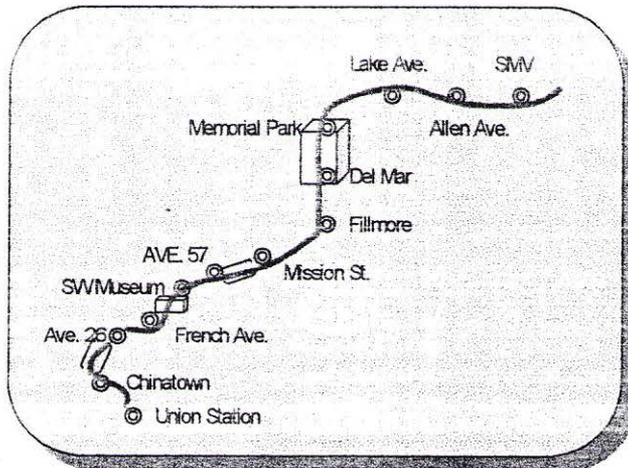


City of Pasadena Public Works & Transportation Department

Pasadena Blue Line Corridor Study



Draft Report

October 23, 1998



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1.0 INTRODUCTION

For more than 20 years the transit plans of the agencies responsible for planning, designing, building, and operating mass transit have included building a rail transit system between the cities of Los Angeles and Pasadena. In 1980 the map presented to the voters by the Los Angeles County Transportation Commission (LACTC) as part of the Proposition A one half percent sales tax referendum showed a rail transit line between the two cities. Once again in 1990 when the LACTC presented the documentation and maps as part of the successful Proposition C one half percent sales tax referendum a light rail transit (LRT) line between Los Angeles and Pasadena appeared in the literature.

With the passage of both Propositions A and C and the accompanying literature surrounding the votes, many persons in both Los Angeles and Pasadena were convinced that the light rail line would be built in a timely manner. For example, the Final Environmental Impact Report (FEIR) on the project was completed in 1990. Also, the 20 year rail transit development plan adopted by the LACTC in 1991 identified the 13.6 mile Pasadena Blue Line as a priority and projected completion of the construction in mid-1998 with full operations by 1999. Construction of the line began in 1994. Less than one year later in 1995 the Metropolitan Transportation Authority (MTA), the successor to the LACTC, projected in its update of the 20 year financial plan completion of the Pasadena Blue Line in late 2000 with full operations in early 2001. Subsequent revisions slipped the date to as late as 2008.

1.1 Background of the Study

Between 1994 and 1997 the MTA encountered a number of situations all of which appeared to negatively impact its financial plans and development programs. First, the Los Angeles economy did not rebound from the 1990-2 recession as predicted resulting in substantially less revenues than MTA had estimated from the Prop A and C sales taxes. Forecasts of future revenues also had to be reduced. Second, the MTA experienced significantly greater cost overruns and many more construction problems than anticipated on the MOS-2 and MOS-3 operable segments of the Red Line subway. Third, the MTA got embroiled in a series of funding disputes with the Congress and the U.S. Department of Transportation (DOT). This resulted in the MTA's annual appropriations for rail construction being withheld by Congress for one year and thereafter significantly reduced below minimum expectations. In part, this contributed to both a cash flow and a funding crisis in MTA's capital program.

While the rail construction and funding issues seemed to be all quite negative, the bus funding and service quality problems were equally difficult. In a fourth set of events the MTA in October 1996 entered into a Consent Decree rather than litigate a case in Federal District Court involving potential civil rights issues surrounding the deteriorating quality of bus service in the metropolitan area. The Consent Decree required the MTA to meet a series of increasingly stringent performance standards regarding its bus operations while

limiting its ability to raise fares to pay for a part of the added costs of expanding and improving the on-street services. In addition, the Decree required an expansion of the fleet by 102 buses. The impact of the Decree on the capital and operating budgets clearly has been quite significant.

In December 1996 the Federal Transit Administration (FTA) of the DOT became so concerned about the financial commitments of the MTA that it demanded a financial recovery plan from the agency to meet what was identified as more than a \$ 1 billion shortfall in its capital program. The FTA stated emphatically that it would not release any additional federal funds for construction of the Red Line subway until a financial recovery plan had been submitted by MTA and approved by the FTA Administrator. The MTA submitted its financial recovery plan in January 1997. After careful review the FTA rejected the plan as not responsive to the requirements. The MTA then resubmitted a revised financial recovery plan in August 1997. In September 1997 this financial plan was disapproved by FTA in a letter which made rather harsh criticisms of the agency and the plan including its assumptions, methodology, and approach.

Within less than a month after receipt of the letter from FTA, the MTA Board replaced its management. A new interim CEO was appointed in September 1997. Almost immediately, a new management team was brought on by the interim CEO to begin to address the financial issues and other problem areas identified above. A comprehensive effort was initiated to analyze the financial issues and begin the process of developing a financial recovery plan that would meet the FTA requirements. As the analysis moved forward it became increasingly clear to MTA that it could not meet all of its existing project and contractual obligations, Consent Decree requirements, and other program commitments while it continued to pursue design and construction of several rail system extensions.

In January 1998 the interim CEO recommended and the MTA Board approved the suspension for a minimum of six months all rail transit work in three corridors. The work temporarily suspended amounted to more than \$ 2.2 billion in project design and construction related activity. These corridors included the Pasadena Blue Line, the Metro Red Line East Side Extension, and the Metro Red Line Mid-City Extension. Work also was suspended on the San Fernando Valley East/West corridor where a major planning and engineering study was underway. In terms of completion the Pasadena Blue Line was the closest to being finished – the final design was about 75 percent complete, more than 10 percent of the construction had been completed, the rail cars had been purchased and were being delivered, and nearly all of the right-of-way had been acquired.

1.2 The MTA's Financial Restructuring Plan

With the suspension of nearly half of the MTA's capital program in place the interim CEO was in a position to complete the preparation of the third version of the financial recovery plan. The plan was redefined as the Financial Restructuring Plan and drafted in detailed form by staff between January and April 1998. It was reviewed by the Board and approved for submission to FTA in May 1998. After careful review of the

Restructuring Plan, the FTA in July favorably commented on its contents, approved its provisions, and directed MTA to begin implementation of its requirements.

The Plan contains a number of tasks and activities related to the capital program and others related to the operations of the MTA bus and rail systems. One key component of the Plan is the completion of studies documenting viable options for improving the areas that would be serviced by the Mid-City, East Side and Pasadena Blue Lines as well as the San Fernando Valley. The MTA is committed by terms of the Plan to having study reports for each of the areas to the Board for consideration by the end of October 1998. In fact, the Plan declares on page 147 that the studies "will include the full range of options and recommendations contained in the analysis as well as a funding plan. The Study will form the basis for a recommended regional transportation mobility plan."

In a related matter the MTA was able to negotiate with the California Transportation Commission (CTC), its funding partner at the State level, a very significant memorandum of understanding (MOU) dated June 2, 1998. The MOU extends from June to December 2, 1998, the submission of the MTA financial programming documents required by the CTC to complete the final State Transportation Improvements Program (STIP). This was an especially large concession to MTA in view of the fact that the CTC has more than \$ 680 million in new funds in the 1999 STIP to program for projects in Los Angeles County. Thus, by MOU the CTC agreed to hold up on those decisions until December 2, 1998, pending the results of the MTA studies in the four corridors identified above. The MOU requires the MTA to define projects and "to fully fund adequate transit services including alternative services in those areas where full funding of major transit systems cannot currently be demonstrated." However, the MOU is very clear that no extensions will be granted by the CTC. Further, the MOU indicates that should the MTA not be able to meet this schedule, the CTC intends to reclaim its authority to make all programming decisions in the STIP for Los Angeles County without any input from the MTA.

An important commitment of the MTA in the Restructuring Plan is to meet the terms and conditions of the Consent Decree. It includes a series of specific tasks, capital investments, and ongoing programs focused on meeting the operating standards agreed to in the Consent Decree. However, less than three months after FTA's approval of the Plan and almost two years after entering into the Consent Decree, the MTA in September 1998 formally acknowledged that it had failed to meet the operating standards and requirements on more than 90 percent of the bus lines that are being monitored for compliance purposes. In its statement the MTA suggested that the aging bus fleet along with frequent breakdowns of the coaches were some of the primary reasons for its failure to meet the requirements of the Decree.

As part of what appears to be a new initiative to restore quality to the bus operations, the MTA in September also announced a revised bus capital program. The revised bus plan would purchase from 1,600 to 2,200 new CNG powered buses at a cost of \$ 500-600 million over the next eight years. The MTA has not yet released any detailed schedule or estimates of the costs in millions of dollars required to convert its facilities from diesel to CNG in order to handle the operations and maintenance of its proposed new fleet.

Further, it remains to be seen how the FTA will react to this proposal and program since it was not included in the Financial Recovery Plan approved in July 1998. Also unknown is how the CTC will react to this proposed capital investment which will require up to 25 percent in matching dollars from the State. This is an especially important issue due to the fact that the new buses and facilities will add hundreds of millions of dollars to the capital budget of MTA that may or may not satisfy the requirements of the MOU with the CTC.

1.3 Context of the Study

The context of this study can be defined in a number of ways. The context clearly is one of multiple issues. Sometimes there have been conflicting and unclear policy positions at the MTA and uncertainties associated with major financial issues. These have forced the CTC and the FTA to become directly involved in requiring MTA to meet the programming and financial standards required of all other transit systems which are recipients of state and federal funds. Moreover, there are serious lingering doubts about whether or not MTA can reasonably recover from its problems. At their core the financial issues are associated with shortfalls and/or overspending of the local sales tax funds which go to the MTA for transportation purposes. In turn, these issues have created other problems for the MTA some of which go to the fundamentals of the transit development program as presented to the voters in 1980 and again in 1990 when Propositions A and C were approved.

The past four years, for example, have seen a reversal of policy and management direction at the MTA as it relates to the Pasadena Blue Line. As the issues described in the sections above are discussed and dealt with at several levels of government, many persons are now beginning to raise questions as to whether or not the Pasadena Blue Line can ever be built by the MTA given its financial position. Others are raising questions about whether or not it should be built under any circumstances. In addition, alternatives to light rail transit (LRT) are being openly discussed by policy and management persons at the MTA and in the cities of Los Angeles, Pasadena, and elsewhere.

In this context Senator Adam Schiff introduced SB-1847 which identified as principal co-authors Senator Richard Polanco and Assemblymen Bob Margett and Jack Scott. SB-1847 provides for the creation of a construction authority with a five-member governing board appointed by the city councils of the cities of Los Angeles, Pasadena, and South Pasadena, the San Gabriel Valley Council of Governments (SGVCOG), and the MTA.

The construction authority would assume the design and construction responsibilities of the MTA related to building the Pasadena Blue Line. The bill was passed by the Legislature in September and signed by the Governor. The legislation becomes effective January 1, 1999, and it establishes the Pasadena Metro Blue Line Construction Authority for the completion of the project from downtown Los Angeles to Sierra Madre Villa in Pasadena. In addition, the legislation defines the project to include the design and construction of any transit guideway planned for extension between Pasadena and Claremont.

Thus, a new institution has been created to supersede the MTA as the agency responsible for designing and building the Pasadena Blue Line at potential extensions further to the east.

2.0 SCOPE OF THE STUDY

In order to handle the more than 68,000 daily passengers that are projected by MTA in the EIR to ride the system in 2010, the most common alternative discussed to LRT is an exclusive busway. Either the LRT or the exclusive busway would service the corridor, the central business districts of the cities of Los Angeles and Pasadena, and would extend in an easterly direction along the I-210 corridor to the vicinity of Sierra Madre Villa Avenue in Pasadena. The corridor consists primarily of the right-of-way now owned by the MTA which formerly was an asset of the Santa Fe Railroad.

2.1 Feasibility Analysis of the Alternatives

The purpose of this report is to focus on the key physical and operational feasibility issues to determine whether or not and at what costs a major transit facility – an exclusive busway or an light rail line – can be built and operated in the corridor. The baseline of the study is the existing design of the LRT line of 13.6 miles and 13 stations that was suspended by MTA in January 1998. The exclusive busway examined by this study would have essentially the same alignment, number and locations of stations, and similar maintenance and other facilities.

