in 1973, and revenue service began in the fall of 1983. In Atlanta, final design on the 13.7-mile first phase system began in 1972; revenue

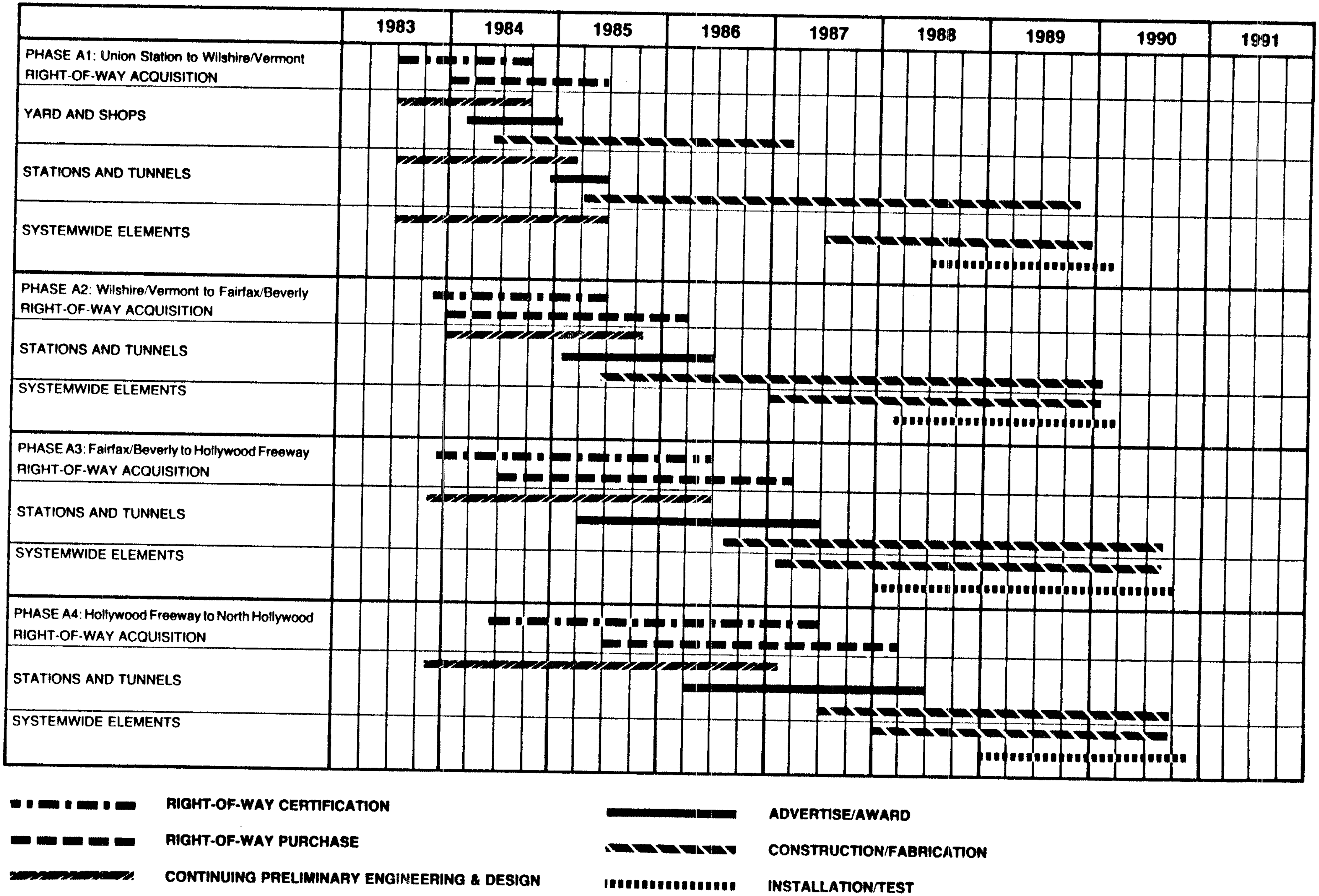


FIGURE 8-2
Preliminary Implementation Schedule of the Metro Rail Project

service was opened on the 6-mile East Line in 1979 and on the full 13.7-mile system in 1981. On the 71-mile BARTD system, final design started in 1962 and revenue service was initiated in 1972.

To accomplish the projected Metro Rail implementation schedule, it will be necessary for the project to be divided into a number of final design and construction packages of varying sizes. This approach will enable work to proceed concurrently in several areas; in addition, the size and scope of the various packages will ensure bidding competition and opportunities for small as well as large contractors. The Metro Rail fixed facilities, the tunnels, stations, yard and shops, have been divided into 16 contracts for final design and will be further subdivided for construction. Additional contracts will be issued for procurement of equipment/vehicles, train control, communications, etc.

FUNDING REQUIREMENTS

To accomplish the implementation schedule described above, a stable annual commitment of funds is necessary from various sources. Figure 8-3 shows the anticipated annual commitment of funds from the various agencies expected to participate in the project. As the figure indicates, UMTA Section 3 funds will supply the largest proportion of the project requirements, accounting for 62 percent of project funds in fiscal years 1984 through 1990 and approximately 77 percent in fiscal year 1983.

Under the program shown in Figure 8-3, funding commitments average about $550 million in fiscal years 1985 through 1989, with the maximum commitment of funds ($563 million) occurring in fiscal year 1986. The combined commitment of funds from all sources for the entire 9-year period equals the $3.3 billion estimated capital cost of the project.

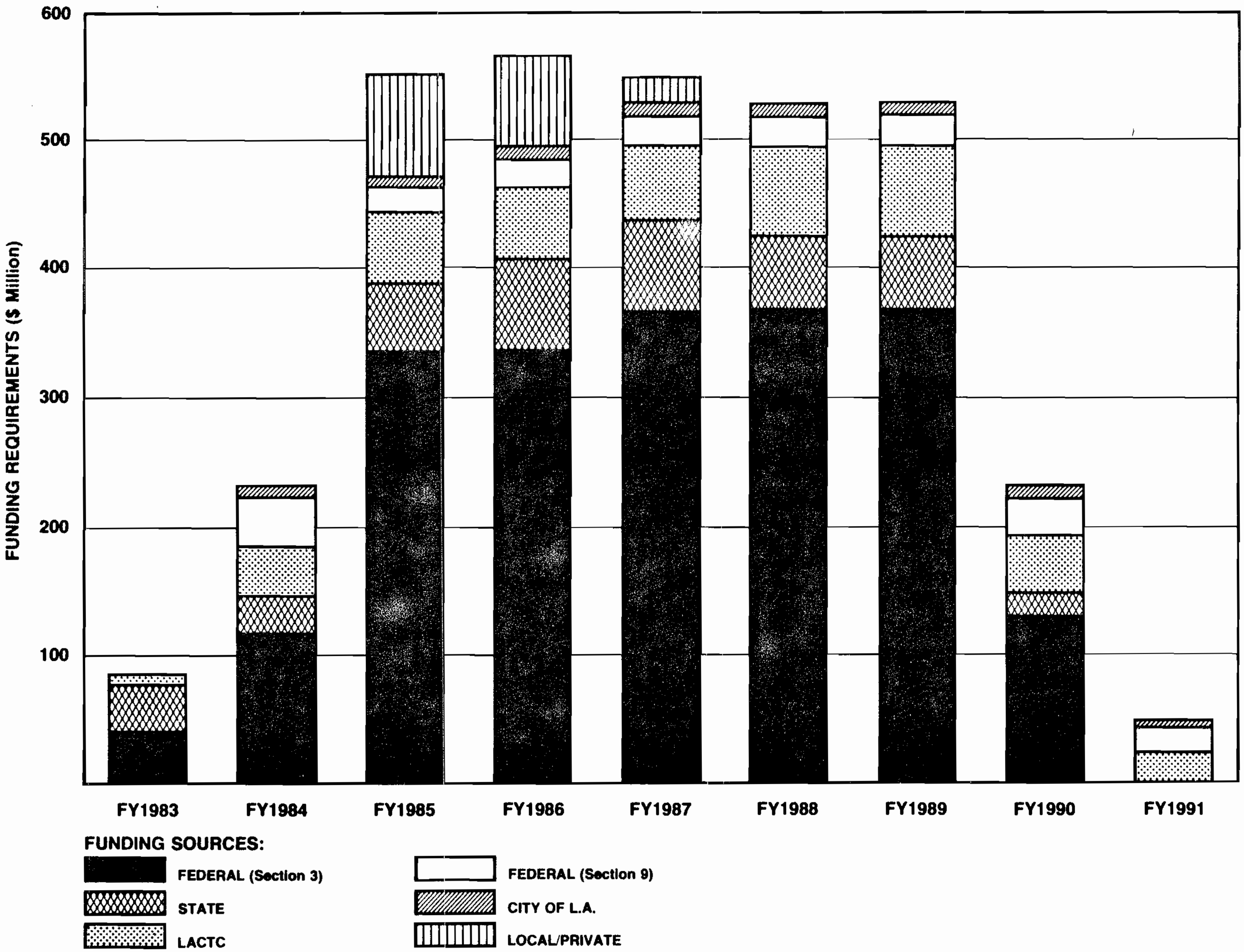


FIGURE 8-3
Anticipated Annual Commitment of Funds

APPENDIX A - GLOSSARY

APPENDIX A
GLOSSARY

This appendix presents definitions of the key terms found in the Milestone 12 Report, followed by a listing of the more frequently used acronyms and abbreviations.

DEFINITIONS OF KEY TERMS

Above Grade - Elevated or above the ground.

A-Car - The car of a dependent pair of passenger vehicles that is equipped with the pair's only air compressor, but lacks batteries and related equipment (see B-car).

Alignment - The route of the Metro Rail project, including the location of stations with respect to the surrounding area and their depth beneath the surface.

Alignment, horizontal - The location of the right-of-way and stations with respect to the surrounding area.

Alignment, vertical - The location of the track and structures beneath the ground, relative to the surface.

Arts Council - A group which will be established by the SCRTD Board of Directors to review and select art used in the Metro Rail system.

At grade - On the surface.

Automatic Train Operation (ATO) - The function within the automatic train control subsystem that regulates speed and programs the train for station entry and stopping.

Automatic Train Protection (ATP) - The function within the automatic train control subsystem that maintains safe train operation by providing for train detection, train separation, safe movement through track switches, and speed limit enforcement.

Automatic Train Supervision (ATS) - The function within the automatic train control subsystem that monitors the system status and provides the appropriate controls to direct the operation of trains in order to maintain intended traffic patterns and minimize the effect of train delays on the operating schedule.

Availability - The probability that a system or system element will be operational when called upon to perform.

B-Car - The car of a dependent pair of passenger vehicles that is equipped with the pair's only batteries, but lacks an air compressor (see A-car).

Below Grade - Underground.

Blow-down Facility - A pit in the vehicle maintenance shop where the underside of the passenger vehicles are cleaned with compressed air.

Blue Light Stations - Emergency trip stations located at tunnel cross passages so that traction power can be turned off locally in an emergency.

Bored Tunneling - Construction method of excavating tunnels by tunnel boring machines, which results in little, if any, surface disruption.

Bus Bays - On- or off-street areas for loading and unloading Metro Rail bus passengers without impeding traffic flow.

Bus Terminals - Off-street structures for loading and unloading Metro Rail bus passengers.

Capital Grant - Funding assistance to acquire, construct, reconstruct and improve transport facilities and equipment.

Cooling Towers - Structures that cool ambient air for the station.

"Concept Los Angeles", or the "Centers Plan" - The long-range plan for the City of Los Angeles adopted in 1974 which calls for increased clustering of on-going urban development in the high activity "centers", while allowing other areas to remain at lower densities. Having a means for rapid transit between "centers" is considered essential to the success of this plan. The County of Los Angeles and SCAG have adopted similar, complementary plans.

Consist - The specific grouping of identified vehicles into a train; the number and type of equipment of which a single train consists. For the Metro Rail system this is usually six cars, and the minimum consist is two cars.

Corridor - An area where a transit demand has been determined, or where a transit system is either being considered or is currently operating.

Cost-Effectiveness - A measure of the benefits or improvements in performance obtained relative to the money spent.

Criteria - A set of standards to be met by the designers and builders of the Metro Rail system.

Crossover - A segment of trackwork that allows train movement between two parallel sets of tracks.

Cut-and-Cover - A construction method that involves excavation under a temporary decking structure so that surface disruptions will be kept to a minimum.

Dependability - The ability of the system to perform as planned when called upon to do so.

Dependent Pair - Two passenger vehicles functioning together as a unit. (See "A-car and "B-car")

Density - The concentration of people or buildings per square unit of area.

Dwell Time - The total time from the instant that a train stops in a station until the instant it resumes moving.

Environmental Impact Statement/Environmental Impact Report (EIS/EIR) - A detailed evaluation of the impacts that a proposed project would have on the environment, including the adverse impacts and feasible mitigation measures for these impacts. An EIS is required for major federally funded projects; the EIR is required by the State of California.

Failure Management - An advanced design discipline which identifies and eliminates potential failures and copes with actual failures.

Feeder Bus - A bus which provides local, limited, or express service, collecting riders and transporting them to a central point for transfer onto other buses or rail service.

Fire/life Safety - The program directed at fire protection, fire suppression, and emergency preparedness aspects of the Metro Rail system. It includes the development of design criteria and verification of the design against the criteria. This process permits the design to meet the intent of local and state codes and standards.

Footprint Drawings - Preliminary site plans/drawings indicating basic surface and station features.

Grade Separation - The separation of intersecting routes by provision of a crossing structure.

Guideway - The structure and tracks upon which the transit vehicles will travel and be guided.

Headway - The time interval between two trains, both traveling in the same direction on the same track.

Interface - The point where two or more systems or subsystems meet and interact. An interface may be electrical, mechanical, functional, or contractural.

Kiss-and-Ride - A station access facility for auto drivers to drop off and pick up transit passengers.

Land Use - The existing conditions and projected planning for development, revitalization or preservation of land as defined by adopted community and governmental plans and codes.

Life Cycle Cost - A measure of the total cost of any item over its lifetime including the cost of acquiring the item. The life cycle cost is measured in terms of an annual equivalent cost where the initial capital cost is paid off over the item's lifetime at an appropriate interest rate.

Light Rail Transit (LRT) - An urban transport system that uses electrically powered rail cars on fixed rail lines. LRT operates at lower speeds and has less capacity than rail rapid transit.

Line - An established transport connection between two terminals, along which passengers can board and alight at designated stops or stations.

Link - That portion of a transport network which connects two modes.

Link Volume - The maximum number of passengers who will travel in one direction between each station on the Metro Rail route.

Maintainability - The capability of properly maintained equipment to be fixed or restored to working condition within a minimum time period.

Maintenance of Way - The repair and routine maintenance of track-work and other physical facilities of the system, including stations.

Maximum Design Earthquake (MDE) - An earthquake event which has a probability of occurring once every several thousand years.

Midline Turnback - A point other than the end of the line where trains can stop and turn back. This can occur only at stations where crossovers are provided.

Milestone - A significant point in project development that requires a major technical and/or policy decision.

Mimimum Operable Segment (MOS) - The minimum segment that the transit system can have and still provide reasonable service levels and operations. Required by UMTA, it has been defined as the Union Station to Fairfax/Beverly portion of the Metro Rail route.

Mode - A particular form or method of travel.

National Register of Historical Buildings and Districts - The Advisory Council on Historic Preservation and the federal agency responsible for the listing of all properties and districts that should be preserved.

Off-peak period - The hours of Metro Rail operation other than those of the heavy demand period.

Operating and Maintenance (O/M) Cost - SCRTD's cost for operating, maintaining, and managing transit service. O&M costs are usually stated on an annual basis.

Operating Design Earthquake (ODE) - An earthquake event which has a probability of occurring once every several hundred years.

Park-and-Ride - A parking facility for transit users who arrive by automobile.

Peak Periods - Periods of the day when the greatest number of passengers are traveling. In the Los Angeles area, the weekday peak periods are 6:30 to 9:00 A.M. and 3:30 to 6:30 P.M.

Pocket Track - A track, auxiliary to the main track, for passing, turnback, or storing trains.

Preliminary Engineering - The stage of the Metro Rail project which identifies and resolves major design and engineering issues, provides precise project definitions, and produces reliable cost estimates.

Program Plan - A formal set of statements used to implement and evaluate the progress of the safety, fire/life safety, security, and systems assurance management, and technical activities as they are performed through all program phases.

Quality Assurance - Systematic procedures to assure that items and equipment designed for the system will perform satisfactorily and as specified during actual operations.

Rail Rapid Transit - A transit mode that offers high speed rail service in electrically powered trains on grade separated routes.

Redundancy - The existence in a system of more than one means of accomplishing a given function, usually to provide a secondary level of safety.

Regional Core Area - A 55-square-mile portion of the metropolitan center of Los Angeles.

Right-of-Way - The land required for a transport system installation.

Second Tier EIS/EIR - A detailed, site-specific environmental analysis of the project as developed during the preliminary engineering phase of the project.

Subway station entrance - The segment of the station which provides passenger access between the ground level and the mezzanine.

Superelevation - The amount by which a track is banked on a curve.

System Assurance - The features that assure the system will provide dependable service, measured by reliability, maintainability, and quality assurance.

System Safety - The application of operating, technical, and management safety techniques to the system to reduce hazards to the lowest level possible within system resources.

Terminus - The starting and ending points of a transit line.

Track Switch - A track mechanism used to transfer the train from one set of tracks to another.

Truck - A subsystem element of rail vehicles that includes the wheels, axles, traction motors, gearbox, friction brakes, suspension systems, and the frame that holds these components. The rail vehicle has two trucks.

Urbanized Area - Land which has uninterrupted urban development.

Value Capture - Methods which enable public interests to actively share in the monetary benefits accruing from the implementation of a regional rapid transit system.

Ways and Structures - The track, guideway, and tunnels which transit vehicles traverse.

