

**A Study of Rail Transit System Phasing  
and Expansion Decisions**

by

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University College Dublin, Ireland, 1994

Submitted to the Department of Civil and Environmental Engineering  
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## **Abstract**

This thesis considers the subject of system phasing and expansion with a view to establishing what makes for an appropriate phasing strategy and how it can contribute to the ultimate success of a system. The purpose is one of discerning how systems develop and expand, how phases are prioritized for implementation, and what factors need to be addressed to facilitate system expansion in the most effective manner. An analysis framework is developed which provides a systematic way of considering the various facets of system phasing and expansion decisions. The facets of analysis are described as technical, transportation and service, political, social, financial, environmental, and economic. To learn more about what constitutes a good phasing strategy, case studies of five rail transit systems in Buffalo, Miami, Calgary, Caracas and San Diego, are examined to assess what factors influenced the phasing strategies adopted and the effectiveness of the strategies themselves.

The analysis identified several important issues in the development of a phasing strategy which can influence the ultimate success of the system. In general, the likelihood of network expansion beyond Phase I seems to be a function of the perceived success of the initial phases. The success of early phases permits the harnessing of public and political support to aggressively pursue system expansion. Prior implementation of effective bus transit operation forms a prototype for subsequent rail development. Once in place, the integration of other transit services to feed the rail system and complement it where rail service does not exist is another feature of effective phasing strategies. System expansion should also be coordinated with the phasing of developments and improvements to the urban area and integrated with transit, transportation and land use planning.

Maintaining speed and momentum of expansion allows the benefits of a system to become more apparent for all to see, thereby creating support for further extensions. The use of local or federal funding will also affect the system phasing decisions with implications for the pace of implementation. The identification of markets and the prioritization of service to lower income or higher income areas must also be considered in the choice of phasing strategy and will depend upon the characteristics of the urban area in question. Finally, long-term planning allows the reservation of rights-of-way and permits public participation in rail transit development and phasing decisions. Such planning also allows funding opportunities to be seized as soon as they arise.

The lessons and implications of this research are applied to the case of the proposed Tren Urbano rail transit system in San Juan, Puerto Rico. Construction of Phase I of this system is about to commence and the development of a phasing strategy for the implementation of subsequent phases is about to begin. Future expansion prospects will rely heavily on the successful implementation of the first phase. It is also important that the bus and público services are upgraded beforehand and that these modes are integrated

as feeders to the rail system. Long term planning will help identify rights-of-way and maintain expansion plans in a state of readiness, as well as inform the public of the costs of further system development.

**Thesis Advisor: Dr. Nigel H. M. Wilson**

**Title: Professor of Civil and Environmental Engineering**



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# Chapter One

## Introduction

In the late 1800's the growth of many cities was highly influenced by the streetcar. This technology allowed workers to relocate to new developing residential nodes outside the city center while preserving access to their working locations. However, over time the advent of the automobile resulted in the decline and eventual disappearance of the streetcar as the dominant mode of suburbs to city center transportation. The period from the 1940s to the 1970s saw huge public investment in the development of highway infrastructure. However, only so many highways could be built without unacceptable destruction of the social fabric, and all too often highway construction only created more travel demand resulting in even greater congestion. Another approach to satisfying transportation demand was needed and in an effort to combat this congestion, increase accessibility and sustain or enhance economic activity, many regions returned to rail transit in the hope of providing a partial solution to their congestion woes. Such development now relies on public investment however, as opposed to the privately owned and operated streetcars of the nineteenth century.

Over the years, the rail transit option has met with varying degrees of success. In some areas it has become a legitimate alternative to the automobile and is clearly a worthwhile and viable investment. However, in other areas, rail transit has had a disappointingly small impact and has been viewed as an expensive failure.

Indeed, some even question whether rail transit has been successful at all. They cite the huge costs of rail system investments in combination with the limited service and often low ridership to denounce such expenditures.<sup>1</sup> Rail transit advocates, on the other hand, point

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<sup>1</sup> See for example Richmond, Jonathan E.D. (1991), "Transport of Delight - The Mythical Conception of Rail Transit in Los Angeles," MIT: doctoral dissertation; and Pickrell, Don H. (1992), "A Desire Named Streetcar - Fantasy and Fact in Rail Transit Planning," Journal of the American Planning Association.

to the highly subsidized and equally large urban highway investments as part of their counter-argument. Nevertheless, highway comparisons aside, some rail systems have become established as important transportation options, whereas others have never taken root. But why hasn't rail transit been uniformly successful? Why have some systems succeeded in expanding through multiple stages, whereas others have never advanced beyond the initial phase? Clearly, if congestion is to be addressed, and money is to be invested productively, viable solutions need to be found. If a rail transit system is to be the solution adopted, then everything possible must be done to facilitate successful expansion.

Obviously, these systems are large projects which do not come into being overnight. For economic and logistical reasons implementation proceeds in stages, and if successful over time a comprehensive and extensive service is achieved. Many factors influence the phasing and expansion of these networks and the development of an appropriate phasing strategy is critical to the ultimate success of the system.

This thesis considers the subject of system phasing and expansion decisions. The purpose is one of discerning how systems develop and expand, how phases are prioritized for implementation, and what factors need to be addressed to facilitate system expansion in the most effective manner. Consideration of these issues will help suggest how the implementation of a rail transit system should ideally proceed in order to enhance the prospects for its extensive development.

As a hypothesis, the prioritization of phases and the successful expansion of a system depends upon a host of interacting factors from the obvious technical ones, to financial considerations, to political influences and more. The goal of effective system development can be arrived at through the careful assessment of these differing elements and their incorporation into an appropriate phasing strategy.

To learn more about what constitutes a good phasing strategy, case studies of a number of relatively recent rail systems are examined to assess what factors influenced the manner in which segments of these systems were implemented. An assessment is then made of the

extent to which the phasing strategies they adopted were successful. To help structure the case studies an analysis framework has been developed and is presented in Chapter 2. It provides a systematic way of approaching the analysis and categorizing the different elements that arise. As such, the framework considers the various facets of system phasing and expansion decisions. These facets of analysis are described as technical, transportation and service, political, social, financial, environmental, and economic. In this way, the factors influencing a particular phasing approach can be identified and grouped and the success of a phasing strategy in dealing with these facets can be assessed.

Chapter 3 presents the case study analyses. The objective was to study the phasing approaches adopted by a subset of rail transit systems in North and South America that have begun operations in the last 25 years. The development of five rail transit systems in particular are detailed; Buffalo, Miami, Calgary, Caracas, and San Diego. These were chosen as providing a good sample both of rail systems which have successfully expanded through multiple phases and others which have not. In each case the analysis first reviews the original plans, proposals and phasing suggestions prior to the construction of each system. With the application of the analysis framework, the discussion then summarizes the factors which influenced the phasing of the system. The next step is the evaluation of the phasing strategies followed by a consideration of the implications for future phasing. Each case study concludes with a summary of the phasing strategy adopted and a review of the lessons learned.

Having already identified the role that various factors played in influencing phasing including the technical, transportation and service, political, social, financial, environmental and economic facets, Chapter 4 attempts to integrate the lessons and implications drawn from the case studies. The discussion in this chapter focuses on two main issues; first, the identification of the roles specific factors played in system phasing; and second, the identification of items that should be addressed and steps that should be taken to facilitate the development of a successful phasing strategy.

Chapter 5 then examines the development of a phasing strategy for the implementation of the Tren Urbano Rail Transit Project in San Juan, Puerto Rico. This rail transit system is still in the design stages although construction of Phase I is to commence in July, 1996 and studies of future phases are about to begin. As such, the consideration of an appropriate phasing strategy is very relevant at this time. This examination highlights the issues to be addressed and steps to be taken in designing a successful phasing strategy. Initially a discussion of the existing system implementation plans, proposals and phasing approaches which have been suggested is presented. The rationale for the present Phase I alignment are discussed in order to provide some background on the decision environment. From this point, an attempt is made to identify those factors particular to San Juan which are likely to have a strong bearing on the subsequent phasing approach to be adopted. Finally, the lessons learned from the analysis of other transit systems are applied to the case of Tren Urbano.

Chapter 6 provides a review of the major lessons from Chapters 4 and 5 and discusses areas for further research.

# Chapter Two

## Framework for Analyzing System Phasing and Expansion Decisions

Our objectives are to identify the factors influencing system phasing decisions and to consider how phases are prioritized for implementation. As we carry out our analysis we are also trying to identify issues that should be addressed and steps that should be taken to facilitate effective system development.

An analysis framework has been devised to help in the structuring of the case studies and the achievement of our objective. It provides a systematic way of approaching the analysis and categorizing the different elements that arise. The framework basically comprises:

- The definition of the differing facets of a phasing strategy.
- The identification of the factors which influence each facet of phasing.
- The evaluation of phasing strategies in dealing with each facet.

### 2.1 Facets of the Analysis

There are a number of aspects of any phasing strategy which may be important. The goal is to determine the best phasing of segments/lines recognizing the differing facets of the phasing strategy that exist.

The facets of the analysis that need to be looked at in the consideration of phasing strategies can be categorized as:

1. Technical
2. Transportation and Service
3. Political
4. Social
5. Financial
6. Environmental
7. Economic

Each facet should be considered in assessing alternative phasing options before selecting the preferred strategy. This thesis will examine how systems integrated these various

facets of phasing in their development of an overall phasing strategy. To carry out this examination we have outlined an analysis framework which details some of the factors influencing each facet of phasing and which will aid in assessing the success of strategies in dealing with each facet.

By pursuing our analysis in this manner, we will be able to identify those factors which have the greatest bearing on phasing decisions and subsequently to identify steps to be taken to aid in developing a successful phasing strategy.

### ***2.1.1 Technical***

The technical facet of the phasing decision addresses the question: What technical factors may influence phasing, and in what way?

#### ***2.1.1.1 Factors:***

- Construction in an existing right-of-way is obviously technically easier, less expensive, less controversial, and faster than the process involved in obtaining right-of-way where none previously existed. Therefore, the availability of rights-of-way may influence phasing decisions and prioritize construction in existing rights-of-way to get the system up and running.
- If suitable sites for stations are already available, this may influence the decision to proceed with a certain segment or line initially as opposed to another section that may involve more delays in acquiring station sites.
- Terrain type may also affect phasing choice. The decision may be one of proceeding with easier and faster to construct 'at-grade' elements initially rather than more complicated elevated or tunnel sections.
- It is possible that physical impediments/obstructions could complicate and perhaps delay construction. Furthermore, projects often have some elements of complexity which have the potential to delay the completion of certain system segments and may influence the choice of phasing strategy.

- Operational feasibility and the necessity of building phases in an order such that built segments have access to the maintenance/railroad yard will impact the phasing strategy.

### ***2.1.2 Transportation and Service***

The transportation/service facet of the phasing decision addresses the question: What transportation/service factors may influence phasing, and in what way?

Making decisions regarding which service elements to initiate at what time is really what deciding upon a network phasing strategy is all about. However, if we consider phasing from the narrower perspectives of the size of the population that could potentially be served, and the question of how the service integrates with existing transit service, then the following factors come into play:

#### ***2.1.2.1 Factors:***

- Decisions on which approach to adopt may be linked to the need to develop minimum usable segments. Under such circumstances, the approach of implementing all of one line initially before proceeding with another line may be taken. On the other hand, if the support of a number of areas is necessary for the development of a system, then a strategy of building a number of lines concurrently to satisfy these differing areas may be pursued.
- Service phasing decisions might also be influenced by service integration issues. The approach may be one of linking built segments with other types of transit such as bus along individual corridors until such time as the system is whole. Or the approach may be one of totally replacing the trunk bus service in a particular corridor. Furthermore, certain corridors, although potentially having high demand, may already have adequate transportation capacity which would make the provision of an extra travel mode less of a priority. Therefore, the manner in which built segments integrate with and contribute to the overall transportation system may be fundamental to the phasing strategy.

- Many of the existing transit services could be oriented to serve as feeder or connecting services for the rail line. The ease of coordinating these other transit elements, and the question of which phases of the rail system integrate most readily with the existing transportation system, may generate phasing suggestions.
- The need to connect major activity centers may be seen as a priority in any phasing strategy. This may suggest the linking of business, medical, and educational centers to high density residential areas.
- The identification of the present corridors of highest travel demand and the recognition of which corridors will have high future demand will influence the design of a phasing strategy to address these present and future transit needs.
- The need to provide or improve public transit efficiency, convenience and reliability along certain corridors or to service special transit dependent groups (elderly, handicapped, captive riders) may affect the phasing strategy. If certain areas have a demonstrated greater need for transit service, the phasing strategy may be designed to prioritize the implementation of service to these areas.
- The identification of which phases provide the greatest ridership and travel time improvements may suggest the implementation of these phases first.

### **2.1.3 Political**

The political facet of the phasing decision addresses the question: What political factors may influence phasing, and in what way?

#### **2.1.3.1 Factors:**

- Political interests may suggest or require the implementation of certain segments or lines before others for a variety of reasons. For example, certain sections may have higher visibility, make a bolder statement and thus have a greater positive political image. Another factor may be that certain corridors may embrace the notion of transit



accessibility to their area with greater or lesser enthusiasm, resulting in varying degrees of political support.

- The question of the stability of the political administration and the probability of continued political support for the project may impact the phasing strategy. A difficulty of developing a system is the maintenance of the political support for project implementation through changes of the political administration at local and national levels. A phasing strategy may be one of committing projects in such a manner that their implementation will proceed even if the political climate alters.
- Public support or the lack of public opposition may impact the choice of phasing strategy. Over the lifetime of the project implementation process public support may strengthen or dwindle for a number of reasons. This support may decline if significant disruption is experienced by the public during construction. However, support may increase if project completion results in positive impacts to the urban area, e.g. the building of parks, pedestrian zones, new economic development, revitalization of older areas, etc.. The careful design of a phasing strategy may be able to harness positive public feelings and avoid possibly negative perceptions.
- The issue of preserving the momentum of expansion and the utilization of political and public support while it exists in order to hasten system development can be important elements of a phasing strategy. Successful initial phases may create an environment where system extensions can be aggressively pursued. On the other hand, negative perceptions of the initial phase would mean that an aggressive approach to further implementation would not be possible.
- Private sector support in the form of business community support, joint development of stations and the donation of rights-of-way may influence phasing decisions. If private sector support is to be pursued then the design of a phasing strategy would have to recognize the time constraints and the other needs of the private investors in the development of the system.

## **2.1.4 Social**

The social facet of the phasing decision addresses the question: What social factors may influence phasing, and in what way?

### **2.1.4.1 Factors:**

Community perceptions are critical to the success of any phasing strategy. Many factors influence people's perceptions of the system and these should be recognized in the development of a phasing strategy.

- For instance, if the first phase of the system is located in a poor/crime-ridden/minority area, this could create the impression that it is a 'poorman's' travel mode as well as being 'unsafe'. Therefore, the idea of transit expansion might be less likely to be embraced by other communities when they consider the prospect of transit serving their area. On the other hand, the idea that the system is providing access to the less "well-off" may well be viewed in positive terms.
- If the first phase is aligned through a wealthy neighborhood it may create a more positive impression as a service 'for the well-off', as well as being 'safe' and 'clean'. This might more easily facilitate the implementation of further phases as rail transit service would be perceived as something worth having. On the other hand, this might lead to negative perceptions in the sense that the system is providing subsidized service to those who could quite easily afford alternatives.
- People will already have perceptions about transit before any of the phases are implemented. Possibly they have good experiences of transit in general through existing service provision. Therefore they may support development in their area. This may influence phasing decisions.
- If the phasing strategy is such that much of the system is to be implemented before any one element becomes operational then perceptions of system extensions will be governed mainly by people's experiences of the construction process of preceding segments. However, if one phase is operational before the implementation of the next

phase is begun, then people's support for the implementation of the second phase will be influenced by issues such as the success of the first phase in meeting ridership goals, revenue targets, and whether the first phase is safe and pleasant to use. If the implementation of the second phase is delayed still further, then support for its implementation will also be influenced by the success of the initial phase in promoting development and revitalizing the economy.

Apart from the perceptions of the community, the recognition of the social and neighborhood impacts of a rail transit system will also influence phasing decisions.