If it is physically and operationally feasible to build both an exclusive busway and an LRT line, the study will identify and document the reasons for arriving at that determination. Among others these include such issues as the possible use of the planned LRT yards and shops for bus maintenance facilities, use of existing and new LRT bridge structures for an exclusive busway, and elimination of high platforms at LRT stations in favor of low platform busway stations. In terms of operations the study will examine the costs of operating the LRT system as compared to the exclusive busway.

In terms of vehicles the study will examine the requirements to provide equivalent person carrying capacity between the two modes and discuss the impacts of bus and rail operations on existing surface streets and facilities in Los Angeles, South Pasadena, and Pasadena. Neither system would have unusual or unique features unless it was absolutely essential for the system to function according to accepted industry standards.

The scope of the study includes three major elements. First, there is an analysis of the physical requirements and constraints associated with completing either a light rail line or an exclusive busway within the former Santa Fe right-of-way and adjacent real estate. Second, the study includes an assessment of the operations of both an LRT and an exclusive busway in the corridor. Third, the costs of completing and operating both systems are analyzed in order to determine whether or not either, both, or none should be carried forward into the next stage for further consideration.

2.2 Description of the LRT Alternative

The project development process associated with the planning, engineering, and construction of the Pasadena Blue Line LRT has been underway for more than 10 years. It officially began with the preparation of the Draft Environmental Impact Report (DEIR) that was completed in December 1988. Next came the Final EIR that was completed in 1990 and two Supplemental EIRs that were done between 1992 and 1994. Over the past ten years the project evolved to the point that by January 1998 when the work was suspended by the MTA much of the final design was complete. In addition, by January 1998 work had been completed on the new construction and/or retrofit of some 13 bridges along the alignment. Finally, one station shell and platforms had been constructed.

As developed to date the Pasadena Blue Line consists of 13 stations and 13.6 miles of guideway. Figure 1 on the following page shows the alignment and station locations. The right-of-way ranges from 29 feet at its most narrow point to more than 80 feet at its widest point along the route. The alignment traverses in a northeasterly direction from Union Station in downtown Los Angeles through Chinatown, through South Pasadena, and skirting the downtown areas of Pasadena on the west, then turning in an easterly direction, and terminating at the eastern boundary of the City of Pasadena.

The Pasadena Blue Line includes high platform stations each of which has a nominal platform length of 274 feet which will accommodate a three car train. Nine of the stations have center platforms while four – the Avenue 26, Mission Street, French Avenue and Memorial Park facilities -- are side platform stations. Figures 2 and 3 below show sketches of side platform and center platform stations. The yard and shop facilities, known as Midway Yard, are located in the triangle immediately south of the Los Angeles River, east of the I-5 freeway, and west of the LRT rail mainline in a former switch yard operated by the Southern Pacific Railroad.

The guideway consists of approximately 3,600 feet of elevated structure as the line transitions from Union Station in a northeastern direction through Chinatown and across the Los Angeles River channel. There the alignment alternately goes to grade and on embankment until it reaches a cut/cover subway section of approximately 2,300 feet between the French Avenue and Southwest Museum stations. Thereafter, the line proceeds northeast at grade until it reaches a cut/cover subway section of 3,400 feet which includes both the Del Mar and Memorial Park Stations in Pasadena. Upon leaving the Memorial Park Station the line transitions from subway to an elevated line extending in median or on embankment some 20,000 feet in the center of the I-210 freeway.

Three stations are included in the median/embankment segment, one at Lake Avenue, one at Allen, and one at Sierra Madre Villa Avenue which is the northeastern terminus of the LRT line. In total about 7.6 miles of the 13.6 mile line are grade separated – aerial on columns, on embankment, or in subway -- with about 6.0 miles at surface.

Figure 1
Pasadena Blue Line Alignment and Stations

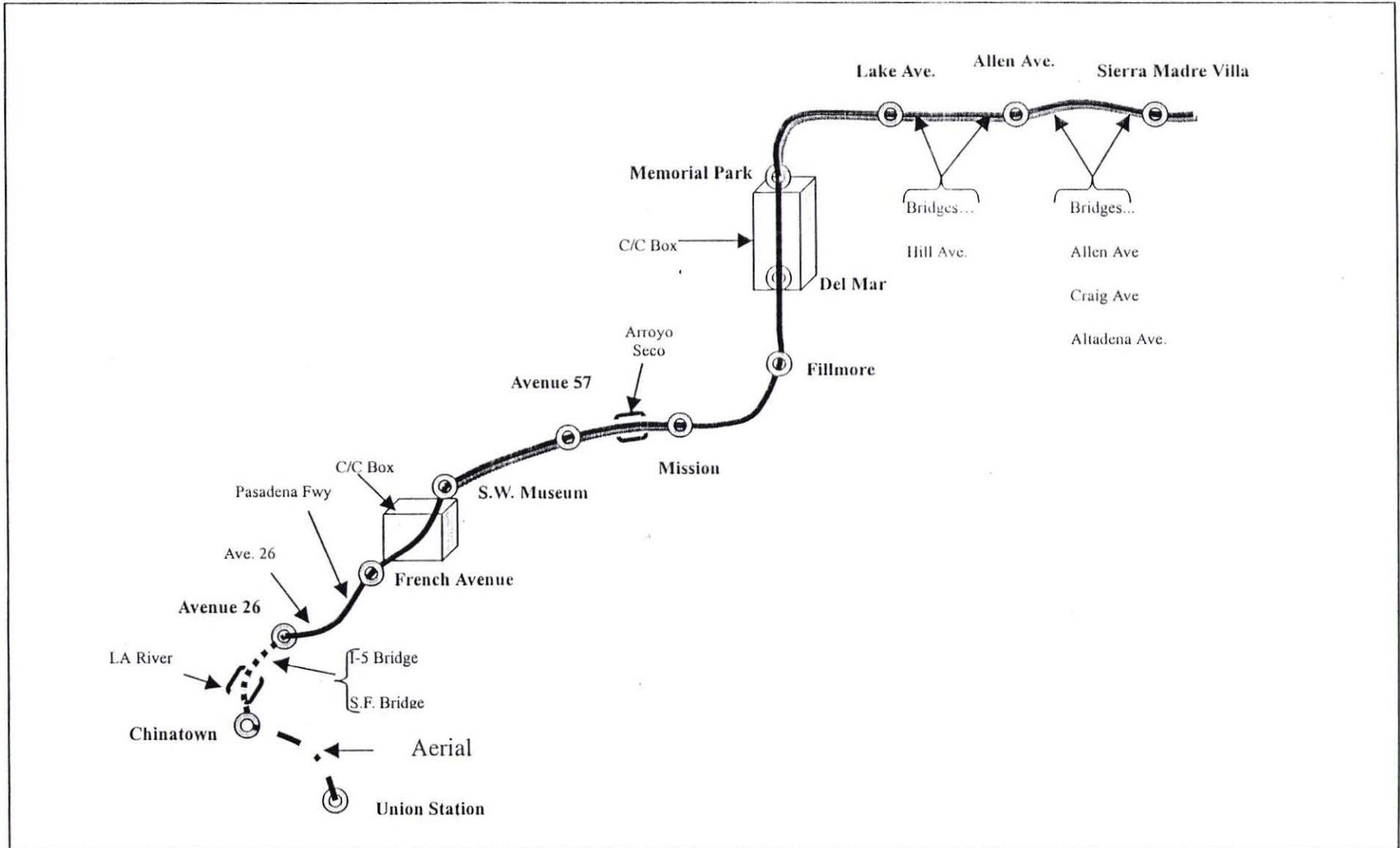
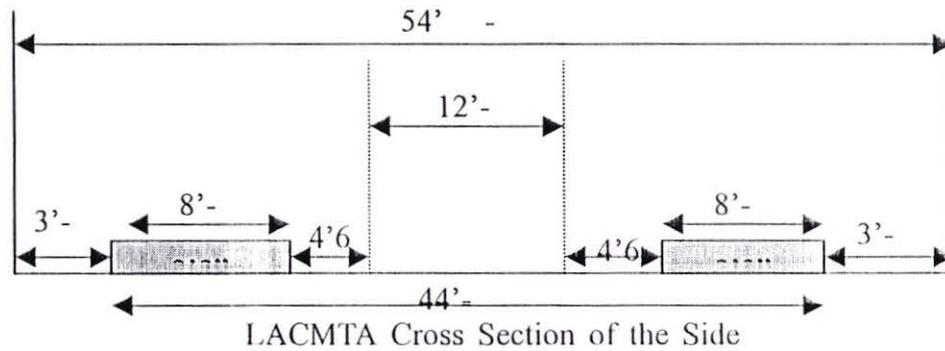
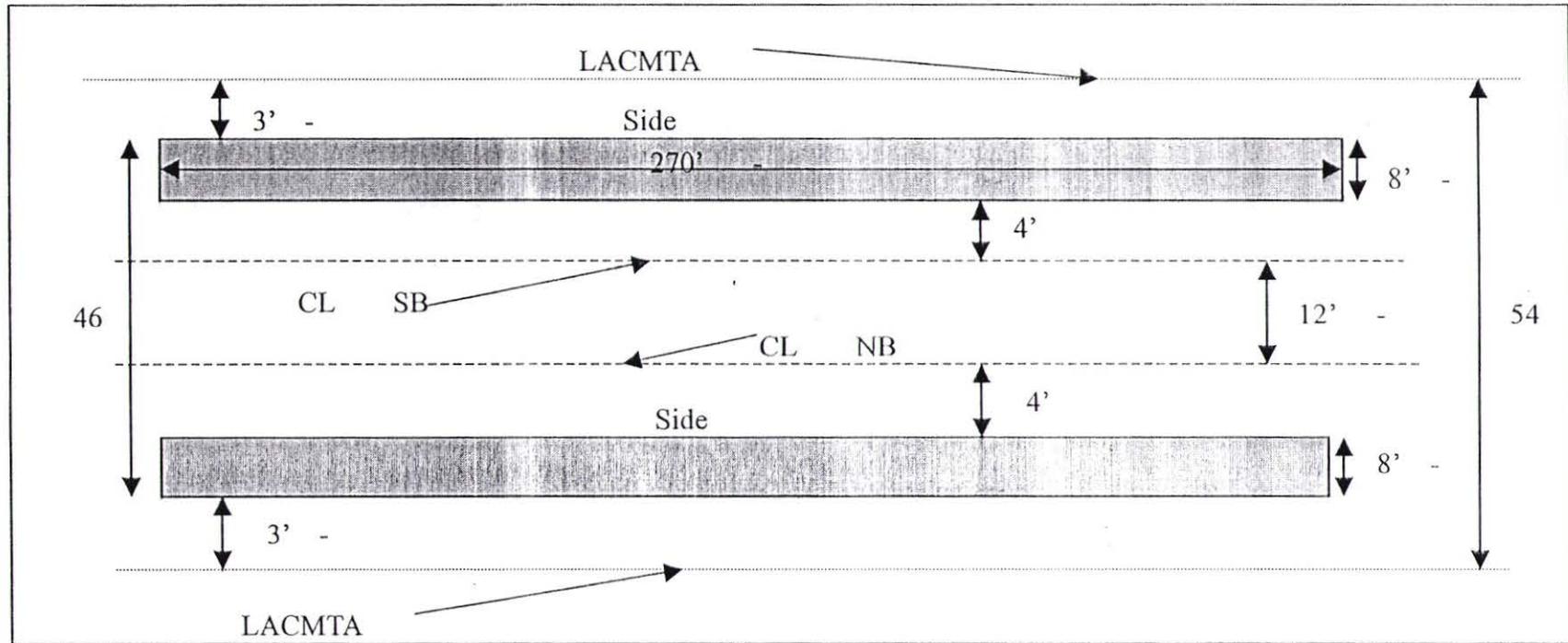


Figure 3
Pasadena Blue Line Side Platform Station
Schematic Arrangement (Typical)



LACMTA Cross Section of the Side

2.3 Description of the Busway Alternative

In developing the busway alternative, the intent was to make it as close as is reasonably possible in alignment, station locations, configuration, and operating conditions to the LRT alternative. To accomplish this a careful review was undertaken of the available LRT line section drawings, station drawings, and yard and shop drawings. Some of the drawing packages were 100 percent complete. Others were in a range of 50 to 85 percent complete. In addition, members of the consultant team undertook a very careful review of the physical and operational requirements of a dedicated busway. Finally, a field review of the alignment was undertaken to examine the actual site conditions along the 13.6-mile right-of-way.