ABBREVIATIONS AND ACRONYMS

AA/EIS - Alternative Analysis/Environmental Impact Statement

AA/EIS/EIR - Alternative Analysis/Environmental Impact Statement/ Environmental Impact Report

ACHP - Advisory Council on Historic Preservation

APTA - American Public Transit Association

ATC - Automatic train control

ATEL - Administrative telephone system

ATO - Automatic train operation

ATP - Automatic train protection

ATS - Automatic train supervision

BARTD - Bay Area Rapid Transit District (San Francisco)

BPL - Bureau of Power and Light

BRRTS - Baltimore Rail Rapid Transit System

Btu - British thermal units

Caltrans - California Department of Transportation

CARB - California Air Resources Board

CBD - Central business district

CCTV - Closed-circuit television

CFM - Cubic feet per minute

CRA - Community Redevelopment Agency

CRT - Cathode ray tube

CTA - Chicago Transit Authority

CTC - California Transportation Commission

CTS - Cable transmission service

DOT - Department of Transportation

DTS - Data transmission service

EIR - Environmental Impact Report

EIS - Environmental Impact Statement

EPA - Environmental Protection Agency

ETEL - Emergency telephone system

ETS - Emergency trip station

FY - Fiscal year

GCRTA - Greater Cleveland Regional Transit Authority

kWh - Kilowatt hours

LACM - Natural History Museum of Los Angeles County

LACTC - Los Angeles County Transportation Commission

LADOP - City of Los Angeles Department of Planning

LAPD - Los Angeles Police Department

LARTS - Los Angeles Regional Transportation Study

LAUPT - Los Angeles Union Passenger Terminal

LRT - Light rail transit

MARTA - Metropolitan Atlanta Rapid Transit Authority

MBTA - Massachusetts Bay Transportation Authority

MDCTA - Metropolitan Dade County Transportation Administration

MDE - Maximum design earthquake

MOS - Minimum operable segment

MTEL - Maintenance telephone system

NHPA - National Historic Preservation Act

NYCTA - New York City Transit Authority

ODE - Operating design earthquak

O/M - Operations and maintenance

PABX - Private automatic branch exchange

PATCO - Port Authority Transit Corporation

APPENDIX B - BIBLIOGRAPHY

APPENDIX B

BIBLIOGRAPHY

This appendix presents a list of reports, drawings, and specifications which were prepared for the Metro Rail project in the following areas:

- Public Policy and Community Participation
- Patronage and System Operations
- Design Criteria and Standards
- Safety, Fire/Life Safety, Security and System Assurance
- Environmental and Geotechnical Considerations
- Ways and Structures
- Stations
- Subsystems
- Maintenance, Yards and Shops
- Cost Estimates.

The key reports which were written in each of the areas above are presented first, followed by the list of drawings and specifications.

REPORTS

Public Policy and Community Participation

Hollywood Citizens' Advisory Committee. Special Alternatives Analysis - Hollywood Area (WBS 11DAB16) Los Angeles: December, 1982. 54 pages plus 348 pages of appendices.

Outlines the Metro Rail Community Participation Program and local perspectives and recommendations from the Hollywood area. Discusses alignment alternatives, station locations, and operating plans. Appendices contain copies of all maps, handouts, petitions, letters, and other documents submitted to committee members.

Metro Rail Project, SCRTD. Metro Rail Community Participation Work Plan (WBS 11DAB) Los Angeles: 1981. Revised March, 1982. 17 pages plus exhibits.

Addresses the mechanisms by which interested, concerned, and affected citizens of the Los Angeles area may interact with and provide input to the Metro Rail project team, local

elected officials, and SCRTD Board of Directors on issues related to planning and development of rapid transit.

Metro Rail Project, SCRTD. Metro Rail Milestone 5 Final Report - Right-of-Way Acquisition & Relocations Policies & Procedures (WBS 14AAC) Los Angeles: July, 1982. 83 pages.

Outlines comprehensive policies and procedures developed to assure the timely availability of real estate for construction of the Metro Rail system, while assuring compliance with legal requirements for land acquisition. Topics covered include: public acquisition and relocation policies; SCRTD real estate process; appraisal of property; acquisition of property; relocation policies and procedures; and property management. Public comments and responses are also incorporated into this report.

Metro Rail Project, SCRTD. Metro Rail Project Milestone 6 Final Report - Land Use and Development Policies (WBS 14BAK) Los Angeles: January, 1983. 103 pages plus appendices.

Develops an effective and coherent set of SCRTD land use and development objectives and policies that will effectively govern the implementation of the Metro Rail Project. Also discusses: land use and transportation issues; the Metro Rail station area master planning process; joint development; and value capture. Public comments and responses are also incorporated.

North Hollywood Citizens' Advisory Committee. Special Alternatives Analysis - North Hollywood (WBS 11DAB16) Los Angeles: December, 1982. 136 pages plus 443 pages of appendices.

Describes the Metro Rail community participation program and outlines community perspectives and recommendations for the North Hollywood area. Alignment alternatives, station locations, and operating plans are discussed. Appendices contain copies of all documents submitted to committee members, a minority report, and minutes of committee meetings.

Patronage and System Operations

Metro Rail Project, SCRTD. Metro Rail Project Milestone 9 Draft Report - Supporting Services Plan (WBS 16BAX) Los Angeles: March, 1983. 136 pages plus appendices.

Describes methods and designs to ensure that the supporting services connected with the Metro Rail system will be integrated effectively and efficiently into the overall transit project. Topics covered include: supporting services policies and standards; integrated bus route configuration;

station design considerations; and future considerations. Public comments and responses are also included.

Metro Rail Project, SCRTD. Metro Rail Project Milestone 1 Final Report - Preliminary System Definition and Operating Plan (WBS 12H) Los Angeles: August, 1982. 38 pages plus appendices.

Presents the preliminary system definition and operating plan for the Metro Rail system as defined at the start of preliminary engineering. Identifies major design and operating alternatives to be analyzed and outlines alternatives and basic evaluation criteria. Public comments and responses are also incorporated into this report.

Booz, Allen & Hamilton Inc. Minimum Operable Segment Report (WBS 15B). Los Angeles: available approximately May, 1983.

Presents the operating plan for the minimum operable segment of the Metro Rail system, which extends from Union Station to Fairfax and Beverly. Identifies major design and operating alternatives to be analyzed and outlines alternatives and basic evaluation criteria.

Barton-Aschman Associates, Inc. in association with Jefferson Associates, Inc. Patronage Impact of Possible Future Line Extensions (WBS 12B) Los Angeles: June, 1981. 161 pages.

Presents results of a technical analysis of possible future line extensions on starter line traffic volumes and travel pattern characteristics. Discusses option network design description, travel demand methodology, and travel demand results.

Booz, Allen & Hamilton Inc. Preliminary Operating Plan (WBS 13DAA) Los Angeles: May, 1982. 40 pages.

Defines initial service and operating characteristics for the SCRTD Metro Rail system in the year 1995. Provides a point of reference for system design and for further analysis of operating alternatives. Topics include: system description; baseline operating plan for 1995; ultimate system capacity; ridership forecasts; and calculation of train round-trip times.

Design Criteria and Standards

Kaiser Engineers California. Review of Codes, Guidelines and Regulations (WBS 12F) Los Angeles: November, 1982. 61 pages.

Surveys codes, guidelines, and regulations applicable to the Metro Rail project. Topics covered include: passenger vehicle; communications; automatic train control; electrical power; elevators and escalators.

Metro Rail Project, SCRTD. Metro Rail Project Milestone 2 Final Report - System Design (WBS 12H) Los Angeles: August, 1982. 29 pages plus appendices.

Outlines the basic rules, requirements and guidelines used during the design process to ensure that the system design comforms to project objectives and requirements and all applicable laws. Defines and describes: general system criteria; subsystem design criteria; civil/structural design criteria; and mechanical/electrical design criteria. Public comments and responses are included.

Metro Rail Project SCRTD. Metro Rail System Design Criteria and Standards (WBS 13A,B,C,D) Los Angeles: 1982. Five volumes.

Defines detailed criteria and standards for design of all Metro Rail system elements. Covers: ways and structures; stations and architecture; mechanical and electrical system design; and subsystem design.

Booz, Allen & Hamilton Inc. Configuration Management Plan (WBS 14DAH) Los Angeles: October, 1982. 27 pages plus appendices.

Outlines and describes the configuration management plan, a formalized program that enables Metro Rail project management to monitor and control the development of documents that affect the design considerations and configuration of the Metro Rail system during the preliminary engineering phases. This plan specifies requirements to: identify and document physical and operational characteristics of the Metro Rail system, obtain reviews and approvals to control changes to these characteristics, and to record and report on the change process and status.

Metro Rail Project, SCRTD. Metro Rail Project Milestone 8 Draft Report - Systems and Subsystems (WBS 15D) Los Angeles: January, 1983. 75 pages plus appendices.

Provides an overview of the system and subsystem analyses which were performed to evaluate system operating requirements and select preferred subsystem (e.g., vehicles, train control, traction power, technology) alternatives. Includes: system description and approach; system operating requirements; subsystem alternatives; and emerging technology. Public comments and responses are also included.

Booz, Allen & Hamilton Inc. SCRTD Metro Rail Project System Specification (WBS 16DAM) Los Angeles: available approximately June, 1983.

Defines requirements for SCRTD initial segment. Serves as single source document to define functions, features, and performance levels and interface requirements of the system and its elements.

Safety, Fire/Life Safety, Security, and System Assurance

Booz, Allen & Hamilton Inc. Safety Criteria (WBS 13DAD) Los Angeles: August, 1982. 32 pages.

Documents a system safety approach stressing hazard identification, evaluation, and resolution in the design phase. The approach also emphasizes the use of the critical physical and functional interfaces between systems and subsystems. Addressed herein are safety criteria for: stations and sites; communications; passenger vehicles; train control; traction power and distribution; Central Control; ways and structures; operations; maintenance and training.

Kaiser Engineers California and Gage-Babcock & Associates, Inc. Fire/Life Safety Criteria (WBS 13DAK) Los Angeles: January 1983. 84 pages.

Outlines and establishes fire/life safety criteria for guidance in the final engineering phase of the Metro Rail project. Provides basis for personal safety and system reliability consideration, as well as reconciliation of local and state codes and federal guidelines. Identifies and addresses the needs of fire/life safety in: station facilities; trainway facilities; passenger vehicles; yard and maintenance facilities; communications; Central Control facility; and inspection, maintenance and training.

Booz, Allen & Hamilton Inc. and Kaiser Engineers California. Security Criteria (WBS 13DAD) Los Angeles: August, 1982. 26 pages.

Discusses design methods for eliminating or reducing crimes and acts of vandalism associated with the Metro Rail system. Topics covered include: site and landscape considerations; lighting; parking and access requirements; architectural features; CCTV and other electronic surveillance; restroom security; station closure; security for non-public areas and on-board vehicle considerations.

Booz, Allen & Hamilton Inc. System Assurance Criteria (WBS 13DAD) Los Angeles: November, 1982. 18 pages.

Defines and enumerates the significant factors pertaining to reliability, availability, maintainability, dependability,

and quality assurance. Establishes criteria for these categories which are to be used throughout all phases of the Metro Rail project.

Booz, Allen & Hamilton Inc. System Safety Program Plan (WBS 14DAD) Los Angeles: October, 1982. 29 pages.

Describes the Metro Rail System Safety Program. Outlines management structure of the program, safety techniques, and the methodology required to achieve a level of safety commensurate with those of other transit systems in all phases of the Metro Rail project. Discusses in detail both system description and system safety program tasks.

Booz, Allen & Hamilton Inc. Security Program Plan (WBS 14DAD) Los Angeles: December, 1982.

Describes the security program for all aspects of the Metro Rail system. Discusses: types of security problems; the system security approach; and security-related activities.

Booz, Allen & Hamilton Inc. System Assurance Plan (WBS 14DAD) Los Angeles: December, 1982.

Outlines the program plan whereby the various systems of the Metro Rail project will be kept operational. System assurance criteria are described in terms of reliability, maintainability, failure management, and quality assurance.

Metro Rail Project, SCRTD. Metro Rail Project Milestone 7 Draft Report - Safety, Fire/Life Safety, Security, and Systems Assurance. (WBS 15D) Los Angeles: December, 1982. 101 pages plus appendices.

Covers all aspects to satisfy transit safety, fire/life safety, security, and systems assurance requirements. Public comments and responses are also included.

Environmental and Geotechnical Considerations

Converse Consultants. Geotechnical Investigation Report (WBS 12AAC) Los Angeles: November, 1981.

Outlines results of subsurface soil investigation. Describes exploration and testing program; project geologic features of engineering significance; previous tunneling experience in the area; anticipated ground behavior in underground construction; anticipated ground behavior in surface excavations; design considerations; specific subsurface problems in design and construction.

Converse Consultants. Seismological Investigation and Design Criteria (WBS 12AAD) Los Angeles: October 9, 1981.

Outlines findings of seismic investigation and establishes design criteria for the Metro Rail project. Topics covered include: geologic setting; historic seismicity; geologic seismicity; probable ground motions; maximum credible ground motions; fault crossing rupture hazard.

Waters Consultants Division of Professional Services Group, Inc. Soil Conservation Study (WBS 12AAH) Los Angeles: January 6, 1983. 21 pages plus drawings and calculations.

Examines soil conditions with regard to the Metro Rail project. Topics covered include: soil corrosivity vs. resistivity; building criteria for metallic structures; and building criteria for concrete structures. Provides recommendations concerning piping, liner segments, station depths, conduits, and elevator hydraulic cylinders.

Wilson-Ihrig Associates. Noise and Vibration Study - Alternative Route Alignments for the Metro Rail Project (WBS 12AAJ) Los Angeles: October, 1982. 99 pages.

Outlines results of a study of the noise and vibrational characteristics to be expected from the Metro Rail system operations along the proposed alignment. Topics include: existing noise levels; ground-borne noise and vibration from subway operations; fan and vent shaft noise levels; ancillary facility noise; noise levels from surface and aerial structure operation; yard noise; construction noise levels; and noise level changes due to changes in traffic patterns.

Wilson-Ihrig Associates. Noise and Vibration (13AAH). Los Angeles: August, 1981.

Summarizes applicable regulations. Provides noise survey results. Outlines: noise and vibrational control procedures; construction noise and vibration; pressure transient controls.

Booz, Allen & Hamilton Inc. Additional Investigations of Energy Management Alternatives for the Starter Line of the SCRTD Metro Rail Project (WBS 13DAC) Los Angeles: March, 1982. 29 pages.

Summarizes energy management recommendations. Topics include: revised application of energy data from previous simulation runs; review of additional capital costs, operating costs, and maintenance costs for vertical profiles, summaries of cost data, cost comparisons, and conclusions; review of JPL reports; and recommendations.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Environmental Control System - Preliminary Design Report (WBS 16AAQ) Los Angeles: March 4, 1983.

Documents the preliminary design of the environmental control system for the public areas and tunnels of the Metro Rail system. Discusses control of environmental conditions, in terms of temperature, velocity and pressure, needed to meet the diverse needs of normal operations and emergencies, including fire. Discusses fan systems and shafts, station equipment, and emergency ventilation operation.

Urban Mass Transportation Administration, U.S. Department of Transportation in cooperation with the SCRTD. Preliminary Draft of Environmental Impact Statement and Environmental Impact Report, Los Angeles Rail Rapid Transit Project, Metro Rail (WBS 18CAC12). Los Angeles: available approximately May, 1983. 355 pages.

Identifies and describes primary impact areas affected by the Metro Rail project. These include: the major categories of transportation; land use; socio-economic impacts; and energy impacts. Other impact areas discussed include: air quality; noise and vibration; security; historic resource preservation; and impacts of construction activity. A "No Project" alternative is defined and evaluated, as is a "Minimum Operable Segment".

Ways and Structures

Metro Rail Project, SCRTD. Metro Rail Project Milestone 3 Final Report - Route Alignment Alternatives (WBS 14AAA) Los Angeles: February, 1983. 140 pages plus appendices.

Outlines route alignment alternatives and explains the analysis procedure used to evaluate such alternatives. Discusses: alignment alternatives considered; evaluation methodology and criteria; analysis and evaluation; community suggested options; and board actions and final alignment.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Investigation of Rail Sections (WBS 14AAK) Los Angeles: February 4, 1983. 9 pages.

Reviews and discusses various rail sections, both foreign and domestic, available for use as running rails on the Metro Rail project. "Tee" type rails, designed for general use in open track systems, are described. Also covered: future maintenance; structural considerations; electrical characteristics; available rail sections; and life cycle costs.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Special Report on Tunnel Arrangements (WBS 14AAM) Los Angeles: February, 1983. 12 pages.

Describes and evaluates alternative tunnel arrangements to determine the most feasible, cost effective and environmentally acceptable solutions to tunneling problems. Considers both soft ground and hard rock tunnels in terms of tunnel configuration, geotechnical considerations, cost, effects on station configurations, crossovers, pocket tracks, and future lines. Also incorporated in this report are fire-safety requirements and ventilation considerations. Recommended configurations and arrangements for both soft ground and rock tunnels are included.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Interim Report on Muck Disposal (WBS 14AAN) Los Angeles: August, 1982. 14 pages.

Details the quantities, type and timing of the production of excavated spoil (muck) from the proposed Metro Rail project. Topics include: calculation of volume and production rates; backfill; and oil-contaminated material.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Report on Construction Methods - Line Construction (WBS 14BAF) Los Angeles: December, 1982. 92 pages.

Describes various construction methods available for both the line and station structures of the Metro Rail project. Recommends methods for the various segments of the system and establishes foundation upon which preliminary cost estimate is based. Discussed herein are: cut-and-cover construction, open cut construction, bored tunneling, aerial structures, underground utilities, street detours, and working space considerations.

Stations

Metro Rail Project, SCRTD. Metro Rail Project Milestone 4 Final Report - Station Location Alternatives (WBS 14BAA) Los Angeles: available May, 1983.

Outlines the development of the selection of station locations for the Metro Rail system. Topics covered include: design philosophy; station entrances; station components; patron movement; and other station considerations. Specific station descriptions for all locally preferred location sites are also provided. Public comments and responses are also included.

weighs the possibility of purchasing rail grinding equipment vs. contracting this work.