- The decision to build a transit line in a certain area can have many impacts. Such impacts may include influence on land-use decisions, on development patterns and density, and the general rejuvenation of the area. The decisions regarding phasing may relate to prioritizing the construction of lines to those areas where such impacts are of most value. Alternatively, the approach may be the reverse in that the selection of a phasing strategy may be determined by choosing alignments through areas that already have higher density development and pedestrian friendly environments. Different phasing strategies may be decided upon depending on which of these approaches is adopted. In general, the design of the phasing strategy will be heavily influenced by the role that the system is to adopt in addressing the social needs of the city. If social factors are a significant component of system implementation decisions, a phasing strategy which prioritizes serving low-income, minority or transit dependent areas should prevail.

### **2.1.5 Financial**

The financial facet of the phasing decision addresses the question: What financial factors may influence phasing, and in what way?

#### **2.1.5.1 Factors:**

- The costs of construction and the degree of capital availability at a given time are important concerns. All systems are dependent upon funding availability and

constraints. The times at which portions of this funding become available may be a critical determinant in phasing decisions. For instance, if limited funding is available initially, the phasing strategy may be to proceed with the lowest cost segment of the system first. The establishment of this element of the system may then be considered a substantial argument for seeking and obtaining further funding to implement subsequent phases.

- The state of the economy and the certainty/uncertainty of future funding sources will have input into the choice of phasing strategy. For instance, if federal or state funding commitments are in place for transit development, future funding of system extensions will be assured. This will mean that funding will not be such an issue in the prioritization of phases for implementation and other factors such as public support or service inadequacies will more likely dictate the choice of phasing strategy.
- The influence of Federal Transit Administration (FTA) cost-effectiveness criteria on the relative likelihood of obtaining funding support for certain segments will impact phasing decisions. The cost-effectiveness measure is a critical factor as to whether a project is accepted into alternatives analysis for possible federal financial support. Since financing is such an important element of system development, the cost-effectiveness index may well prioritize the implementation of phases. As such, this particular measure may have a large bearing on the choice of phasing strategy.

### ***2.1.6 Environmental***

The environmental facet of the phasing decision addresses the question: What environmental factors may influence phasing, and in what way?

#### ***2.1.6.1 Factors:***

- The phasing decisions may relate to the need to relieve congestion and improve air quality along a particular corridor or the system as a whole. Certain corridors may therefore be considered priorities from an environmental point of view which may argue for earlier implementation.

- Furthermore, as all federally funded projects require an Environmental Impact Study, this may also have a bearing on phasing decisions. Some segments may proceed more speedily through the environmental impact assessment process and may be in a position to be implemented sooner as a result.
- Construction impacts will also influence the choice of phasing strategy. The construction required during project implementation may dictate which elements of the system are constructed in what order and over what span of time. It may be unrealistic, for example, to implement all of the system at once as the impacts on the city or the construction resources required may be too great to handle. Implementing limited segments at a time may be easier to mitigate.

### **2.1.7 Economic**

The economic facet of the phasing decision addresses the question: What economic factors may influence phasing, and in what way?

#### **2.1.7.1 Factors:**

- One goal of system implementation may be the economic revitalization of certain areas or the city in general. The prioritization of those areas requiring economic stimulation may in turn prioritize the implementation of certain phases of the system. For instance, the prosperity of the downtown area generally relies on the degree of accessibility it enjoys. The provision of transit access from the high demand suburban areas may help regenerate economic activity in the downtown. Similarly, the provision of transit access to many other areas such as the airport or low-income, transit dependent regions may enhance the economic prosperity of these particular areas and ultimately the city as a whole.

## **2.2 Evaluation of phasing strategies**

Phasing strategies represent alternative approaches to the task of implementing a system and there are a range of issues which may be important in their design. For instance, the

phasing strategy may be designed in a manner which accounts for the likelihood that only a certain portion of the project might be fundable at a time or political uncertainties such as questions over the degree of political support or the stability of the present administration may require incorporation into the phasing strategy. However, if political, or funding, or other uncertainties do not exist, then the phasing strategy adopted may be quite different.

The success of the in-place system in achieving stated goals such as increasing transit ridership, reducing air pollution, revitalizing the economy, and reducing congestion, although important in encouraging expansion, is not in itself an indication of the success of a phasing strategy. Furthermore, views on what constitutes a “successful phasing strategy” may vary with the perspective of the individual or agency. The engineering perspective is important given the number of engineers involved in the planning and implementation of any rail transit system. Engineers tend to focus on the operational features of the system rather than the broader view of how the system contributes to general societal goals. Thus, the engineer’s evaluation of the success of a phasing strategy would more likely reflect concerns for the technical issues involved.

Another perspective is that of the economist who generally is concerned with minimizing costs while maximizing benefits. The view of economists is important as their advice will frequently be used as the basis for assessing the worthiness of an investment. They utilize the tools of economics, converting all the perceived costs and benefits to monetary units by assigning weights and interpreting the outcomes. Their basis for decision-making differs from that of the engineer and consequently their views on what constitutes a successful phasing strategy may also differ.

Perspectives which are likely to vary from those of the engineer or the economist are those of sociologists, political scientists and development planners. They are more likely to be concerned with issues such as equity, political reality and appropriate development. Their evaluation would be influenced by social and community impacts, the provision of service to those in need, the impact on urban development, and the role of government in guiding

change. Thus, their evaluation of the success of a phasing strategy would incorporate a much wider realm than the methodologies and criteria employed by engineers and economists.

Another group, that of architects, city planners and transport planners, tend to look beyond merely the physical construction of the facility to its coordination with other developments and its impact on the welfare of the community. Their attempt to take a more comprehensive approach to problem solving, recognizing the wider urban development implications, will obviously impact their opinion of the success of a phasing strategy.

The political perspective is perhaps the most important, and may be in conflict with the perspective of engineers, economists and planners. The need for highly visible accomplishments in the short time span of a political administration can result in very different views of phasing success. Whereas in reality the benefits of a rail transit system may not be realized for some time, politicians will often be more concerned with immediate, tangible, election-winning impacts.

As we proceed through the case study analyses we will consider what constitutes a successful phasing strategy. In Chapter 4, where we discuss the lessons and implications arising from the case studies, the findings will be presented.

## **2.3 Summary of Analysis Framework**

The preceding pages have described the 'Analysis Framework' which represents a structured way of approaching the study of the rail transit systems chosen. The case studies will focus on examining system phasing and expansion decisions incorporating the differing facets of analysis as detailed. The various factors influencing phasing decisions that we encounter will be categorized under these facets of analysis (see Table 2-1). From this point we will evaluate the success of various phasing strategies in dealing with each facet. Our ultimate objective is to identify those elements of phasing strategies that best contribute to the effective implementation of rail transit systems.

**Table 2- 1 Summary of Analysis Framework**

FACETS OF ANALYSIS	FACTORS
<b>1. Technical</b>	<ul style="list-style-type: none"> <li>• ROW availability</li> <li>• Suitable station sites</li> <li>• Terrain type</li> <li>• Technical complexity</li> <li>• Physical obstructions</li> <li>• Location of maintenance facilities</li> </ul>
<b>2. Transportation/Service</b>	<ul style="list-style-type: none"> <li>• Corridors served/minimum usable segments</li> <li>• Transit service integration issues</li> <li>• Need to connect activity centers</li> <li>• Need to satisfy travel demand</li> <li>• Need to improve transit service</li> <li>• Identification of highest ridership routes</li> <li>• Integration with transportation system</li> </ul>
<b>3. Political</b>	<ul style="list-style-type: none"> <li>• Degree of visibility of phases</li> <li>• Stability of Political administration</li> <li>• Public support</li> <li>• Private sector support</li> </ul>
<b>4. Social</b>	<ul style="list-style-type: none"> <li>• Perceptions of the system</li> <li>• Existing perceptions of transit service</li> <li>• Community impacts of transit system</li> </ul>
<b>5. Financial</b>	<ul style="list-style-type: none"> <li>• Construction costs</li> <li>• Capital availability</li> <li>• State of economy</li> <li>• Reliability of funding sources</li> <li>• Cost-effectiveness</li> </ul>
<b>6. Environmental</b>	<ul style="list-style-type: none"> <li>• Need to relieve congestion</li> <li>• Need to improve air quality</li> <li>• Environmental Impact Analysis Process</li> <li>• Disruption due to construction</li> </ul>
<b>7. Economic</b>	<ul style="list-style-type: none"> <li>• Stimulation of economic activity</li> </ul>



# Chapter Three

## Case Studies

This chapter presents the case study analyses. The objective was to study the phasing approaches adopted by a subset of rail transit systems in North and South America that have begun operations in the last 25 years. Initially 24 systems were identified as candidate case studies (see Appendix A). From this set, the development of five rail transit systems were studied in detail; Buffalo, Miami, Calgary, Caracas, and San Diego. These were chosen as they provided a good sample both of rail systems which have successfully expanded through multiple phases and others which have not (see Table 3-1). In each case the analysis first reviews the original plans, proposals and phasing suggestions prior to the construction of each system. With the application of the analysis framework, the discussion then summarizes the factors which influenced the phasing of the system. The next step is the evaluation of the phasing strategies followed by a consideration of the implications for future phasing. Each case study concludes with a summary of the phasing strategy adopted and a review of the lessons learned. In Table 3- 1, we provide a summary of the main statistics of the rail systems studied. The analysis begins by examining those systems that have failed to expand beyond their initial stage and proceeds to look at systems that have expanded through several phases.

Location of System	# of Lines	Kilometers of rail lines	# of stations	At-grade/Below-grade/Above-grade	Year initially opened	Construction Cost	Service Area Population	Funding Sources
Buffalo	1	10.3	14	18% at-grade, 82% below-grade	1984	\$550 million	370,000	Federal and State
Miami	1	33	21	Mostly above-grade	1985	\$1 billion	1,791,000	Federal, State and Local
Calgary	3	30	20	87% at-grade, 5% grade separated bridges, 8% below-grade	1981	\$543 million (Canadian)	738,000	Provincial Government
Caracas	3	45	42	10% at-grade, 80% below-grade, 10% above-grade	1983	Not Available	3,500,000	Federal
San Diego	3	61.2	36	Mostly at-grade	1981	\$430 million (approx.)	1,900,000	Local, State and Federal

**Table 3-1 Summary Statistics of Rail System Studied**

## **3.1 Buffalo**

### **3.1.1 Introduction**

Buffalo, New York, with a population of about 370,000, is the major city of an international region of about 1.6 million people which includes the two-county Niagara Frontier Region in New York State and Canada. The urbanized area, focused on Buffalo and Niagara Falls, contains about a million people in New York State and about another 100,000 in Ontario. The population of the City of Buffalo peaked at 580,132 people in 1950, but has been in decline ever since.<sup>2</sup>

The Metro Rail in Buffalo is a light rail system built and operated by the Niagara Frontier Transportation Authority (NFTA). Planning, design and construction of the present system spanned a period of sixteen years and was funded by Federal and State grants at a cost of \$550 million.

The system comprises a 10.3 kilometer mainline of which 1.9 kilometers are at-grade, 2.7 kilometers are in cut-and-cover subway, and 5.6 kilometers are in twin-bore hard rock tunnel. There are fourteen stations - six at-grade and eight underground. (see figure 3-1).

The facility combines features of heavy and light rail transit. In the underground sections, passengers board from car-floor-level platforms while on the at-grade sections boarding is from the curb-level. The system uses overhead catenary instead of third rail in order to enable the trains to operate in a mix with pedestrians. The six downtown stations are at-grade and operate in a transit/pedestrian mall, known as Buffalo Place. This is a fare-free zone and in this way the Metro Rail functions as a downtown people-mover.<sup>3</sup>

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<sup>2</sup> "Buffalo Metro Rail Project, Creativity in Engineering," Buffalo Section-American Society of Civil Engineers, January 1989.

<sup>3</sup> "Project Completion Report, UMTA NY-03-0072, Buffalo Metro Rail Project," Niagara Frontier Transportation Authority, November 1989.

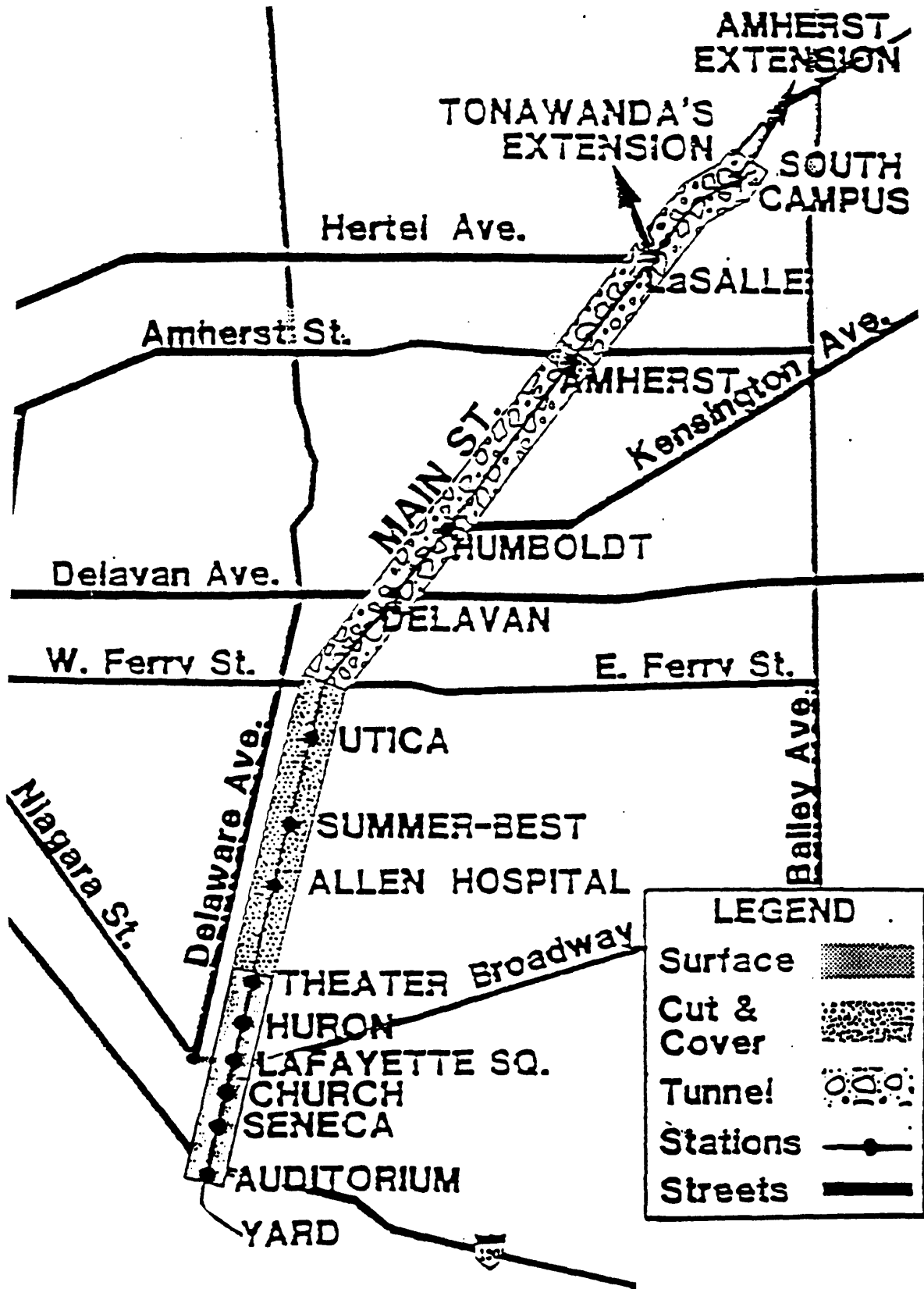


Figure 3-1 Buffalo System Map

The system serves downtown Buffalo to the State University of New York South Campus. Construction began in February, 1979 and the surface section was opened on October 9th, 1984. In May of 1985, the underground line was opened as far as the Amherst station followed by the opening to the South Campus station in November of 1986.<sup>4</sup>

The original system plans were much more extensive and envisioned a 46-mile network with a link from Cathedral Park to the Amherst Government Center, a connection to North Tonawanda, a connection to the Greater Buffalo International Airport in the town of Cheektowaga, and a connection southward to the Buffalo River.<sup>5</sup> (see figure 3- 2).

### ***3.1.2 Development Context of Metro Rail***

In May, 1978 the NFTA's capital grant application for Buffalo's light rail rapid transit project was submitted to the Urban Mass Transportation Administration identifying a number of project objectives. These included improving accessibility for transit corridor residents and particularly the transit dependent, as well as providing travel benefits to existing users and reducing corridor traffic congestion.<sup>6</sup>

Other major motivations for developing a rail transit project were seen as the economic revitalization of downtown Buffalo, and the integration of the east and west sides of the city. As part of this process, the NFTA developed a transit mall through which the Metro Rail line travels for 1.9 kilometers with stops at six stations along the route.<sup>7</sup>

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<sup>4</sup> "System Description, N.F.T Metro Rail," NFTA, American Public Transportation Conference, June 6, 7, and 8, 1988.