Based on these tasks and activities the busway alternative is 13.6 miles in length. The horizontal alignment and station locations do not vary from that of the LRT alternative. The configuration of the busway stations, however, varies in three major respects. First, all 13 busway stations must be designed and built as side platform stations. Otherwise, unsafe bus operating conditions and passenger boarding requirements would occur as shown in Figure 4 below if riders were required to board buses from center platform stations. Second, a bypass lane for express, emergency, and other operations would be created between the side platforms and bus boarding lanes at each of the stations. Third, each of the stations would be to be developed with low platforms based on an absolute need to have low floor buses operating on the busway in order to provide for quicker boarding and exiting of passengers and to more appropriately meet the ADA requirements of the State and Federal governments. Figure 5 below shows a sketch of a typical busway station with low platforms.

In terms of the vertical alignment a careful review of the LRT alignment has resulted in the conclusion that a series of changes must be made. First, the bridge structures and the guideway sections must include New Jersey type barriers on either side of the running surfaces. Figure 6 below shows a sketch of a cross section of the exclusive busway. Second, as discussed in Section 4.0 below the alignment will have to be grade separated/protected to enable the busway to perform at its required levels of service.

Finally, at both ends of the exclusive busway substantial changes in the configuration and alignment are required. At the south end at Union Station the busway would remain in an elevated configuration for approximately an additional 1200 feet transitioning directly into the Union Station bus terminal area as opposed to the station location and termination point of the LRT vehicles in the rail alternative. At the Sierra Madre Villa station on the northeast, the busway alternative requires a ramp structure to allow buses to exit the busway, make turning movements, and re-enter the busway in the opposite direction. In addition, off line storage space would be required to store from 10-20 buses in order to meet the low frequency, high-capacity operating requirements of the peak periods. Figure 7 shows a sketch of the required configurations and ramps at the Sierra Madre Villa station.

The yard and shop facility for the busway would be located at the same site as the LRT shops – the Midway Yard. Its size and configuration will allow for construction of the necessary facilities to house, fuel, and maintain either articulated 60-foot, low floor buses or standard 40-foot, low floor coaches.

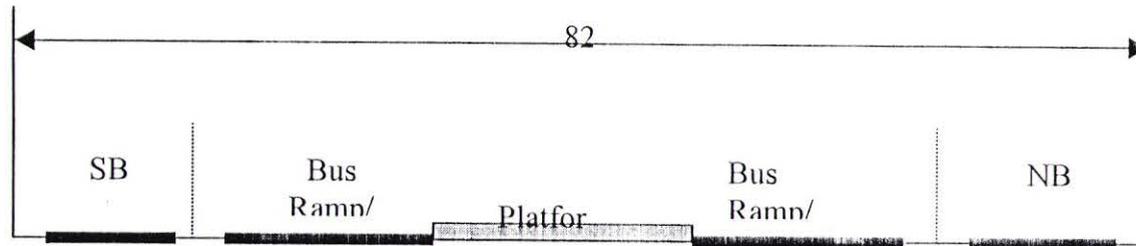
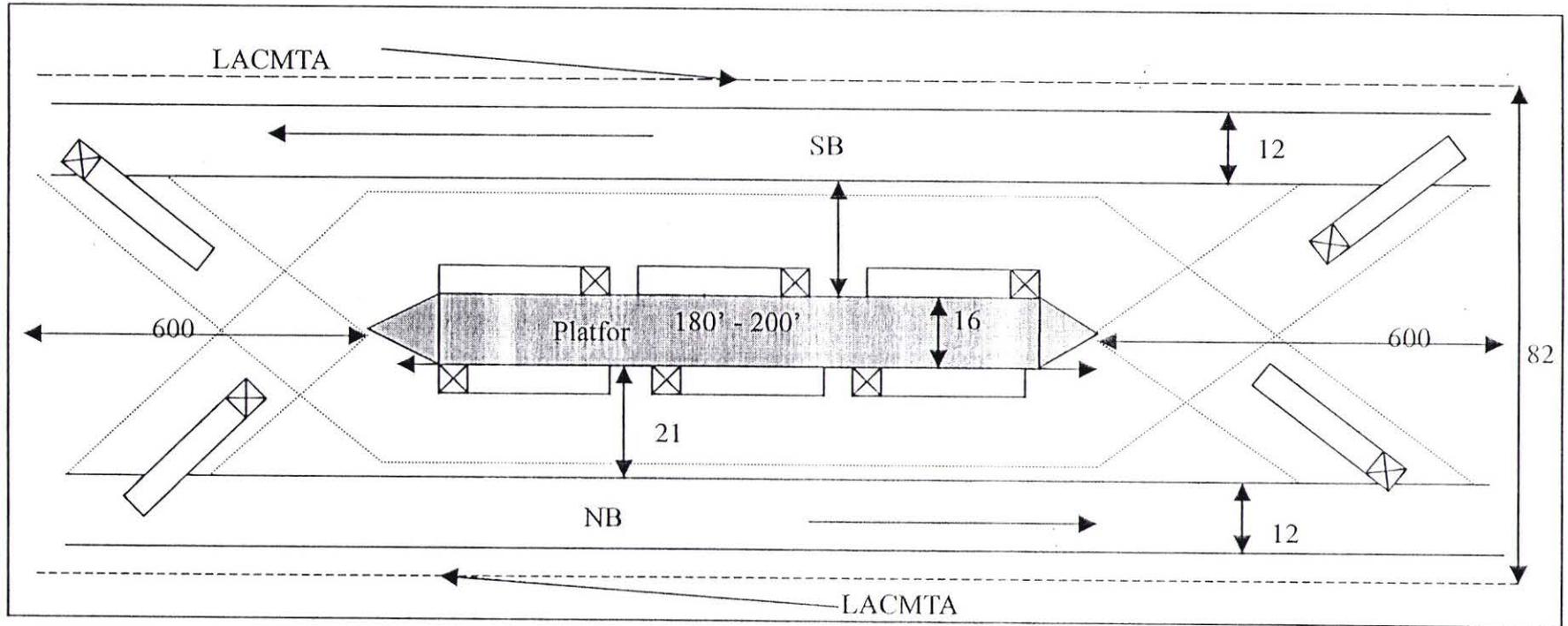
2.4 Costs of the Alternatives

The capital and operating costs associated with both of the alternatives are important considerations in determining feasibility. In terms of capital costs this study considers the costs to complete both of the alternatives. The capital dollars already expended on the Pasadena Blue Line amount to \$ 242 million. For purposes of this study those expenditures are considered as sunk costs. Therefore, they are not included in the cost to complete estimate of the LRT alternative. To the extent the LRT right-of-way, facilities, and equipment can be used and/or adapted to the busway alternative, they are incorporated as “no cost” items in the cost to complete estimate of the exclusive busway.

The cost to operate both of the alternatives is the other key component of the picture. While capital costs are one-time investments, operating costs occur on an ongoing basis each year that the facility is in operation. Operating costs are generally defined as those expenses associated with the labor, materials, fuel, and other items required to operate the and maintain the vehicles. In addition, operating costs will include those expenses required to operate and maintain the facilities and system components (station signage and lighting, CCTV, traffic signal pre-emption equipment, parking structures, and many others) in the corridor.

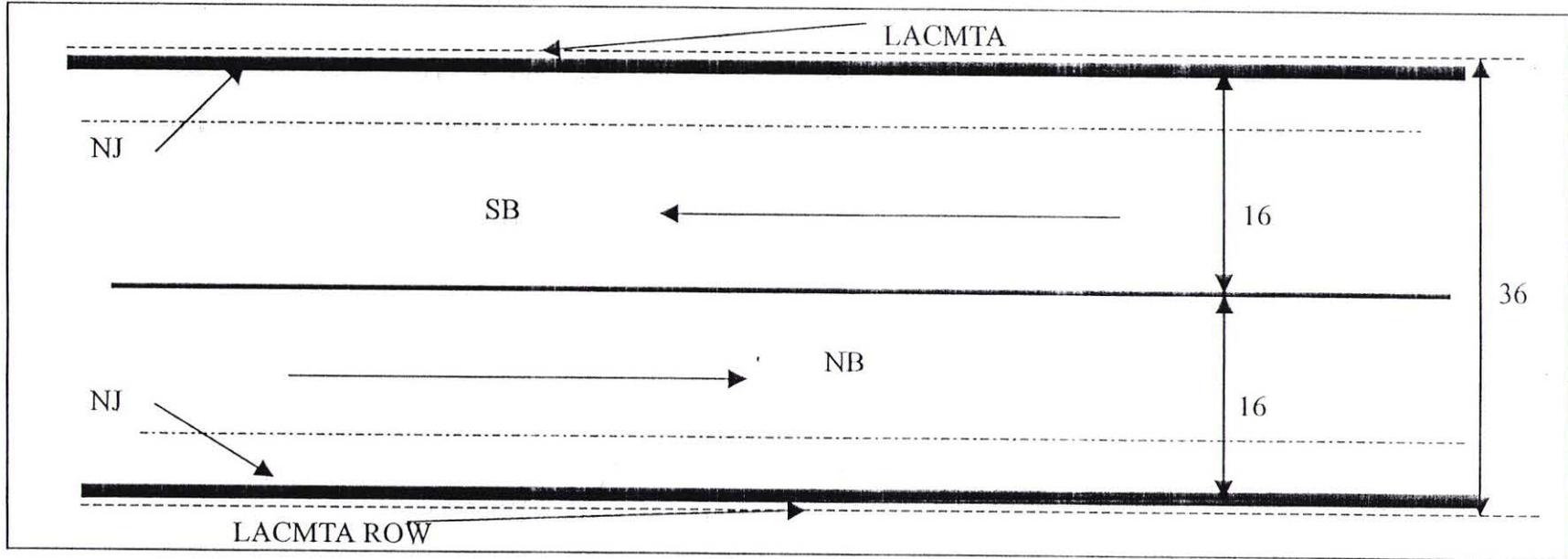
In this study the capital costs to complete and the operating costs associated with both of the alternatives are developed to a comparable level of detail. The objective of the cost analysis is to document the real outlays required to complete the design and construction of each alternative and then to establish a basis for comparing the operating costs associated with each of the alternatives. These costs should be important considerations if either the MTA or the Pasadena Metro Blue Line Construction Authority decides to consider a re-start of the suspended LRT Project or to move in the direction of initiating the planning and environmental process leading to the development of the exclusive busway alternative. In addition, the costs of time need to be factored into any equation related to costs at about 3-4 percent per year compounded to the mid-point of construction.