Kaiser Engineers California. Passenger Vehicle System Definition (WBS 16CAA) Los Angeles: available approximately May, 1983.

Provides overall description of passenger vehicle system and its subsystems. Outlines the operational function of each subsystem and the internal interface requirements. Topics include: vehicle body; operator's cab; doors; heating, ventilation and air conditioning; lighting; couplers; propulsion; friction brakes; auxiliary electrical subsystem; trucks; automatic train control; and communications.

Kaiser Engineers California. Train Control System Description (WBS 16CAB) Los Angeles: January 14, 1983.

Defines basic subsystem and elements of the automatic train control system and its equipment elements, based on SCRTD Metro Rail criteria and direction received from the Metro Rail project staff. Discusses: functional requirements; automatic train protection; automatic train control; and the management information system.

Kaiser Engineers California and Pacific International Engineers/ L. H. Hajnal & Associates. Alternatives Analysis - Traction Power (WBS 14CAD11) Los Angeles: November 1982. 78 pages plus appendices.

Describes design alternatives for the Metro Rail traction power subsystem and its major components. Includes analyses of the alternatives and recommendations for the substation configuration, transformer cooling system, contact rail material, primary switchgear, conduit system, and DC distribution voltage. Also in this report is an evaluation of substation locations.

Kaiser Engineers California and Pacific International Engineers/ L. H. Hajnal & Associates. Alternatives Analysis - Auxiliary Power (WBS 14CAD12) Los Angeles: December, 1982. 73 pages plus appendices.

Analyzes alternatives for the passenger station primary power supply, secondary power distribution systems and major subsystems such as the standby engine generator, low-voltage switching protective equipment, and tunnel lighting. Evaluates all alternatives on a technical level, compares qualitative differences. Weighs annual equivalent costs, and develops an auxiliary power subsystem which optimizes economy, performance and reliability.

Kaiser Engineers California. Communications Alternatives Analyses (WBS 14CAC) Los Angeles: January, 1983. 45 pages plus appendices.

Outlines and analyzes various alternatives concerning preferred design alternatives for the Metro Rail communications system and its major components. Includes alternatives and recommendations for vehicle radio service, telephone service, closed-circuit television, and cable transmission service.

Kaiser Engineers California. Communications System Description (WBS 16CAC) Los Angeles: February 16, 1983. 39 pages.

Outlines considerations pertaining to preliminary designs and specifications for the communications system to be utilized by the Metro Rail system. Describes the functional requirements of the general subsystem and the following lesser subsystems: radio; telephone; fire and security communications; public address; station intercom; closed circuit television; the master clock; yard intercom/paging; data transmission; and cable transmission.

Maintenance, Yards and Shops

Booz, Allen & Hamilton Inc. Yards and Shops Operational Criteria (WBS 13DAJ) Los Angeles: May, 1982. 34 pages.

Defines specific functional requirements and operational criteria associated with yards and shops. Identifies the needs of the initial 18-mile segment for both the year 1995 and ultimate system capacity. Serves as a guide for the layout and design of these facilities.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Functional Plan - Yards and Shops (WBS 14AAG) Los Angeles: December 14, 1982. 70 pages.

Describes and discusses considerations concerning the system of yards and shops needed for the storage and maintenance of Metro Rail transit vehicles. Outlines plans and configurations of yard and shop facilities. Covered herein are: yard operating philosophy; yard functions; description of shops and their functions; maintenance philosophy; shop administration and supervision considerations; and descriptions and layouts of specific yard and shop buildings.

Booz, Allen & Hamilton Inc. System Maintenance Plan (WBS 16DAJ) Los Angeles: available approximately May, 1983

Describes the major maintenance activities required for Metro Rail. Defines the tasks required to develop maintenance requirements. Identifies a maintenance function organization and describes the methods to be used in developing detailed maintenance procedures.

Cost Estimates

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Estimating Methodology and Procedures (WBS 14AAE) Los Angeles: February, 1983. 39 pages.

Outlines procedures and methods used for cost estimating for the Metro Rail system. Topics include: estimate structure; quantity survey; direct cost estimate; indirect cost estimate.

Metro Rail Project, SCRTD. Metro Rail Project Milestone 11 Draft Report - Preliminary Cost Estimate (WBS 17D) Los Angeles: April, 1983. 66 pages plus appendices.

Presents the preliminary engineering estimates of system capital cost, together with estimated maintenance and operating costs. Outlines cost estimating base and methodology. Also discusses: capital cost estimate; operating and maintenance cost estimates; and program schedule and cash flow.

DRAWINGS AND SPECIFICATIONS

Public Policy and Community Participation

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Property Acquisition Requirements (WBS 16AAH11) Los Angeles: November, 1982. Right-of-way plans.

Design Criteria and Standards

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Civil Criteria (WBS 13AAA) Los Angeles: May, 1982. Preliminary design drawings.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Track Work Criteria (WBS 13AAD) Los Angeles: available approximately May, 1983. Preliminary design drawings.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Yards and Shops Criteria (WBS 13AAD) Los

Angeles: available approximately May, 1983. Preliminary design drawings.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Ventilation Criteria (WBS 13AAE) Los Angeles: available approximately May, 1983. Preliminary design drawings.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Civil/Structural Design (WBS 16AAA) Los Angeles: November, 1982. Civil/structural plans.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Contract Packaging Drawings (WBS 16AAR) Los Angeles: available approximately July, 1983. Preliminary drawings.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Directive and Standard Drawings (WBS 16AAW) Los Angeles: available approximately July, 1983.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. General Plans (WBS 16AAV) Los Angeles: available approximately July, 1983.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. General Plans - Civil (WBS 16AB12) Los Angeles: available approximately April, 1983. Preliminary street plans.

Ways and Structures

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Trackwork System Design (WBS 16AAC) Los Angeles: November, 1982. Trackwork design plans.

Stations

Harry Weese & Associates. Architectural Drawings (WBS 16BAA) Los Angeles: available approximately June, 1983. General plans for each station, including floor plans, sections, and elevators as required.

Harry Weese & Associates. Civil Drawings - Site Work (WBS 16BAB11) Los Angeles: available approximately June, 1983. Site plans for each Metro Rail station, showing streets, traffic and pedestrian movements, existing property lines, critical spot elevations, and the locations of all existing and proposed site structures.

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Station Structural Engineering Drawings (WBS 16BAC) Los Angeles: available approximately May, 1983. Framing plans and sections.

Harry Weese & Associates. Mechanical Engineering Drawings (WBS 16BAD) Los Angeles: available approximately June, 1983. Floor plans and sections indicating the basic mechanical systems in schematic form for each station. Includes: heating, ventilation and air conditioning; plumbing; fire protection; elevators; and escalators.

Harry Weese & Associates. Electrical Engineering Drawings (WBS 16BAE) Los Angeles: available approximately June, 1983. Floor plans and sections indicating the basic and standby electrical systems in schematic form for each station. Includes provisions for communications and alarm systems.

Harry Weese & Associates. Elevator/Escalator Requirements (WBS 16BAJ) Los Angeles: available approximately May, 1983. Schematic designs and outline specifications.

Harry Weese & Associates. Lighting (WBS 16BAS) Los Angeles: available approximately May, 1983. Lighting designs for each Metro Rail station plan.

Subsystems

Kaiser Engineers California. Passenger Vehicles (WBS 16CAA) Los Angeles: available approximately April, 1983. Preliminary designs, drawings and specifications.

Kaiser Engineers California. Mechanical and Electrical Equipment (WBS 16CAE12) Los Angeles: available approximately April, 1983. Final design drawings and specifications.

Kaiser Engineers California. Auxiliary Vehicles (WBS 16CAE13) Los Angeles: available approximately June, 1983. Preliminary designs, drawings and specifications.

Kaiser Engineers California. Traction Power and Distribution (WBS 16AD11) Los Angeles: available approximately May, 1983. Preliminary designs, drawings and specifications.

Kaiser Engineers California. Auxiliary Power (WBS 16CAD11) Los Angeles: available approximately May, 1983. Preliminary designs, drawings and specifications.

Kaiser Engineers California. Communications (WBS 16CAC11) Los Angeles: available approximately April, 1983. Preliminary designs, drawings and specifications.

Kaiser Engineers California. Fare Collection (WBS 16CAE11) Los Angeles: available approximately April, 1983. Preliminary design drawings and specifications.

Maintenance, Yards and Shops

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Yards & Shops Facilities Design (WBS 16AAB) Los Angeles: February, 1983. Yards and shop plans.

Cost Estimates

Daniel, Mann, Johnson, & Mendenhall/Parsons, Brinckerhoff, Quade and Douglas. Capital Cost Estimates (WBS 17BAA) Los Angeles: available approximately April, 1983.

APPENDIX C - PUBLIC COMMENTS AND SCRTD RESPONSES

APPENDIX C
RESPONSES TO PUBLIC COMMENTS

Following the publication of the Milestone 12 Preliminary Draft Report in May 1983, public meetings were held to enable area residents to coment on that milestone. At the meetings, held in two rounds during the weeks of May 16-19 and May 23-26, 1983, the comments of area residents were recorded by a representative of the SCRTD Community Relations staff, and attendees were also encouraged to send in written comments. Responses to the public's comments were compiled by SCRTD staff and consultants and were published, in June 1983, in an addendum to the Milestone 12 Preliminary Draft Report.

This appendix reproduces the comments and responses published in the June 1983 addendum, organized in the following sections:

- Implementation and Funding
- Environmental Impacts
- Planning
- System Design
- Station Design
- Equipment Design
- Construction
- Safety and Security
- Operational Service
- Fare Collection
- Cost Estimation

IMPLEMENTATION AND FUNDING

1. How is the Metro Rail financial strategy coordinated with Washington's budget development process?

   A. Los Angeles complies with all relevant federal guidelines and is following the federal budgeting process in planning and establishing funding needs for the Metro Rail project. Part of SCRTD's financial strategy is to seek 62 percent of Metro Rail's construction cost from federal funding sources. SCRTD has been participating in the congressional budgetary process to secure those needed federal dollars. As of this writing, Congress is reviewing the Metro Rail project and will soon make a final determination as to how much federal funding will be appropriated for the project's construction in the next fiscal year, beginning October 1. Success in this effort will mark the first step toward a full-funding federal construction commitment for Metro Rail.

2. Why do we have to depend on the federal government for money?

   A. For years, residents of Los Angeles have been contributing federal taxes that have been used to construct rapid transit systems in other metropolitan areas that have fewer people, less density, and lower growth and transit needs. Therefore, it is not a question of depending on the federal government, but an opportunity to obtain Los Angeles taxpayers' fair share of available federal money to pay for a system in their own "backyard."

3. How much funding has the project received to date?

   A. The project has received $91 million in federal, state, and county funds for planning studies, preliminary engineering, and design work. The California Transportation Commission has allocated an additional $32.6 million to acquire the property for the Metro Rail central maintenance yard near downtown Los Angeles. This award brings the total to $123.6 million.

4. If Houston is saying they have a 50 percent local match, why can't we do it here?

   A. Over the last 5 years, Houston has been building a local funding base which was initiated by a 1978 vote for a one-cent sales tax. In Los Angeles, a one-half cent sales tax was voted for in November

1980, but collection of funds did not start until July 1982. These funds will be used until 1985 to reduce SCRTD bus fares. In 1985, 35 percent of the funds will then be available for all local rail transit projects. Only a percentage of this amount will be available for the Metro Rail project. Therefore, Los Angeles does not have the same local funding base as Houston and cannot, at present, have a 50 percent funding match.

5. What is the chance that Metro Rail will not get constructed at all?

   A. We feel the chance of the project not being constructed is remote. During the past few years, the federal government has been investing in preliminary engineering for the project. As recently as the end of May, the federal government, for the first time, recommended funds to start construction of the project. The state has pledged $400 million for the project. Besides additional funding, public support for the project is strong and growing. In 1980, voters passed a half-cent sales tax increase which will provide local matching funds for construction, which clearly shows a public mandate for the project.

6. There are no track facilities west of Fairfax or east of Union Station. Because of budget constraints, will only a segment of Metro Rail be built?

   A. We do not anticipate building only a segment of the Metro Rail system. Our budgetary projections and final design and construction plans and schedules contemplate constructing the entire system.

7. With "money being funny" in Washington, how realistic is the possibility of extending the construction schedule from the projected 6 years to as long as 10 years?

   A. The projected 6-year construction schedule was developed from a proposed funding plan. Deviation from any of the needed fiscal year allocation of federal funding will cause the 6-year construction schedule to stretch out somewhat. We cannot judge what the funding availability will be at this time, so we cannot estimate a firm schedule for completion.

8. What happens if the project loses funding in the midst of construction?

A. It is unlikely that this situation will occur. Construction will not begin until we have assurance of a full funding commitment. Federal authorization will not be given unless funding to a satisfactory state of completion is assured.

9. What do congressional leaders think of our Metro Rail project, compared to Houston's?

   A. Both cities have congressional delegations which have publicly stated support for each project. We have not heard of any comparison of the two projects.

10. Considering that both Los Angeles and Houston have been awarded $110 million for construction next year, are we still in competition with Houston?

    A. Since the Houston bond referendum failed on June 11, 1983, the Houston funding was dropped to a proposed level of $45.5 million. Los Angeles' potential funding is now $127.5 million. It is uncertain what Houston's plans are at present or if a competition exists.

11. Can you explain why Houston was awarded the same amount of money as Los Angeles when they have not done preliminary engineering to the detail that we have?

    A. See response to Question 10.

12. Where will extra money come from if Metro Rail has a 62 percent federal and 38 percent local funding split?

    With 62 percent of the total funding provided by the federal gasoline tax revenue, the 38 percent will come from state and local public funds and from the private sector through joint development and value capture.

13. Have you considered increasing taxes to generate more local match dollars?

    A. No, we have not. The voters in Los Angeles County have already voted to tax themselves for transit through the one-half cent sales tax provided by Proposition A.

14. Can private money be used to build the project? Can SCRTD sell bonds?

    A. Yes, private money can be used. SCRTD is attempting to secure the authority to sell bonds through legislation which is currently being considered by the State Legislature. It is hoped this will soon be signed into law.

15. Didn't BART finance construction through revenue bonds?

    A. No, BART financed construction with general obligation bonds which the voters approved in November 1962.

16. How can you justify adding more stations when you're having problems finding financing for the first 16 stations?

    A. The justification for stations comes from a number of factors. Stations provide access to the trains that move people from one part of the city to another. The decision to add any station must be made on the basis of a careful analysis that weighs the positive aspects of the station, including increasing patronage, operating revenue, joint development opportunities, support of land use objectives, etc. with the cost aspects of the station.

ENVIRONMENTAL IMPACTS

17. What about noise and emission control of bus operations in the vicinity of Metro Rail stations?

    A. Noise Control. A number of noise surveys have been performed at several SCRTD facilities to examine noise conditions resulting from bus operations. The most intrusive, long-term noise will be from engines idling while passengers board and alight from the buses.

       Generally, the noise generated varies between 60 and 65 dB(A). Utilizing the proper combination of mitigation techniques, noise could be reduced in many instances by as much as 15 dB(A). This would lower noise to levels ranging from 50 to 55 dB(A), thereby making it generally compatible with local noise ordinances.

       Acceleration from a standing position is also another noise consideration. In the most extreme cases, noise levels can range between 75 and 85 dB(A), especially when a bus is accelerating away from an on-street bus stop. Acceleration rates and therefore noise levels are usually lower in off-street facilities. SCRTD can apply the following mitigation measures at off-street locations to further reduce noise:

       - Effective separation between bus bay and adjacent properties through proper site design
       - Physical barriers which either absorb or block noise, such as:
         - Solid-faced masonry walls, with or without special sound absorption material
         - Creative landscaping with shrubbery such as trees and bushes
       - Drive-through "tunnels" which completely surround noise generation
       - Modified engine idling procedures
       - Replacement of old buses with newer buses, designed with built-in noise abatement equipment.

Emission Control. Several measurements have been taken at regional and local sites of air quality emissions from vehicular traffic, which includes bus operations.

Although feeder buses would contribute incrementally to local carbon monoxide (CO) concentrations at several station locations, standards will be exceeded at these "hot spot" locations anyway -- with or without the project. Therefore, the rail and associated feeder bus activity would not of itself create unhealthful air quality conditions in the vicinity of Metro Rail stations. Moreover, any additional feeder bus volumes which result from redesign of route configurations and schedules would be insignificant compared with the already existing background bus activity at these corresponding locations (intersections).

Nevertheless, air pollution abatement techniques will be applied where practicable and feasible. Such mitigation measures include, but are not limited to, the following:

- Shutting off bus engines if idling duration is above a given amount of time
- Designing stations and associated bus bays for efficient, smooth traffic flow. This would tend to decrease the number of "stop-go" type movements and, in turn, tend to decrease sporadic pollutant emissions.
- Replacing of old buses with new buses, designed with built-in pollution control equipment
- Providing facilities at stations for bicycle and motorcycle parking in order to reduce the need for excessive feeder bus traffic.

18. Why isn't the traffic study for North Hollywood in the Milestone 12 Preliminary Draft Report?

A. Milestone 12 is intended to be a summary document covering all steps in the milestone process. Traffic analyses are discussed in more detail in the Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR), which has now been published, and its supporting technical reports. The traffic analyses were done by the City of Los Angeles Department of Transportation (LADOT), using the SCRTD station plans, feeder bus plans, and patronage projections available at that time. Now that more refined plans and projections are available, we are funding LADOT to update their analyses, especially in the North Hollywood and Universal City areas. Results of these new analyses will be available in the coming months. Much of this work will be completed in time to be reflected in the Final EIS/EIR.