<sup>5</sup> "A Transit Development Program for the Niagara Frontier Region," Niagara Frontier Transportation Authority, June 1974.

<sup>6</sup> "Project Completion Report, UMTA NY-03-0072, Buffalo Metro Rail Project," Niagara Frontier Transportation Authority, November 1989.

<sup>7</sup> "The Dawn of a New Era in Transportation, Metro Rail and You," NFTA, May 1985.

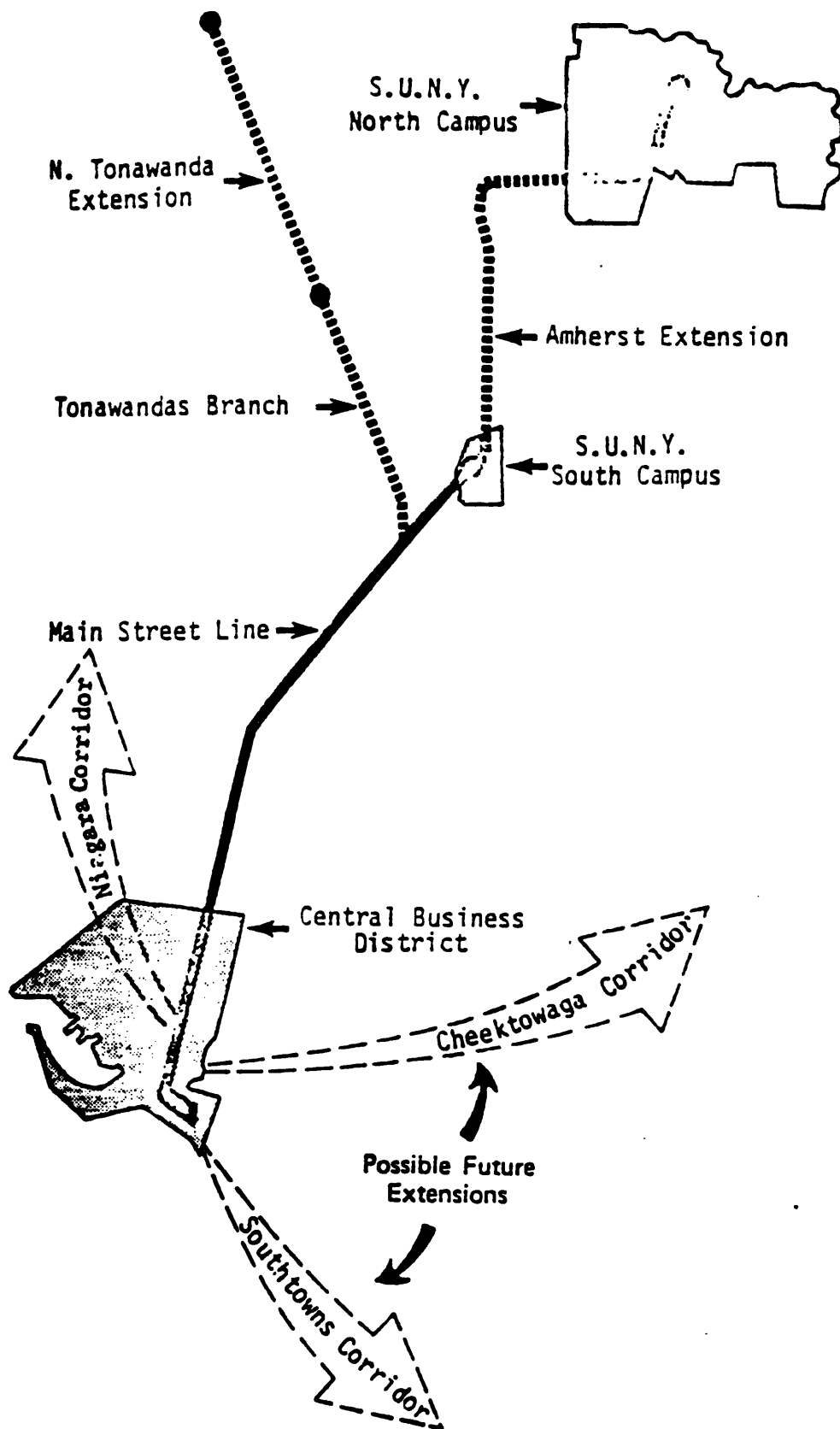


Figure 3-2 Buffalo System Map with possible future extensions

The transit mall was developed at a cost of \$42 million and aimed at changing the Main Street downtown from a traditional street to a pedestrian walkway and gathering place. This would have spin-off effects reviving the retail business of the area and encouraging the development of office space.<sup>8</sup> Further benefits would be the creation of thousands of jobs through the construction and operation of the line, and the attraction of new business and industry and expansion of job opportunities.

### ***3.1.3 Original System Plans, Proposals and Phasing Suggestions***

A number of plans in the late sixties and early seventies proposed various network configurations of a transit system for Buffalo. In June of 1967, the City of Buffalo Planning Board's "Community Summaries: Buffalo, New York", proposed two rapid transit lines. On October 25 of 1968, in the Erie County Department of Planning's "A Plan for 1,300,000 People: The Comprehensive Master Plan of Erie County", a network of four rapid transit lines radiating from Buffalo were described.<sup>9</sup>

The development of rail transit in the Buffalo-Amherst Corridor was receiving particular attention at this time. The New York State Office of Planning Coordination (OPC) completed the Buffalo-Amherst Corridor Urban Impact Study in 1969 which recommended that a rapid transit line be constructed. This led to the Niagara Frontier Mass Transit Study of 1970-71 which investigated the feasibility of an exclusive right-of-way transit facility in the Buffalo-Amherst corridor. The 20.1 kilometer rail rapid transit system linking downtown Buffalo and the new campus to be developed for the State University of New York in Amherst was recommended. The New York State Legislature authorized the development of the system and a series of advanced planning, preliminary engineering and environmental impact analyses were carried out between 1972 and 1974 along with community hearings and forums.

As referred to above (see section 3.1.1), in the 1974 Transit Development Program for the Niagara Frontier Region, the ultimate rail system was envisioned to be a 74 kilometer

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<sup>8</sup> "The Buffalo News," May 15, 1985.

<sup>9</sup> "A Chronology of the Buffalo Metro Rail Project," NFTA, 1985.

network. The revised Phase 1 was to cost \$354 million in 1974 dollars and would link Cathedral Park to North Campus - a distance of 17.7 kilometers. Construction was anticipated to begin in 1976 and extend over a five-year period. At that time, it was estimated that 169,300 riders would use the Phase 1 section by 1995; 57% using the three downtown stations; 59% having their trips wholly within Buffalo and 23% using the two SUNYAB stations.

Phase 2, proposed to be carried out during 1974-1981, envisioned extension of the Buffalo-Amherst Corridor southward to the Buffalo River, and northward to Audubon new town, and development of the Buffalo-Tonawanda Corridor. Future phases were to consider an extension to the airport in the town of Cheektowaga.<sup>10</sup>

The preliminary design and environmental impact analysis for the modified and refined 17.7 kilometer rail line in the Buffalo-Amherst corridor were completed in June of 1974. On review of the work however, UMTA determined that a review of alternative modes and extent of system development was now necessary.<sup>11</sup>

On February 11, 1976 the NFTA submitted to UMTA the Alan M. Voorhees report, "Metro for Buffalo", which described a comprehensive analysis and evaluation of transit alternatives for the Buffalo-Amherst-Tonawandas Corridor.<sup>12</sup> Also submitted was a report by the Metro Construction Division outlining staff conclusions and recommendations for a 10.3 kilometer light rail system in Buffalo as the initial increment of a larger rail transit system, eventually to provide the entire Niagara Frontier with improved public transit service. In July of 1976, the NFTA submitted an application to UMTA for a Mass Transportation Capital Improvement Grant to finance an environmental impact statement

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<sup>10</sup> "A Transit Development Program for the Niagara Frontier Region," Niagara Frontier Transportation Authority, June 1974.

<sup>11</sup> "Metro for Buffalo," Alan M. Voorhees, submitted by NFTA to UMTA on February 11, 1976.

<sup>12</sup>Ibid.



and general engineering activities for the 10.3 kilometer project.<sup>13</sup> UMTA granted the NFTA \$439.8 million for the construction of this system in September, 1978.<sup>14</sup>

The Phasing Objectives were clearly expressed in the recommendations of the Metro Construction Division of February, 1976 which stated “Implementation on an incremental basis is mandatory to live within present funding constraints. The extent and nature of the system must also match the size of the community being served. To provide all parts of our community with the benefits of rapid transit service, maximum design flexibility must be maintained to construct extensions at low cost, providing more system miles for the dollars spent.” The report also noted that “Extensions to the minimum LRRT system, particularly in the Amherst corridor, greatly enhance the system’s financial performance. Costs per passenger carried are reduced and total system deficits are reduced or eliminated providing costs do not escalate faster than revenues over subsequent years.”<sup>15</sup>

### ***3.1.4 Factors influencing system phasing***

#### ***3.1.4.1 Transportation and Service***

As detailed, originally the first phase endpoints were planned to be downtown Buffalo and the north campus of the State University of New York. With the objections to the original alignment however, much of the system had to be put below grade. This had severe funding implications and the increased costs contributed towards the necessity of reducing the length of the proposed line. Although, as mentioned above the Metro Construction Division recommended that “maximum design flexibility must be maintained to construct extensions at low cost, providing more system miles for the dollars spent,” it is clear that the initial phase was not implemented in this manner.

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<sup>13</sup> “A Chronology of the Buffalo Metro Rail Project,” NFTA, 1985.

<sup>14</sup> “System Description, N.F.T Metro Rail,” NFTA, American Public Transportation Conference, June 6, 7, and 8, 1988.

<sup>15</sup> “Evaluation of Transit Alternatives, Buffalo-Amherst-Tonawandas Corridor - Staff Conclusions and Recommendations,” NFTA Metro Construction Division, February 1976.

#### ***3.1.4.2 Political***

Serious planning for a rail rapid transit system in the Western New York region began in the 1960's as a result of then-Governor Nelson A. Rockefeller's \$6.4 billion plan to revitalize transportation in New York State. The key to the proposal was a \$2.5 billion transportation bond issue which would need the approval of the Legislature. The governor recognized that upstate legislators might oppose the bond issue as most of the funds to be realized would be directed towards modernizing New York City's subways. To appease the upstate legislators, he proposed a regional transportation authority for the Niagara Frontier. Political factors such as this and the support of numerous government officials and community leaders played a major role in securing the transit funding for the Niagara Frontier Region.<sup>16</sup> The Buffalo-Amherst corridor had been prioritized for initial construction in 1969 by the New York State Office of Planning Coordination (OPC). Although other corridors were later identified, it was this study which gave the impetus for the initial rail transit line to be implemented in this corridor.

#### ***3.1.4.3 Financial***

As mentioned before, upon the completion of the preliminary design and environmental impact analysis for the modified 17.7 kilometer rail rapid transit line in June of 1974, the increase in costs compared to the original 1969-1970 study prompted a federally requested re-evaluation of the alternatives. One general UMTA concern was that there were insufficient funds in the national assistance program to accommodate the anticipated transit proposals of a number of cities.<sup>17</sup> Eventually however, the 6.4-mile "reduced" rail line from downtown Buffalo to the South (old) Campus of the University was approved for federal funding in 1976. The ultimate funding for the project comprised an 80% Federal government share and 20% State of New York share. This was seen to be the first increment of a larger rail transit system recognizing the constraints on the availability of federal funding at that time.

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<sup>16</sup> "The Dawn of a New Era in Transportation, Metro Rail and You," NFTA, May 1985.

<sup>17</sup> "Metro for Buffalo," Alan M. Voorhees, submitted by NFTA to UMTA on February 11, 1976.

#### ***3.1.4.4 Environmental***

The 1971 Environmental Impact Study had originally suggested that a 20.1 kilometer heavy rail system be built in the Buffalo-Amherst corridor with 58 percent in aerial configuration. This alignment however, brought about community opposition in the form of NOT, the ‘No Overhead Transit’ organization, who were not opposed to rapid transit but were opposed to an aerial structure which would have displaced many residents in the Main Street/Kensington Avenue district. This began a series of community forums to help in the planning process during the preliminary engineering design. Eventually a modified 17.7 kilometer alignment, largely in subway, was decided upon and gained the support of those initially opposed to the project.<sup>18</sup> As detailed, eventually funding constraints dictated that only 10.3 kilometers of this proposal were actually implemented.

#### ***3.1.4.5 Economic***

The NFTA came into being on September 1, 1967 but actual plans to implement a mass transit feasibility study were not initiated for more than a year. In March, 1969, the New York State Office of Planning Coordination (OPC) completed the “Buffalo-Amherst Corridor Urban Impact Study” which indicated a “prime potential” for a mass transit facility between Buffalo’s downtown center and the proposed new State University Campus in suburban Amherst. The reasons to build this line were many but most importantly the purpose was seen as enhancing the areas economic vitality.<sup>19</sup>

#### ***3.1.4.6 Consideration of Phasing Strategies***

In choosing the present system, the analyses conducted attempted to assess all of the possible factors. For example, in the 1976 Alternatives Analysis, various combinations of project staging, alternative technologies and system configurations were assessed. The evaluation framework developed to assist in the evaluation process comprised a number of evaluation factors and corresponding measures. These are summarized in Table 3-2.

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<sup>18</sup> “The Dawn of a New Era in Transportation, Metro Rail and You,” NFTA, May 1985.

<sup>19</sup>Ibid.

In assessing the various evaluation factors, the different points of view of transit and non-transit users were taken into account depending on the factor or measure in question. It was also recognized that factors and measures differed in that some were concerned with regional or system-wide impacts, whereas others were concerned with local, sub-area impacts. The evaluation framework made no attempt to anticipate the importance that various decision-makers attached to particular evaluation factors and the trade-offs between those factors.<sup>20</sup>

**Table 3- 2 Evaluation Framework**

EVALUATION FACTOR	TYPICAL MEASURES
1. System usage	Patronage; mode share; productivity
2. System Costs and Revenues	Capital costs; operating costs; system revenues; cost performance
3. Quality of transportation service	Accessibility; safety; comfort; reliability
4. Economic Effects	Transportation benefits; community benefits; energy savings
5. Effects upon surrounding community/environment	Displacements; visual quality; nonuser safety
6. Levels of environmental pollutants	Air pollution; noise vibration
7. Patterns of urbanization and growth	Distribution of land use; growth stimulus
8. Implementation issues	Uncertainties; financing potential

### **3.1.5 Evaluation of system phasing**

#### **3.1.5.1 Technical**

One particular negative aspect of the system was the disruption caused during construction. This disruption made the downtown unattractive and even dangerous to move about in<sup>21</sup> and is considered by some to be partly responsible for the population reduction, decline of retail activity and movement of business out of the downtown. This was a negative aspect of the implementation process which contributed to the poor perceptions of rail transit development.

<sup>20</sup> "Metro for Buffalo," Alan M. Voorhees, submitted by NFTA to UMTA on February 11, 1976.

<sup>21</sup> "The Buffalo News," May 15, 1985.

### ***3.1.5.2 Transportation and Service***

The Metro Rail is an urban system and not a city-to-suburbs system, and serves a densely populated and heavily traveled corridor. The rail line reduced the travel time from Main Street to South Campus from 45 minutes by bus to 22 minutes. The same trip by automobile was measured as about 25 minutes. However, the running time on the system is actually much greater than it was originally projected to be.<sup>22</sup>

When Buffalo was thinking in terms of the initial 20.1 kilometer system (see section 3.1.4.4), 80,000 daily riders were projected. After the system was scaled down to its present 6.4 miles, the ridership forecast was scaled down to 40,000.<sup>23</sup> The system currently carries 29,000 riders on an average weekday, well below expectations for a number of reasons. Many of the assumptions in the original modeling did not hold true. Population and employment which were projected to increase through 1985 were overestimated by 20% and 39% respectively.<sup>24</sup> This was coupled with the fact that some business pulled out of the area and the University did not expand as expected. Although disappointing when compared with expectations, the system still however, carried more riders per rail-car owned than any LRT in North America. The system also carried more weekday riders per mile of line than any other LRT line opened in North America since 1964.<sup>25</sup>

Although Metro Rail is a good service to those located along the line, the system can best be described as minimal. It falls well short of its original intended goal - the North Campus of SUNY - which is 9.6 kilometers further and has in the region of 27,000 students. As mentioned, this was at least partly due to the extra cost involved in the decision to place much of the system below grade. "The only way they could get agreement, finally, for federal funding was to promise to put most of the line in subway. A

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<sup>22</sup> "Buffalo's Metro Rail - A Ridership Success Story," Anthony J. Schill, Presented at the 1987 APTA Rail Meeting in Toronto, Ontario.