Figure 4
Pasadena Busway Center Platform Concept
Schematic Arrangement

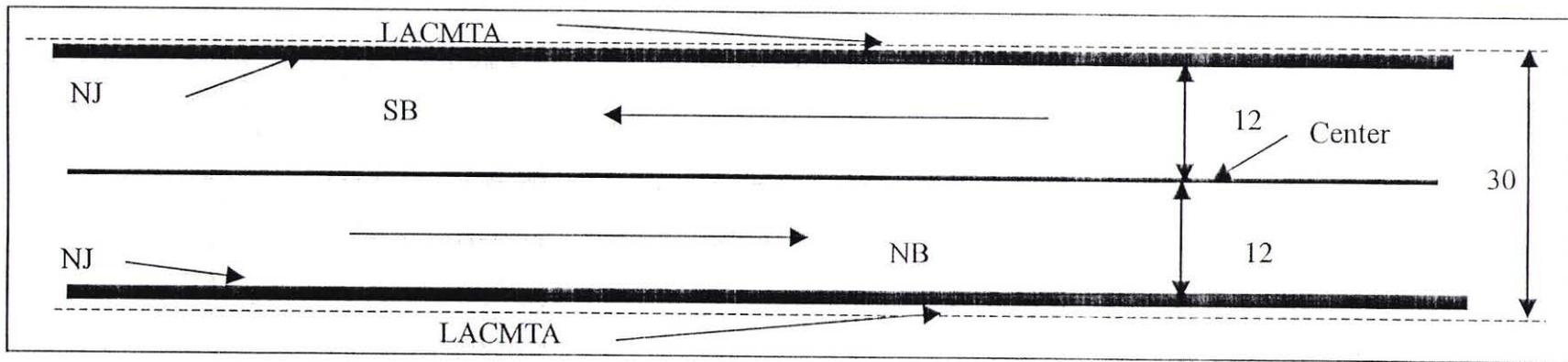


Cross Section of Busway Level
Gateway Station

Figure 6
Pasadena Exclusive Busway Concept
Schematic Arrangement Standard and Minimum

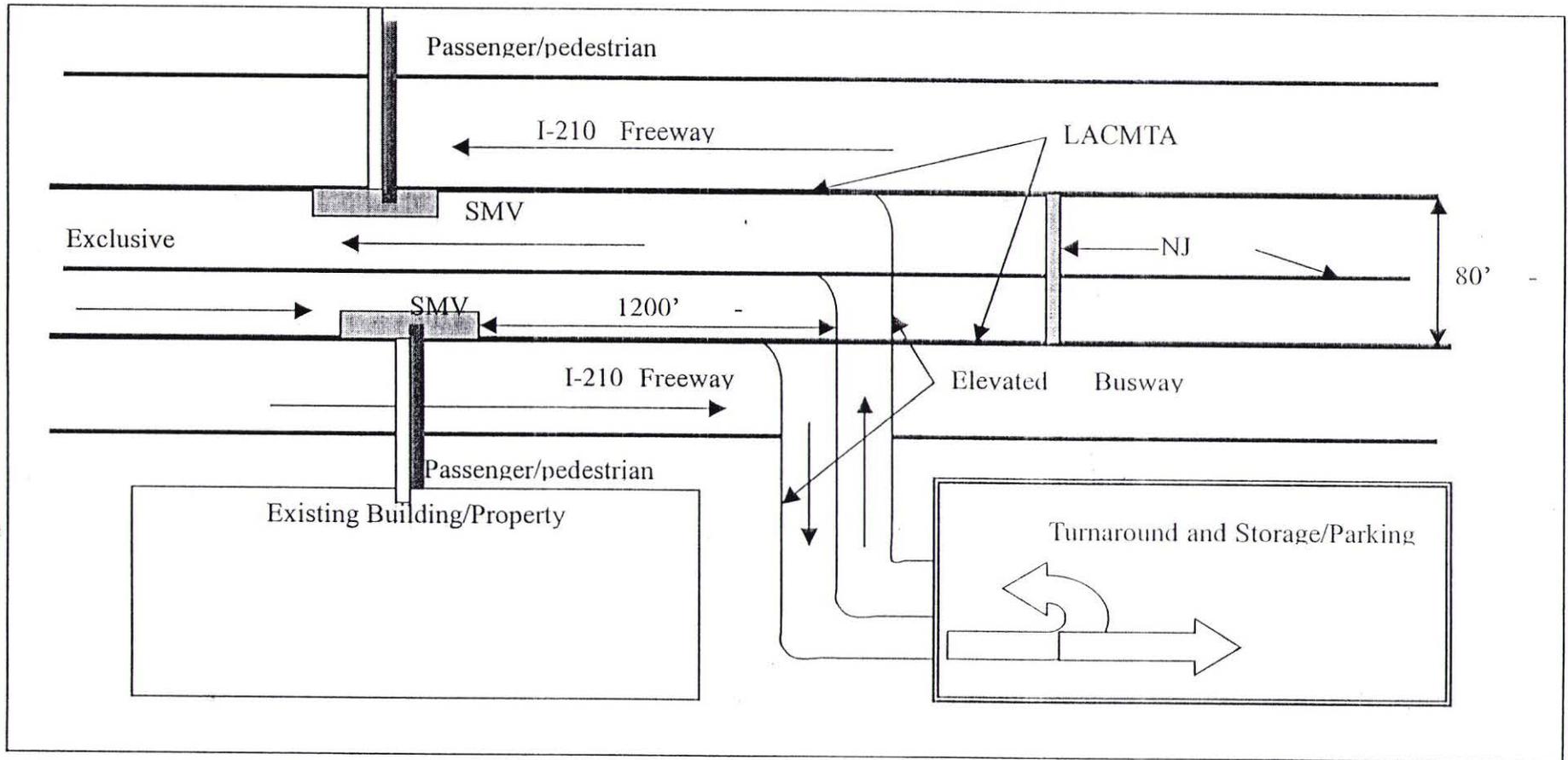


Exclusive Busway Lane



Two Lane Busway Concept

Figure 7
Pasadena Sierra Madre Villa Busway Station
Access Ramps/Bus Storage Concept/Schematic Arrangement



3.0 FACILITIES AND EQUIPMENT ASSESSMENT

The facilities and equipment assessment consists of a technical and engineering evaluation of whether or not a exclusive busway including 13 stations can be built within the alignment proposed for the Pasadena Blue Line LRT. Also, where a dedicated busway could not be built within the alignment, this section will identify what additional rights-of-way and/or other actions would be required to build a dedicated busway on the general alignment with necessary modifications.

A second element of the assessment relates to the environmental requirements associated with completing the LRT alternative or building an exclusive busway with 13 stations in the corridor from Pasadena to downtown Los Angeles. A third component of the assessment is an analysis of the construction and procurement requirements necessary to complete both the LRT and the exclusive busway alternatives.

3.1 Engineering Requirements and Issues

In terms of the feasibility of the LRT alternative there are no significant engineering issues. They have been resolved through the design development and environmental processes that have been underway for the past 10 years. The only requirement associated with the LRT alternative is the need for policy makers and managers to recognize the "shelf life" of the work on the design packages that were suspended by the MTA on January 14, 1998. As a practical matter the term "shelf life" refers to the time -- usually about 12-24 months -- that a design remains valid after it is finished or suspended in an incomplete status and before it is put out to bid. In the case of the Pasadena LRT alternative the shelf life of the design work is about 12 to 24 months from January 1998. The design work that was at 50-85 percent completion at the time of suspension may have substantially less shelf life.

The exclusive busway alternative has required an extensive analysis of the proposed alignment, especially the bridge structures and the station locations. The right-of-way requirements for an exclusive busway had to be examined in some detail. Figure 8 on the following page shows the engineering analysis of the bridge structures. Although several bridge structures are marginal in terms of the 30 foot minimum required by the busway cross section, Figure 8 documents the engineering conclusion that all of the new bridge structures and those modified for the LRT can be further modified for exclusive busway use. In addition to preparation of the running surfaces for buses instead of rail, each of the bridge structures will require a "New Jersey" type barrier on either side as a safety measure to prevent a bus from leaving the structure in the event of an accident. In the surface and embankment sections, the width of the track is sufficient to accommodate the bus guideway requirements as shown on the minimum cross section of 30 feet in Figure 6 above. Where sufficient right-of-way is available, a cross section of 36 feet would be desirable for the busway.

The 13 exclusive busway stations all can be located at the same sites as those of the LRT alternative. However, the widths and approaches to the busway stations will require a

total redesign of each of the stations. As Figure 5 above shows approximately 1,200 feet is required from the limits of the taper on either end of each station. Figure 6 shows the widths of a typical side platform station to be approximately 86 feet. Figure 9 shows the right-of-way widths at each of the stations in the LRT alternative. Thus, the exclusive busway's station dimensions will require additional right-of-way takes of about 180-200 front feet at all station locations, some of which are residential and some are commercial properties. At approximately \$ 60 - 80 per square foot the additional right-of-way costs will amount to some \$ 22.0 million for the exclusive busway alternative.

The terminal stations at Sierra Madre Villa Avenue in Pasadena and at Union Station in Los Angeles also will require special design considerations. These treatments will be required to make those two stations functionally efficient and provide for the high volume on/off movements of the buses as well as interfaces with auto, rail, and pedestrian accesses, as appropriate. In addition, the terminal stations, especially the Sierra Madre Villa Avenue station will require a surface area for the storage and layover of some 15-20 coaches to make the operations of the exclusive busway function properly in peak hours.

3.2 Environmental Requirements

The environmental requirements associated with the LRT alternative have been essentially completed. In accordance with the California Environmental Quality Act (CEQA) a Final EIR has been certified. In addition, two Supplemental EIRs that resulted in relatively small changes in the project have been completed and certified. Since construction began in 1994 on the Pasadena Blue Line a Mitigation Monitoring Program has been in place at the MTA. This program has tracked the construction progress to insure that the mitigation measures committed to in the EIRs are implemented in the construction of the system. No additional environmental actions above and beyond those in place are required for the LRT alternative to be in full compliance with CEQA.

Because an exclusive busway alternative has not been considered previously, an entirely new environmental process under CEQA would have to be initiated if a decision is made to proceed forward with a busway project. Under the best of circumstances it would take approximately 24 to 30 months to complete the environmental process as defined by CEQA.

This process could begin with an Initial Study which is the first step under CEQA. Alternatively, as provided by CEQA the process could begin with the preparation of a Draft EIR which would be the most logical starting point because it is clear that an exclusive busway would have many environmental impacts that could not be addressed by a Negative Declaration. The Draft EIR would have to be done as part of or in parallel with the preliminary engineering program which would define in detail the engineering requirements and bring the design to approximately 25-30 percent of completion. The next step would be the preparation of a Final EIR. This would be followed by the certification process and the adoption of a Mitigation Monitoring Program which would bring the busway alternative to the same place sequentially as the Pasadena Blue Line was when construction was ready to begin in 1994.

3.3 Construction and Procurement Requirements and Issues

A substantial amount of money has been spent by the MTA on the Pasadena Blue Line for environmental work, engineering, real estate acquisition, and the construction of new bridges and retrofitting of existing bridges. In addition, the rail cars and crossties for the project all have been purchased. However, much of the heavy construction and procurement and installation work remains to be done. In fact, about 10-15 percent of the total construction and procurement requirements has been completed.

For example, none of the cut and cover line section work has been started, only one station shell has been constructed, none of the yard and shop site preparation and facilities construction work has started, and all of the track bed work remains to be done. On the equipment side none of the overhead catenary system, electrification, train control, communications and other systems have been procured. In defense of the project work to date, however, it must be stated that the design of many of the construction and equipment packages was quite far along when the Pasadena Blue Line was suspended. Therefore, many if not all of these activities and tasks would have been completed in a period of 12 to 18 months had the project gone forward.

In terms of the exclusive busway alternative the project would start with a clean slate so to speak in terms of design, construction, and procurement of equipment and systems. Since no serious planning or engineering work has been done on the alternative to date, the initial steps would be the development of a project planning program followed by a preliminary engineering program including the development of a Draft EIR. The PE phase would be followed by a final design program including the preparation of a Final EIR. This would be followed by a construction and procurements phase of the project. A pre-operational testing phase would conclude the project development process and ready the alternative for full operations. If and when a firm decision is made to proceed with the busway alternative, it would take an estimated 8-10 years to have the project ready for full operations. Figure 10 on the following page shows the project development process required to move the exclusive busway to full operations. The LRT alternative would require approximately four years to complete while the exclusive busway would require an additional five years to complete and make ready for full operations.