19. When will the EIS/EIR be available?

    A. The Draft EIS/EIR became available on June 3; the Final EIS/EIR is currently scheduled to become available October 3.

20. Please discuss the need for socioeconomic studies of the riders.

    A. Generally, the focus of the Metro Rail project has been on performing a transportation function as opposed to a social service function. Nevertheless, both the first tier and second tier EIS/EIR have documented that the proposed facilities do not discriminate against one social or economic group in favor of another. In fact, the Alternatives Analysis had as one objective the identification of a project that would serve as broad a social and economic constituency as possible.

    With regard to the transportation function, projected levels of patronage and use are important to an effective system design. Transit use and patronage are associated with socioeconomic conditions -- for example, low-density, high-income neighborhoods, particularly those with few children, tend to have a low demand for public transit. Therefore, to develop estimates of patronage and use for Metro Rail, a model is used which incorporates the socioeconomic characteristics of the potential service area.

PLANNING

21. Why didn't you employ monorail technology? Isn't it cheaper?

    A. Monorail technology would be unsuitable for the Metro Rail system. The capacity of existing monorail systems is too low for the patronage anticipated and speeds are too low for the trip lengths. Further, a monorail system would cause severe community impact because more private property would have to be acquired, and there would be a permanent negative aesthetic effect.

22. How are the transportation funds for Los Angeles apportioned?

    A. Funding of Metro Rail will involve a variety of federal, state, and local resources, including the following:

SOURCE	PERCENT OF FUNDING
Urban Mass Transportation Administration:	
° Section 3 capital funds	62
° Section 9 capital funds	7
State funds	11
Los Angeles County Transportation Committee (Proposition A and state transit assistance funds)	13
City of Los Angeles Proposition A local funds	2
Private sector	5

23. Are the light rail transit (LRT) projects under the direction of the SCRTD?

    A. The light rail systems under consideration are (or will be) under the cognizance of the Los Angeles County Transportation Committee during planning, design, and construction. SCRTD will operate these light rail lines when they are completed.

24. Why couldn't you use a light rail system as the starter line like the San Diego Trolley?

A. The light rail system capacity is not adequate for the patronage expected on the Los Angeles Metro Rail system. Also, the average speed of light rail systems is less than that needed to be able to offer high-speed rail transit.

25. Will there be a joint station for Metro Rail and the L.A./Long Beach trolley? Will both systems be able to use the same tracks?

A. There are no firm plans at present for joint Metro Rail/Long Beach light rail stations. The LACTC is studying where and how to terminate the Long Beach light rail system in downtown Los Angeles. One possibility is a station adjacent to the Metro Rail 7th/Flower Street Station which would afford easy transfer.

The two systems will use different types of power systems. Metro Rail will use a third rail system, and the Long Beach light rail transit will use a catenary or overhead system. Therefore, there will be no common usage of tracks for revenue operation. However, vehicles from either system could be moved on the tracks of the other system, as both will be of the same gauge.

26. What is proposed for existing abandoned Pacific Electric stations in the Los Angeles area?

A. The LACTC is reviewing possible rights-of-way for new rail transit development. Where Pacific Electric rights-of-way and stations are still available, the locations will be fully considered.

27. Will Union Station be used only for Metro Rail or other systems like the Bullet Train and AMTRAK? (42)

A. The long-range goal of the California Transportation Commission is to make Union Station a multimodal terminal, serving as a major transfer point in Los Angeles. Caltrans is now attempting to acquire the station for that use.

28. How can you say the freeway ride will take more time than the Metro Rail ride?

A. The Metro Rail system will clearly offer higher speed service than the private automobile at the freeway speeds presently encountered during much of the day (35 mph for Metro Rail versus 20 mph or less on freeways). During non-peak hours, both modes are expected to have higher speeds.

Traffic congestion throughout the region is expected to increase substantially. The Southern California Association of Governments, in its freeway projections, shows a capacity deficiency of three full lanes (one way) on the Hollywood Freeway. Metro Rail will be unimpeded by traffic congestion.

29. Will riders use Metro Rail if a bus ride to the same destination is faster?

    A. It is difficult to envision a situation where a rider could reach a destination served by Metro Rail faster by bus than by the subway. First, Metro Rail will provide higher speed service than buses. Secondly, Metro Rail and buses will not directly duplicate service. The bus system designed to interface with the Metro Rail system will maintain existing travel patterns except where those routes would duplicate the Metro Rail route. In those areas, bus lines may be terminated at stations or deviated from their current routes to stop right at the station. See Milestone 9 for a fuller discussion.

30. Why are you terminating so many Wilshire bus lines at the Vermont Station?

    A. Only two lines will be terminated at the Vermont Station. Line 51 (Avalon Boulevard-West 7th Street) currently terminates in the vicinity of the proposed Vermont Station, as does Line 201 (Silver Lake Boulevard). Service on Vermont Avenue (Line 204), 6th Street (Line 18), and Wilshire Boulevard (Lines 20-21-22), will be continued as a through-service.

31. Will all express buses terminate at the Universal City Station?

    A. All San Fernando Valley express lines will be terminated at either of the two Valley stations. Buses no longer needed to travel all the way to downtown will be placed back in service within the Valley to bring people quickly to Valley stations.

32. "It is the policy of the SCRTD Board of Directors that the Metro Rail system shall maximize capital and operating cost-effectiveness in terms of costs per passengers carried and passenger miles traveled." (p.28)*

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* The page numbers referenced throughout this Section refer to the Preliminary Draft Report for Milestone 12, System Plan.

"The daily patronage of the Hollywood Bowl Station is projected to be very low, with only 1,350 people entering the system during the off season..." (p.127)

This is over 5 times less than the projected daily patronage at the next higher use station, Wilshire/La Brea. As the Hollywood Bowl Station will be one of the most expensive stations on the system, isn't its approval by the Board a direct contradiction of their stated policy?

A. The SCRTD Board acted to adopt the Hollywood Bowl Station on May 12, 1983. The station was adopted because the Board wanted to enhance a major cultural resource for the entire Los Angeles basin. Currently, as part of Milestone 12, the Board is reconsidering the adoption of the Hollywood Bowl Station. A study is underway of alternatives for facilitating later addition of the Hollywood Bowl Station, if a decision to defer its construction is reached during the Milestone 12 process.

33. Was the approval of the Hollywood Bowl station final?

A. No. Decisions by the SCRTD Board of Directors can be reversed by subsequent Board action, at the discretion of the Board.

34. Can people be bused from the Hollywood/Cahuenga Station to the Hollywood Bowl?

A. Bus service could and would be provided from the Universal City Station and the Hollywood/Cahuenga Station if the Hollywood Bowl Station is eliminated.

35. Why is a Crenshaw Station being studied? Land use plans will limit the extent of development around the station, and thus it can't generate any value capture revenues.

A. The City Council voted on June 6, 1983 to amend the Park Mile Plan to allow for location of a station in the vicinity of Crenshaw and Wilshire. The station would provide access to a large and densely populated transit-dependent community. Crenshaw Boulevard is a natural corridor to move people from that area to and from destinations downtown, in Hollywood and farther west out Wilshire Boulevard. To eliminate the station would require transporting bus patrons another 0.5 mile beyond Crenshaw and Wilshire to Western Avenue. This area is heavily congested, and would require establishment of a major bus terminal on land that would otherwise be prime land for development.

The addition of the station increases accessibility to Los Angeles residents, reduces pressure on the Western Avenue Station, and retains for development areas which would otherwise be taken up by bus layover.

36. What is the status of the Crenshaw Station?

    A. The Crenshaw Station was adopted for inclusion on the Metro Rail alignment by the SCRTD Board of Directors on June 16, 1983.

37. Why is the Wilshire/Fairfax Station six blocks from Fairfax?

    A. The proposed entrances to the Wilshire/Fairfax station are located approximately four blocks east of Fairfax. The siting of the Wilshire/Fairfax Station is felt to be the best compromise of location and cost. Moving the station farther west would result in higher costs due to the large radius curve necessary to turn onto Fairfax.

38. As a member of the Hollywood Citizens' Advisory Committee, I recall that the committee report received unanimous approval. I am unaware of the existence of the minority report listed on page B-1.

    A. Your comment is entirely valid. The description of this document is in error and will be corrected. The subject report was approved unanimously by the Hollywood Citizen's Advisory Committee.

39. Will any light rail construction start before Metro Rail begins operation?

    A. The Los Angeles-Long Beach line should also be under construction during the same period as Metro Rail.

40. Will Metro Rail extensions be of various modes, or will they all be in subway?

    A. The Metro Rail system may be extended in two ways: by an extension to the system itself, and by an extension to service through the provision of, for instance, interfaces with light rail service. All extensions to the Metro Rail system itself will be heavy rail. Portions may be in subway, elevated, or at grade. If light rail systems are built and operated by SCRTD, they will require separate systems and facilities. These systems may also operate above, below, or at grade.

Any extension to Metro Rail will be subjected to an alternatives analysis to establish route and mode, with public participation expected throughout the process.

41. Do you have plans for an extension to Metro Rail at the Chandler/Lankershim Station?

    A. No firm plans yet exist for any extensions to Metro Rail.

42. "A basic policy of the SCRTD Board of Directors is...that the initial 18-mile system can accommodate line extensions without major cost or disruption to existing services." (p.11) Will the proposed cost-saving measures affect the implementation of this policy?

    A. The proposed cost saving measures will not prevent the future extension of Metro Rail. However, they will make the costs of such extensions somewhat higher.

43. What steps have been taken to pursue joint development ventures?

    A. SCRTD is seeking major commitments for real estate development at many of the proposed Metro Rail station sites. Meetings and discussions are being held with the private sector on a continuing basis. In addition, SCRTD is funding the preparation of specific station area development plans in conjunction with the City of Los Angeles and the Community Redevelopment Agency of the City of Los Angeles. Similar plans will be prepared for the Fairfax/Santa Monica Station, which is located in Los Angeles County. These plans will lead to the development of project packages that will provide capital cost contributions to SCRTD for the Metro Rail system, and also generate revenues for the system's operation and maintenance. To enhance the potential for joint development, state legislation (S.B. 1159) is now pending which would give SCRTD the authority to purchase land adjacent to Metro Rail facilities for development purposes.

44. What percentage of the local matching dollars does joint development represent?

    A. Joint development may provide revenues equivalent to 5 to 20 percent of total Metro Rail construction costs. In its planning, SCRTD is assuming that joint development revenues will equal the conservative 5 percent figure. If joint development revenues exceed this percentage, the additional funds will be used to defray Metro Rail's operating and maintenance costs.

45. Presumably certain real estate values will change as a result of the system. Are there any windfall profit taxes?

    A. No plans exist to impose windfall profit taxes. However, SCRTD is seeking to implement special benefit assessment districts around stations in order to capture some of the monetary benefits generated by the public investment in the Metro Rail facilities. See the Milestone 6 Report for a fuller discussion.

46. Will the operation of this system increase property taxes?

    A. No, the construction and operation of the Metro Rail system is not tied to property taxes. However, it is expected that additional tax revenues will be generated as new development occurs around station locations, both from existing property taxes levied on the new development and from the special benefit assessments described above.

SYSTEM DESIGN

47. What gauge is the track?

    A. The Metro Rail track gauge is standard railway gauge: 4 feet, 8-1/2 inches.

48. Will you use the existing Hill Street tunnel?

    A. Metro Rail will not use the existing subway tunnel running northwest from the Subway Terminal Building on Hill Street. This tunnel is not coincident with the Metro Rail route alignment and is no longer usable due to penetration by foundations of recently constructed buildings.

49. Will the Subway Terminal be used?

    A. Plans for the Metro Rail station at 5th and Hill Streets include provision for a future entrance adjacent to the Subway Terminal Building, but not for use of the building itself.

50. What's the significance of a 100-year design life?

    A. The significance of a 100-year design life is in relation to design of the major system facilities, primarily the tunnels and stations. These facilities are being designed to have a useful life of at least 100 years. This means that they are expected to be capable of performing their intended function without major modification or renovation over a period of 100 years. Therefore, they must be designed for durability and to accommodate future demand.

51. Why not design tunnels to accommodate a catenary power system for light rail dual capability operations?

    A. While the Metro Rail system design is based on third rail power distribution, it has been determined that tunnel size and configuration are adequate to accommodate a catenary power system. However, there is no intent to permit shared operation of Metro Rail and light rail vehicles during revenue service. This policy was established to avoid complicating system design and diminishing system capacity.

52. The six-car maximum train length proposed will handle traffic demands upon initiation of service and for some time thereafter. However, this policy limits future flexibility unless station designs permit platform

extensions without major reconstruction. Full rapid transit systems generally are built to operate at least eight-car trains. Additionally, standard car lengths in the future may be 85 feet instead of 75 feet.

A. Our studies and analyses continue to show that six-car trains will be adequate for the Metro Rail system, even with future year patronage growth projections. Several of the newest rail transit systems in the United States are designing for a six-car train length. We do not think 85-foot cars will be the standard for the future.

53. How will the train turn around at the end of the line?

A. The train will not turn around at the end of the line but will simply change tracks and reverse direction. This will be accomplished by using the crossover tracks provided adjacent to each terminal station and having the operator transfer to the cab at the other end of the train while the train is in the station.

54. What will prevent noise?

A. Numerous provisions are being incorporated in the system design to minimize noise production and propagation. These provisions include use of continuously welded rail, insulating pads between the rail and track bed, and noise reducing wheel and suspension design. In addition, special provisions such as floating slabs will be used if necessary in noise sensitive areas.

55. Is it possible to build the Crenshaw and Hollywood Bowl Stations after the system is built?

A. Yes, it will be possible to build the Crenshaw and Hollywood Bowl stations after the system is built. Provisions can be made during initial construction to facilitate the later addition of these stations.

56. What provisions are being made for westward and eastward extensions?

A. In the interest of minimizing initial capital cost, no specific provision is included for system extensions. However, the system design precludes neither westward nor eastward extensions.

57. Will future construction of the line extensions seriously disrupt system operations?

A. Disruption caused by future construction of line extensions will be highly dependent on the location and orientation of the extension. However, it is expected that probable extensions can be designed so their construction will require only minimal disruption to system operations.

58. Why did you eliminate so many crossover tracks? What happens during a service interruption at peak period?

A. Three of ten proposed crossover tracks were eliminated in the interest of reducing initial system cost. Elimination of these will not impact normal system operation, but will reduce system capacity under certain service interruptions. One of the eliminated crossovers was located north of the North Hollywood Station to facilitate train storage, and its elimination will have little impact on system service capability. The other two eliminated were adjacent to the Wilshire/Vermont and Sunset/La Brea Stations. Their elimination will decrease system capacity in the event of a system blockage, such as an unmovable train, in those line segments by 20 to 30 percent. However, such events are not frequent, and the capacity reduction will only apply when the blockage occurs on the affected line segments.

59. What is the impact of a train failure at the Alvarado crossover?

A. A train failure involving an immovable train at the Alvarado crossover probably would not have any greater impact than one occurring on the adjacent line segments. Since blockage of both legs of the double crossover by a single train is a very unlikely event, the other leg would probably be available for single-tracking around the blockage. In the unlikely event of simultaneous blockage of both legs, system capacity would be reduced to an average of about one train every 20 minutes in each direction.

60. Why not provide amenities to attract and keep patrons as regular users of the Metro Rail system? Such features as barrier-free transfer between bus and Metro Rail (where feasible), normal passage between cars, and passenger visibility out the front and rear of trains are designed into many rail rapid transit systems throughout the world. In addition to passenger convenience, passage between cars aids passenger security in certain situations prior to an emergency developing. Likewise, visibility from the passenger compartment through the control cab

(with operator protected from rear light reflections) adds to security when cab ends are coupled in midtrain. Personal observations indicate that many passengers enjoy looking ahead of the train when such visibility is available.

A. Extensive effort is being made in system design to provide amenities to attract and keep patrons. Experience on other systems shows that safe, fast, low cost, and reliable service are the most important factors for patronage attraction, so primary design emphasis is directed at these. The amenities suggested are, in some cases, in conflict with primary factors. Provision of barrier-free transfer between bus and rail was examined but rejected because of the additional capital cost. Study has shown that encouraging passage between cars represents a safety hazard. Vehicle design will provide high visibility between vehicles and platforms and between vehicles to the extent permitted by operator cab design requirements.

61. Consideration should be given to providing adequate tunnel height for overhead catenary and insulator clearance to allow for possible future conversion to a high-voltage traction-power system.

A. Tunnel size and configuration as specified is adequate to permit future conversion to high-voltage overhead power distribution.

62. Deletion of the bus platform entrance at Universal City eliminates one of the better opportunities for barrier-free transfer.

A. Projected savings from provision of barrier-free bus transfer at the Universal City Station have not been found to be sufficient to justify the cost of providing the additional station entrance.

63. When preliminary engineering comes to an end, will this mean the system designs are 30 percent complete?

A. Upon completion of preliminary engineering, overall Metro Rail system design will be 30 percent complete. This does not mean that each element will be exactly 30 percent complete. Some will be more or less complete, but the total design will be 30 percent complete.

64. How much of the equipment and vehicles will be built in America?

A. The "Buy America" clause imposed with federal participation in funding of Metro Rail requires that labor and material content of all equipment items, including vehicles, must be at least 50 percent American. This means that even if an equipment contract is won by a foreign bidder, at least 50 percent of the product must be of American origin.

STATION DESIGN

65. Will you use vandal-resistant wall tile in stations?

    A. All materials for use in the stations will be selected on the basis of safety, durability, ease of maintenance, and resistance to vandalism. Surfaces exposed to the public will be finished in such a manner that the results of casual vandalism can be readily removed with normal maintenance techniques.

66. Are you going to have piped-in music at the stations?

    A. It is not likely that piped-in music will be provided in the stations. Such a program would require operating and maintenance expense, and would interfere with both routine and emergency information transmitted over the public address system.

67. Which stations will have above-ground and below-ground power substations?

    A. Final design will determine the actual location of the substations. At present stations located at 7th/Flower, Wilshire/Vermont, Wilshire/Western, Wilshire/Fairfax, Wilshire/La Brea and La Brea/Sunset have above-grade traction power substations. All other stations have below-ground substations.