<sup>23</sup> "Buffalo: A cautionary tale," Railway Age, September 1986.

<sup>24</sup> "Urban Rail Transit Projects: Forecast Versus Actual Ridership and Costs," Prepared by Don H. Pickrell for UMTA, Final Report, October, 1990.

<sup>25</sup> "Project Completion Report, UMTA NY-03-0072, Buffalo Metro Rail Project," Niagara Frontier Transportation Authority, November 1989.

good system could have been built for one third the price they finally paid.”<sup>26</sup>

Furthermore, Metro Rail only provides service to one of many travel corridors and is impractical for many who are located far away from the line. “Buffalo is built like a half-wheel and Metro Rail is built along one spoke - if you live along that spoke you can use it.”<sup>27</sup>

The initial system is seen to be a failure from a transportation perspective due to the perceived failure to achieve ridership forecasts. Furthermore, although the NFTA operates a policy of allowing free bus to rail transfers which has been somewhat successful in contributing to the concept of an integrated transit system, the system still suffers from a lack of coverage. Thus, although the phasing strategy regarded the 6.4-mile system as an initial increment, negative perceptions have contributed towards a failure to expand further.

### ***3.1.5.3 Financial***

The total cost of the Metro was around \$550 million which represented a cost overrun of only about 5% over early cost projections. This however, is very expensive given that the system is only 10.3 kilometers in length and is due to the fact that much of the system is below grade. The system farebox recovery ratio is in the region of only 30% with an operating deficit of about \$8 million per year.<sup>28</sup> These operating costs are significantly higher than originally projected.<sup>29</sup> However, many more people use the system than is indicated by the farebox recovery figure. The 1.9 kilometer surface section of the line, which runs through the transit/pedestrian mall with six stations, is a fare-free zone which was a conscious policy decision made recognizing that it would impact the farebox recovery ratio. This was considered worthwhile however, as it was expected to contribute to the revitalization of the downtown. Furthermore, the rail line does not get credit for

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<sup>26</sup> “Buffalo: A cautionary tale,” *Railway Age*, September 1986.

<sup>27</sup> “NFTA: Revenue trains roll in Buffalo,” *Railway Age*, July 1985.

<sup>28</sup> “Buffalo’s Metro Rail - A Ridership Success Story,” Anthony J. Schill, Presented at the 1987 APTA Rail Meeting in Toronto, Ontario.

<sup>29</sup> “Project Completion Report, UMTA NY-03-0072, Buffalo Metro Rail Project,” Niagara Frontier Transportation Authority, November 1989.

the thousands of riders who feed onto it with free transfers from connecting bus lines.<sup>30</sup> This “downtown people mover” aspect of Metro Rail is considered to have been particularly effective in helping to revitalize the central business district in addition to familiarizing the general population with the advantages of the rail line.<sup>31</sup>

However, a phasing strategy which relied on federal funding sources severely impacted the expansion of the system. The non-availability of funding during the Reagan Administration effectively froze any expansion plans. Furthermore, given the high operating deficits of the existing system, and the difficulties which were encountered in finding dedicated sources to cover these deficits, the likelihood of obtaining support to fund system expansion was negligible.

#### ***3.1.5.4 Social***

The plan for the present system was developed in the 1970’s with a major element of public input. However, come its implementation in 1985, the system was described by such terms as “floppo” and as a line that “went nowhere - slowly.”<sup>32</sup> The negative perceptions of the existing system due to its low coverage, low ridership, and the disruption its construction caused did little to encourage the NFTA to consider future extensions. As such, the implementation of such a short, initial phase which was expensive to construct and operate was a negative feature of the phasing strategy.

#### ***3.1.5.5 Economic***

The Metro had an immediate positive impact on the local economy by the creation of 2,000 construction jobs at a time when the economy was in need of a boost. The system was also introduced with the intention of revitalizing the downtown by creating a more pedestrian friendly environment through the development of the transit mall which would encourage retail and business activity. Some success has been achieved in this area with examples of public and private investment in the form of retail and office space

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<sup>30</sup> “Buffalo: A cautionary tale,” *Railway Age*, September 1986.

<sup>31</sup> “Project Completion Report, UMTA NY-03-0072, Buffalo Metro Rail Project,” Niagara Frontier Transportation Authority, November 1989.

<sup>32</sup> “LRRT confounds the skeptics,” Luther S. Miller, *Railway Age*, May 1988.

development.<sup>33</sup> However, the disruption caused by the construction of the system made the downtown area a very unattractive environment for many years. As mentioned, this contributed to a decline in economic activity directly contrary to the transit line's intended purpose.

### ***3.1.6 Implications for future phasing***

At the time of the opening of the initial 10.3 kilometers of the system, hoped-for extensions into the two heavily populated corridors, one to the Town of Tonawanda and one to Amherst, were already in the alternatives analysis stage. The Northern Corridors Refinement Study was underway with an objective of developing sufficient information so that decision makers could determine whether to give first priority to the Amherst Corridor or the Tonawandas Corridor.<sup>34</sup> Even then however, prospects for funding were recognized as bleak given the Reagan Administration's anti-rail stance.<sup>35</sup> Other extensions further down the priority list included the Southtowns Corridor, extending 22.5 kilometers southward to Hamburg and passing through Lackawanna, and the Cheektowaga corridor, running east from downtown to the airport about 17.7 kilometers.

#### ***3.1.6.1 Technical***

Another factor shaping negative perceptions of the system is the fact that the existing system was over-designed to begin with. The phasing strategy was such that the initial phase engaged all of the latest, state of the art technologies so that the hardware was in place to support a much more extensive system. However, this was costly to implement and maintain and in hindsight is viewed as a lesson in what not to do.<sup>36</sup>

#### ***3.1.6.2 Transportation and Service***

The inaccuracy of the ridership projections led to the perception that the system was unsuccessful. These faulty projections were due to incorrect assumptions regarding

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<sup>33</sup> "Project Completion Report, UMTA NY-03-0072, Buffalo Metro Rail Project," Niagara Frontier Transportation Authority, November 1989.

<sup>34</sup> "The Dawn of a New Era in Transportation, Metro Rail and You," NFTA, May 1985.

<sup>35</sup> "NFTA: Revenue trains roll in Buffalo," Railway Age, July 1985.

<sup>36</sup> "LRRT confounds the skeptics," Luther S. Miller, Railway Age, May 1988.



population growth and employment as well as other factors such as the projected cost of automobile travel. However, on some measures, the actual ridership and productivity of the line compares favorably with other LRT systems in North America. The optimistic original ridership projections, although probably useful in obtaining the initial funding of the project, led to a perception of the system as being unsuccessful and this bad press has made the funding of extensions to the system more difficult to justify.

### ***3.1.6.3 Political***

The most important element of any future rail extensions is political will. At the time that the Reagan Administration's policy against new rail starts was set in place, there was no federal commitment to Buffalo beyond the 10.3 kilometer system. Rail plans not then covered by federal commitments were considered new, so Buffalo's extensions would have been a new rail start.<sup>37</sup> As mentioned, this reliance upon federal support effectively eliminated any hopes of expansion. Furthermore, the negative perceptions of the existing system made political support at the local or state level even less likely. This highlights the importance of political support in the design of a phasing strategy.

### ***3.1.6.4 Financial***

The funding to expand the system did not exist at the federal, state or local level. Furthermore, even by 1988 the NFTA was already having difficulties finding a dedicated source to cover its operating deficit, which made the outlook unpromising for future phases of the system.<sup>38</sup> As mentioned before, the farebox recovery ratio was only about 30%<sup>39</sup> which led to negative system perceptions. These details demonstrate the impact of financial issues on phasing decisions.

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<sup>37</sup> "Buffalo: A wedding of heavy and light rail," *Railway Age*, November 8, 1992.

<sup>38</sup> "LRRT confounds the skeptics," Luther S. Miller, *Railway Age*, May 1988.

<sup>39</sup> "Buffalo's Metro Rail - A Ridership Success Story," Anthony J. Schill, Presented at the 1987 APTA Rail Meeting in Toronto, Ontario.

### **3.1.7 Summary of the Phasing Strategy**

Although the 1974 Transit Development Program for the Niagara Frontier Region<sup>40</sup> envisioned a 74 kilometer network, it is clear that Buffalo has not achieved this objective. Indeed, whether this really was an objective or rather just wishful thinking is debatable. Certainly early system implementation focused very quickly on the initial 17.7 kilometer segment in the Buffalo-Amherst corridor. All of the engineering and political effort were directed at the implementation of this first phase with consideration of future phases pushed into the background. Of course, the Buffalo-Amherst line was never completed as originally planned and instead the reduced 10.3 kilometer link from downtown Buffalo to the South Campus of SUNY was eventually settled upon.

As has been detailed, many factors influenced the development of the in-place system and the consideration of full system implementation yields many lessons. The primary lesson is that further expansion was difficult given the lack of success of the initial phase. This discussion has identified many of the factors contributing to the perceived lack of success. However, we can question whether the system would have been successful if these factors had been addressed. Would the system have expanded further? Did the first phase merely demonstrate that a rail transit system is not viable in Buffalo and that its expansion is not warranted? The answers to these questions are not clear and are a matter of opinion. However, it can be said that the first phase implementation had many elements that would have been done differently with the benefit of hindsight and the in-place system did little to suggest or encourage the expansion of the system.

### **3.1.8 Lessons Learned**

Of course, the study illustrates the major roles that political and funding factors play in getting a rail transit start going in the first place (see section 3.1.4.2). In the case of Buffalo, political support and funding availability were the primary factors promoting the development of the system to begin with. The dependence upon state and federal political

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<sup>40</sup> "A Transit Development Program for the Niagara Frontier Region," Niagara Frontier Transportation Authority, June 1974.

and funding support were the main reasons why the system failed to develop further (see sections 3.1.6.3 and 3.1.6.4).

We also notice from the Buffalo experience, the necessity of developing a phasing strategy which recognizes the importance of the perceptions of the existing system on the prospects for future expansion. In the Buffalo case, negative perceptions of the existing system - the idea that the system was a failure - were brought about by the inaccuracies of the ridership projections (see section 3.1.6.2), the large operating deficits (see sections 3.1.5.3 and 3.1.6.4), and the large initial cost of construction given the small size of the system (see section 1.5.2). These negative perceptions of the rail line may have impacted prospects for its successful expansion.

In considering the phasing strategy of any rail transit system, the Buffalo case would suggest that attention be given to the issue of how the system will be perceived. It is true that rail systems are built for the long and not the short-term and their success should be gauged in the long-term. Nevertheless, measures such as meeting ridership and operating cost projections will inevitably be used to judge the success of the system in the short-term.

Additionally, the case study highlights the fact that any phasing strategy should consider carefully the subsidies that would be required to operate extensions to the system. Having adequate resources to cover the initial capital costs of expansion is not sufficient. The success of the system will also rely on sufficient funding to offset operating deficits (see section 3.1.6.4).

Another significant factor was the disruption caused by construction (see section 3.1.5.1). This was responsible for the exodus of many people from the downtown - the very people whom the rail line was intended to serve. Construction disruption is bad for two reasons. First, it tries peoples patience and builds up resentment towards the project before it is even operating. Second, it can force people away from the areas that the system is being built to serve. These factors clearly defeat the very purpose for building the system. When considering a phasing strategy, particular care should be taken to

minimize these externalities, to assist in the achievement of a successful operational system.

An important issue relates to how the constraints of the federal funding process and the associated environmental impact standards can impact a phasing strategy. In the case of Buffalo this required that most of the initial line be put underground. This compromised their intended phasing strategy and their goal of providing more system miles per dollar spent.

Another lesson to be drawn from the Buffalo experience relates to the importance of a phasing strategy that focuses on implementing segments of sufficient coverage and significant destinations. The existing system only goes halfway to the original proposed terminus of the line and the ridership that it would have served (see sections 3.1.5.2 and 3.1.4.1), but has a costly control system and other overhead associated with a far larger operation (see section 3.1.6.1). Had the construction proceeded 'at-grade' as originally proposed, perhaps the funding would have existed to construct a system of greater coverage, thus benefiting more of the community. The public pressure and resultant decision to place much of the system below grade, resulted in a costly process and a system that is minimal in extent. Whether the in-place, below-grade system is worth the trade-off in coverage is arguable.

Furthermore, compromising on system extent raises the question of whether the project is worth implementing at all. The shortening of the proposed first phase resulted in a system that has not been successful in itself and has also discouraged any future expansion. Had such compromises not been made or if project implementation had been delayed until such time as funding for a complete Phase 1 had been available, perhaps the prospects for full system expansion would have been better. The Buffalo example illustrates the importance of a phasing strategy which focuses upon implementing extensive system segments such that credible coverage is provided.

Buffalo's LRRT has sometimes been referred to as a "gold-plated subway"<sup>41</sup> and unnecessarily sophisticated and expensive to operate considering the modest extent of the line. This experience highlights the dangers of "Technical Overkill" as well as the effect of compromising on system extent. These factors can impact the success or 'perceived' success of the as-built system.

Finally, the Buffalo example illustrates that the promotion of future phases of the system is difficult, while the first phase struggles to justify its existence.

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<sup>41</sup> "Buffalo: A cautionary tale," Railway Age, September 1986.

**Table 3- 3 Summary of Lessons Learned**

<p>1. Political support was the main factor responsible for getting the project started. The lack of political motivation was the main reason why the system did not expand further. This illustrates the importance of developing a phasing strategy which harnesses and maintains political support.</p>
<p>2. Funding for the project relied primarily on federal sources. Without political support at the federal level, system expansion is difficult unless funding can be obtained from state or local sources.</p>
<p>3. The phasing strategy must recognize that perceptions of the existing system influence support for future expansion. The negative perceptions of the Buffalo system were due to:</p> <ul style="list-style-type: none"><li>• The ridership, although good by North American standards, did not meet projections and so was seen as disappointing.</li><li>• The system had a poor farebox recovery ratio and the operating deficits were much larger than projected.</li><li>• The system had a very large initial cost of construction considering the limited coverage it offers.</li><li>• The skimpiness of the system meant that it did not serve many people and so was not useful or relevant to many people.</li><li>• Disruption due to construction.</li></ul>
<p>4. The phasing strategy should consider carefully the issue of securing funding to cover the extra operating deficits associated with future extensions.</p>
<p>5. The development of a phasing strategy should consider the need to limit and mitigate disruption due to construction.</p>
<p>6. When developing a system, the role and expense of technology should be carefully considered.</p>
<p>7. The issue of ‘at-’ or ‘above-grade’, lower-cost construction versus ‘below-grade’, higher cost construction, can affect system coverage and success which in turn has implications for future construction.</p>
<p>8. The constraints associated with the federal funding process and the associated environmental impact standards should be carefully considered in the development of a phasing strategy.</p>
<p>9. When implementing a phasing strategy, it should be recognized that compromising on the extent of phases mean that they may not fulfill the role intended of them. This makes it more difficult for them to be successful and if unsuccessful, system expansion is harder to achieve.</p>

## **3.2 Miami**

### **3.2.1 Introduction**

The “Metrorail” is an elevated, steel on steel, heavy rail transit system operated by the Metro-Dade Transit Agency. Early planning for Metrorail began in 1958 and construction started in June of 1979. The system cost over \$1 billion and was funded by the federal government (77%), the state of Florida (10%) and by local sources (13%).<sup>42</sup>

The 16.9 kilometer south leg of the system opened on May 20, 1984 and was followed by the north segment of the system which opened in 1985.<sup>43</sup> The total system consists of a single line 33 kilometers long, with 21 stations along the route, each about 1 mile apart.

The current system runs from the Dadeland area through downtown Miami, to the Civic Center, and along NW 79<sup>th</sup> Street to Hialeah.<sup>44</sup> Complementary to the heavy rail system the area also boasts a downtown distribution people mover - called “Metromover” - which was opened in 1985 and connects to the Metrorail at the Government Center and Brickell stations.<sup>45</sup> (See figure 3- 3).