Figure 8
Pasadena Blue Line Engineering Analysis of Bridge Structures

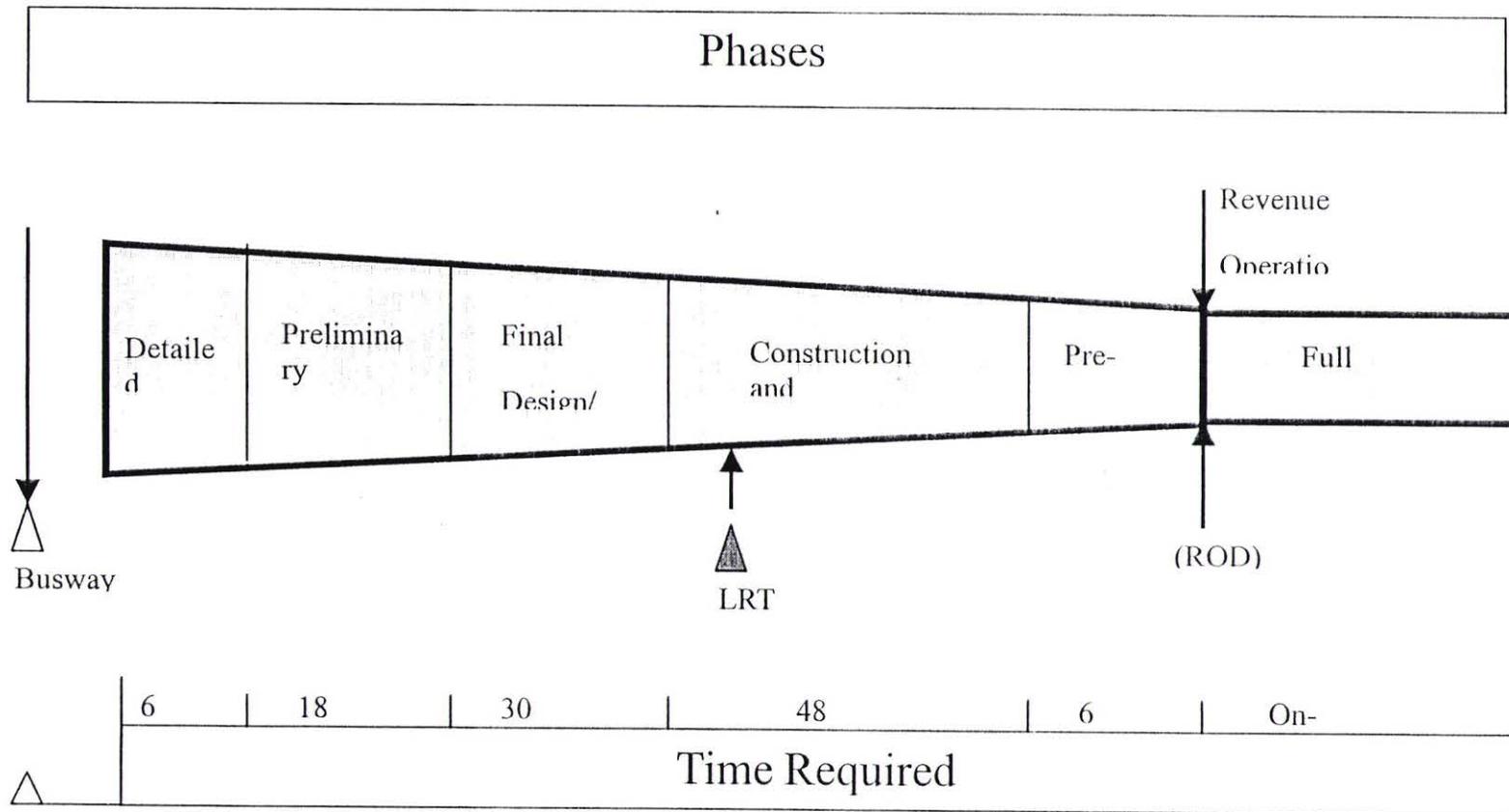
Item	Structure	Location	Status	Track System	Width	Min. changes
1	Chinatown	116+00-	New	Direct	29'6"	Replace Track System w/Concrete Deck
2	LA River Bridge	182+00-	New	Ballast	27'6"	Replace Track System w/Concrete Deck
3	Slab Bridge	197+00-	Existing	Ballast	32'	Replace Track System w/Concrete Deck
4	Ave. 19 Bridge	201+00-	Existing	Ballast	32'	Replace Track System w/Concrete Deck
5	San Fernando Rd. Bridge	206+00-	Existing	Ballast	32'	Replace Track System w/Concrete Deck
6	I-5 Bridge	215+00-	Existing	Ballast	36'	Replace Track System w/Concrete Deck
7	Ave. 26 Bridge	222+00-	Existing	Ballast	26'	Replace Track System w/Concrete Deck
8	Pasadena Fwy Bridge	246+00-	Existing	Ballast	27'6"	Replace Track System w/Concrete Deck
9	C/C Box	260+00-	New	Direct	Varies	Add Normal Ventilation System
10	Arroyo Seco Bridge	390+00-	Existing	Direct	31'	Replace Track System w/Concrete Deck
11	SR 110 bridge	501+00-	Existing	Ballast	38'	Replace Track System w/Concrete Deck
12	C/C Box	590+00-	New	Direct	Varies	Add Normal Ventilation System
13	Hill Ave. Bridge	699+00-	New	Direct	24'10"	Replace Track System w/Concrete Deck
14	Sierra Bonita Bridge	711+00-	New	Direct	24'10"	Replace Track System w/Concrete Deck
15	Allen Ave. Bridge	724+00-	Widened	Ballast	37'8"	Replace Track System w/Concrete Deck
16	Craig Ave. Bridge	745+00-	Widened	Ballast	24'10"	Replace Track System w/Concrete Deck
17	Altadena Ave. bridge	768+00-	Widened	Ballast	24'10"	Replace Track System w/Concrete Deck
18	Sierra Madre/S.G Bridge	779+00-	Widened	Ballast	25'	Replace Track System w/Concrete Deck
19	Sunny Slope Bridge	794+00-	Widened	Ballast	25'10"	Replace Track System w/Concrete Deck
20	Foothill Blvd. Bridge	801+00-	Widened	Ballast	24'10"	Replace Track System w/Concrete Deck
21	Madre St. Bridge	823+00-	Widened	Ballast	62'	Replace Track System w/Concrete Deck

Figure 9
Pasadena Blue Line Engineering Analysis of Station Structures

Item	Station	Location	ROW Width	Platform Length/Width	Platform	Min. changes
1	Union Station (A)	114+00	60'	270'/24'	Center	Replace Track System w/Concrete Deck
2	Chinatown Station (E)	137+40	45'	279'/23'	Center	Replace Track System w/Concrete Deck
3	Avenue 26 Station (E)	219+30	50'	270'/12'x2	Side	Replace Track System w/Concrete Deck
4	French Avenue Station (A)	250+30	52'	270'/12'x2	Side	Replace Track System w/Concrete Deck
5	S.W. Museum Station (E)	297+70	52'	300'/16'	Center	Replace Track System w/Concrete Deck
6	Avenue 57 Station (A)	366+00	58'	300'/16'	Center	Replace Track System w/Concrete Deck
7	Mission Station (A)	477+70	52'	270'/12'x2	Side	Replace Track System w/Concrete Deck
8	Fillmore Station (A)	556+80	52'	270'/16'	Center	Replace Track System w/Concrete Deck
9	Del Mar Station (S)	585+80	45'	270'/18'	Center	Add Normal Ventilation System
10	Memorial Park Station (S)	611+14	52'	270'/16'x2	Side	Replace Track System w/Concrete Deck
11	Lake Avenue Station (E)	664+37	45'	279'/16'6"	Center	Replace Track System w/Concrete Deck
12	Allen Avenue Station (E)	719+30	45'	373'/16'	Center	Add Normal Ventilation System
13	Sierra Madre Villa Station (E)	824+30	60'	250'/18'	Center	Replace Track System w/Concrete Deck

Note: (A): At Grade Station; (E): Elevated/Embankment Station; S: Subway Station

Figure 10
 Project Development Process
 LA/Pasadena LRT and Exclusive Busway Projects
 (Conventional Concept Development Process)



Legen

-  Busway
-  LRT Status

4.0 OPERATIONS ASSESSMENT

The operations assessment consists of a technical analysis of the operating configurations and conditions under which the LRT and the busway alternatives would perform the daily task of carrying approximately 68,000 riders in 2010 as forecasted by the MTA. Initially the operating configurations are discussed. A second element of the assessment is an analysis of the operating constraints and issues associated with each. Finally, a third component of the assessment is an analysis of the equipment and system issues associated with operating the both of the alternatives.

4.1 Operating Constraints and Issues

The MTA ridership projection of more than 68,000 passengers in 2010 on the Pasadena Blue Line LRT appears to be realistic in that bus ridership in the corridor has been historically quite high. Second, the LRT serves neighborhoods and communities that are not well served today by bus operations. Finally, the Los Angeles to Long Beach Blue Line LRT surprisingly has very high present day ridership -- above 57,000. This is about equal to the 2010 forecast made in 1990 immediately before the line opened. The high ridership is indicative of the success of the rail service in Los Angeles which is not often recognized publicly.

This has occurred in a corridor that did not have a high bus ridership prior to the construction of the LRT line. However, the LA to Long Beach LRT line has now reached its maximum capacity. The MTA has been considering ways to extend the station platforms to accommodate four-car trains which seems to be one of the only reasonable options to expand the capacity of the line. No decisions have been made, but none of the options appears to be an easy choice.

The requirement to meet the ridership demand in the Pasadena corridor, however, is a major issue. For example, no more than two or three light rail lines in North America today carry 68,000 riders per day. The LRT success stories such as Portland and San Diego carry significantly less riders -- 30,000 on 33 miles and 48,000 on 47 miles respectively. Moreover, no exclusive busways in the U.S. even approach that number. For example, in Pittsburgh the two exclusive busways -- one running south and the other east -- carry 16,000 and 31,000 riders respectively each day. The Ottawa-Carlton Regional Transit Commission (O-C Transpo) in Canada has the most extensive busway system in North America. On approximately 20 miles of grade separated exclusive busway that includes three separate lines, O-C Transpo carries approximately 200,000 riders each day with more than 50 separate bus routes and several hundred different buses using the transitway system throughout a 24-hour period.

Given these facts it is clear that in the Pasadena Blue Line corridor either a LRT or an exclusive busway alternative must be developed from the perspective that it will be a high capacity system. It will have to perform at levels of service greater than any bus or rail lines presently in operation in Los Angeles and equivalent to the best performing lines in North America. The loading of the Pasadena line as projected by MTA is not

particularly unusual. About 63.7 percent of the riders will use the system during peak hours. About 60 percent of the total riders during the peak rush hours will go toward Los Angeles in the morning peak, and about 10 percent of the total ridership or about 6,800 riders will be the peak hour, peak direction volumes. The reverse would be the case in the evening rush hours as riders move from downtown Los Angeles to Pasadena.

The peak hour, peak direction volumes are commonly used to size the vehicle fleet, the station platforms, and other features of a system to be built. Under certain conditions the peak hour, peak direction volumes also can dictate the vertical configuration of the guideway. The size of the vehicle fleet required to accommodate the projected peak hour ridership would be as follows:

- (1) For the LRT Alternative: 12 three-car trains, carrying approximately 600 passengers each, and operating on five minute headways. A total of nine trains would be required because each train would make the round-trip in approximately 45 minutes.
- (2) For the Exclusive Busway Alternative: Either 113 standard 40 foot buses or 76 articulated buses, each carrying approximately 60 and 90 passengers respectively, would be required to meet the peak hour, peak direction flow of riders. The standard buses would operate on about 30 second headways and the articulated buses would operate on about 45 second headways. A total of 94 standard or 64 articulated buses would be required because buses would make the round-trip in about 50 minutes including the off/on movements at both ends of the busway.
- (3) Including spares, the total fleet requirements for the LRT alternative would be about 33 to 36 rail cars. The total fleet requirements for the Exclusive Busway alternative would be about 108 standard coaches or 74 articulated buses including spares.