68. Are you going to have skylights so that light can get into some stations?

    A. The use of skylights will be encouraged wherever practicable.

69. What considerations are you making for the handicapped, including the special needs of the blind?

    A. Stations will be fully accessible for the handicapped, in accordance with current federal and state requirements. Examples of special access provisions include elevators and special fare gates in Metro Rail stations; priority seating in passenger vehicles; an advisory system to warn patrons (including the hearing impaired) of approaching vehicles; and tactile safety strips to help patrons detect the platform edge.

70. Will there be restrooms on Metro Rail?

    A. A staff restroom will be provided at each station, accessible to the handicapped, and available to the public in emergencies.

71. How do you gain access to the restrooms?

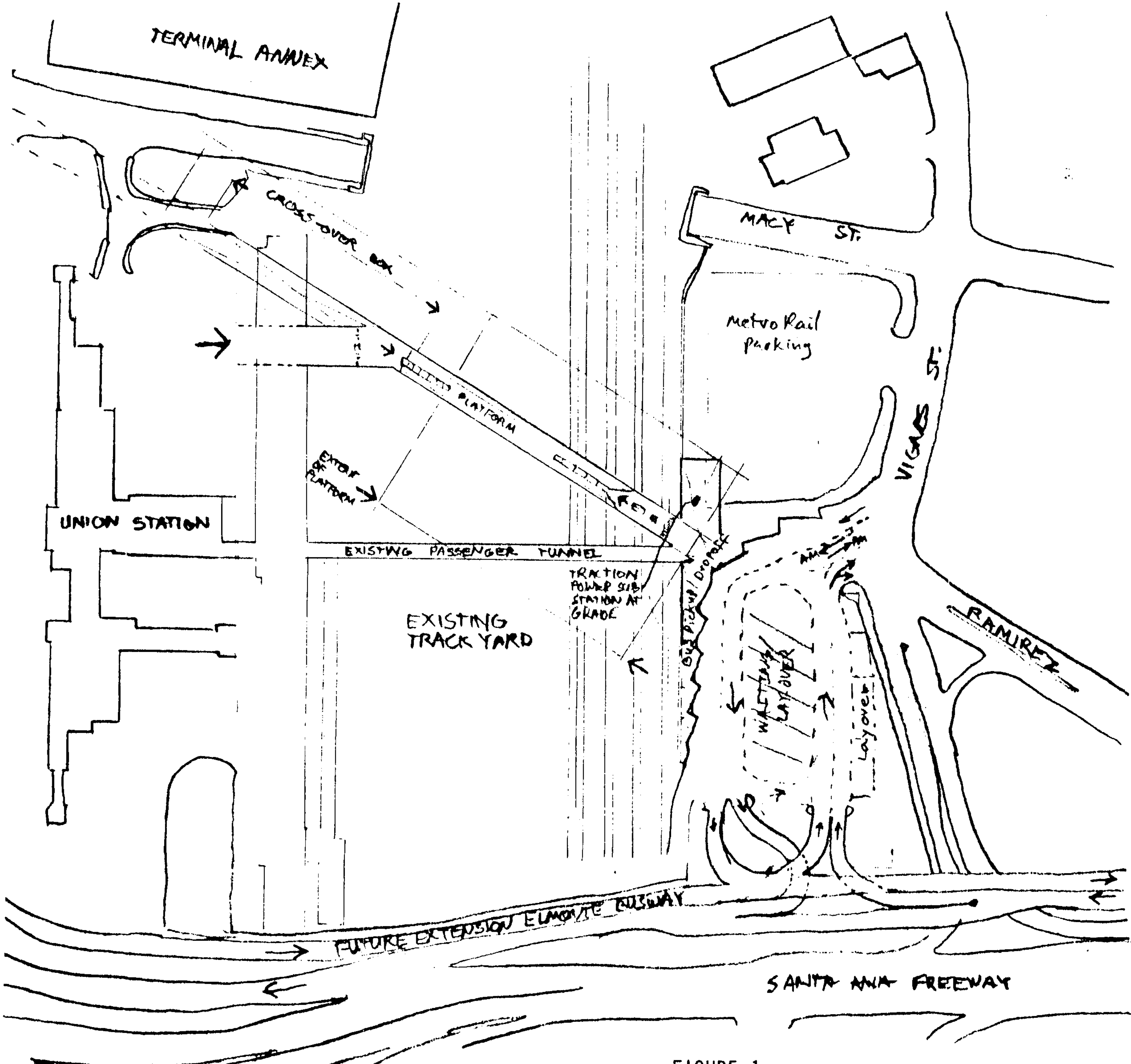
A. Locked restrooms will be located in the paid areas of the mezzanines, adjacent to the ticketing gates. All restroom facilities wll be equipped with remote-controlled door unlocking devices operable from Central Control. Patrons will be able to gain access by using conveniently located phones to contact Central Control. In addition, station agents will be available in some stations to unlock the doors for public use.

72. Will you allow smoking in stations or on trains?

A. Smoking will not be allowed in the stations or on trains.

73. Union Station: I can't imagine Metro Rail passengers arriving from the east via the El Monte Busway desiring to walk from the northeast corner of Arcadia and Alameda Streets, across the parking lot, through the Union Station Terminal Building, to the Metro Rail station entrance. There must be some means provided for express buses to stop directly adjacent to one or the other station entrances. One possible solution would be to provide ramps from the busway to a loop at the east entrance to the station (See Figure 1). Ramps could be provided to allow loop traffic to enter the busway in either direction, allowing passengers arriving on Metro Rail to easily transfer to buses going northwest to Olivera Street and China Town. Also, buses not terminating at Union Station could continue along the busway to serve downtown areas not within walking distance of Metro Rail stations.

A. The configuration of bus facilities at Union Station is being studied, in conjunction with other transportation modes, by SCRTD, Caltrans, the City of Los Angeles, and the Los Angeles County Transportation Commission. A bus (and possibly light rail) loop between old Union Station and the railroad tracks in the Railway Express Agency (REA) building area is considered to provide a good combination of service for all interfacing transportation modes. A version of this possible scheme is shown in the Milestone 10 Draft Report. A bus loop east of the station is possible, but would require difficult and expensive connections to the existing busway, and would not provide for interconnection between travel modes.



Bus loop and ramps
not to scale

FIGURE 1

74. Will the reduced ancillary space in stations adversely affect the future possibility of lengthening passenger-loading platforms?

    A. There is virtually no possibility of lengthening passenger loading platforms with current station designs. Allowing provisions for platform lengthening would be extremely expensive and would not fit present alignments. (See response to Question 52.)

75. I heartily approve of the policy to exclude all food, beverage, and tobacco concessions from the Metro Rail stations.

    A. Your concurrence regarding our concession policy is appreciated.

76. Will there be a passageway into the Pershing Square garage from the 5th/Hill Station?

    A. An entrance from the 5th/Hill Station through the garage into Pershing Square is not planned at this time. While difficult and expensive, it is not precluded in the future.

77. Why can't you use cheaper land for bus facilities?

    A. Off-street bus facilities are located in accordance with the transportation function. In satisfying that function, they have been placed on the least costly and least developed land that is available.

78. The installation of automatic teller machines (ATMs) is an interesting idea, especially if they could be modified to dispense Metro Rail tickets and passes.

    A. Your suggestion is worthwhile and we will pursue the feasibility of doing so.

79. I feel that audiovisual advertising would be fine as long as it is not integrated with system information. When riding on the BART system, I found it extremely annoying to have to watch for system information squeezed between a bunch of advertisements on their otherwise excellent annunciators.

    A. Your suggestions regarding audiovisual advertising are appreciated.

80. I completely disagree with the policy on station restrooms -- it will create more problems than it solves:

- Increased incidence of urination in the trains and stations.
- Further compounding of the problem of lack of public restrooms in public places.

Placing the restrooms in the "paid" area of the stations (as BART does) and providing them with doors that can be locked open will alleviate many of the security and maintenance problems.

A. The present SCRTD Board policy regarding restrooms was derived, in large part, because of the experience of other rail transit agencies in this matter. Almost uniformly, their experience with restrooms that were made routinely available to the public has been unfavorable.

81. Agent's booths will not be constructed in stations. Where will stocks of Metro Rail maps, guides, and other information be kept for distribution to patrons entering stations?

A. There is space in Metro Rail stations that could be utilized for storage of maps, guides, and other patron information, including the Staff Room. The actual location of the distribution point for this information will be determined during final design.

82. Why will there only be surface parking? Can't you find a separate source of funding for parking structures?

A. Other sources of funding for Metro Rail parking structures will certainly be sought, including the private sector. In their absence, only surface parking is deemed cost-effective for initial construction.

EQUIPMENT DESIGN

83. Will high-voltage lines from Southern California Edison Company and the Department of Water and Power be above or below ground? Who will pay for putting them underground?

    A. The majority of the existing high-voltage lines from the Department of Water and Power in the vicinity of the future Metro Rail facilities are routed underground. These lines would be extended to the Metro Rail facilities below ground as well. For those existing lines presently above ground, the service feeders to the Metro Rail facilities will be routed below ground, possibly at no extra cost.

    The only Metro Rail facility that may be supplied by the Southern California Edison Company (SCE) is the Fairfax/Santa Monica Station. The routing of high-voltage service feeders to this station will be negotiated with SCE at a later date.

84. Will there be rearward-facing seats?

    A. Yes. Since the vehicle is required to move in either direction on the tracks without turning around, seating arrangements are designed so that approximately one-third the seated passengers face forward, one-third face toward the rear, and one-third face toward the center of the vehicle, regardless of which direction the vehicle is going.

85. How will purchase options on rolling stock built for other systems affect Metro Rail's unique specifications?

    A. An attempt will be made to write passenger vehicle specifications that will allow the bidders to propose existing cars with only minor modifications. Therefore, purchase options on rolling stock built for other systems will not affect the Metro Rail specifications.

86. What kind of braking system will be used on Metro Rail trains?

    A. The pneumatic braking system will utilize both electrical and mechanical friction brakes. The primary electric brake will utilize the traction motors as generators with electrical current fed to on-board resistors or regenerated into the power line. The friction brakes will have the capability of full service and emergency braking, and will be blended with the electric system when necessary to achieve the braking rate.

87. What back-up system is planned in case of a power failure?

A. Each Metro Rail passenger station will be supplied with power from two separate utility company high-voltage lines. Only one line will normally be utilized; the other line will act as a back-up supply.

A battery-supported, uninterruptible power supply will provide back-up power at each station to ensure that essential services may continue to operate in the event of a total utility power supply failure.

88. It was my experience on the BART system that as the train approached top speed (above approximately 70 mph) conversation became difficult or impossible. What will be the maximum ambient noise level (dB(A)) in the Metro Rail vehicles at top speed?

A. The top speed of the vehicles will be 70 mph. However, there will be few areas in the initial system where this speed will be attained. In contrast, at BART, where there are long distances between stations, the speed of 70 mph is attained and maintained for considerable periods of time. Based on data from other systems at a speed of 50 mph, which is close to a typical top speed for Metro Rail, the noise level inside the passenger vehicle will be approximately 78 dB(A). At 78 dB(A), conversation between passengers seated next to each other will be possible.

89. I agree that the carbody design should be aesthetically pleasing, and I also believe some consideration should be given to aerodynamics. The car shown in Figure 2-1 on page 138 doesn't appear to meet either criteria. I would encourage a carbody design more along the lines of the BART system.

A. Vehicles traveling in small tunnels do not require aerodynamic shapes. The clearance between the tunnel wall and the vehicles is sufficiently small so that air does not pass through this space. Instead, the air is pushed ahead of the vehicle by piston action and exits via the tunnel ventilation shafts. An aerodynamic shape on the front of each vehicle would not improve its performance.

Furthermore, a door is required on the end of each vehicle so that passengers can be evacuated in an emergency. A sloping face on the end of the vehicle (such as that on the BART cars) would make the door installation more complex.

Both of these considerations are believed to be more important than aesthetics, and the Metro Rail vehicle will be designed with flat ends.

90. Why not use a portable gas back-up system for emergency power? What about a diesel generator?

A. Mobile engine-driven generators are being considered as a means of providing emergency power at passenger stations. They would be located at strategic locations along the system route so they could be transported to any substation location within an established time. Because the units are mobile the cost of purchase, installation and maintenance of an emergency generator at each substation would not be necessary. Immediate backup of emergency functions such as station lighting will be provided by batteries at each station. We do not think the emergency generators will see much use because each substation will have dual independent feeds from the power company.

91. Will there be jerk factor limits to ensure a smooth ride?

A. Yes, there will be a jerk limit imposed on vehicle propulsion and braking performance so that a smooth ride is ensured. A maximum jerk level of about 2 mphpsps will be required during acceleration and deceleration under normal operating conditions. During an emergency brake application when maximum possible braking is needed, no limit will be placed on the jerk level.

CONSTRUCTION

92. How soon will construction begin? Will it start at more than one point at one time?

    A. Construction of the Metro Rail project is scheduled to begin in the fall of 1984. Initially, construction will start in the major maintenance and repair facility located near Union Station. Other construction contracts in the downtown area will begin within 4 to 6 months of the initial construction.

93. How long is the construction period if your funding does not come in the 6-year increments you originally planned?

    A. Based on the most recent projections of federal funds, construction can be completed in 1991, which is one year later than originally planned.

94. Assuming we only get a portion of the requested funding, how much construction would we be able to do next year?

    A. The amount of construction that could be started in 1984 will depend on the funds available. It is expected that sufficient funds will be available in 1984 to start construction of the major maintenance and repair facility and several of the downtown stations and adjacent tunnel segements.

95. What steps are being taken to mitigate construction noise?

    A. Both the County and City of Los Angeles have adopted a Noise Element to the General Plan in compliance with California Government Code Section 65302(9). These ordinances contain specific guidelines to mitigate construction noise. SCRTD will comply with these ordinances. The EIS/EIR specifies the measures to be taken to mitigate the temporary impacts of Metro Rail construction.

96. What impacts (if any) will construction have on the Olympics?

    A. Construction of the Metro Rail project will have no impact on the 1984 Olympics as it will not begin until after the Olympics.

97. Why do you say it's better to have two smaller tunnels rather than one large one?

A. Two 17-foot, 6-inch tunnels are less costly, are easier to construct, produce less surface settlement and can provide a safe refuge for passengers in the unlikely event of a fire in the adjacent tunnel.

98. By use of the alternate plan of a steeper tunnel grade southeast of Hollywood Bowl and by moving the station to a location under Highland Avenue, both ends of the station could be brought relatively close to the surface, thus effecting a considerable reduction in construction cost.

A. Your suggestion is appreciated. It will be examined together with other suggestions for cost-reducing measures.

99. How long will it take to complete the system? How long did BART take?

A. The time to complete the system will depend on the availability of federal funds. The current schedule is to complete the system in 1990. However, reductions in the funding rate from that on which the proposed schedule is based would result in some delay in completion (see response to Question 76).

BART construction was initiated in 1972, and over 10 years were needed to complete the system and begin revenue operations. However, BART is a 71-mile system, while Metro Rail is only 18 miles.

100. Where will special trackwork such as floating slabs and direct fixation...ties be used? In the Fairfax area?

A. Special trackwork such as floating slabs or resilient rail fasteners will be used where train operations would cause a substantial increase in the ambient noise or vibration environment. In the Fairfax area, such measures will likely be located in the vicinity of the CBS Television City, King Solomon Home for the Elderly, Country Villa Wilshire Convalescent Hospital, and the Garden of Palms Rest Home.

SAFETY AND SECURITY

101. Where is the safest, most modern heavy rail system?

A. Many of the newer U.S. heavy rail systems, including those in the cities of Miami, Baltimore, Atlanta, Washington, and San Francisco, are designed and constructed to similar standards and utilize a generally equivalent level of hardware technology. This generation, as contrasted to the older portions of systems in Boston, New York, Cleveland, Philadelphia, and Chicago, contain features and design approaches similar to those described in Milestone 7. They have demonstrated superior levels of patron and employee safety to such an extent that comparisons of the isolated injuries and/or fatalities are not meaningful.

Despite this general level of advanced safety, each system, during its design, construction, and operation, attempts to reduce any possible risk through a continual process of review of the hazards, real or imagined, on other systems. Design procedures or policies which further reduce or eliminate these potential events are incorporated.

102. Please comment on safety during all phases of development including preliminary engineering and final design, construction, and revenue operations.

A. SCRTD has developed a comprehensive safety program to provide a safe environment and protection for Metro Rail patrons, employees, and equipment. The safety program focuses on the activities, management controls, and analytical processes which are required in each of the phases of Metro Rail's development.

The overall safety philosophy emphasizes preventive measures over corrective measures to eliminate unsafe conditions. Therefore, the major emphasis on safety during the preliminary engineering and final design phases is on eliminating or controlling hazards and providing for emergencies.

During the construction phase, the primary safety-related activities will include reviews and approvals for all safety-related contractor analyses reports; on-site auditing of contractors' facilities; preparation of safety certification procedures; establishment of a training program and training requirements; refinement of documentation procedures, and the safety certification process.

During the start-up and revenue operations phases, safety personnel will participate in investigations of safety-related incidents and in documentation control board activities. In addition, document control procedures will be monitored. (See the Milestone 7 Report for more specific details.)

103. For safety purposes, why don't you have all the people sitting down on trains?

A. Standing on trains does not present any real hazard. During starting and stopping, the rates of acceleration and braking are kept at sufficiently low levels so that a standing patron will not experience any difficulty in maintaining good balance. In comparison to an automobile or bus, a transit car starts and stops very gently. Also, liberal use of stanchions and grab rails will permit all standees to have handholds for support. (Also see response to Question 91.)

104. How would trains be stopped at the end of the line in the event of a runaway train?

A. With the advent of fully automatic fail-safe train control systems, a "runaway train" is highly improbable. Modern equipment is designed so that any failure of equipment or by human forces results in the stopping of a train (fail-safe). Extensions of the rail lines are provided at ends of line to accommodate the unlikely event of a train overshooting the end station. Finally, bumping posts are provided at the ends of the mainline and on yard storage tracks, but they are seen as an extra safety factor; prime reliance is put on the fail-safe nature of the train control system.