The original system plans envisioned a 87 kilometer system which included extensions of the rapid transit lines northeast to 193<sup>rd</sup> Street near the Broward County line, south to Cutler Ridge and west to Midway Mall with a link at the airport.<sup>46</sup>

### **3.2.2 Development Context of Metrorail**

In the early 70s plans were in place for the construction of a 116 kilometer, \$900-million expressway system. However, in 1972 Dade County voters approved \$132.5 million for transit development in the Decade of Progress bond issue. In 1974, public opposition to the six proposed expressways caused their elimination from the transportation plan.<sup>47</sup> This

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<sup>42</sup> “Metrorail Chronology,” June 1979.

<sup>43</sup> “Milestones in the history of Metrorail,” Miami Herald, May 20, 1984.

<sup>44</sup> “Metrorail Chronology,” June 1979.

<sup>45</sup> “Dade County Transit Map,” 1995.

<sup>46</sup> “Metrorail Chronology,” June 1979.

<sup>47</sup> “Milestones in the history of Metrorail,” Miami Herald, May 20, 1984.



Figure 3- 3 Miami System Map



was the period of the oil crisis and a general public opposition to the building of additional urban highways. It was expected that rising fuel costs would cause many more people to use public transportation for work, school and recreation trips. However, it was also believed that buses alone could not solve Dade County's transit problems, so a combined rapid transit and feeder bus system was deemed appropriate.

The reduction of demand on the freeway and highway system as well as the generation of jobs and economic revitalization were all seen as motivations for rapid transit implementation. It was further recognized that the system had a role in integrating Greater Miami's diverse municipalities. In the words of U.S. Rep. William Lehman at the dedication of the Overtown station, "We have a community that is fragmented. Metrorail will be a way to bring the community back together, from the Latins in Hialeah, to the Blacks in Liberty City and Overtown, to the Anglos in the southwest."<sup>48</sup>

### ***3.2.3 Original System Plans, Proposals and Phasing Suggestions***

As early as 1958, the County transportation department recommended a study of a potential rail system using the Florida East Coast Railway right-of-way along US 1. In 1964 this recommendation was followed with the Miami Urban Area Transportation Study (MUATS) which began with a feasibility study of transit for Dade County.

In 1969 as the county's population reached 800,000, the first stage of MUATS concluded that rapid transit would indeed be feasible and desirable. The completed study in 1972 recommended an \$800 million, 87 kilometer system with 54 stations. The main proposed route ran from Cutler Ridge in the south, to NE 163<sup>rd</sup> Street, looping to Miami Beach and then downtown via the MacArthur Causeway. Another leg was to head west to the Miami International Airport.

Later in 1972, on the basis of the MUATS recommendations, voters approved by a 2-1 margin, \$132.5 million for transit in the Decade of Progress bond issue. This was to

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<sup>48</sup> "Metrorail mixed blessing for Overtown," Miami Herald, May 19, 1984.

provide the local share of the cost of construction of rapid transit plus the implementation of expanded bus service to supplement the system.<sup>49</sup>

In 1975, the preliminary engineering for the system proposed a staging plan which provided for the construction of the core system in three stages spanning a ten-year time frame. Each of the stages was defined to constitute a usable segment and to provide service to areas having the most need.<sup>50</sup>

In 1977, with Dade's population over 1.4 million, the Urban Mass Transportation Administration (UMTA) officially committed \$575 million to cover its 80% share of construction costs for Phase I, 26.6 kilometers of track running from Dadeland to NW 67<sup>th</sup> Street. The State and County agreed to split the remaining 20% funding not covered by the Federal government. However, the town of Hialeah requested that the system extend to that area and that the maintenance/storage yard be located there. In December, Washington increased its share to include the extra 6.4 kilometers necessary to bring the rail line into Hialeah. The first phase was scheduled to open in May, 1983.<sup>51</sup>

In March, 1978, Dade voters narrowly defeated - by 2,500 votes in an election in which 234,000 votes were cast - a proposal to scuttle the rail project. In July of that year, County Commissioners approved a Transportation Master Plan for the year 2000, which included extensions of the system northeast to 193<sup>rd</sup> Street near the Broward County line, south to Cutler Ridge and west to the Midway Mall with a link at the airport. In June, 1979, construction of Phase I began.<sup>52</sup>

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<sup>49</sup> "Milestones in the history of Metrorail," Miami Herald, May 20, 1984.

<sup>50</sup> "Draft Milestone 8 Report, Final System Plan, Dade County Transit Improvement Program," Kaiser Engineers, May, 1975.

<sup>51</sup> "Metrorail Chronology," June 1979.

<sup>52</sup> "Metrorail Chronology," June 1979 and "Milestones in the history of Metrorail," Miami Herald, May 20, 1984.

### **3.2.4 Factors influencing system phasing**

#### **3.2.4.1 Technical**

The primary factor influencing the present alignment and its prioritization for Phase I implementation was the availability of the 15.3 kilometer abandoned Florida East Coast Railway (FEC) right-of-way for the south line. In April, 1979 the transfer of the right-of-way was ratified by the Interstate Commerce Commission and the FEC began removal of the tracks. This represented nearly half the length of the proposed Phase I and was acquired in one contract. The purchase provided the momentum to get the project up and running. It also allowed time to facilitate the purchase of the parcels of land required for the extension of the system into the northwest corridor. Construction of Phase I was able to begin on the southwest segment even before all of the land for the northwest segment had been acquired.

Another technical factor influencing the phasing of the system was the location of the maintenance/storage facilities. It was important to get an acceptable site for the facility. Initially the alignment was to be 26.6 kilometers in length terminating at NW 67<sup>th</sup> Street. Hialeah officials lobbied hard for the yard and shops to be located in their city. County officials agreed and successfully requested an additional \$57 million from UMTA for the 6.4 kilometer extension.

A feature of the system is the fact that it is elevated. This is because the water table in South Florida would make tunnels and an underground system impractical and traffic patterns in Dade County made an at-grade transit system infeasible.<sup>53</sup>

#### **3.2.4.2 Transportation and Service**

The long range plan for the area identified the corridors of highest traffic demand. The selection of a corridor to serve the CBD was a priority in the choice of alignment. The proposed overall system plan included the north-west to south-west alignment which linked Hialeah and Dadeland via the downtown, and the east-west line which incorporated

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<sup>53</sup> "Metrorail Chronology," June 1979.

the airport and the downtown with a possible extension to Miami Beach. From a transportation perspective, both routes represented corridors of significant travel demand. As mentioned, the primary factor influencing the prioritization of the Hialeah to Dadeland link as Phase I was the easy availability of a right-of-way which constituted half of the needed length. Thus, given a choice of phases to implement, choosing a line of least resistance was an important consideration.

Another important phasing issue was the necessity to serve the minority areas. The northwest segment of the system is aligned through mainly Black and Hispanic communities. The southwest portion serves a mainly Anglo and more affluent population.

### ***3.2.4.3 Political***

The present 20.5-mile first phase of the system represents a longer initial line than is normally implemented. Nevertheless, this was supported by federal sources indicating a positive funding environment in Washington DC with respect to the Miami system.

Another factor influencing the choice of phasing strategy was local political support. A smaller system would have benefited only the city of Miami, but in order to stand any chance of implementation the project really needed the broader support of Dade County. Therefore, from a political perspective, it was important to achieve a more extensive system serving both the city and county.<sup>54</sup>

Furthermore, as already described, although Phase I was originally supposed to be 26.6 kilometers in length, the desire of the town of Hialeah to be served by the system motivated the 6.4 kilometer extension of the proposal.

In general, there was an extensive public involvement program which was set forth in work plans developed by the consultants and the county in 1974. This laid out a number of objectives which included maximum public participation in the deliberations leading to

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<sup>54</sup> Interview with Mario Garcia, Chief System Development Division, Metro-Dade Transit, February 6, 1996.

transit-related decisions.<sup>55</sup> Every municipality was given funding to conduct their own meetings to provide input into station location and route alignment decisions.

#### ***3.2.4.4 Social***

As mentioned, the public participation process was very important in the design of major features of the system. The importance of equity considerations in serving the minority areas and the desires of the communities impacted were fundamental to phasing decisions. As mentioned, northwest Dade is primarily lower income, minority communities which are heavy users of bus service. The Metro was viewed as important in providing accessibility to work locations.

#### ***3.2.4.5 Financial***

As mentioned, the availability of the Florida East Coast Railroad right-of-way for \$30 million represented a very big cost savings and greatly facilitated the implementation of Phase I.

Designing an elevated system was also cheaper than underground construction which was considered prohibitive from both financial and technical perspectives.

### ***3.2.5 Evaluation of system phasing***

#### ***3.2.5.1 Transportation and Service***

The original system planning considered a 77.3 kilometer fixed guideway rapid transit system and a projected total transit system ridership of 445,985 in 1985. 280,000 to 443,000 of these trips were projected to be made on the fixed guideway portion of the transit system, with an additional 124,000 to 204,000 trips on special and express buses operating on exclusive busways forming part of the core system plus supporting services.<sup>56</sup>

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<sup>55</sup> "Draft Milestone 8 Report, Final System Plan, Dade County Transit Improvement Program," Kaiser Engineers, May, 1975.

<sup>56</sup> "Draft Milestone 8 Report, Final System Plan, Dade County Transit Improvement Program," Kaiser Engineers, May, 1975.

However, the rapid transit system has not expanded as planned and actual ridership on the Phase I of the system did not meet projections. At 50,000 riders/day carried by rail transit, this represents less than one-quarter of the forecast ridership for this segment of the system.

The Phase I system was implemented as originally envisioned but the plans to implement Phases II and III of the system within a ten year time-frame have not materialized. As a result, the system suffers from lack of coverage and service destinations and is seen as irrelevant to many parts of the urban area.

Furthermore, Metrorail was a major, but not the only, component of a system plan which included the addition of 350 buses to the Metro Transit Agency fleet and the construction of a Downtown People Mover by 1985. The objective was to provide Dade County residents with a balanced transportation system. The preliminary engineering study recommended that a network of feeder buses and collection-distribution systems be provided to serve the fixed guideway portions of the core system, as well as local and express bus service.

It was considered that the new buses required for Stage I of the Rapid Transit System should be phased in to provide upgraded service early. Secondly, since the bus system was to be integrated with the rail system, the phasing in of the new buses should be pointed towards developing patronage for the rail system and permitting conversion of appropriate bus routes to feeder service for the rail system.

However, the present bus service is not as was planned. Headways are much greater than planned and the service does not complement the rail system to the extent that the original plans considered it should. The result is a bus and rail transit system that falls well short of the hoped-for balanced transit system.

The Downtown People Mover - "Metromover" - was also designed to integrate with the rail system and started operation in 1985. This initially linked to the main system at the Government Center station and, with the expansion of Metromover service, another

transfer point at the Brickell station has also been provided. This service has been successful in providing the final link to the downtown's high rises.

However, in general, the failure of the system to achieve the forecast ridership and the lack of integration of the bus and rail system has had a negative impact on perceptions of the system. As a result, support for system development is not strong.

### ***3.2.5.2 Political***

Initial perceptions of the system were formed during the construction process. Indeed from its conception, the project was a source of continual controversy. In 1977 a small group of citizens petitioned the County Commission for a referendum to stop all further spending on the rapid transit system. The proposal to scuttle the project was narrowly defeated in March of 1978.

Cost overruns, delays to the opening plans, and federal investigations into allegations of shoddy construction, all fed the controversy. Over the course of its five years of construction, the line picked up a number of nicknames such as "Metrofail," the "road to nowhere" and "Stonehenge South."<sup>57</sup> All of these factors contributed to negative perceptions of the system and made expansion difficult to promote.

Today, the system is perceived as clean and efficient but ridership is nowhere near the original projections. The service is perceived as good for what it is but not providing enough benefits and irrelevant to much of the urban area.

### ***3.2.5.3 Financial***

The system cost \$1.02 billion to build which represented a \$150 million cost overrun, largely due to factors which could not have been foreseen. At the time that the parcels of land for the northwest portion of the system were being acquired, there was a huge demand for housing in the city. The arrival at Key West of 125,000 boat immigrants who had been permitted to leave Cuba led to an unexpected demand for housing which drove

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<sup>57</sup> "Milestones in the history of Metrorail," Miami Herald, May 20, 1984.

up land prices. This factor coupled with high inflation impacted project costs. Although unforeseeable, nevertheless these imponderables created negative perceptions of the system.<sup>58</sup>

Since then the total transit system has only managed to achieve a 40% farebox recovery ratio, which has contributed to the perceived lack of success from a financial perspective.

#### ***3.2.5.4 Economic***

At the time of the system construction the country as a whole was in the midst of recession. The Dade County area however, was largely unaffected and this was at least partly due to the \$632 million injection of federal funds over a 4-year period.

#### ***3.2.6 Implications for future phasing***

##### ***3.2.6.1 Technical***

The availability of the Florida East Coast Railroad right-of-way was a significant factor in getting the system up and running and its utilization was a successful element of the phasing strategy. The ease of implementing the southwest portion of Phase I motivated the implementation of the northwest segment. However, future extensions of the system will not have the advantage of existing rights-of-way which will make expansion much more difficult. When and if the system expands, it may have to resort to alignments following public rights-of-way, as is the case for the proposed East-West Corridor plan on State Road 836 land.

##### ***3.2.6.2 Transportation and Service***

The original ridership projections proved to be wildly inaccurate. These misleading projections were perhaps partly due to inaccurate assumptions relating to the potential effects of increasing fuel costs on transit system ridership. With actual ridership only 25% of that projected however, the temptation to call the system a failure is large. The case for

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<sup>58</sup> Interview with Mario Garcia, Chief System Development Division, Metro-Dade Transit, February 19, 1996



extensions will be difficult to make given the evidence of the in-place system. This demonstrates the importance of a successful first phase in achieving any phasing strategy.

### ***3.2.6.3 Political and Financial***

At the time that the Reagan Administration's policy against new rail starts was put in place, there was no federal commitment to Miami beyond the initial 33 kilometers. Political support in Washington DC was instrumental in obtaining the necessary federal funding for the initial phase. Without such support and given the funding environment, there was little hope for system expansion.

### ***3.2.6.4 Immediate expansion plans***

Nevertheless, despite the above factors, there are plans in place to expand the system. One proposal exists to extend the North Corridor to the Joe Robbie Stadium and Miami-Dade Community College, with possible penetration of Broward County. The preliminary engineering and DEIS work is scheduled to start in April, 1996.

There is also a proposal under design to extend the existing line from the Okeechobee station to reach the north-south Palmetto Expressway.

Another system expansion would be the proposed east-west alignment to be carried out in three phases. The first phase would link the airport and the seaport. Subsequent phases would link the airport to the Florida International University and connect the seaport or the Central Business District to the Miami Beach Convention Center.

### ***3.2.7 Summary of the Phasing Strategy***

As detailed, the original system plans comprised an 87 kilometer system to be constructed in three phases. The stated objective was to serve those areas most in need. However, any of the proposed phases could have satisfied this criteria. The actual choice of which phase to implement first was motivated by social and technical factors. These have already been described as the need to serve the minority areas and the availability of the right-of-way to the southwest. Clearly, the approach was to implement the most

convenient phase first. An interesting phasing issue however, was the fact that the Phase I construction and operation began with the southern leg of the line initially where the alignment utilized the existing right-of-way. The northern portion of the line did not open until the following year. However, the maintenance/storage yard was located to the north in the town of Hialeah. This made the transfer of the cars to the southern portion of the line very inconvenient.

A phasing strategy which focused on utilizing the available right-of-way was successful in getting the first phase of the system operational. However, poor perceptions of the system were formed due to the negative publicity developed during the construction process. These perceptions of the system were worsened when Phase I did not perform to expectations. The failure to achieve ridership goals could have been due to over-optimistic projections to begin with, but may also have resulted from the failure to integrate the rail system with planned bus system improvements. Had these bus enhancements been phased in as was originally envisioned, perhaps the rail system would have performed better. In any event, these factors and the negative perceptions that they induced have made future expansion difficult to justify.

### ***3.2.8 Lessons Learned***

The Miami system is another case underlining the importance of political and funding factors in the development of a phasing strategy (see sections 3.2.4.3 and 3.2.6.3). A positive funding environment in Washington DC facilitated first phase implementation but the lack of this support in the mid-80s meant that expansion was not possible given the non-availability of additional local funding.