In terms of headway or intervals between the vehicles operating as part of the exclusive busway alternative, the buses would pose rather serious problems. If the vertical configuration of the busway was at surface, operating buses for the duration of each peak hour at 30 or 45 seconds each way on the busway would tie up continuously all cross streets along the corridor in Los Angeles, South Pasadena, and Pasadena. A two minute headway on the buses would mean the traffic signals at each intersection would be pre-empted by a crossing bus every minute while each bus would be impossibly overloaded with passengers. Even a four minute headway on the buses running at surface on the busway would require pre-emption of the signals at every intersection every two minutes, a condition that probably would not be acceptable to the Departments of Transportation and traffic engineers in the cities.

In short, the passenger demand and operating requirements are such that the exclusive busway cannot reasonably be premised or proposed as a surface running operation in the corridor. Such a proposed project could not reasonably address the environmental,

traffic, and other impacts that would be defined in detail in the preliminary engineering phase of development as described above.

4.2 Operating Configurations

The design of the Pasadena Blue Line alternative provides for a total of 13 stations. Each of these are known as high platform stations meaning that passengers board arriving trains that stop with an interval of about three inches from a platform approximately 36 inches above the track level. The elevation enables passengers to make a level step from the platform to the floor of the rail car and vice versa. The passenger movement is much like a person moving from one room to another in an office. High platform stations require combinations of stairs, elevators, and escalators to enable passengers to reach the platforms no matter whether the stations are at surface, elevated above the surface, or below surface in subway. Figure 9 above shows that the Pasadena Blue Line has six stations that are elevated either on columns or embankment, two stations that are in subway, and five stations that are at surface. The vertical configuration of the line and stations are in shown in Figure 11 on the following page.

The operating constraints and issues discussed above in section 4.1 require that the exclusive busway be developed as fully grade separated and/or grade protected facility. Although there are several options, the best alternative probably means extending the cut and cover segment in Pasadena south for another 3,000 feet or so south of the Filmore Station. At that point it could be transitioned up to an aerial configuration and placed in part on columns and in part on embankment. The aerial configuration would be continued south for about 20,000 to 25,000 feet using new and existing embankment and grade protection facilities until it reached the embankment at the Avenue 26 station. From that point further south the alignment would continue in the proposed/existing elevated configuration until it reached a new transition point to the termination point at the bus concourse at the Union Station complex.

Each of the 13 exclusive busway stations would be side platform in configuration as shown in Figure 5 above. The stations would be designed as low platform facilities meaning that the platform would be approximately 8-12 inches above surface. The buses would be of a "low floor" design meaning that the floor of the bus would be approximately 12-18 inches above surface. Passengers boarding or leaving the buses would have to make one level step to transfer from the bus to the platform. The boarding and alighting from low floor buses and/or low floor platforms also would be greatly simplified for disabled persons who could negotiate the small incline of a bus ramp if in wheelchairs or negotiate the single step, if able. For all persons the time lapsed to board low floor buses is reduced by almost 50 percent thereby greatly reducing the time required to board passengers. In turn, the reduced time at station stops would greatly improve the running speeds of the buses. On balance, the low floor buses combined with the side platform stations that have low boarding platforms will greatly improve the access/egress from the buses making it almost as good as the LRT with its high platform stations.

4.3 Equipment and Systems Issues

In terms of the LRT alternative there is only one serious issue which is the rail vehicle contract. In 1993 the MTA awarded a contract for some 52 light rail cars to Siemens Transportation Systems. The bid price was slightly in excess of \$ 3 million per vehicle. Approximately 32-36 of the vehicles were slated for the Los Angeles to Long Beach Blue Line. The remaining cars were slated for the Metro Green Line. Most of the cars presently being used on the Green Line and the LA to Long Beach Blue Line would be transferred to the Pasadena Line. In 1998 and thereafter Siemens began delivering the LRT vehicles to MTA. The MTA will have an immediate use for about 20 of LRT vehicles on the Green Line. However, the balance will be surplus when delivered in the period from 1999-2002. In the event that the LRT alternative is abandoned by policy makers in the near future MTA will have to deal with the issue of how it wants to dispose of the surplus cars. The CTC at the state level will have a major interest in this determination because a substantial amount of state dollars have been invested in the vehicle contract.

In terms of the exclusive busway alternative there are a number of equipment and systems issues. First, an initial decision will have to be made as to whether or not standard 40 foot buses or articulated 60-foot coaches will be used. This decision will affect the design and construction of the busway stations and the maintenance facility shops and bus yards. The most likely decision would be to go to a standard 40-foot bus because it would fit with the existing fleet. Second, it is readily available with alternate fueled power plants. Third, the maintenance persons know how to maintain the vehicles without additional training, tools, and facilities.

Los Angeles has very little experience with articulated buses. In the late 1970s and 1980s the SCRTD which operated the bus system at the time had a total of 40 articulated 60-foot coaches. They were operated on the heavily traveled Wilshire Boulevard routes. After more than 12 years of service the buses were abandoned by the SCRTD after numerous studies concluded that they were from 15-20 percent more costly to operate and maintain than conventional 40-foot buses. The two factors that drove up their operating costs per revenue service hour so significantly higher than the standard coaches were the maintenance costs and the costs of on-street accidents. The articulated buses averaged more than twice as many accidents as standard coaches which proved to be very costly in repairs, insurance claims, and other expenses.

A second set of issues related to the bus fleet is that of diesel vs. alternate fuels. At present, a CNG powered 40-foot bus costs approximately \$ 30,000 more per unit than a diesel. For good and compelling reasons the MTA has moved in the direction of an alternate fueled vehicle fleet. Research had determined that there is only one supplier of low floor, 60-foot articulated buses. That supplier, however, does not provide an alternate fueled power plant with the 60-foot articulated coach. Thus, the issue of power plants and diesel vs. alternate fuels will have to be resolved early if a decision is made to go forward with the exclusive busway alternative. The issue is complicated, however, by the use of CNG powered buses operating in tunnel configurations. The potential fire and

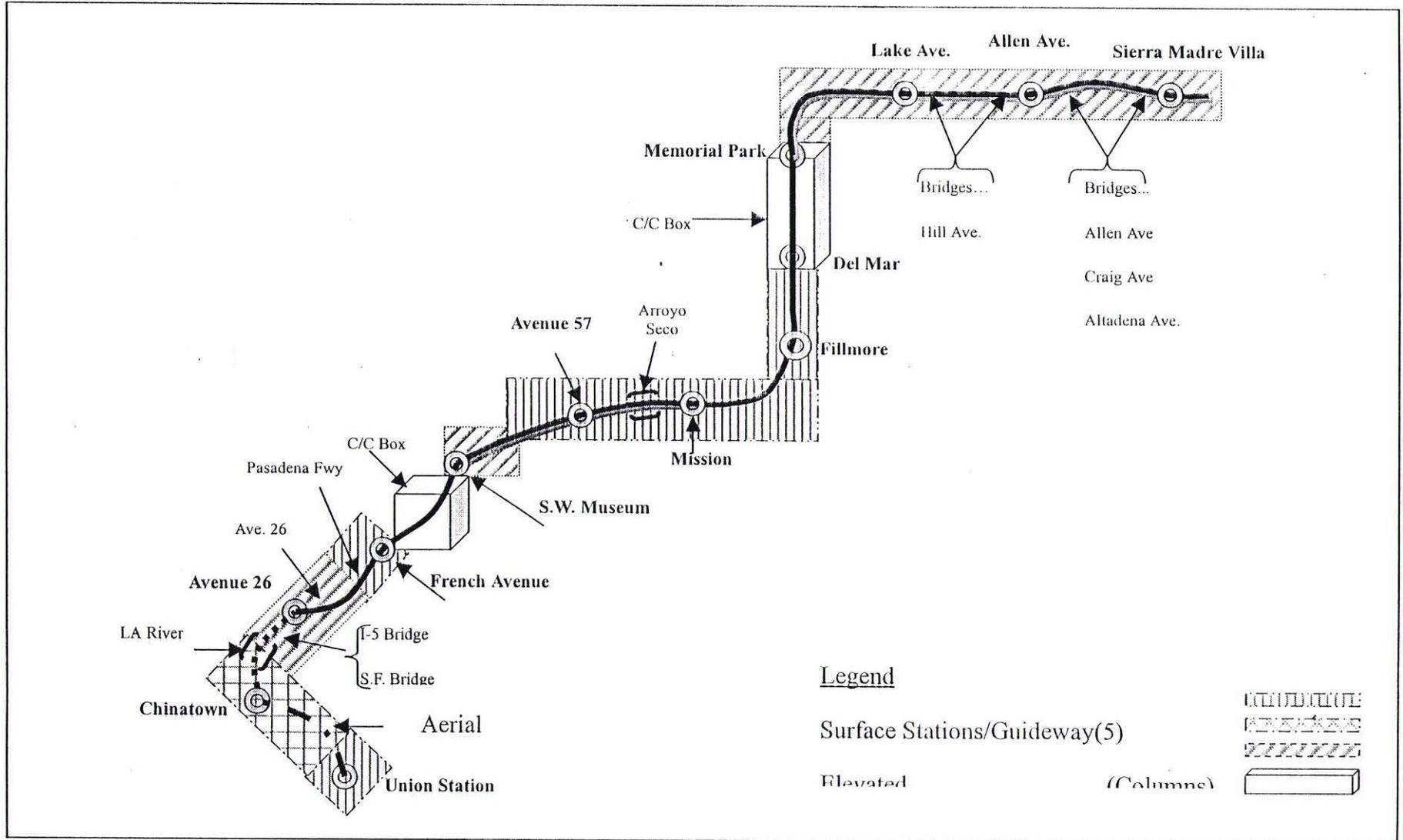
explosiveness dangers of CNG when bus fuel tanks leak or are ruptured in tunnels requires special precautions and design considerations.

The tunnel sections of the exclusive busway clearly would require additional design work to provide for special venting and evacuation measures to meet the fire/life/safety requirements. The costs associated with the design requirements and additional construction costs are well into the millions of dollars. However, the preparation of any cost estimates is well beyond the scope of this study.

Given the issues associated with standard vs. articulated buses this study uses the 40-foot, CNG powered, bus as the baseline for cost estimating and comparison purposes. Clearly, that is the lesser-cost option when compared to the costs of articulated buses. Just how much more expensive an articulated bus fleet would be to purchase, operate, and maintain also is beyond the scope of this study.

The final set of equipment and system issues relates to the perceived need to bring the exclusive busway alternative to approximately the equivalent level comfort, convenience, access, information sharing and other components as the LRT alternative. Thus, the exclusive busway alternative includes stations that would be equipped in similar fashion to the LRT stations with such features as CCTV, message signs, fare vending machines, and the like.

Figure 11
Vertical Configuration of Pasadena Blue Line
Guideway Alignment and Stations



5.0 CAPITAL AND OPERATIONS COST ASSESSMENT

The capital and operations cost assessment includes three elements. First, it is an analysis of the capital costs to complete both the LRT and the exclusive busway alternatives. Second, it includes an analysis of the relative operating costs associated with operating the LRT and the exclusive busway alternatives. Finally, the assessment includes an analysis of the costs in terms of the data that is available and the information that presently is not available but needs to be generated, a task well beyond the scope of this study.

5.1 Capital Cost Estimate

To gain a reasonably accurate perception of the capital costs of the LRT alternative two separate sets of data are presented. The first involves the project cost estimate which is a detailing of the project budget of \$ 803.9 million which has grown to \$ 817.8 million as a result of the suspension action and other scope changes made by MTA either before or immediately after the suspension action. These costs are shown in Figure 12 on the following page. Figure 13 below breaks the project cost estimate into the expenditures incurred to date of \$ 242.2 million and the costs to complete estimated at \$575.6 million.

The second set of data relates to the costs to complete the project. In terms of the LRT alternative these are a primary focus of attention in this analysis because they are the basis for comparison with the costs to complete the exclusive busway alternative. This is due to the fact that the costs to complete are the discretionary future expenditures that must be considered should a decision be made in the future to restart the suspended construction and procurement activity on the LRT line.