105. How will "safe" levels be determined for smoke and toxic fumes during passenger evacuations of tunnels?

A. "Safe" levels of smoke and toxic fumes are ensured by using, to the maximum extent possible, low-combustible materials, and products which produce the least amount of smoke and have low levels of toxicity. If passengers are evacuated into the tunnels during a vehicle fire, the emergency ventilation system will provide a stream of fresh air to direct passengers to safety.

106. Will the tunnel ventilation system be able to handle a worst-case fire?

A. The tunnel ventilation system is being sized and configured to very conservative design criteria. These criteria include a high fire load on each transit car, the largest train (group of cars), conservative aerodynamic resistance factors, failed fan conditions, certain doors and separations not closed off, and a time duration for maintenance of "fresh air" (see answer to Question 105) which is based on the maximum number of people on the entire train.

107. Will an emergency power supply be provided to operate the ventilation system in the event of a utility power failure? If not, how will the above required conditions be met?

A. The operating components of the emergency ventilation system consist of fans and dampers. These electrical devices will be redundantly powered from the adjacent station's electrical supplies. Each of these supplies, in turn, is fed from two independent, dedicated lines, each from a separate utility company substation. Thus, the ventilation system will have essentially four different supply sources. The possibility of failure of all of the sources at the same time that a fire might occur is considered extremely remote.

108. Has consideration been given to an automatic fire extinguishing system on the vehicles?

A. Automatic fire extinguishing systems on transit vehicles have been and are presently being investigated. Research so far has indicated not only that the storage and distribution system for the extinguishing agent would be very heavy and expensive, but that the detection aspects of the system cannot yet be considered sufficiently reliable. While we are monitoring this continuing research carefully, we do not anticipate any breakthroughs which would change the current conclusions.

109. What type of security measures will be taken on-board trains?

A. Transit police officers, both in uniform and in an undercover capacity, will ride the trains. There will also be intercom communications between passengers and the train operator, and radio communications between the train operator and Central Control.

110. Will there be access to operators' cabs?

A. Access to the operator's cab will be through a door from the car interior. It will be locked at all times, whether the operator is in the cab area or not. Patrons will not, therefore, have direct access to the operator (for security reasons), but will be able to communicate with him/her through the intercom system.

111. Please explain what security measures will be taken in the stations.

a. Stations will be designed with consideration for the security of patrons. Closed-circuit television will be positioned at strategic locations and monitored at Central Control by transit police personnel. Emergency phones will be located throughout the stations for patrons. A passenger security zone will be established for patron use during late evening hours. Transit police officers, both in uniform and undercover, will constantly patrol the stations.

112. How quickly will transit police respond to a call?

A. The SCRTD transit police will have primary police jurisdiction on the Metro Rail. This ensures a total security effort which will enhance a response to any emergency. It will also increase the likelihood that a transit police officer will be at the location to prevent any incidents or capture the perpetrators and render aid. Policing of the Metro Rail will be coordinated with transit police surface units patrolling the bus system and with local law enforcement agencies.

113. Will closed-circuit television monitors be installed in stations?

A. Yes. See response to Question 111.

114. The passenger security zone is an excellent idea and will greatly enhance the security of passengers during the late evening hours when the stations will be relatively empty.

A. As indicated in the responses to Questions 111 and 113 above, the safety and security of our patrons is of primary importance. Measures to assure this objective will be constantly evaluated to provide a system that is as safe and secure as possible.

115. What type of security will be provided by SCRTD for the parking facilities?

A. The security measures at parking facilities are currently under study. The options include on-site security personnel, closed-circuit television, controlled access, and patrol. Once the nature of the parking areas is decided, i.e., parking structures or lots, a final determination will be made on the type of security needed.

116. What kind of lighting and directional signs will be used in the emergency evacuation passageways?

A. The lighting and graphics used for possible evacuation paths in the tunnels require utmost care during the design phases because of the major role they play in safe and rapid evacuation. In addition to providing high lighting levels, redundant power sources and on-site battery backup supplies are planned for the lighting systems. The specific design of the graphics has not been initiated at this time; but it will recognize the lessons learned from actual and simulated evacuations on other transit properties, in regard to the type of signs, lights, frequency, colors, placement, and text/ graphics content.

117. What kind of planning is being done to ensure emergency preparedness?

A. Emergency preparedness is an integral part of the SCRTD's Metro Rail program, and a plan is being prepared. Once the plan is developed, procedures will be prepared to provide both the SCRTD and outside agencies with the measures to intervene and mitigate potential emergencies. These plans and procedures will be completed well in advance of the system's operation. During the pre-operational test and start-up phase, these plans and procedures will be tested and evaluated, and refined accordingly. Further, we will continue to conduct emergency exercises throughout the system's operations to ensure that we will continue to be capable of responding to any conceivable type of emergency.

118. The <u>belief</u> that the system is safe and secure is extremely important.

A. We agree with this position. SCRTD recognizes that the perception of a safe and secure system is very important. Towards this end, the SCRTD will have its own police operation, and safety and security measures are being addressed at each stage in the development of the system. The Milestone 7 Report covers many of the steps we will take to offer the feeling and belief of the safety and security of the system.

OPERATIONAL SERVICE

119. How many minutes will it take to go from Union Station to North Hollywood?

A. One-way travel time on the entire route from Union Station to North Hollywood (including Crenshaw Station) will be slightly over 33 minutes in rush hour. Slightly faster times will occur in off-peak periods since less time will be spent stopping at stations.

120. What is the maximum capacity and headways of Metro Rail trains?

A. Maximum capacity of a Metro Rail train is 1,020 passengers based on a 6-car length and 170 passengers per car (76 seated, 94 standing). Headways as small as 2 minutes can be achieved, implying hourly system capacity is 30,600 passengers per direction. The cars will be capable of maximum loads in excess of 200 passengers, providing an additional margin of capacity.

In the year 2000, headways of 3-1/2 minutes will be sufficient to carry passenger demands.

121. How will you move trains in case of an accident?

A. Prior to initiation of system operation, a set of policies and procedures will be developed for moving trains in times of emergency. If a train stalls on one track, system operation can be maintained using the other track. Stalled trains can be removed using another train or an auxiliary vehicle.

122. Will we have the breakdowns and slowdowns that BART experienced in its early years of operation?

A. Every system can be expected to have some problems in early stages of testing and operation, yet we expect these will be kept to a minimum on the Metro Rail system. The experiences of BART, WMATA, MARTA, and other new systems have led to many design improvements. We will benefit from the mistakes of others.

123. How many people will be employed full-time after the system is completed?

A. We have estimated that a total of 839 personnel will be required for operation, maintenance, and administration of the system.

124. How many persons will operate each train?

A. There will be one operator per train at all times. However, operation of each train will be supported at Central Control.

125. Are trains going to pass by the Hollywood Bowl Station when the Bowl is not in season?

A. Trains may bypass the Hollywood Bowl Station when the Hollywood Bowl is closed. The train control system will allow this choice to be made at a later date.

126. How long will it take a wheel-chaired passenger to board a train?

A. A wheel-chaired passenger should be able to board the train quickly. The train floor will be at the same level as the platform, and the space between the train and platform will be small.

127. Can Metro Rail institute an express package delivery in off-peak hours?

A. Metro Rail is not expected to operate package delivery service in off-peak hours. This would be an inconvenience to passengers since it could lead to longer station dwell times and decreased seating ability.

128. How fast will the trains run?

A. Metro Rail trains have been designed to operate at a maximum speed of 70 mph. Average speed in peak hours will be 35 mph, given station stops, acceleration, and deceleration.

FARE COLLECTION

129. Will there be a barrier-free fare collection system at Metro Rail stations?

   A. Based on an analysis that was presented in the Milestone 8 Report, Metro Rail stations will be designed for a barrier fare collection system. This will not preclude instituting barrier-free fare collection if a decision to do so is made at a future date.

130. Will Metro Rail's fare collection method be fully automated like BART's?

   A. Metro Rail's fare collection system will be fully automated. The patrons will purchase tickets from ticket vending machines and insert them into ticket-reading fare gates, or will use machine readable passes purchased at sales outlets. Personnel will be available at some stations to provide assistance in using the system.

131. How will you prevent abuse of passes in an automated fare collection system?

   A. To control abuse of passes, Metro Rail personnel will, on a random basis, observe the fare gate operations. Reduced fare passes will be color coded for ease in identifying these passes during use. Metro Rail is considering designing the fare gates to signal when a reduced fare pass is used.

132. Do you have a projection on fares for individual riders?

   A. We have used a figure of about $0.70 (1983 level) for analytical purposes, but have not yet estimated the actual fare which will be charged when the system opens.

133. Will you have means to transfer from bus to Metro Rail?

   A. It will be possible to transfer from bus to Metro Rail without requiring a payment of two full fares. The detail for implementation of such provisions will be developed as part of final design.

134. Will there be full-credit intermodal transfers?

   A. The actual credit received for transferring to or from a bus will be determined at a later date. There will be a means of transferring between modes without requiring payment of a second full fare.

135. Can I use a $20 fare card on the system and have the fare automatically subtracted on each trip?

A. While the exact fare structure has not been determined, the ability to implement a stored-value fare card such as BART's has been included in the preliminary system design. Final system capabilities will be established in final design as fare structure becomes better defined.

136. What provisions will be made to prevent the use of counterfeit tickets?

A. The experience of the transit industry is that it is never possible to fully prevent the counterfeiting of tickets. Nevertheless, it can be made sufficiently difficult and costly to discourage all but the most determined counterfeiter.

Magnetically-encoded fare cards that are read and interpreted by ticket-reading fare gates will be used on Metro Rail. These encoded cards will be much more difficult to counterfeit than printed cards.

Counterfeiting of the encoded tickets can be made even more difficult by special design of the ticket read/encode mechanism in the fare gate and by use of special code words on the ticket. These are being considered for Metro Rail.

COST ESTIMATION

137. Please explain the liability allocation in your project cost estimate.

A. During the construction phase, estimated liability expenses are $75 million. This is the cost to insure facilities and contractors, including those for Workers' Compensation, General Liability, and Builders' Risk (see page 163 of the Milestone 12 Preliminary Draft Report).

Liability costs for system operation are estimated to be $1.8 million per year. This sum includes insurance and direct compensation for passenger injury and was estimated from experience of the SCRTD bus system.

138. How will the cost of tunneling be handled? Explain the use of eminent domain.

A. The cost of tunneling is part of the general construction cost. The right of eminent domain empowers SCRTD to acquire all properties which are necessary for implementation of the Metro Rail project (see page 16 of the Milestone 12 Preliminary Draft Report). However, property will be acquired primarily by negotiated purchase with eminent domain used as the last resort.

139. "Changing the 1,200-foot-long, three-track subway storage area at North Hollywood to two 500-foot-long tail tracks beyond the station..." (p.61) How will reducing the storage area (about 4 times) affect operating costs? Won't it severely reduce the A.M./P.M. peak capacity of the system? What are the capital cost savings associated with this change?

A. The reducton in train storage capacity at North Hollywood will require some additional train trips in the early A.M. period from Union Station to North Hollywood. The additional annual operating cost has been estimated at $50,000, which is an insignificant fraction of total operating and maintenance costs. The tail tracks have no immediate effect on the a.m./p.m. peak capacity of the system. Capital cost savings have been estimated to be 10 million dollars ($1983).

140. Will the parking revenues cover the operating costs of the parking facilities? What are the anticipated parking fees?

A. Parking revenues or parking fees have not as yet been estimated. However, a policy has been established that parking fees shall be sufficient to defray parking operating and maintenance costs.

141. Will the ridership support the project?

A. It is expected that the Metro Rail system will experience a high level of ridership. Fare levels have not been determined at this time; therefore definitive estimates of passenger revenues have not been established. It is expected that Metro Rail will be able to recover most or all of the operating cost from the farebox, given $45.5 million annual operating cost and over 110 million annual riders.

142. The cost estimates presented are in 1983 dollars. What about inflation?

A. It is uncertain what the level of inflation will be during Metro Rail construction. Total system cost has been calculated at several different inflation rates. At a 7 percent inflation rate, the total cost of the system is estimated to be $3.1 billion.

143. Are the electricity cost estimates for the system--$9.6 million--realistic? Where will the electricity come from?

A. We believe the estimates are realistic. Power requirements for trains, stations, yard and shops, and other facilities have been calculated from system simulation models and detailed engineering estimates. These expenditures have been compared to those of other systems and appear reasonable on this basis. Electricity will come from two power companies, Southern California Edison and the Department of Water and Power.

144. Wouldn't it be far more cost-effective to construct the provisions for line extensions at Wilshire/Fairfax and Union Station now rather than in the future? I would like to see a cost analysis of both options indicating how much will be saved now vs. how much will be spent later when extensions are made.

A. It would be somewhat more cost-effective to construct the provisions for extensions at present rather than in the future. However, we had to make significant cost reductions to bring the total system cost down to a level at which we could reasonably expect federal funding. Also the federal government has indicated that provisions for future extensions might not be funded by them. If so, the entire cost of these provisions would have to come out of state and local funds.

APPENDIX D - SCRTD RESPONSES TO UMTA MILESTONE ADVISEMENT MEMORANDUM NO. 12

US Department of Transportation
Urban Mass Transportation Administration

REGION IX
Arizona California
Hawaii Nevada Guam

Two Embarcadero Center
Suite 620
San Francisco California 94111

Mr. John A. Dyer
General Manager
Southern California Rapid
Transit District
425 South Main Street
Los Angeles, California 90013

Re: Project No. CA-03-0130-4
Milestone Advisement Memorandum
No. 12

Dear Mr. Dyer:

Enclosed is Milestone Advisement Memorandum No. 12, which documents our review comments and suggestions on the District's preliminary draft report for this final milestone. As you know, this memorandum was delayed to permit incorporation, as appropriate, of the results of the UMTA value engineering/cost reduction review conducted after your Milestone 12 report preliminary draft was issued.

As indicated in our memorandum, we are pleased to find that the report gives an excellent presentation of the METRO RAIL system plan as envisioned by the District at the end of the preliminary engineering phase of the project. In the main, the specific comments made in our advisement memorandum summarize or otherwise reinforce our comments made for earlier milestone reports or from the above-mentioned UMTA value engineering/cost reduction review.

We look forward to your response to our comments and suggestions regarding this final milestone report. Completion of this final report and the responses thereto marks the end of the preliminary engineering milestone process, which we feel has been highly productive. We commend you, the members of your staff, the many SCRTD consultants, the SCRTD Board, the participating citizens and all others involved in the process for their efforts in ensuring the outstanding success of the milestone process.

Sincerely,

Henry Nejako
for Brigid Hynes-Cherin
Regional Administrator

RECEIVED
SCRTD
OCT 20 1983
TRANSIT SYSTEMS DEV.

Enclosure

MILESTONE ADVISEMENT MEMORANDUM NO. 12

This milestone advisement memorandum documents UMTA's review comments and suggestions on the District's preliminary draft report for Milestone No. 12: System Plan.

GENERAL COMMENTS:

From our review of this final milestone report, we find that it gives an excellent presentation of the METRO RAIL system plan at a level of detail that is very appropriate for understanding by both technical professionals and by its intended audience, the general public. Because the system plan described in the report presents the METRO RAIL design as envisioned by the District at the end of the Preliminary Engineering phase of the project, our comments and suggestions are oriented toward further system design improvements that might be explored by the District and its consultants during Continuing Preliminary Engineering (CPE) and Final Design.

With this orientation in mind, in the specific comments that follow, we have (1) offered some ideas on further definition/implementation of the District's policies on commissioned artwork and on the integration of METRO RAIL with other transit modes, (2) suggested possible changes in such system-level requirements as service characteristics, ultimate capacity of the maintenance facility, and noise and vibration attenuation, and (3) suggested a number of cost-reduction and cost-effectiveness opportunities in the major system areas of Ways and Structures, Stations, Yard and Shops, and Subsystems.

SPECIFIC COMMENTS:

Chapter 2. Metro Rail System Policies

1. Artwork Program (page 33) -- The policy of a maximum of 0.5 percent of the estimated cost of the station structure for commissioned artwork at each station totals approximately $30 million for the 16-station system. It is important that these costs be carefully controlled, be allocated on a station-specific basis, and not detract from the functional needs and costs of the overall system.

2. Future Development (page 34) -- The policy on light rail provisions and the accompanying text are silent on the Los Angeles/Long Beach light rail project. Because this project is in preliminary engineering and is projected to be operational prior to the Metro Rail system, we suggest that additional policy and implementing plans be formulated to further ensure the most cost-effective integration of these two modes.

Chapter 3. Metro Rail System-level Requirements

3. Service Characteristics (page 46) -- We suggest review of the 70 mph maximum train speed in terms of operational and maintenance costs. The PATCO

system and other systems have found that it pays to reduce the top operating speed.

4. Ultimate Capacity -- Consideration should be given to construction of the maintenance facility to accommodate the repair and inspection of the 130 vehicles required for initial operations, deferring expansion of the facility to the proposed 214-vehicle level to the Year 2010 or later.

5. Noise and Vibration (page 49) -- During peak periods, attenuation of noise to achieve ambient sound levels similar to that of an average office, except when trains are arriving or departing, may be very difficult to achieve.

Chapter 4. Ways and Structure

6. Cost-reducing Changes (page 61) -- We suggest that additional cost-reducing changes be considered such as:

Vertically stack the Wilshire/Fairfax Station to reduce the impact of the station and adjacent open-cut construction on the LaBrea Tar Pits.

Reduce the tunnel diameter to the maximum amount feasible throughout the line sections.

7. Four-inch Superelevation (page 68) -- We suggest that a larger superelevation be considered to reduce the need for greater lengths of unbalanced superelevation. This should also reduce rail wear.

8. Traction Power Substations (page 72) -- As agreed during the UMTA value engineering/cost reduction review, the number of substations should be reduced by two, reflecting the elimination of two substations between the North Hollywood and Hollywood/Cahuenga stations.