The original phasing strategy recognized the importance of a total and integrated transportation system (see section 3.2.5.1). System operation was to rely on feeder buses and a general all-round enhanced public transit system. Such phasing of the bus system improvements was not carried out however, and this impacted the performance of the rail component of the network. The Miami case highlights the fact that rail transit systems, particularly in the early stages of development, can not be viewed as stand alone facilities

and, to function successfully, their integration into the overall transit system is an absolute priority.

Whether overly optimistic ridership projections, incorrect modeling assumptions, or other factors such as lack of system integration, are responsible for the divergence between the actual and forecast ridership is a matter of opinion. Whatever the reason, the result is a system that is seen as failing to achieve its immediate goals. The implication is that future expansion will be hard to justify. (See section 3.2.5.1).

An important aspect of the phasing strategy is the maintenance of public support for project implementation during the construction of system elements. Poor perceptions of the implementation process will also discourage support for expansion. (See section 3.2.5.2).

Finally, the case study illustrates a classic example of the effect that unforeseen factors can have on the success of a system. The housing demand generated by the large influx of Cuban emigrants increased land prices which quickly consumed the contingency funding for the project and contributed to the increased construction costs (see section 3.2.5.3). The cost increases combined with the existing controversy over project funding (see section 3.2.5.2) further fueled anti-rail system sentiments. Such sentiments discourage expansion.

**Table 3- 4 Summary of Lessons Learned**

<p>1. Political and funding factors are crucial elements in the development of a phasing strategy.</p>
<p>2. Failure to achieve ridership projections is one factor which suggests the failure of the system to achieve its goals. The failure of initial phases, whether real or perceived, makes system expansion more difficult to accomplish. A successful initial phase is important in the implementation of a phasing strategy.</p>
<p>3. A phasing strategy should incorporate the integration of rail and bus into a total transportation system spanning all public transit modes.</p>
<p>4. An important aspect of the phasing strategy is the maintenance of public support for project implementation during the construction of system elements. Poor perceptions of the implementation process because of cost overruns or management or technical problems during construction will also discourage support for expansion.</p>
<p>5. Unforeseen factors have the potential to de-rail a project.</p>

## **3.3 Calgary**

### ***3.3.1 Introduction***

Calgary, Alberta located at the base of the Rocky Mountain foothills in western Canada has been growing steadily over the past three decades. During this period the population has almost doubled from 400,000 in 1971 to its current population of approximately 738,000. The city has grown around a well defined, and highly developed downtown area with low density suburbs to the north, west and south of the city. An industrial district has taken root to the east. Everyday more than 86,000 employees commute to and from the downtown area from the suburban areas of the city. This high volume of commuting made it necessary for the city to explore alternatives to auto use.

Calgary Transit is composed of a light rail transit (LRT) system, known as C-Train and a bus system that serves as a feeder for the LRT as well as supplementing the rail system in outer reaches of the city. In 1972 the City of Calgary created a Transportation Department, and the planning, design and construction of the LRT system and Calgary Transit began to take shape. Nine years later in May, 1981 the 10.9 Km south line opened for service. Two more lines would be added over the next several years at a total cost of \$543 million (Canadian).

The entire LRT system is 30 kilometers long with three lines radiating from the downtown area to the South, the Northeast, and the Northwest. These lines merge in the Downtown Area forming a "Y" shaped network (see figure 3- 4). 87% of the alignment is at grade, 5% on grade separated bridges and 8% underground. There are 20 major stations with 11 unidirectional platforms in the downtown area. The system also contains a free fare zone in the downtown area.

Passengers board from high level platforms, and the system is powered from overhead lines that enable trains to operate in pedestrian malls. Within the downtown area, the LRT operates along the 7th Avenue transit mall which also allows buses and emergency

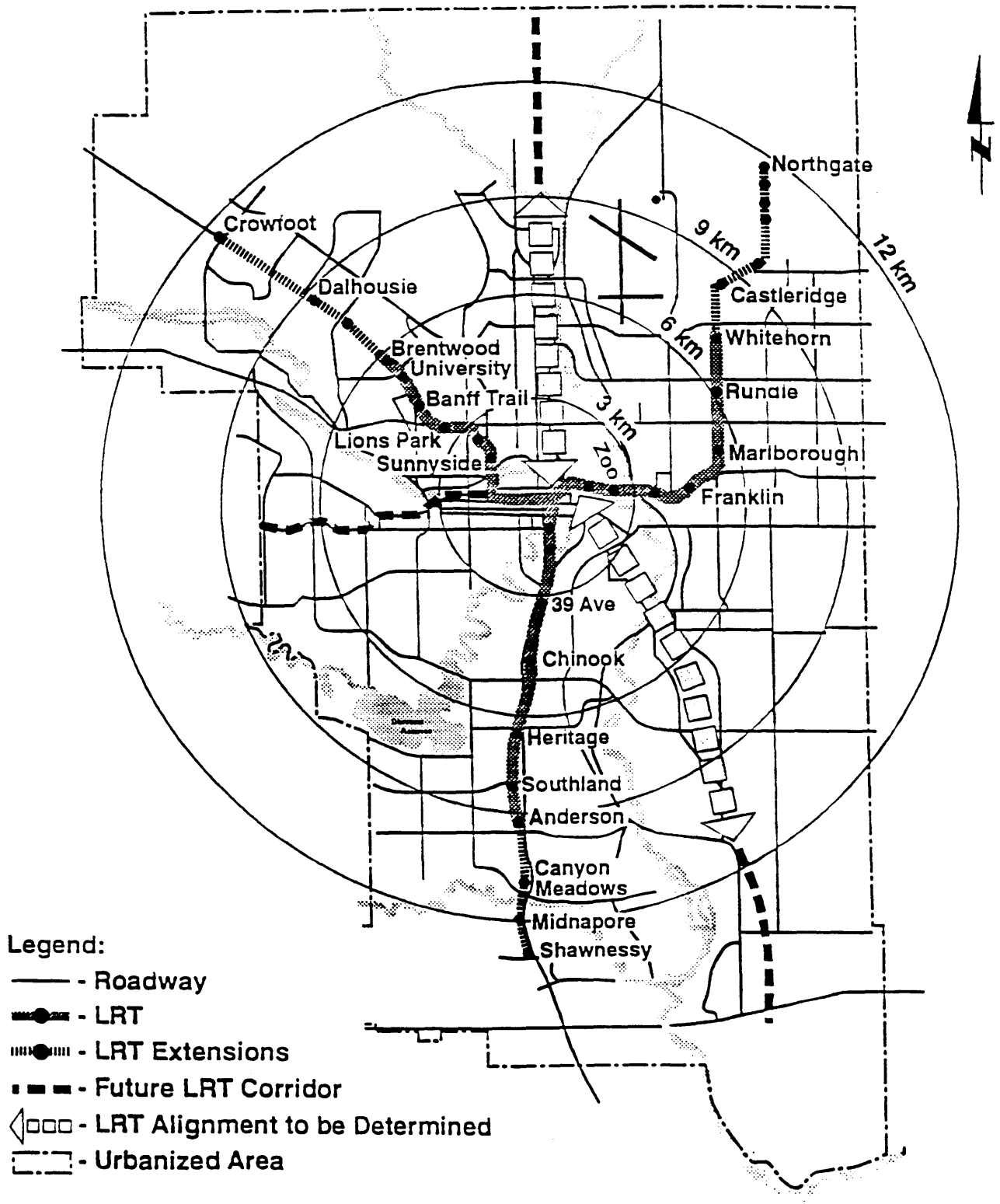


Figure 3- 4 Calgary System Map

vehicles, but no private vehicles. However, traffic does cross 7th Avenue and this flow is controlled by conventional traffic signals. An attempt to minimize delays caused by the traffic signals has been made by putting a signal progression in place that is biased towards LRT demands. At surface level crossings outside the downtown area, trains pre-empt the normal operation of the traffic signals to simulate the benefits of a rapid transit system with its own right-of-way. Uninterrupted movement between stations allows for faster travel.

The system in place goes a long way towards meeting the present demands of the city and matches the original system plans to a high degree. Only the northwest line does not extend into the suburbs as far as was planned. Overall the Calgary Transit system was well thought out, was implemented without much opposition, and exists reasonably true to its original design.<sup>59</sup>

### ***3.3.2 Development Context of C-Train***

The smooth development of rapid transit in Calgary was facilitated by city government recognition of potential future transportation problems. Planning for rail transit began in 1966 with a series of studies carried out by Simpson and Curtin Ltd. at the request of the City Council. At this time preliminary plans for a rail transit network were developed, and two of the high priority corridors were protected.

The following year in 1967, Calgary City Council adopted a transportation plan that would provide for the city's needs for the next twenty years. At that time the planning emphasis was still on freeways with spending estimates of \$450 million and \$80 million for roads and transit development respectively.<sup>60</sup> The freeway plan soon ran into opposition however, and the city began to look for a revised approach to urban mobility in 1971 when a section of a major north-south freeway was relocated.

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<sup>59</sup> "Light Rail Transit in Calgary: 1981-1995: 'A Retrospective Review,'" John Hubbell; Dave Colquhoun; Dan Bolger; John Morrall, 1995.

<sup>60</sup> Ibid.

As mentioned, in 1972, the Calgary City Council established a Transportation Department to look into improved transportation in the city and the region. The new department brought together several City departments that had been carrying out transportation functions separately up to that point. The coordination of transportation and land-use planning under one department allowed for the development of supportive land use and transportation policies. In addition to the great deal of local support that transit was receiving in Calgary at the time, the Province of Alberta also initiated a new funding program for transportation in urban areas in 1972. The program made funds available for the planning and construction of public transit and arterial roads. However, in order to get the program funding a city needed to pass a Transportation Bylaw and obtain Provincial approval of funded projects.<sup>61</sup>

At this point, a majority of the plans for proposed freeways for the inner city were dropped, and Calgary began to concentrate on rehabilitating the public bus system. New equipment was purchased and a new express bus service was developed which prepared the way for the proposed rail system. Then in 1976, the Transportation Department produced several studies on the feasibility of Light Rail Transit in Calgary. Light Rail versus bus was compared for the south corridor and transit versus roadway expansion was analyzed. The City Council decided to maintain its policy of road expansion in the suburban areas and move toward light rail transit in the City.

### ***3.3.3 Original System Plans, Proposals and Phasing Suggestions***

When it became clear in the early to mid 1970's that there was going to be a short-fall in transportation capacity in the South Corridor by the mid 1980's, the city began to weigh all of its alternatives for increasing transit capacity. The conclusion was reached that transit capacity could be increased by the construction of new roads in addition to the development of higher capacity transit service. It was then the belief that these improvements could take place in either one of two ways. The development of a transit system could either proceed or follow road construction, and if the new transit system was

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<sup>61</sup> "Calgary' Light Rail Transit System," W.C. Kuyt, Transportation Department City of Calgary, August, 1977.



developed first then road construction could be delayed to a later time. It was also recognized that new roads alone would not be able to support the increase in commuter traffic that was projected into the next decade.<sup>62</sup>

At this point, there was a push for increased transit options in the area south of the downtown. The three options that were evaluated for the transit system were exclusive bus lanes, light rail transit and busways.<sup>63</sup> It was assumed that the bus system would use a bus lane along an eight mile surface route from the south into the downtown area. There would be no stations only bus stops marked by shelters located along the route. The LRT would follow the present alignment for the south line with seven percent of the line underground and the rest at-grade. The busway would also operate in this alignment with some slight changes to avoid the portions of the route that would be underground.

The impact that each would have on traffic was examined very carefully, and it was determined that an exclusive bus lane would add to the congestion already on the roadways. It was considered that LRT would have a lower impact on traffic and given its own right-of-way, performance would be better and the system could be more easily controlled. LRT was also chosen because of its potential to expand to other corridors, the possibility of increasing capacity in the future, and because of the lower negative environmental impacts. Most importantly, however, it was felt that the level of service and capacity which could be offered by LRT would be necessary to achieve long term transit objectives. Having decided upon the LRT alternative, construction on the south corridor was begun in 1977 and it opened for service in May, 1981. This was the first of three phases of LRT to be constructed in Calgary (see Table 3- 5).

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<sup>62</sup> "Light Rail Transit for Calgary," Transportation Department City of Calgary, April, 1976.

<sup>63</sup> "Calgary' Light Rail Transit System," W.C. Kuyt, Transportation Department City of Calgary, August, 1977.

**Table 3- 5 Phases of the Calgary system**

<b>PHASE</b>	<b>LENGTH (KM)</b>	<b>OPENED</b>
South leg and 7 <sup>th</sup> Avenue	12.9	May, 1981
Northeast leg	9.8	April, 1985
Northwest leg	5.6	September, 1987
Northwest extension	1.0	August, 1990
	Total = 29.3	

### **3.3.4 Factors influencing system phasing**

#### **3.3.4.1 Technical**

In the original design of the system phasing strategy, it was considered desirable to gain experience in the construction and operation of rail transit before building the complete network. Given the decision to implement the system incrementally, the south corridor became the obvious priority for initial construction. As such, the Transportation Department proposed that planning, design and construction of the south line be undertaken and evaluated before further transit lines were included in the list of construction priorities.<sup>64</sup>

For the construction of both the south and northeast lines, the LRT met with very little opposition because the rights of way had been set aside a long time before they were needed. When it came time to build the LRT system, communities were less opposed because it did not disrupt their lives or force the removal of homes or facilities.

Originally the northwest line had been the second priority for construction. However, a right-of-way for the northwest segment had not been reserved and priority shifted to the northeast line when community opposition was encountered.

#### **3.3.4.2 Transportation and Service**

After abandoning much of the freeways proposed for the inner city and as the first element of their phasing strategy, Calgary concentrated on rehabilitating the public transit bus system. The upgrading of the bus transit system formed a prototype for the eventual rail

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<sup>64</sup> "Light Rail Transit for Calgary," Transportation Department City of Calgary, April, 1976.

system proposed. The express bus system promoted the development of transit corridors and included park and ride facilities and supporting feeder bus routes. In the meantime, the planning and design of an intermediate capacity rail transit system proceeded.<sup>65</sup>

In 1976, studies on the feasibility of light rail transit for Calgary concluded that the first priority for construction should be the south leg of the system. Transit passenger volumes in the south were expected to be almost twice as high as those in any other corridor in the City.<sup>66</sup>

#### ***3.3.4.3 Political***

Planning for light rail transit in Calgary was influenced by the conducive atmosphere for transit development that existed in both the City of Calgary and the Province of Alberta. The funding program put in place by the Province in 1972 encouraged Calgary to look away from road development and towards rapid transit development.<sup>67</sup>

The foresight of the City Council was also instrumental in making rapid transit development in Calgary possible. Without the initiative of the city to conduct studies and research for future needs it may otherwise have been too late to move on the necessary items needed for rapid transit development such as right of ways.<sup>68</sup>

Implementation of the northwest extension was delayed by a controversy over its alignment. Although the line had been advocated by a Transit Commission in 1964, no action had been taken on right of way acquisition through the inner city. While extensive community consultation on this issue was being undertaken, implementation priority was switched to the northeast line whose right-of-way had been protected in the median of roadways planned for the area. The 9.8-km northeast line opened in 1985, sharing a downtown section with the south line.

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<sup>65</sup> "Light Rail Transit in Calgary: 1981-1995: 'A Retrospective Review,'" John Hubbell; Dave Colquhoun; Dan Bolger; John Morrall, 1995.

<sup>66</sup> "Light Rail Transit for Calgary," Transportation Department City of Calgary, April, 1976.

<sup>67</sup> "Light Rail Transit in Calgary: 1981-1995: 'A Retrospective Review,'" John Hubbell; Dave Colquhoun; Dan Bolger; John Morrall, 1995.

<sup>68</sup> "Calgary' Light Rail Transit System," W.C. Kuyt, Transportation Department City of Calgary, August, 1977.

The upcoming 1988 Winter Olympics however, gave the city the push needed to resolve the community opposition to the northwest line.<sup>69</sup> This line was important because it would serve several important facilities for the Games. The northwest line was the third phase to finish and it opened in 1987 connecting with the south line.

#### ***3.3.4.4 Financial***

With the downturn in the economy in the early 1980s, the City's perceived need for rapid implementation of LRT and its ability to finance the system were altered. A new staging plan was adopted and in 1984, the Province announced a restructured assistance program providing continued financial support. Because of these funding constraints, the northwest line was constructed in stages.

### ***3.3.5 Evaluation of system phasing***

#### ***3.3.5.1 Technical***

There was very little disruption to the daily lives of people due to the construction of the system. In the case of the south and northeast lines the rights-of-way had been protected before they were needed so very little disruption was necessary before system building could take place. This prevented a possibly lengthy and destructive construction process which might have caused the areas to lose retail activity and even cause people to move out, which would have created negative perceptions of the rapid transit system among the population.