An analysis of the MTA costs to complete the Pasadena Blue Line has been undertaken. Based on this review we are convinced the project development program previously being managed by MTA can be restructured, new contracting approaches implemented, and the MTA costs to complete estimates can be reduced from \$ 575.7 to \$ 469.6 million, a savings of \$ 106 million. A summary of this financial analysis and budgetary adjustments required is shown in Figure 14 below.

In terms of the exclusive busway alternative a costs to complete estimate has been prepared based on the following assumptions:

- (1) The project would begin with a detailed planning study;
- (2) The project would utilize the same right-of-way as the LRT alternative;
- (3) The project would require additional rights-of-way takes at six to eight stations to accommodate the side platform stations and other access requirements;
- (4) The project would include 13 side platform stations and special design features at the terminal stations at Union Station and Sierra Madre Villa Avenue;

- (5) The project would include a grade separated/protected guideway alignment to accommodate the bus volumes required to meet the ridership demand estimated at 68,000 daily;
- (6) The project would include the most modern low-floor, wide door, 40 foot, CNG powered vehicles;
- (7) Amenities and busway station features would be included at an equivalent level to that provided at rail stations in the LRT alternative; and
- (8) A conventional project development process would be employed by the agency building the project.

The detail of the costs to complete estimate of \$ 777 million is shown in Figure 15 below. The primary costs are in the structure costs to grade separate the busway facilities including both the guideway and the stations. This includes an approximately 3,000 feet of additional cut and cover subway construction and about 22,000 feet of elevated guideway on columns and embankment. In addition, all 13 of the stations are grade protected/separated. Other major construction costs are those associated with the construction and equipping of the maintenance facility and yard, and the purchase of 106 40-foot, CNG powered, buses to operate on the busway.

The engineering costs are estimated based on the initiation of a comprehensive preliminary engineering program to run in tandem with the preparation of the DEIR. This would be followed by a final design program and the preparation of the FEIR. Upon clearance of the FEIR all of the required mitigation measures would be identified, incorporated into the design, and the drawing packages would be completed and prepared for bidding. The construction management costs are estimated at a fixed percentage of six percent of construction and procurement costs. Project administration costs are estimated at approximately four percent of construction and procurement costs. The right-of-way acquisition costs are estimated based on the additional takes required at five stations. Finally the owner's insurance costs are estimated at seven percent of the costs to complete the construction and procurement.

5.2 Estimates of Operating Costs

The operating costs of the LRT alternative and the exclusive busway option can be addressed in a number of ways. Typically, detailed studies of operating costs use single purpose measures such as cost per revenue service mile, costs per revenue service hour, subsidy per passenger, cost of staff employees per passenger carried, and others to generate cost estimates which are used to analyze the costs of individual bus or rail lines.

They also are used to compare and contrast the costs of bus systems operated by different public and private agencies. In the context of demonstrating cost comparability between modes, such as LRT and an exclusive busway, these single purpose measures do not perform well because the categories and methods used to account for expenditures and to build up the costs are so different. In short, the results often are an "apples to oranges" type of analysis which are disputed by advocates of one mode or the other.

As a matter of fact the only meaningful basis for measuring the operating costs of LRT and busway systems that can be used to compare the modes is their cost per passenger mile. The cost per passenger mile measure is widely accepted in the transit industry nationally and by the private sector as the best way to measure costs between modes. The cost per passenger mile takes into account three key components of operating costs. The components are: (1) The number of passengers carried; (2) The distance the riders are transported; and (3) The cost to transport the riders.

In terms of the cost per passenger mile for the LRT alternative there is considerable data available from systems both in Los Angeles and elsewhere in the U.S. In Dallas the cost per passenger mile is 54 cents; in San Francisco it is 50 cents; in San Diego it is 28 cents and in St. Louis the cost is 30 cents. Portland, a city that is widely recognized as operating an efficient system, has a cost of 38 cents per passenger mile. The MTA cost per passenger mile on the LA/Long Beach Blue Line and the Metro Green Line is 43 cents.

There is less data available on the cost per passenger mile for dedicated busway operations. The systems that operate busways do not report specific operating cost data for busway operations because so many of the bus routes that use the busways also use surface streets for many of their route miles. This makes the calculations quite difficult and problematic to maintain. At the peak of its El Monte Busway operations in the mid-1980s, the SCRTD did several cost analyses of busway operations comparing costs to the systemwide bus operating costs. The busway costs ranged from 15 to 20 percent greater than the systemwide operating costs, in part due to the reduced running speeds, higher accident rates, and other factors associated with the busway where automobiles and other vehicles were allowed on the busway lanes.

Those studies documented in the 1980s that it would be possible to get the operating costs of the El Monte busway down to the systemwide costs if major changes were made in its operations. The changes would have required measures to increase the operating speeds of the buses and to reduce accidents, mostly involving other vehicles, on the busway running lanes.

Today, with much less MTA operations and greater congestion from other vehicles operating on the El Monte Busway than in the 1980s, the cost per passenger mile probably has increased substantially when compared to the systemwide costs, although no MTA studies on the subject are known to be available at this time.

Under these circumstances this study has assumed that the operating costs of a dedicated busway in the corridor between Los Angeles and Pasadena would be no greater than the MTA systemwide bus operating costs per passenger mile. The most current MTA data shows that the cost per passenger mile for bus operations is 48 cents compared to 43 cents for the LRT lines. For purposes of a reasonableness check, the comparable data was reviewed in other cities operating both the LRT and bus modes.

For example, the bus operating data in Dallas shows a cost per passenger mile of 70 cents compared to 54 cents for the LRT system. In San Diego the bus operating data shows a cost per passenger mile of 37 cents compared to the LRT costs of 28 cents. Other systems that showed similar relationships between the rail and bus cost data were Portland, St. Louis, Sacramento, and San Francisco. Thus, it is reasonable to conclude that the cost per passenger mile of the LRT would be from 5 to 8 cents less than that of the dedicated busway in the 13.6 mile corridor between Los Angeles and Pasadena.

5.3 Analysis of Costs

The analysis of the costs really involves only two issues. They are: (1) What is the cost of each alternative to build; and (2) What is the cost of each alternative to operate each year? Each of the alternatives assumes the same ridership. Each has the same number and location of stations. To the maximum degree possible each has the same types of passenger amenities and other features that would make the systems equally attractive for passengers riding the system. The comparable costs of the alternatives are summarized in Figure 16 on the following page.

In terms of capital costs the LRT alternative as developed in this study has a total cost of \$ 817 million. These costs are escalated to the mid-point of construction which is the standard practice in projects of this nature. These total project costs can be reduced by \$106 million to \$ 711 million if a series of recommended procurement and construction measures is implemented by the MTA or its successor construction agency, the Pasadena Metro Blue Line Construction Authority. The costs to complete the LRT alternative are estimated at \$ 575 million. They can be reduced to \$ 469 million if the recommended measures are implemented.

The capital costs of the exclusive busway alternative total \$ 777 million as developed in this study. The description of the cost items is contained in Subsection 5.1 above and specifically in Figure 15. These costs, however, are in current dollars which means they would have to be escalated to the mid-point of construction when the project is moved forward to the preliminary engineering phase. The cost increase would be about 3 percent per year compounded to the mid-point of construction, a sum that would amount to at least an increase of \$ 124 million if the project began in January 1999 and was based on a schedule showing completion in June 2008. This means the real cost to complete the exclusive busway alternative would be about \$ 901 million compared to the \$ 469 for the LRT system. Thus, an "apples to apples" comparison suggests that the exclusive busway alternative would cost at least \$ 432 million more to complete, and it would take at least four to five more years to finish and make ready for operations.

In terms of operating costs the LRT and the exclusive busway alternatives have been analyzed in terms of the operating costs per passenger mile. The analysis the MTA's operating costs for LRT and bus operations has been found to be reasonable in comparison to other transit systems operating both modes. Further, the analysis has shown that the MTA's differences in costs per passenger mile between rail and bus operations are reasonable.

Using this data a calculation has been made to determine the relative relationships between the operating costs. It shows that the annual costs to operate the LRT alternative would be about \$ 37.1 million while the exclusive busway would cost about \$ 42.3 million. This means that during each year of revenue service the LRT alternative would be about \$ 5.2 million less costly in current dollars to operate than would the exclusive busway alternative.

Figure 12
MTA Revised Budget
Pasadena Blue Line
(\$'000)

Item	Description	MTA Revised Budget (Sept. '97)	Pending Project Scope Changes	Demobilization Costs	Master Schedule Delays	Revised MTA Budget
1	Guideway and Stations	222,307	--	--	2,223	224,530
2	Maintenance Facility/Yard	37,844	--	--	378	38,222
3	Hazardous Material Removal	9,459	--	--	--	9,456
4	Utility Relocations	10,679	--	1,000	--	11,679
5	Total Fixed Facilities Construction	280,289	--	1,000	2,601	283,890
6	Traction Power Supply and Install	26,850	5,370	--	269	32,489
7	Communications Supply and Install	2,123	--	--	21	2,144
8	Signaling, Supply & Install	35,311	--	--	353	35,664
9	Fare Vending Equipment S&I	2,924	--	--	29	2,953
10	Trackwork, Supply & Install	26,082	--	--	164	16,612
11	System Tests & Commission	9,634	--	--	--	9,634
12	Total Systems Elements	93,290	5,370	--	836	99,496
13	Total Construction	373,579	5,370	1,000	3,437	383,386

Figure 12: Continued

(\$'000)

Item	Description	MTA Revised Budget (Sept. '97)	Pending Project Scope Changes	Demobilization Costs	Master Schedule Delays	Revised MTA Budget
14	General Engineering	126,060	(1,284)	2,174	--	126,950
15	Construction Management	60,692	--	920	--	61,612
16	MTA Special Consultants	20,635	--	--	--	20,635
17	MTA Project Administration	65,997	--	2,287	--	68,284
18	Total Engineering & Adm.	273,384	(1,284)	5,381	--	277,481
19	Real Estate	49,760	--	100	--	49,860
20	Master Agreement-Utilities	15,400	--	--	--	15,400
21	Project revenue	(1,297)	--	--	--	(1,297)
22	Special Programs	5,936	--	--	--	5,936
23	Owner's Insurance	31,650	--	--	--	31,650
24	Subtotal (Before Contingency)	748,412	4,086	--	3,437	762,416
25	Contingency	55,457	--	6,481	--	55,457
26	Grand Total	803,869	4,086	6,481	3,437	817,873

Figure 13
MTA Budget Estimated Expenditure and Estimated Costs to Complete
Pasadena Blue Line
(\$'000)

Item	Description	Revised MTA Budget (Sept. '97)	Estimated Expenditures To April '98	Estimated Budgeted Expenditures	Estimated total MTA Expenditures	Estimate to Complete
1	Guideway and Stations	224,530	38,861	900	39,761	184,769
2	Maintenance Facility/Yard	38,222	600	--	600	37,622
3	Hazardous Material Removal	9,459	--	--	--	9,459
4	Utility Relocations	11,679	4,783	950	5,733	5,946
5	Total Fixed Facilities Construction	283,890	44,244	1,850	46,094	237,796
6	Traction Power Supply and Install	32,489	235	--	235	32,354
7	Communications Supply and Install	2,144	--	--	--	2,144
8	Signaling, Supply & Install	35,664	40	--	40	36,624
9	Fare Vending Equipment S&I	2,953	--	--	--	2,953
10	Trackwork, Supply & Install	16,612	2,554	--	2,554	14,058
11	System Tests & Commission	9,634	--	--	--	9,634
12	Total Systems Elements	99,496	2,829	--	2,829	96,667
13	Total Construction	383,386	47,073	1,850	48,923	334,463

Figure 13: Continued

(\$'000)