Chapter 5. Station Designs and Descriptions

9. Hollywood Bowl Station (page 85) -- Consideration should be given to the impact of the Hollywood Bowl station. Current maximum patronage projections for the year 2000 are in the 3,000 to 4,000 passengers per day range. The Hollywood Bowl is only open two months of the year, and at its present level of usage will not be a large generator of transit patronage. Additionally, inclusion of the station will require that all trains stop at the station, adding approximately one minute to the travel time of all passengers. The estimated construction cost in 1983 dollars is $50 million for the station. Inclusion of the station will also significantly increase the system's annual operating and maintenance costs. For these reasons, you should consider the impact of inclusion of the Hollywood Bowl station on the system's cost effectiveness and on overall funding availability.

10. System Changes (page 85) -- Beyond the changes summarized in this chapter, we suggest that the following additional cost-reduction changes be considered during Continuing Preliminary Engineering (CPE) and Final Design:

Consider reducing station platform widths as follows:

From 32 ft. to 28 ft. at Union Station. UMTA agrees with the District's planned reduction of the Wilshire/Fairfax station from 32 ft. to 28 ft.

From 32 ft. to 26 ft. at Civic Center Station
From 28 ft. to 24 ft. at Wilshire/Normandie, Wilshire/Western, Wilshire/LaBrea, Fairfax/Beverly, Fairfax/Santa Monica, Sunset/LaBrea, Hollywood/Cahuenga, and Wilshire/Crenshaw stations.

Consider deferring the entranceway from the north side of the Wilshire/Fairfax station until patronage demand justifies its construction.

Consider decreasing station depths wherever feasible by raising the tunnel profiles within 1 1/2 tunnel diameters from the surface to reduce construction costs. Additional cost reductions are also possible by decreasing the internal size of stations by reducing the mezzanine and platform clear heights.

Consider using surface headhouses at several stations. At the Wilshire/Alvarado, Wilshire/Vermont, and Fairfax/Beverly stations, surface headhouses would significantly reduce construction costs and have a potential to simplify the station layouts. If it is feasible to raise the station profile closer to the surface at the Universal City station, a surface headhouse would also offer similar benefits. We suggest that, during CPE and Final Design, alternative construction techniques such as the use of piling support be explored to ascertain the feasibility of raising the Universal City station profile.

Reduction of the station lighting levels has a high potential for significantly reducing the system's long term auxiliary power costs. Such cost reductions might also be considered during CPE and Final Design.

Consider using standard off-the-shelf elevator equipment for the system's E&H access facilities.

Consider locating the Universal City station parking facility on the station side of the freeway and constructing a parking garage if necessary. In this event, the remote parking facilities across the freeway would be developed only when patronage demand at the station requires additional parking capacity.

11. Station Access Facilities (page 90) -- At some stations, construction of suitable parking structures may be more cost effective than the acquisition of extensive property.

12. Station Descriptions (pages 95-127) -- In addition to the above suggestions impacting on various Metro Rail stations, we offer the following station-specific suggestions for consideration during CPE and Final Design.

Union Station (page 95) -- consider deferral of one stair and escalator from the east end of the platform.

7th/Flower Station (page 101) -- consider reduction of the length of the Hope Street passageway length from 200 feet to approximately 100 feet to enhance system safety and security at this station.

Chapter 6. Main Yard and Shops

13. Yard Sizing (page 129) -- During CPE and Final Design, we suggest that the main yard be laid out to accommodate the anticipated service requirements for the year 2000-to-year 2010 timeframe and that the full yard and shop layout for 214 vehicles be deferred until needed.

14. Storage Yard (page 129) -- Consider the feasibility of (1) redesigning the entrance transfer tracks from four future to three tracks to minimize the number of switches and (2) using only two tracks during initial system operations. Reconfiguration of the main yard layout within the upper western portion of the Santa Fe property with one train stored per track would minimize the property requirements and possibly simplify the future operations and maintenance requirements for the yard. This suggested layout has the potential to minimize interference with the First Street bridge and eliminate any disturbance of the Fourth Street bridge.

15. Main Shop Building (page 132) -- Consider shortening the Service and Inspection Shop by eliminating the gaps now provided for between the two married pairs.

Chapter 7. Subsystems

The following comments and suggestions regarding subsystems are presented as cost-reduction candidates for consideration during CPE and Final Design.

16. Automatic Train Control (page 141) -- Three cost-reduction possibilities are suggested regarding automatic train control:

Consider reevaluation of the use of redundant microprocessors in the onboard train control system as an alternative design philosophy for ATD/ATP/ATS

Consider (1) reevaluation of the need to transmit track occupancies to the central tower and (2) investigation of the use of pole-mounted pushbutton control for yard switch machines.

Consider reevaluation of the need for train stops at all main line interlockings.

17. Traction Power (page 152) -- We suggest reevaluation of the degree of redundancy provided for between the proposed 17 substations of the initial Metro Rail system. The reevaluation might factor in some limited allowance for degraded service versus capital, operating, and maintenance costs to assess the sensitivity of this potential modification.

18. Fare Collection (page 153) -- Consider reevaluation during CPE and Final Design of the use of automatic fare gate systems versus other fare collection systems from the standpoint of long term operating and maintenance costs as well as initial capital costs.

Chapter 8. Estimated Costs

UMTA comments and suggestions of Milestone Advisement Memorandum No. 11 are pertinent to this chapter.

SCRTD RESPONSES TO UMTA COMMENTS

COMMENT 1: Artwork Program

The policy of a maximum of 0.5 percent of the estimated cost of the station structure for commissioned artwork at each station totals approximately $30 million for the 16-station system. It is important that these costs be carefully controlled, be allocated on a station-specific basis, and not detract from the functional needs and costs of the overall system.

SCRTD Response

The artwork program being established by SCRTD budgets a maximum of one-half of 1 percent (0.5 percent) of the estimated cost of station structure. The total cost of the program is projected at between $1.5 and $2.0 million, rather than the $30 million cited by UMTA. SCRTD concurs with UMTA's remaining comments and is establishing an artwork committee to guide the choice of artwork at each station. The committee for each station will include five permanent members and the architect for the particular station under consideration. The station architect will serve as a voting member and as a technical adviser for artist selection and art review, to ensure that selected artwork does not detract from the functional needs of the station. The committee will work within a budget allocated on a station-specific basis and subject to all project cost review and control procedures.

COMMENT 2: Future Development

The policy on light rail provisions and the accompanying text are silent on the Los Angeles/Long Beach light rail project. Because this project is in preliminary engineering and is projected to be operational prior to the Metro Rail system, we suggest that additional policy and implementing plans be formulated to further ensure the most cost-effective integration of these two modes.

SCRTD Response

As the designated operator of the Los Angeles/Long Beach light rail project, SCRTD is very aware of the importance of its cost-effective integration with the Metro Rail system. Toward this end, SCRTD is working with the Los Angeles County Transportation Commission, the lead agency for the Los Angeles/Long Beach LRT project's design and construction, to provide for effective integration of the two systems. Integration issues being considered include operations control, fare collection, security, transfer stations, and service connections for interline movement of vehicles.

COMMENT 3: Service Characteristics

We suggest review of the 70 mph maximum train speed in terms of operational and maintenance costs. The PATCO system and other systems have found that it pays to reduce the top operating speed.

SCRTD Response

The revised operating plan as reflected in the Milestone 12 Final Report calls for normal operation to be limited to 90 percent of acceleration and top-speed capability. This revision results in a maximum train speed under normal operation of 63 mph, with a speed of 70 mph available for schedule recovery. As the UMTA comment notes, analysis has shown that this reduction in normal top speed will produce significant savings in energy and maintenance costs, with only minor penalties in trip times.

COMMENT 4: Ultimate Capacity

Consideration should be given to construction of the maintenance facility to accommodate the repair and inspection of the 130 vehicles required for initial operations, deferring expansion of the facility to the proposed 214-vehicle level to the year 2010 or later.

SCRTD Response

As a result of previous UMTA comments on the sizing of the yard facilities, SCRTD has redesigned the main yard, reducing its total area from 45 acres to approximately 40 acres and reducing its storage capacity to 170 vehicles (85 married pairs on 10 tracks). Each storage track will be divided into three storage positions by required interior transverse fire access roads. Each storage position may be used by one six-car consist, one four-car consist, or two two-car consists. (Storage of consists shorter than six cars in length will be necessary to provide operational flexibility without necessary consist changes.)

It is SCRTD's conclusion that all 10 storage tracks will be needed to handle start-up demands, despite the fact that the initial fleet size will be 130 vehicles as opposed to the ultimate fleet size of 198. The storage track requirements must consider the start-up as well as the in-service demands of the system. These start-up demands include:

- Unloading, set-up, and receiving of new transit vehicles
- Some portion of the acceptance testing of new vehicles, previously allocated to the now-deleted test track
- Shuffling of the vehicle fleet to accommodate the fault determination, corrective actions, modifications, and retrofitting commonly associated with new car programs.

Many of these initial demands will focus on a married pair rather than on longer consists. The storage capacity of the proposed 10-track yard will be only 120 vehicles if all consists are two-car ones.

The repair and inspection facilities within the main yard have similarly been sized to accommodate the 198-car fleet. For this redesign, SCRTD thoroughly analyzed all opportunities for reductions or deferrals in constructing and outfitting the Metro Rail shops. Our conclusions are as follows:

S & I shop. The S & I shop provides for the routine inspection and preventive maintenance of transit vehicles. The design assumes that any future satellite yard will include its own S & I facility; hence, this shop will support only the vehicles to be stored in the main yard. Although the S & I shop will initially be used to support a 130-car fleet, sizing of the shop must consider the difficulty of future shop expansion and the start-up demands of a new vehicle progam. Consequently, the S & I shop, formerly designed with nine married pair positions, has been redesigned with eight married pair positions capable of supporting the 198-car ultimate fleet.

The eight positions have been accommodated by eliminating the building extensions, thus shortening the length of the S & I shop from 562 feet to 360 feet and reducing the total area of the shop by approximately 12,000 square feet. The number of married pair positions on the original three tracks has been reduced from three to two (reducing the number of aisle gaps from two to one), and a fourth track has been added, also with two positions. Due to a separate pit reconfiguration, the distances between track centers has been reduced, resulting in only a 5- to 10-foot increase in building width to accommodate the fourth track.

Main shop. The heavy repair shop is planned to be the central repair facility for the entire Metro Rail system and, as such, cannot be reduced in capacity despite the reduction in size of the main yard. The future satellite yards will not contain heavy repair bays; all heavy repair work will be performed in this shop. The initial demands on the heavy repair shop will depend on the new transit cars and their reliability. SCRTD has determined that it is not practical to defer any of the heavy repair positions. Adding additional tracks or lengthening an in-service heavy repair shop at a future date will be an operational nightmare. However, the deferral of the purchase and installation of some equipment not required to support the initial fleet, such as the car body lifts at two of the four married pair work locations, is feasible.

The support shops and system stores are less sensitive to fleet size. An axle lathe, wheel boring machine, and wheel press, for example, all in the axle and wheel shop, are necessary irrespective of the number of cars. We will examine the equipment lists for the support shop and will purchase only the equipment that is essential for the initial fleet.

We believe that the new main yard and shops design provides the minimum facility practical to construct, and that no further reductions are possible without impairing system performance and reliability.

COMMENT 5: Noise and Vibration

During peak periods, attenuation of noise to achieve ambient sound levels similar to that of an average office, except when trains are arriving or departing, may be very difficult to achieve.

SCRTD Response

Sound levels in Metro Rail stations will be approximately 55 dBA except when trains are in the station or are entering or departing the station. This rating is comparable to that achieved by other recently built rail rapid transit systems.

COMMENT 6: Cost-Reducing Changes

We suggest that additional cost-reducing changes be considered, such as:

a. Vertically stack the Wilshire/Fairfax Station to reduce the impact of the station and adjacent open-cut construction on the La Brea Tar Pits.

b. Reduce the tunnel diameter to the maximum amount feasible throughout the line sections.

SCRTD Response

a. Vertically stack the Wilshire/Fairfax Station--In response to UMTA's recommendation to develop a "stacked station" at Wilshire/Fairfax, and to extensive comments received on the draft EIS, SCRTD has relocated the Wilshire/Fairfax Station to a site behind the existing May Company department store and has redesigned the station with a stacked platform configuration. The use of this site will reduce potential adverse environmental impacts in the La Brea Tar Pits area, and has in addition enabled SCRTD to take advantage of a significant joint-development opportunity.

b. Reduce tunnel diameter--As a result of UMTA's previous concerns and comments, SCRTD conducted a thorough examination of the 17-foot 6-inch tunnel size with regard to maintenance and rerailment requirements, as well as vehicle/tunnel clearances necessary to ensure an unobstructed vehicle path. These findings are as follows:

- Any reduction in tunnel diameter would negatively impact routine train operations and emergency maintenance. Third-rail vehicle pick-up shoe paddling and servicing of disabled vehicles along the right-of-way are already restricted at the current tunnel diameter.

- The Fire/Life Safety Committee has agreed to the 17-foot 6-inch tunnel since it in general enables their clearance criterion for safety and maintenance walkways to be met, providing a clearance envelope 24 inches wide and 80 inches high. This is the minimum acceptable clearance, and in fact the committee has already agreed to accept some reduced walkway widths at selected tunnel segments on curves. Any further reduction in tunnel diameter would result in unacceptable conditions, particularly with regard to suppressing an incipient fire on the third rail side of the tunnel.

- Jacking distances for rerailing are already below the desired minimum at tunnel segments on curves.

- Slab thicknesses for track beds cannot be reduced without compromising structural integrity and infringing on necessary construction tolerances for steel reinforcement and track laying. Use of heavy-weight concrete does not offer any further economies relative to slab thickness.

- The tunnel blockage ratio created by the 17-foot 6-inch tunnel diameter and the proposed vehicle cross-sectional area will generate station platform air velocities and air pressure transients that are at a maximum acceptable level from a patron's point of view. Any increase in this ratio would require the installation of larger emergency fans, blast shafts, and dampers than those being planned, resulting in higher capital costs and increased power consumption. Furthermore, more train propulsion power would have to be furnished through larger traction power facilities (with consequent increases in capital and operating costs) to overcome the added air resistance caused by the reduced tunnel diameter.

At the Third Transit Technical Advisory Committee meeting held in July 1983, in which UMTA was an active participant, committee members expressed serious concern about the effects on vehicle maintenance, debris removal, and rerailing of any clearance reductions in Metro Rail tunnels. On the basis of the committee's comments and the results of the in-depth analysis cited above, SCRTD has concluded that a tunnel diameter of 17 feet 6 inches provides the minimum acceptable clearances and operating characteristics for the system. No further reductions are achievable.

COMMENT 7: Four-inch Superelevation

We suggest that a larger superelevation be considered to reduce the need for greater lengths of unbalanced superelevation. This should also reduce rail wear.

SCRTD Response

Superelevation on the Metro Rail system will continue to be assessed during CPE, subject to the constraints of the dynamic envelope, to determine the optimum superelevation for the system.

COMMENT 8: Traction Power Substations

As agreed during the UMTA value engineering/cost reduction review, the number of substations should be reduced by two, reflecting the elimination of two substations between the North Hollywood and Hollywood/Cahuenga Stations.

SCRTD Response

In accordance with the decision reached during the UMTA value engineering/cost reduction review, two traction power substations have been eliminated, one between the Hollywood/Cahuenga and Universal City Stations and one between the Universal City and North Hollywood Stations. (This assumes that the Hollywood Bowl Station will not be built; if it is constructed, a traction power substation will be required at its site.)

COMMENT 9: Hollywood Bowl Station

Consideration should be given to the impact of the Hollywood Bowl Station. Current maximum patronage projections for the year 2000 are in the 3,000 to 4,000 passengers per day range. The Hollywood Bowl is only open two months of the year, and at its present level of usage will not be a large generator of transit patronage. Additionally, inclusion of the station will require that all trains stop at the station, adding approximately one minute to the travel time of all passengers. The estimated construction cost in 1983 dollars is $50 million for the station. Inclusion of the station will also significantly increase the system's annual operating and maintenance costs. For these reasons, you should consider the impact of inclusion of the Hollywood Bowl station on the system's cost effectiveness and on overall funding availability.

SCRTD Response

The Hollywood Bowl Station was adopted by the SCRTD Board of Directors on the basis of the following considerations:

- Traffic congestion and limited parking in the Hollywood Bowl area severely limit access and use of the Bowl and adjacent facilities and cause severe environmental problems for merchants and homeowners.
- A Metro Rail station at the Hollywood Bowl will provide increased access to Bowl area events for all members of the public.
- A Metro Rail station at the Hollywood Bowl will provide for the first time practical access to Bowl area events for persons living in East Los Angeles, South Central Los Angeles, and the more distant areas of Los Angeles County.
- A Metro Rail station at the Hollywood Bowl will provide access to the thousands of low-cost seats available at the Bowl, which is of special importance to the elderly, children, handicapped persons, and low-income families.
- A Metro Rail station at the Hollywood Bowl will increase patronage, with consequent benefits to the community of performing artists.

Because of these considerations, the Board of Directors has retained its intention to construct the Hollywood Bowl Station. However, because of the impact of the station on overall funding availability, the Board of Directors reached a decision, in December 1983, to defer construction of the Hollywood Bowl Station and to exclude its cost from the project's initial federal funding grant application. As part of this decision, the Board directed that:

- The profile of the subway tunnel that is aligned directly below the Bowl entrance area be raised to approximately 50 feet beneath the surface so as to allow for construction of the station

- The design of the station be taken from its current design level to approximately 50 percent of design completion

- The Bowl area tunnel design and construction be done in a manner which will provide maximum opportunity for later station construction, and preclude any danger to the safe and continued operation of the Metro Rail system should operations have begun

- A program be targeted to begin station construction in accordance with the current Metro Rail design and construction schedule so as to take advantage of the cost savings resulting from coordinated construction efforts and avoid cost escalation

- An effort be initiated with local, state and federal agencies, government entities, and community organizations to identify and provide funding for station construction.