#### ***3.3.5.2 Transportation and Service***

The C-Train serves two purposes in the metropolitan Calgary area. It functions both as a people mover in a densely populated, highly developed downtown area, and as a city-to-suburbs commuter system that radiates outward from the downtown area to the South, Northeast and the Northwest. This second function is where the most impact can be seen. Where it once took forty-five or fifty minutes to travel from the southern terminus to the

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<sup>69</sup> "Light Rail Transit in Calgary: 1981-1995: 'A Retrospective Review,'" John Hubbell; Dave Colquhoun; Dan Bolger; John Morrall, 1995.

downtown by bus, it now takes thirty by C-Train.<sup>70</sup> This increased mobility for the commuter along with other transit-oriented practices that the city has implemented, have resulted in an increase in the number of transit commuters in Calgary. However, in order to accommodate those who still wish to drive into the downtown area the city of Calgary has constructed parking structures at its perimeter. This increase in rapid transit as opposed to automobile commuting has had the effect predicted in the early stages of planning. With an average rail transit ridership of about 100,000 passengers per day,<sup>71</sup> less intense highway and road construction has been possible, and road congestion has been kept under control.<sup>72</sup>

Developing a ridership base for rapid transit by using express buses along the same routes that the trains would travel proved to be an effective strategy. It made the introduction of rail in the corridor the next natural step in the process. People in the community saw the service that the LRT could provide for them based on the bus system that was already in place.

### **3.3.5.3 Social**

Success in the downtown area has been measured as the ability to lower the number of private automobiles driven into the area by daily commuters while continuing to achieve business growth. This goal was, and still is, the main focus of transportation policy for the downtown area. Over the past decade there has been an increase in public transit patronage aided by a phasing strategy which has focused on gradually reducing the number of parking spaces relative to growth in the downtown area. Current Land Use Bylaw requirements for office buildings specify one parking stall per 140 sq. m (1,500 sq. ft.) of net floor area. However, as of 1992 transit usage was at 39% of all peak hour trips to the downtown which is a decrease from previous years and a high of 43% in 1981. Nevertheless, a greater number of actual people are using rapid transit overall in the downtown area because of its continued growth. Also, the exclusive LRT and bus

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<sup>70</sup> "Light Rail Transit for Calgary," Transportation Department City of Calgary, April, 1976.

<sup>71</sup> "LRT Technical Data," Calgary Transit, 1994 figures.

<sup>72</sup> "Calgary Transportation Plan," Transportation Department City of Calgary, 1995.

corridor on 7th Avenue and the pedestrian mall on 8th Avenue combine to make Calgary a very pedestrian oriented city.<sup>73</sup>

The people of Calgary view the rapid transit system, both the C-Train and the different bus routes as vital to the present and future success and growth of their city. An important factor in the growth of the city has been the ability to maintain high levels of mobility. Other factors such as preventing air pollution, preserving the environment, and providing transit service to those in need, also promote rapid transit development. The system is seen as being essential to the maintenance of a healthy and vibrant city in the future.<sup>74</sup>

#### ***3.3.5.4 Economic***

The system was planned with the intention of supporting a high density commercial, office and economically viable downtown area. To achieve these goals easy access to the downtown from the surrounding suburbs was essential. The present prosperity of Calgary suggests that the city has indeed achieved what was envisioned as the goals of its transit system.<sup>75</sup>

#### ***3.3.6 Implications for future phasing***

The present system was built in three phases with the South line and its connection to the downtown area being implemented first. Then the Northeast line was built followed by the Northwest line. With these three lines most of the entire system as first proposed is now up and running. This past phasing success and the present success that the rapid transit system currently enjoys can only encourage any future extension plans.

##### ***3.3.6.1 Technical***

To accommodate future system expansion, rights-of-way have been protected for extension of the existing LRT system to the northwest, south and northeast. Furthermore,

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<sup>73</sup> "Light Rail Transit in Calgary: 1981-1995: 'A Retrospective Review,'" John Hubbell; Dave Colquhoun; Dan Bolger; John Morrall, 1995.

<sup>74</sup> "Calgary Transportation Plan," Transportation Department City of Calgary, 1995.

<sup>75</sup> Ibid.

route location studies have been undertaken to protect the rights-of-way for future LRT lines to the southeast, west and north.

### ***3.3.6.2 Political***

In Calgary, the political will to expand and improve the rail system is clearly present. This is demonstrated by the development of the new Calgary Transportation plan, "GoPlan" which is looking at the travel needs of the region for the next thirty years. The elected officials of Calgary have taken the future growth of the region very seriously and believe that rail transit will play a vital role in that growth. The City Council has created a Steering Committee of Aldermen to oversee the project, and has made a serious effort to determine what the people of Calgary demand from public transit for its success.

### ***3.3.6.3 Social***

In Calgary, the success of the rapid transit system has been measured by the influence it has had on regional growth, and not on its ridership growth. The public believes that it contributes towards increasing the standard of living and positively impacting the environment. There is a belief that the City can promote transit use by offering a level of service competitive with private cars, and managing parking availability in the downtown area. The present goal is to achieve a 50% modal split within the next thirty years. Policies such as these show the importance of rail transit in the future development of the city.<sup>76</sup>

### ***3.3.6.4 Financial***

During the early and mid eighties when the original three lines were built a great deal of the funding for the rail system came from the provincial government. At the time this was a key factor in getting the system off the ground and was a positive element of the phasing strategy. The funding made it possible to concentrate more heavily on rapid transit as opposed to the building of more highways and the proposed express bus system.<sup>77</sup> Now

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<sup>76</sup> "Light Rail Transit in Calgary: 1981-1995: 'A Retrospective Review,'" John Hubbell; Dave Colquhoun; Dan Bolger; John Morrall, 1995.

<sup>77</sup> "Light Rail Transit for Calgary," Transportation Department City of Calgary, April, 1976.

however, even with the recognized decreased support for transportation from the provincial government the City of Calgary is willing to consider future expansions of their system. Calgarians have determined that it is important enough to the future of their city and their standard of living to maintain and develop rapid transit, that they have made the decision to increase the local level of spending on transportation.<sup>78</sup>

### **3.3.7 Summary of the Phasing Strategy**

The phasing strategy for the Calgary C-Train arose out of a planning process which integrated transit, transportation and land use planning. This permitted the reservation of rights-of-way which greatly facilitated the later construction of the system. An approach of implementing bus service over the proposed rail transit corridors was then adopted which helped develop ridership and create an awareness of a transit presence.

It was considered that an incremental approach to project implementation should then be taken. This would allow experience of the construction and operation of a rail transit system to be built up gradually while the full system came into being. Therefore, the implementation of the three proposed lines was phased. The south line was considered the obvious initial priority due to its high ridership potential and the existence of a reserved right-of-way.

Although the northwest line was originally selected as the second phase for implementation, this was delayed due to community opposition because of the non-availability of a right-of-way. However, the momentum of expansion was maintained with the shift of emphasis to the northeast line. The subsequent completion of the northwest line was promoted by the 1988 Winter Olympics which were held in Calgary.

### **3.3.8 Lessons Learned**

This case study illustrates the impact that public and political determination can have on the success of a transit system. The LRT system in Calgary has proven to be successful for three reasons. First, in the early and mid 70's the City Council began serious long

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<sup>78</sup> "Calgary Transportation Plan," Transportation Department City of Calgary, 1995.



range planning for the future transportation needs of the region (see sections 3.3.2 and 3.3.4.3). Second, over the past decade there has been a reduced dependency on private vehicles by the community. And third, the transit system is seen as a vital part of the economic success of Calgary which has led to a higher standard of living for the people of the area (see section 3.3.6.4).

The Calgary case study demonstrates the success of a well-planned, publicly supported system. The protection of rights-of-way for transit use years before they were needed, proved to be extremely helpful when it came time to build. This public involvement in the early planning stages allowed the community to become familiar with, and have some input into, system development and contributed to the development of a successful phasing strategy (see section 3.3.4.1). Furthermore, the Calgary case demonstrates the value of integrating transit planning with transportation (roads, pedestrian, parking) and land use planning.

An important element of the phasing strategy was the implementation of express bus service prior to the construction of the LRT. This was a good prototype and helped develop ridership in the future rail corridors. The feeder route network and the LRT are mutually dependent upon each other for their success. Their integration substantially enhances the attractiveness of transit for travel to the downtown and also utilizes opportunities which the LRT presents for meeting non CBD oriented transit trips.

Early provincial government support of the system in the form of grants was also important. Without this support it is very likely that rapid transit would not exist in Calgary today. The fact that economic growth continued in the Calgary area following the opening of the rapid transit system may have also had a great deal to do with its success. Other factors such as the Olympic Games have proven to have had a great impact on the phasing of the transit system. All of these factors combined to bring a feeling of prosperity and growth to the downtown area, and in some ways the rapid transit system in Calgary is tied to this prosperity in the eyes of Calgarians. This has allowed them to "adopt" the system and provide the support that is necessary for future growth (see

sections 3.3.5.3 and 3.3.6.3). Additionally, a phasing strategy which focused on the implementation of the LRT expansion in successive stages helped maintain the momentum and developed expertise among the project management team and the construction contractors.

**Table 3- 6 Summary of Lessons Learned**

<p>1. Long-term planning recognizing future transportation needs and integrated with other transportation and land use planning, allows the reservation of rights-of-way and permits public comment and acceptance, which in turn facilitates system expansion.</p>
<p>2. External factors (such as the 1988 Winter Olympic Games) can be incorporated into the phasing strategy and used to motivate the expansion of the system.</p>
<p>3. Prior implementation of bus service along proposed rapid transit alignments develops ridership and promotes an awareness of transit service along the corridor. This facilitated the subsequent implementation of the rail system.</p>
<p>4. An extensive public involvement process promotes an awareness of system development which contributes to a successful phasing strategy.</p>
<p>5. A phasing strategy which allows for incremental system implementation permits experience of rail system construction and operation to be developed and applied over time.</p>

## **3.4 Caracas**

### ***3.4.1 Introduction***

Caracas is the capital city of Venezuela with a population of 3.5 million and an additional 700,000 daily commuters who live outside the city. About 1.2 million of the population reside in informal settlements. The economy of the city relies on its role as a political, administrative, trade and services center. In general, the national oil revenues create a very large bureaucracy and consequently employment base for the city and country at large.

Built in narrow valleys between steep hills, the city has a linear development pattern. The existing densities are already very high and, given the geographical constraints, there is little room for city expansion. The urban structure comprises a mixed-use, multi-nodal pattern stretching along the main corridors. The densities tend to diminish and residential use to increase away from these corridors and the low-income informal settlements are located at the periphery of the city. The inner city already has a very extensive but heavily congested highway system and because the country has the lowest gas prices in the world, private car ownership is very high.

The Caracas Metro is a heavy rail transit system operated by the completely autonomous Caracas Metro Agency. The Metro has three lines in operation which represents close to 50% of the originally planned complete network. The system was financed by Federal funding and operation first began in 1983. The present system is 45 kilometers in length, with 42 stations and is 80% below-grade, 10% at-grade and 10% above-grade (see figure 3- 5). It carries 1.3 million passengers per day.

Line 1, which is 21 kilometers in length, comprises 22 stations and was developed in 3 phases, the first of which went into operation in 1983. It serves the main valley corridor in which more than 50% of the residential population, jobs and amenities are concentrated. Line 2 is 19 kilometers long with 13 stations and extends into a secondary valley serving

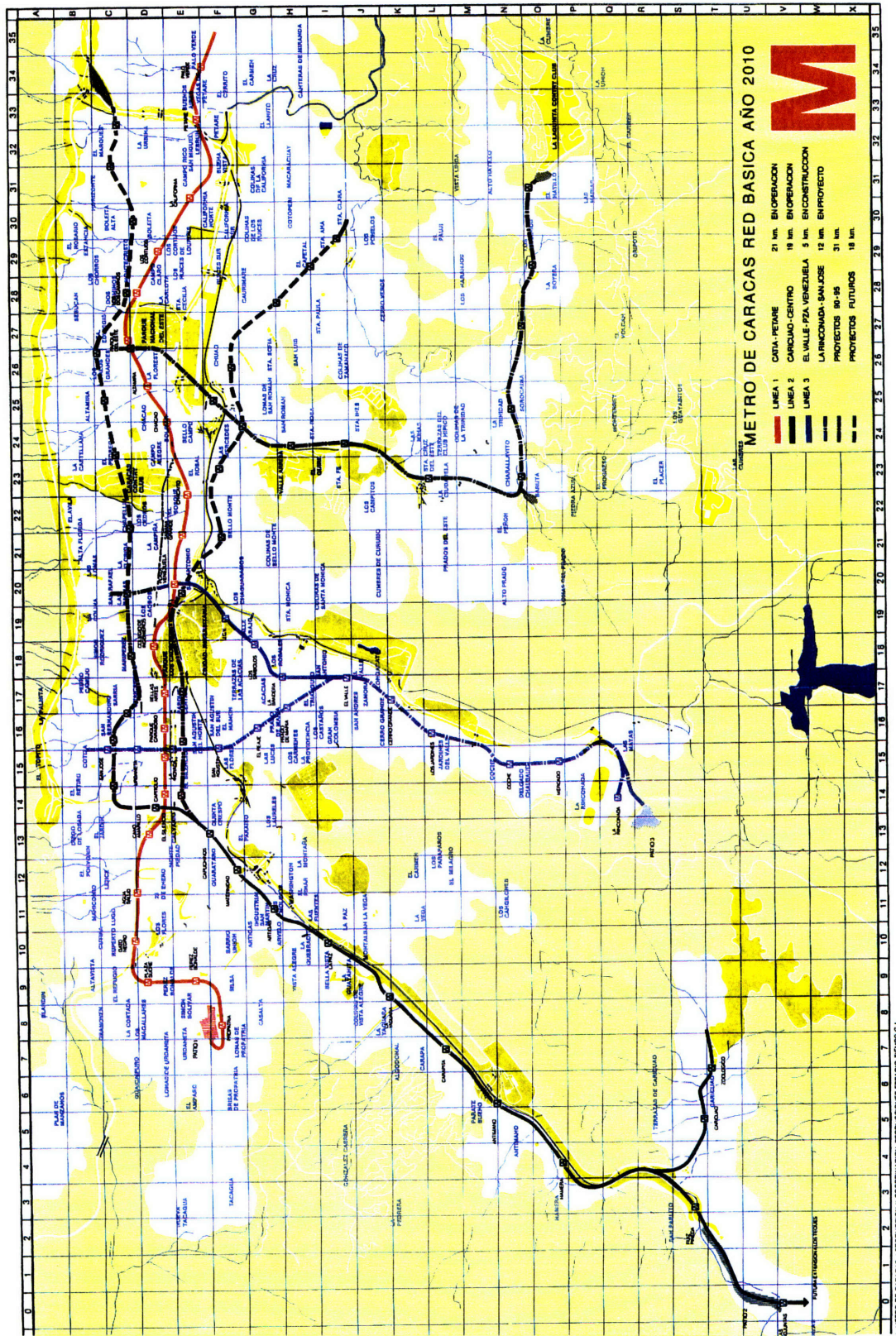


Figure 3-5 Caracas System Map

low and middle income areas and was put into operation all at once in 1989. Line 3 is still under construction and is to extend into another secondary valley serving primarily low income areas and incorporating important public services such as the city's main university campus. The first of two phases of this line went into operation in 1995 and is 5.6 kilometers in length.

### ***3.4.2 Development Context of the Caracas Metro***

Twenty years ago the City of Caracas was suffering from severe congestion but the inner city already had an extensive highway system that occupied a high percentage of open space. The option of expanding the city did not exist because of the geographical constraints presented by the valley walls between which the city had developed. Also, as mentioned, the city had a linear pattern with clearly defined activity corridors and very high density and mixed-use development trends. All of these factors suggested that a Metro would be the most appropriate solution to the city's problems despite the high costs of land acquisitions and the technical difficulties involved. It was seen to be the best method of improving transportation, increasing city performance, improving environmental quality and inducing urban change in the city.

### ***3.4.3 System Plans, Proposals and Phasing Suggestions***

In the implementation of the system, the general strategy was to get as much of the system in place as possible, as soon as possible, taking advantage of the financial bonanza represented by the oil boom and the favorable public and political support that existed at the time. It was recognized that technically and financially, due to the magnitude and complexity of the project, the time-frame to plan and construct the different lines would extend over a 20 year period.