Item	Description	Revised MTA Budget (Sept. '97)	Estimated Expenditures To April '98	Estimated Budgeted Expenditures	Estimated total MTA Expenditures	Estimate to Complete
14	General Engineering	126,950	92,355	2,836	95,191	31,759
15	Construction Management	61,612	19,169	920	20,089	41,523
16	MTA Special Consultants	20,635	6,751	--	6,751	13,884
17	MTA Project Administration	68,284	24,601	1,212	25,813	42,471
18	Total Engineering & Adm.	277,481	124,481	4,968	147,844	129,637
19	Real Estate	49,680	30,136	30	30,166	19,694
20	Master Agreement-Utilities	15,400	5,000	--	5,000	10,400
21	Project revenue	(1,297)	--	--	--	(1,297)
22	Special Programs	5,936	300	--	300	5,636
23	Owner's Insurance	31,650	10,000	--	10,000	21,650
24	Subtotal (Before Contingency)	792,416	235,385	6,848	242,233	--
25	Contingency	55,457	--	--	--	55,457
26	Grand Total	817,873	235,385	6,848	242,233	575,640

Figure 14
Revised Project Budget and Costs to Complete Estimates
Pasadena Blue Line
(\$'000)

Item	Description	Estimate To Complete	Budget Adjustments	Estimated Costs to Complete
1	Guideway and Stations	184,769	(10,000)	174,769
2	Maintenance Facility/Yard	37,622	(3,000)	34,622
3	Hazardous Material Removal	9,459	(3,000)	6,459
4	Utility Relocations	5,946	(2,000)	3,946
5	Total Fixed Facilities Construction	237,796	(18,000)	219,796
6	Traction Power Supply and Install	32,354	(2,000)	30,254
7	Communications Supply and Install	2,144	--	2,144
8	Signaling, Supply & Install	35,624	(2,000)	33,624
9	Fare Vending Equipment S&I	2,953	--	2,953
10	Trackwork, Supply & Install	14,058	(1,000)	13,058
11	System Tests & Commission	9,634	(200)	9,434
12	Total Systems Elements	96,667	(5,200)	91,467
13	Total Construction	334,463	(23,200)	311,263

Figure 14: Continued

(\$'000)

Item	Description	Estimate To Complete	Budget Adjustments	Estimated Costs to Complete
14	General Engineering	31,759	(15,000)	16,496
15	Construction Management	41,523	(24,500)	17,023
16	MTA Special Consultants	13,884	(4,300)	9,584
17	MTA Project Administration	42,471	(28,000)	14,471
18	Total Engineering & Adm.	129,637	(71,800)	57,837
19	Real Estate	19,694	(1,000)	18,694
20	Master Agreement-Utilities	10,400	(1,000)	9,400
21	Project revenue	(1,297)	--	(1,297)
22	Special Programs	5,636	--	5,636
23	Owner's Insurance	21,650	(2,000)	19,650
24	Subtotal (Before Contingency)	520,183	(99,000)	421,183
25	Contingency	55,457	(7,000)	48,457
26	Grand Total	575,640	(106,000)	469,640

Figure 15
Estimated Costs to Complete
Pasadena to Los Angeles Exclusive Busway
(\$'000)

Item	Description	Exclusive Busway Costs To Complete
1	Guideway and Stations	368,851
2	Maintenance Facility/Yard	19,500
3	Hazardous Material Removal	9,459
4	Utility Relocations	8,500
5	Total Fixed Facilities Construction	406,310
6	Traction Power Supply and Install	--
7	Communications Supply and Install	2,144
8	Signaling, Supply & Install	--
9	Fare Vending Equipment S&I	2,953
10	Trackwork, Supply & Install	--
11	System Tests & Commission	43,460
12	Pre-revenue Test	2,000
13	Total Systems Elements	50,557
14	Total Construction	456,867

Figure 15: Continued

(\$'000)

Item	Description	Exclusive Busway Costs To Complete
15	General Engineering	36,549
16	Construction Management	31,981
17	MTA Special Consultants	9,584
18	MTA Project Administration	22,843
19	Total Engineering & Adm.	100,957
20	Real Estate	42,400
21	Master Agreement-Utilities	9,400
22	Project revenue	--
23	Special Programs	5,636
24	Owner's Insurance	31,981
25	Subtotal (Before Contingency)	647,241
26	Contingency	129,448
27	Grand Total	776,689

Figure 16
 Summary of Costs of LRT and Busway Alternatives
 Pasadena Corridor

Item	Description	LRT Alternative	Busway Alternative	Busway vs LRT Difference
1	Capital Costs to Complete	\$575,000,000	\$901,000,000	\$326,000,000
2	Capital Costs to Complete with Efficiencies	\$469,000,000	\$901,000,000	\$432,000,000
3	Operating Costs per Passenger Mile	43 cents	48 cents	5 cents
4	Annual Operating Costs	\$37,100,000	\$42,300,000	\$5,200,000

6.0 CONCLUSIONS

A number of conclusions can be drawn from this study about the feasibility of either a LRT alternative or an exclusive busway alternative in the Pasadena corridor. The most important conclusions are related to a determination as to whether or not the facilities required by both alternatives can be built and operated given the physical constraints of the corridor. A second set of conclusions relates to the costs associated with building and operating both of the systems in the corridor. A third set of determinations relates to the project schedule for each of the alternatives.

A final set of conclusions relates to the next steps and key decision points that should be pursued by policy makers and management should a decision be made to proceed with either the LRT or the exclusive busway alternative in the corridor.

6.1 Facilities Feasibility Determinations

This study documents that in terms of the facility requirements either the exclusive busway or the LRT alternative is a feasible option for the Pasadena corridor. The exclusive busway, however, will require additional rights-of-way at about six of the in line station sites. In addition, additional right-of-way will be required to accommodate the two terminal stations and the on/off transition ramps associated with each. The costs associated with the additional rights-of-way are not considered prohibitive.

The exclusive busway also will require special design treatments to address the relatively narrow bridge structures that exist at several of the overpasses of surface streets along the alignment. In addition, the exclusive busway will require a substantial amount of additional elevated structure – both columns and embankment – as well as subsurface cut and cover sections to provide the necessary grade separations for the busway to operate in the required manner. Perhaps the greatest difficulty that would be encountered by an agency deciding to build the exclusive busway alternative would be addressing the environmental impacts of and the community concerns about the additional elevated structure and some of the potential impacts of the side platform stations.

In terms of the busway many of the side platform stations will require some creative design treatments to address the site specific needs associated with the station areas and the neighborhoods they would serve. The stations at both ends of the exclusive busway will require special attention in that they must be designed to accommodate a high passenger volume while at the same time allowing for the easy on/off movement of buses so that they can continue ongoing operations on the busway.

In terms of potential extensions of the LRT and exclusive busway alternatives farther to the east, provisions would have to be made for both options. The LRT alternative is easier to deal with in this context in that the rail line can be extended easterly for several miles without diversion from the railroad right-of-way. The exclusive busway is not as easily dealt with in terms of extensions in that the railroad right-of-way narrows as it

leaves the 210 freeway alignment. Substantial additional studies would have to be conducted in the six-month planning phase noted above as the first task in the busway project development process.

6.2 Operations Feasibility Determinations

In terms of the operations of the LRT and the busway alternatives both are feasible as described in this study. Both alternatives have a series of constraints and issues associated with their operation. In terms of daily operations the exclusive busway would offer a very high level of service with buses operating at less than one minute intervals in peak hours and probably no more than five minute headways during off peak periods. The bus operations would have to deal with the impacts on the neighborhoods of more than 100 buses per hour during peak hours leaving and returning to the busway at both ends of the system. In addition, the noise associated with busway operations during all hours would be an issue that would have to be addressed in the environmental and engineering studies done early in the project development process.

Clearly, the LRT alternative also is operationally feasible. It has been advanced to the point that all of the environmental issues related to operations have been addressed including the noise issues associated with train horns, train operations, and related types of issues. It is clear that in the pre-operations phase, however, there would have to be a major public education campaign related to safety and the absolute need for auto drivers to avoid attempts to drive around crossing gates to beat the trains. The LA/Long Beach Blue Line operating experience has taught the MTA many lessons about rail operations. If a decision is made to complete the construction of the LRT alternative, a major effort will need to be made to build upon the safety advances already made by the MTA on the LA/Long Beach Blue Line.

6.3 Cost Determinations

The costs to complete the LRT and the exclusive busway alternatives are radically different. At maximum the LRT costs to complete are \$ 575 million. This study documents that approximately \$ 106 million in cost reductions could be implemented by a public agency thereby bringing the total costs to complete to \$ 469 million.

In contrast, the exclusive busway alternative would be an entirely new project. In addition to an estimated costs to complete of \$ 900 million, there would be many issues, risks, and uncertainties associated with the exclusive busway project, as there are with any new project. These could include everything from potential new environmental issues, to community objections, to higher than expected right-of-way costs, to many others. In short, a decision to proceed with the exclusive busway alternative would by no means assure it would be built.

In terms of operating costs, it is clear that the LRT alternative would be substantially less costly per passenger mile than would the exclusive busway. The busway would cost about \$ 5.2 million more annually to operate which represents a 14 percent differential.

When escalated over a 20 or 30 life cycle, the operating cost differentials would be in the hundreds of millions of dollars. There is an order of magnitude difference in the costs associated with building and operating the LRT and the exclusive busway alternatives. The MTA already has invested some \$ 235 million in the LRT alternative. Therefore, it should have a cost advantage.

However, even if one includes the existing MTA investment, the LRT still is less costly to complete. On the operating side of the equation, it is important to note that about 60 percent of the cost differences between the alternatives would come from subsidy dollars. This means the taxpayers would be paying an additional \$ 3.1 million in tax dollars each year for the privilege of having an exclusive busway as opposed to the LRT. Thus, in terms of cost determinations the choice between the two alternatives is not a close call. The LRT alternative clearly costs about \$ 430 million less to complete than the exclusive busway. Moreover, it is millions of dollars each year less costly to operate.

6.4 Schedule Determinations

In terms of the project schedule both alternatives face some significant problems. The combination of the environmental issues, the special design treatments associated with the busway configuration, and the additional right-of-way acquisitions result in the exclusive busway project requiring at least eight to ten years to complete. The steps required in the project development process to deliver a completed exclusive busway alternative are shown in Figure 9 above.

If the LRT alternative is re-started within the next three to six months so that the shelf life of the design packages does not expire, the project could be completed within a period of four to five years using a conventional development process. If the new management approaches and contracting and procurement recommendations that will save approximately \$ 106 million are implemented by the lead agency, at least one year can be cut off the completion schedule thereby making the LRT alternative ready for operations within a period of no more than four years.

Thus, it is reasonable to conclude that the LRT alternative would be completed at least four to five years earlier than the exclusive busway option assuming a timely decision is made to proceed with one or the other of the project.

6.5 Next Steps

Policy makers and managers associated with the Pasadena Corridor have essentially three options. They can decide to proceed with any one of the following courses of action:

- (1) To do nothing under which circumstances both alternatives probably will die within 12-18 months as interest dwindles in high capacity transit service;
- (2) To implement the exclusive busway alternative and to allocate sufficient funds to take the project through the preliminary engineering phase at which point in time there

- would be substantially more detailed information about the costs and risks associated with building the project; and
- (3) To implement a re-start of the LRT Alternative which will require the commitment and programming of approximately \$ 469 million over the next four years to assure completion of the project. Of the courses of action only option number three requires near term implementation to avoid substantially more costs associated with the perishable nature of the design packages discussed in Section 3.1 above.

If a decision is made to implement option number two, the lead agency should immediately start the detailed planning process shown in Figure 9 above. This would require bringing on an experienced consulting team through the RFP process and moving forward with the detailed planning scope of work. Upon completion, the lead agency would initiate the preliminary engineering work in order to gain sufficient detail and definition to make a final "build or no build" decision.

In contrast to option number two a decision to move forward with option number three will require immediate attention to developing a detailed organization and funding plan. Among other things this plan should include new procedures for building the project, a remobilization plan, annual programming and funding commitments, decisions about implementing new procurement and construction approaches, and other measures designed to achieve the \$ 106 million in cost savings identified in this study. These activities would consume the first two to three months after which the decision makers and management would be focused on completing the construction and procurement phase on time and on the budget established for the project.