COMMENT 10: System Changes

Beyond the changes summarized in this chapter, we suggest that the following additional cost-reduction changes be considered during Continuing Preliminary Engineering (CPE) and Final Design:

a. Consider reducing station platform widths as follows:

   From 32 ft. to 28 ft. at Union Station. UMTA agrees with the District's planned reduction of the Wilshire/Fairfax Station from 32 ft to 28 ft.

   From 32 ft. to 26 ft. at Civic Center Station.
   From 28 ft. to 24 ft. at Wilshire/Normandie, Wilshire/Western, Wilshire/La Brea, Fairfax/Beverly, Fairfax/Santa Monica, Sunset/La Brea, Hollywood/Cahuenga, and Wilshire/Crenshaw stations.

b. Consider deferring the entranceway from the north side of the Wilshire/Fairfax station until patronage demand justifies its construction.

c. Consider decreasing station depths wherever feasible by raising the tunnel profiles within 1-1\2 tunnel diameters from the surface to reduce construction costs. Additional cost reductions are also possible by decreasing the internal size of stations by reducing the mezzanine and platform clear heights.

d. Consider using surface headhouses at several stations. At the Wilshire/Alvarado, Wilshire/Vermont, and Fairfax/Beverly stations, surface headhouses would significantly reduce construction costs and have a potential to simplify the station layouts. If it is feasible to raise the station profile closer to the surface at the Universal City station, a surface headhouse would also offer similar benefits. We suggest that, during CPE and Final Design, alternative construction techniques such as the use of piling support be explored to ascertain the feasibility of raising the Universal City station profile.

e. Reduction of the station lighting levels has a high potential for significantly reducing the system's long term auxiliary power costs. Such cost reductions might also be considered during CPE and Final Design.

f. Consider using standard off-the-shelf elevator equipment for the system's E&H access facilities.

g. Consider locating the Universal City station parking facility on the station side of the freeway and constructing a parking garage if necessary. In this event, the remote parking facilities across the freeway would be developed only when patronage demand at the station requires additional parking capacity.

SCRTD Response

a. Reduce station platform widths--In response to previous UMTA comments, SCRTD and the Fire/Life Safety Committee have thoroughly analyzed present platform widths and have reached the following conclusions:

- Given the potential for further large-scale developments with sizable employment populations at Union and Civic Center, the 32-foot platform width must be maintained to ensure sufficient capacity.

- The 32-foot width at all central business district (CBD) stations cannot be reduced without further extending box lengths for ancillary rooms since double-end mezzanines are required for patronage capacity and distribution of entry points at these stations. In addition, the number of vertical devices on the platform takes up considerable floor area required for circulation and train loading/unloading at these high-density stations.

- The 28-foot width at Wilshire/Normandie, Wilshire/Western, Wilshire/Crenshaw, Wilshire/La Brea, Fairfax/Beverly, Fairfax/Santa Monica, La Brea/Sunset, and Hollywood/Cahuenga cannot be reduced further because of platform ancillary room dimensional requirements. Train control and communications rooms are already at an absolute minimum in the transverse direction. In addition, escalators, stairs, and columns on the platform have reduced side clearances to less than 7 feet.

- Even at those stations with crossovers (Crenshaw, Beverly, and Cahuenga), virtually all available space at the platform level has been utilized, precluding any reductions in the 28-foot width. Constructing separate cut-and-cover ancillary rooms over tunnels through the use of piles would not be economical because of added piling and utility relocation costs.

b. Defer north entrance at Wilshire/Fairfax--UMTA's comment refers to the superseded design of the Wilshire/Fairfax Station which incorporated station entrances on the north and south sides of Wilshire Boulevard. The station has now been relocated to an off-street location in the northeast quadrant of the Wilshire/Fairfax intersection. It will have stacked side platforms which will be served by two entrances and mezzanines; one entrance will be oriented toward

Wilshire Boulevard, and the other will be oriented toward Fairfax Avenue.

c. Consider decreasing station depths and internal size of stations--In response to UMTA's continued concerns, every effort is being made to raise station top of rail elevations without negatively impacting existing utilities, constructing in or through unstable geological areas, or affecting existing building foundations and natural formations.

   Each Section Designer has been asked to perform an in-depth review of all new utilities survey data and recently completed soils reports and to raise station and line profiles wherever feasible. On the basis of those reviews, it has not been found feasible to decrease the depths of two stations:

   - Wilshire/Vermont Station--The recently completed Vermont Station Designer's analysis reinforced the conclusion that distances being maintained under utilities in Vermont were prudent from an engineering point of view and that no further decreases in depth were possible.

   - Universal City Station--The present design of the Universal City Station has located the station at a depth of 76 feet, based on currently available geotechnical information. Every attempt will be made to raise the elevation of this station through further analysis of ongoing soils investigations and seismic data. Our soils and seismic reports have identified that this station is located in an area highly susceptible to liquefaction in the event of an earthquake of even moderate dimensions. Our structural engineers have recommended anchoring the station on existing rock formations to minimize uplifting.

     Additional borings are to be taken in this area to confirm rock elevations and soil characteristics. The profile will be adjusted upward, as much as possible, once this investigation is completed. Special treatment of the alluvium soil is also being considered to provide a cost-effective method of undertaking the cut-and-cover operation in this area.

   With regard to reducing the height of station boxes, SCRTD has conducted a further analysis and has found that:

- No further reductions are achievable in minimum clearances from top of rail to underside of mezzanine structure for the following reasons:

  - Jacking distance for rerailments from static envelope to underside of obstacle is now at a minimum.

  - Duct sizes for distribution of air to train rooms are at a minimum in the vertical dimension to avoid substantial inefficiencies in fan horsepower sizing and distribution of substantial amounts of air.

  - Platform-level ancillary room heights are already at a minimum, especially for train control and communications.

  - Escalator headroom clearances from structural slab on mezzanine to platform are already at a minimum.

- No further reductions are obtainable in finish mezzanine floor to underside of roof structure height for the following reasons:

  - Ancillary room heights are already at minimum, especially for the traction power substation facilities. Raising the roof slab over the substation would result in potential conflicts with utilities and creation of methane gas pockets, in addition to complicating structural framing and waterproofing details.

  - Elevator override space penetrating into the roof structure would create the need for complicated waterproofing and structural detailing, resulting in higher costs, and potentially could also generate conflicts with utilities.

  - Finish mezzanine floor to underside of longitudinal beam is now at 13 feet. Depth of beam varies relative to overburden and column sizing. Our minimum clear height, including the smoke exhaust/methane relief system, is now at 15 feet 6 inches.

d. <u>Consider using surface headhouses</u>--Station depths at all off-street locations are set by a tunneling criterion that requires a minimum of 1-1/2 tunnel diameters below grade for boring in the soil conditions existing in the basin. In the cases cited by UMTA where the use of headhouses should be reassessed, the station depth is sufficient to develop a mezzanine-type station without cost premiums. Even though a headhouse/concourse would reduce escalator, stair, and elevator quantities, the length of runs for the devices required to reach predetermined platform levels is more costly.

The following discussion summarizes the specific problems associated with surface headhouses at the stations suggested by UMTA:

- Wilshire/Alvarado Station--Top of rail cannot be raised because of the tunnel clearance requirements below the lake west of Alvarado. A very large linear headhouse would have to be built to provide three sets of stairs and elevators, further negating development opportunities. The current mezzanine configuration remains the most cost-effective solution.

- Wilshire/Vermont Station--Top of rail has been set to avoid conflicts with existing utilities in Vermont Avenue and cannot be raised. In addition, entrances are placed on both sides of Vermont Avenue to accommodate major north-south bus interfaces. Two separate headhouses would be required, resulting in higher costs than the present mezzanine configuration.

- Fairfax/Beverly Station--Top of rail has been predetermined to allow for sufficient cover of the bored tunnels immediately north of the station. Therefore, a mezzanine can be cost-effectively accommodated without lowering the station. In addition, a surface headhouse would provide a negative restraint on CBS's development potential at this valuable intersection.

With regard to the Universal City Station, as discussed above in relation to station depth, the top of rail has been determined to overcome potential liquefaction impacts in the event of an earthquake. UMTA's suggestion to locate the station on piles bearing on rock and thus raise the profile may be feasible but is not cost-effective. The piles would have to be designed as columns and would require very large quantities of steel and concrete because of their substantial unsupported length.

In conclusion, current mezzanine-type stations are the most economical at all four locations where headhouses appear feasible from an alignment point of view, and SCRTD will proceed with the design of the mezzanine-type stations at the above locations.

e. Reduce station lighting levels--SCRTD has investigated the lighting levels provided at other recently built transit properties. As a result of this survey, we have concluded that lighting-level standards can be reduced by 5 to 10 foot-candles, depending on the specific functional use of the space. In public areas, a reduction of 5 foot-candles appears appropriate. Lighting levels in ancillary areas can be reduced by up to 10 foot-candles, depending on servicing and maintenance requirements.

f. Consider using standard elevator equipment--SCRTD will use modular, standardized elevator equipment. Cost economies are expected from the use of smaller standardized elevators (previously agreed upon), which will be procured on a systemwide basis for all stations.

g. Consider relocating Universal City Parking--SCRTD has examined parking facilities at the Universal City Station and has concluded that the parking site west of the Hollywood Freeway should be retained, for the following reasons:

- The parking demand projected for the year 2000 is 7,750; for the year 1990, it is 5,818. Using a constrained model with 2,450 spaces, a daily year 2000 usage of 3,655 is predicted. Based on these projections, it is our contention that the additional parking for this site is sorely needed.

- Parking sites on both sides of the freeway were adopted by the SCRTD Board of Directors as the result of an extensive, in-depth Special Alternatives Analysis in which local community groups participated. The abandonment of virtually all parking west of the freeway could result in serious opposition to the project.

The construction of a new bridge over the Hollywood Freeway will provide good access to the station's auto and bus facilities from the west. This bridge will divert much of the project-related traffic away from Cahuenga and Lankershim Boulevards and is therefore a mitigation measure for a number of intersections.

COMMENT 11: Station Access Facilities

At some stations, construction of suitable parking structures may be more cost effective than the acquisition of extensive property.

SCRTD Response

An additional study of parking requirements was made by SCRTD as a part of the Milestone 10 process. On the basis of that study, SCRTD still does not recommend near-term construction of parking structures. Surface parking sized for initial levels of demand will instead be provided, with the construction of parking structures to be considered at a future date.

COMMENT 12: Station Descriptions

In addition to the above suggestions impacting on various Metro Rail stations, we offer the following station-specific suggestions for consideration during CPE and Final Design:

a. Union Station--Consider deferral of one stair and escalator from the east end of the platform.

b. 7th/Flower Station--Consider reduction of the length of the Hope Street passageway from 200 feet to approximately 100 feet to enhance system safety and security at this station.

SCRTD Response

a. Union Station--SCRTD undertook a complete reassessment of the factors used to establish design-hour station loadings. Smaller design-hour loadings at all stations resulted from refinements to the following factors:

- The long-term growth factor for the ultimate design year was decreased from 1.6 to 1.5.

- The "peak-within a peak" factor was decreased from 1.5 to 1.15.

On the basis of these revised factors, an analysis of stairway/escalator requirements at Metro Rail stations was undertaken. A number of potential deferrals were identified, including several at Union Station. The Fire/Life Safety Committee is now reviewing the findings of the analysis. Deferrals of stairways/escalators will be adopted if found not to impact adversely patronage use or emergency exiting capacity.

b. 7th/Flower Station passageway--The length of the Hope Street passageway at the 7th/Flower Station will be reviewed during CPE as more information is obtained regarding the structure of existing buildings.

COMMENT 13: Yard Sizing

During CPE and Final Design, we suggest that the main yard be laid out to accommodate the anticipated service requirements for the year 2000-to-year 2010 timeframe and that the full yard and shop layout for 214 vehicles be deferred until needed.

SCRTD Response

Please see response to Comment 4.

COMMENT 14: Storage Yard

Consider the feasibility of (1) redesigning the entrance transfer tracks from four future to three tracks to minimize the number of switches, and (2) using only two tracks during initial system operations. Reconfiguration of the main yard layout within the upper western portion of the Santa Fe property with one train stored per track would minimize the property requirements and possibly simplify the future operations and maintenance requirements for the yard. This suggested layout has the potential to minimize interference with the First Street bridge and eliminate any disturbance of the Fourth Street bridge.

SCRTD Response

As a result of earlier UMTA recommendations, SCRTD has already reconfigured the transfer zone, reducing the number of transfer tracks from four to three. We feel that three tracks are necessary for reliable service. The transfer zone, in addition to being the location where train control is transferred from the yard tower to Central Control, may also be used for departure testing. The alternative is to install train control equipment for departure testing in the yard prior to the transfer zone.

In either case, a train will occasionally fail the test and remain in or proceed to the transfer zone (to clear yard interlocking) to stop and reverse direction. Two departure tracks are necessary to allow peak hour discharge at the required frequency while allowing for a train direction reversal. The third transfer track is necessary to receive trains returning for consist changes, and to allow for operation in the event of damage or derailment on the extensive special trackwork at both ends of the transfer zone.

As a result of cost-reduction suggestions by UMTA, the yard has been reconfigured to reduce the required area from 45 acres to approximately 40 acres and to eliminate the need for reconstruction of the First Street Bridge. Substantial cost savings can be attributed to this change.

COMMENT 15: Main Shop Building

Consider shortening the Service and Inspection Shop by eliminating the gaps now provided for between the two married pairs.

SCRTD Response

The aisle gap between married pair work positions is provided for efficient personnel and equipment flow within the S & I shop. We anticipate that cars will routinely come to the S & I shop as married pairs and not as coupled trains. Consist changes for revenue service will result in married pairs requiring scheduled inspection at different times. Elimination of the aisles, in addition to disrupting traffic flow, would impose a need for precise car spotting or coupling and would restrict access to the ends of the cars and to the couplers.

As a result of UMTA's recommendations, however, SCRTD has reconfigured the S & I shop pits to reduce the length of the aisle gaps by relocating the pit stairs.

COMMENT 16: Automatic Train Control

Three cost-reduction possibilities are suggested regarding automatic train control:

a. Consider reevaluation of the use of redundant microprocessors in the onboard train control system as an alternative design philosophy for ATO/ATP/ATS.

b. Consider (1) reevaluation of the need to transmit track occupancies to the central tower and (2) investigation of the use of pole-mounted pushbutton control for yard switch machines.

c. Consider reevaluation of the need for train stops at all main line interlockings.

SCRTD Response

a. Microprocessors--SCRTD maintains a high level of interest in the development of vital microprocessor technology. However, for reasons related to the developmental nature of this technology and the likely schedule for it to reach maturity, as well as SCRTD's public posture on implementation of new technology, the District has concluded that it would not yet be prudent to design around microprocessors for vital functions. The use of microprocessors for non-vital functions on the train and test equipment is acceptable and in some cases will be encouraged. SCRTD will also consider the total cost--hardware, software, technical support, and reliability--before making a decision.

b. Yard control--Operation of the yard in an efficient and safe manner is necessary to allow the main-line revenue operation to be maintained without interruption or degradation. To best enable efficient yard operation, a single point of control is required. The yard control tower, as the single point of control, needs indication of all track occupancies and route alignments. This, coupled with knowledge of all present and required train movements, will allow the greatest efficiency in yard operation. If train movements are left to the discretion of individual train operators, conflicting moves and/or blocking moves may be made. Even if no collision occurs, the delays in untangling the conflict could cause delays to trains scheduled to go into revenue service, thus causing a deterioration of the main-line service. An analysis of the suggestion to control the bulk of the yard switch machines from pole-mounted push buttons indicates that, with the cabling and logic required to properly interlock the pole-mounted push buttons, there would be little or no savings.

c. Train stops--The question of using train trip stops is one of cost versus safety. Trip stops will effectively prevent train operators from disregarding a red signal. This has proved to be a problem on ATP/ATO/ATS-equipped rail transit systems without trip stops.

In addition, trip stops provide a means of ensuring train braking at the stub end of a rail line. BART has experienced ATP failure causing a train to overrun the end of track; this would not have occurred if trip stops had been employed in the manner intended by SCRTD.

SCRTD considers the use of trip stops to be a prudent and justified safety measure.

COMMENT 17: Traction Power

We suggest reevaluation of the degree of redundancy provided for between the proposed 17 substations of the initial Metro Rail system. The reevaluation might factor in some limited allowance for degraded service versus capital, operating, and maintenance costs to assess the sensitivity of this potential modification.

SCRTD Response

SCRTD concurs that computer simulation studies using the Transit Operational Model and other programs should be continued as locations and sizing of traction power substations are optimized. A special consultant has been placed under contract to perform energy conservation and cost reduction studies for the Metro Rail power subsystem.

Power for train propulsion has inherent redundancy through interconnection of the DC distribution system, and loss of one traction power substation will not shut down train operation, although it will result in a reduced level of performance (speed and acceleration), which is acceptable under a worst-case scenario. The need to have redundant utility feeders to each traction power substation is not dictated specifically by train propulsion, but rather by the fire/life safety criterion that requires fans used for emergency ventilation to be supplied from two separate power sources. Since these fans represent a large load at each passenger station (900 to 1050 KW), it would be very costly to supply this load by an on-site back-up power source such as a UPS system or engine-generator set. Dual redundant utility feeders appear to be a less costly alternative at this time.

COMMENT 18: Fare Collection

Consider reevaluation during CPE and Final Design of the use of automatic fare gate systems versus other fare collection systems from the standpoint of long-term operating and maintenance costs as well as initial capital costs.

SCRTD Response

Substantial reevaluation of the adopted fare collection system is planned during CPE and Final Design. Investigations will include the simplification of automatic fare gates to improve reliability, as well as the possible elimination of automatic fare gates by the adoption of a proof-of-payment or barrier-free system. Continued examination of fare collection alternatives will include a joint effort during 1984 by SCRTD and the Los Angeles County Transportation Commission to evaluate bus, Metro Rail, and LRT fare collection requirements as an integrated system.