It was clear that the main valley corridor, in which more than 50% of the residential population, jobs and amenities were concentrated, was the first priority. The main phasing imperative was to start construction as soon as possible and prove that the metro was a viable option which would significantly reduce transportation time and, to a lesser degree,



reduce congestion. Line 1 (the Red line) comprised 22 stations and was to be developed in 3 phases.

The corridor to be served by Line 2 (the Green line) carried significant commuter traffic and was subject to high demand peaks. The delays on the single highway serving this corridor created congestion throughout the network. To prevent transferring the congestion to an intermediate point of the system, Line 2 was planned to go into operation all at once.

Line 3 (the Blue line) is to link Plaza Venezuela to La Rinconada, and the branch of this line from El Valla station to San Bernardino was to follow as the fourth priority. This branch is no longer considered so important, However, a link between Capuchinos station (on the Green line) to Plaza Venezuela is now considered the most urgent priority in order to prevent transfer chaos at the Capitolio and El Silencio stations. The extension of this line towards El Cafetal, although not in the original plans, is now considered the third priority for implementation. This area is presently being served by Metrobuses.

The East-West line from Capitolio to El Marques was also not in the original plans but is now the second priority for implementation. Finally, the line between Parque del Este and El Hatillo is the fourth priority. This line, which will serve middle and high income areas, is very congested but was not considered in the original plans.

### ***3.4.4 Factors influencing system phasing***

#### ***3.4.4.1 Transportation and Service***

The main considerations in selecting alignments and station locations, and phasing the implementation of the system were to guarantee user demand. During the planning of the project, elaborate origin-destination surveys were conducted to identify user demand, accounting for existing behavioral patterns and trends. As a result, to attain the objective, all efforts were made to place the system over the principal city corridors and nodes, regardless of the high acquisition costs or the complex technical, legal or managerial difficulties that this presented. It was considered that this would more likely ensure a

successful transit system which would combat the traffic congestion which was paralyzing the city. There appeared to be no alternative to promoting a gradual shift from private car oriented transport and a chaotic and inefficient bus and colectivo system to mass transportation which would be developed mainly below grade.

As a result, Line 1 of the system goes through the main valley corridor, where the greatest concentrations of the population, employment and public services exist. Line 2 extends into a secondary valley serving low and middle income residential areas that were originally served only by a single very congested highway with three hour traffic jams. The delays on this highway created overall congestion on the city's express and arterial roadways and interfered with passenger and freight transportation from the city to the main airport, port and beaches 15 miles away.

Consistent with the principle of providing service to those most in need of it, Line 3 of the system will extend into another secondary valley, serving mainly low income areas and the city's main University campus and residential areas. Higher income areas have high auto ownership and are not served by any branches of the current system. Even where such areas were located in the vicinity of important urban corridors, the metro stations skipped them and were located only on sites which assured higher user demand.

#### ***3.4.4.2 Social***

As mentioned, the policy was primarily one of serving low income areas. The people of these areas were more transit dependent and so represented guaranteed demand. High income areas could afford the car-alternative and so were not served.

To complement the construction of the Metro, the city Planning Agency adopted a scheme called Metro-Corridor which increased densities over the already existing urban centers and city spines. This would ensure that the Metro would be in reach of the majority of the population, encouraging urban development and in turn promoting higher ridership. The corridors served activity centers of very high densities and high real estate values, community services, city landmarks, housing developments, and business and recreational areas.



#### ***3.4.4.3 Financial***

Funding, at least in the early stages of planning and construction (i.e. during the first 12 years) was not a critical issue since the country was going through the peak of the oil boom. The oil industry was nationalized in 1976 and the petrodollars provided Federal funding for the project. The only real financial concern of the project was the fear that the system would require enormous maintenance costs.

#### ***3.4.4.4 Other***

Once the main decisions on alignment and station location were made, legal, social, financial and environmental considerations were analyzed, which led to a more precise project evaluation and in some cases required minor adjustments of the original proposals. Technical construction solutions, additional studies on soil conditions, hydraulics, location of infrastructure, negotiation with private land owners (reaching agreement on land leasing during construction or provision of bonuses concerning development rights), represented additional factors which helped to make final project phasing decisions.

#### ***3.4.4.5 Particular factors influencing the phasing of Line 1***

The planning and construction of the project began with the western portion of line 1.

The main reasons leading to this decision were the following:

- It linked very high density, low income residential areas to the traditional center of Caracas.
- Congestion in this part of the city was extreme.
- Transportation in the area depended on colectivos with numerous private lines operating on similar routes.
- Due to geographical conditions, part of the metro line was to be developed at, and above, grade following the alignment of a covered ravine (municipal land), which would help to reduce land acquisition costs and speed up construction.
- There was no doubt that the user demand would be very high (car ownership was among the lowest in the city).
- It would also result in political benefits as the success of this initial phase of the system would enhance support for the project and assure that financing would move ahead.

### **3.4.5 Evaluation of system phasing**

#### **3.4.5.1 Transportation and Service**

The Metro is considered to have saved the city from virtually total paralysis. It has resulted in less congestion in certain corridors and brought about drastic reductions in the time needed to move around the entire city. The system carries 1.2 million passengers per day, 10% more than originally projected. Of the total system ridership, 65% is carried on Line 1, 25% on Line 2 and 10% on Line 3. The travel time savings due to Line 1 are in the range of 1 to 2 hours; by Line 2, in the range of 2 to 3.5 hours; and by Line 3, 45 minutes to 1 hour.<sup>79</sup> The prioritization of the East-West line for initial implementation was obviously based on the travel demand and indeed, due to saturation of the main corridor, a second line has been proposed to run parallel to Line 1.

The phasing strategy has succeeded in its original service objective of linking the low-income areas to the CBD. This translated into high demand and connecting the less well-off with the primary work locations. The system also has an extensive feeder bus service comprising 25 metrobus routes. These are very heavily patronized and have identified corridors with high potential for metro extensions. The facility exists to transfer between lines and from Metro lines to Metro buses by paying additional fare increments.

#### **3.4.5.2 Political**

As discussed previously, a great deal of financial, public and political support existed at the time that the Metro was being considered. Despite the severe economic recession affecting the country in the last 10 years, the Metro construction has proceeded as originally planned. A phasing strategy which focused on implementing the most likely to succeed elements of the system initially has enhanced political support for the project.

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<sup>79</sup> Information obtained from Arq. David Gouverneur, Professor, Department of Architecture and Design, Universidad Simon Bolivar, Former Vice-Minister of Urban Development of Venezuela.

### ***3.4.5.3 Social***

The phasing strategy for the Metro has also incorporated the accomplishment of wider urban development and societal goals. The Metro is responsible for many major urban improvements at the surface which were carefully planned and built by the Metro Agency. More than 30 kilometers of pedestrian malls, parks, plazas and links were created which together with landscaping has introduced the notion of a widespread urban design. Some streets have been designated as pedestrian-only and the stations have become community meeting places and service centers. The Metro has helped planners, politicians, developers and the community to re-think and create an appreciation for the city.

The increased accessibility provided by the Metro has helped reduce social segregation and tension. As mentioned in section 3.4.4.1 however, the Metro does not serve high income neighborhoods, since the system was implemented with a policy of only serving those who could not afford alternatives.

Initially, a combination of techniques were employed to help create a successful system. These included creating a user-friendly environment, educating people about the system in order to prevent vandalism, assuring a high level of service, high quality design, maintenance, personnel training and public relations. The stations were carefully designed with the objective of enlightening the particular features of each location and art work is a recurrent theme within the stations and in open public space. After 12 years of service, the trains, stations, galleries and passages are still high quality environments defended by the users.

Public support for the Metro is very high, indeed it is considered one of the best government financed and managed projects in the country. The Metro has motivated a sense of pride, respect and identification of the user towards the system and in turn towards the city. It is now difficult to think of Caracas without its metro.

#### ***3.4.5.4 Economic***

The Metro is believed to have contributed significantly to the economic revitalization of the city. The popular use of previously selective commercial facilities and urban areas, the overcrowding of parks and museums, and the emergence of new business activities in the informal areas, are all indicators of this revitalization. It has pulled together a congested and segregated urban fabric, making it more competitive within the nation and the Caribbean region and has increased job opportunities and the choice of place of residence, particularly for the low income users. During construction, 25,000 direct or indirect job positions were created and presently the Metro employs 4,000 people full-time.

The development of the Metro has also brought about other city improvements and increased land values which in turn has triggered large and small scale developments. This has favored new commercial activity and affected the entire dynamics of the city. In general, the positive impacts associated with Metro construction have created support for expansion.

#### ***3.4.6 Implications for future phasing***

In general, given its success, the phasing approach adopted in the planning and implementation of the current system appears to represent a good model of how future phasing of the system should proceed.

##### ***3.4.6.1 Transportation and Service***

The three existing lines of the system have been implemented as planned and represent close to 50% of the originally planned system. However, over the time-frame of their implementation, important changes have occurred in the city performance and in the behavior of the metro itself. For instance, the main city corridor (Line 1) has experienced an increase of density and of public facilities used by the entire city, which is evident in the intense use of public space and facilities (pedestrian malls, parks, museums, etc.). Factors such as these have led metro planners to re-evaluate future alignments and phasing. For instance, the pedestrian congestion at the transfer station between lines 1 and 2 is so severe that planners have prioritized establishing a new link between Capuchinos station

(on the Green line) to Plaza Venezuela in order to bypass the transfer point. Heavy and continuous demand over Line 1 has also led planners to consider planning a new line running parallel to the main city corridor at a spacing of 500 meters, which in turn has a huge potential for urban development. Furthermore, the metro buses which connect fringe areas to the metro lines are very congested and have also led to the consideration of extending the metro lines to serve these areas.

#### ***3.4.6.2 Political and Social***

As clearly demonstrated, the project has been a true success and is well perceived by the public. A great amount of pride exists in the system and this bodes well for future expansion prospects.

#### ***3.4.6.3 Financial***

As mentioned, the country has been suffering economic recession in the last 10 years. Funding of the project, which is completely Federal, has nevertheless been maintained. Given the high degree of public support for the system, it is likely that funding will not be a constraining factor as future phases are considered.

#### ***3.4.7 Summary of the Phasing Strategy***

The original system plans for the Caracas Metro envisioned a comprehensive network and over the last twelve years three of those lines (almost 50% of the originally planned system) have come into being. The aim of the phasing strategy was to get the full system implemented as quickly as possible but it was recognized that the expansion of the system would rely heavily on the success of the initial phases. The phasing strategy was very much a case of building the line with the best prospects of success first. The main travel corridors were identified and routes serving low-income areas that could not fail from a ridership perspective were chosen. Furthermore, the integration of the bus and rail services has been another successful element of the phasing strategy which has helped provide a comprehensive transit service as well as identify corridors of prime potential for metro expansion. Of course, the phasing of the system has also been integrated with

improvements to the urban environment. These improvements have complemented rail transit implementation and have also induced positive perceptions of metro development.

However, expansion has not been based on a blind adherence to the initial plans. It has been recognized that the city has changed over time. An example of this change is reflected by the saturation of the main corridor which has suggested the development of another transit line parallel to Line 1. Thus, the phasing approach has been one of implementing the original system plan while at the same time accounting for alterations that may be warranted. Obviously, the success of initial phases has demonstrated the viability of rail transit for the city and has encouraged its expansion.

### ***3.4.8 Lessons Learned***

Clearly, the availability of significant financial resources, the large public and political support, the topography of the area, and the high densities are the main factors influencing the successful expansion of the Caracas Metro system. The funding generated by the oil revenues permitted the construction of a high quality system and financially unconstrained alignment choices (see section 3.4.4.3). Therefore, the lines could be located where they were most required.

The phasing strategy focused on serving the highest demand routes regardless of the costs of construction. The stations are located on the main city nodes and the construction of the lines is 80% below grade. This policy led to higher land acquisition costs and complex legal, technical and operational problems, but resulted in a system that could not fail from a ridership perspective and which did not rely on zoning or other measures to induce demand. (See section 3.4.4.1).

The phasing approach was also one of only serving those who needed it most. This meant serving the low income areas who did not have the alternative of auto use. High income areas represented high auto ownership and consequently low user demand. Therefore, the system links low income areas to the working locations and the public services. (See section 3.4.4.2)

In phasing the implementation of the system the primary objective was to get as much of the system in place as possible, as quickly as possible. In this way, the benefits of the system became clear for all to see and this created the necessary public and political support for further expansions of the network. (See section 3.4.3)

Another factor which influenced the successful expansion of the system is the fact that people have pride in the Metro. From the outset there was a concern about vandalism and so people were educated to take responsibility and to care for the system. (See section 3.4.5.3).

Furthermore, during the construction of the system, care was taken to use technology to minimize further congestion, noise, environmental decay and community inconvenience. This ensured that people did not build up negative perceptions of the system during the construction process. This is another positive attribute of the phasing strategy which has facilitated easier expansion of the system.

The identification of the main travel corridors linking to the Metro system and the implementation of feeder bus services on these routes has also been successful. This has helped create the concept of a total transportation system, has built up ridership on these routes and has suggested the expansion of the Metro in the most promising of these corridors. (See section 3.4.5.1).

The planning of the project was carried out taking into consideration the impact that it would have on city performance and the opportunities it provided to induce urban transformations (see sections 3.4.4.2 and 3.4.5.3). This has contributed to the positive perceptions of the system and the support for its expansion.

Finally, the Caracas case illustrates that in very large projects, comprehensive planning is necessary, but the uncertainties of urban change (enhanced by the construction of the mass transit system itself), may require the re-examination of the phasing strategy in order to adapt the system to new conditions. (See section 3.4.6.1).

**Table 3- 7 Summary of Lessons Learned**

<p>1. The availability of large financial support allows the flexibility to make the most desirable alignment choices and phasing decisions.</p>
<p>2. The policy of locating stations on the main city nodes and only serving the areas of highest demand, ensures good patronage of the system. This success facilitates the expansion of the system.</p>
<p>3. Prioritizing the expansion to focus on providing service to low income areas which do not have alternatives to transit is shown to be a successful approach.</p>
<p>4. Educating people to respect and have pride in the system creates positive perceptions and facilitates the expansion of the system.</p>
<p>5. When efforts are made to minimize the impacts due to construction, expansions of the system are not viewed negatively from a construction disruption perspective.</p>
<p>6. Constructing and expanding the network as quickly as possible is a good phasing strategy as the benefits of the system become more apparent for all to see and this creates support for further extensions.</p>
<p>7. During the system implementation, efforts to develop and induce urban transformations enhance the success of the project and encourage its expansion.</p>
<p>8. A phasing strategy which incorporates the introduction of feeder services complements the in-place system and helps identify or create corridors of high demand which can be assessed and ranked for potential rail system expansion.</p>
<p>9. The phasing of the project must account for changes in the urban structure while the system is under development and due to changes induced by the implementation of the system itself.</p>



## **3.5 San Diego**

### **3.5.1 Introduction**

The San Diego Metropolitan Transit Development Board (MTDB) was established in 1975 by the passage of the California Senate Bill 101 to plan, construct and operate fixed guideway transit. The Board is responsible for an area of about 570 square miles serving a population of about 1.9 million (73% of the County) in southwestern San Diego County.<sup>80</sup> The Trolley is operated by San Diego Trolley Inc. (SDTI), a separate entity created by the MTD Board specifically for that purpose.<sup>81</sup>

The San Diego Trolley is a light rail transit (LRT) system with manually operated vehicles and minimal grade separation. The system uses overhead catenary and has the capability of operating on city streets in mixed traffic.<sup>82</sup>

The MTDB has planned, designed and built two LRT lines and part of a third, for the current 61.2 kilometer system with other elements being phased in over time. Studies are being conducted and plans are in place for a much more extensive system and if funding permits, the San Diego region will be served by an 138.5 kilometer LRT network by the year 2010.<sup>83</sup> LRT lines in various stages of construction, planning and design are the North Line/Old Town Segment, Mission Valley Line, North Line/Mid-Coast Segment and the I-15 Line (see figure 3- 6 and Table 3- 8).<sup>84</sup>

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<sup>80</sup> "Metropolitan San Diego Short Range Transit Plan, FY 1995-2001," MTDB, June, 1994.

<sup>81</sup> "The Metropolitan Transit Development Board Organization, Jurisdiction and Function," MTDB, June, 1991.

<sup>82</sup> "San Diego Trolley: The First Three Years," Summary Report, U.S. Department of Transportation, DOT-I-85-10, November, 1984.

<sup>83</sup> "San Diego Regional Rail Transit Plan," MTDB, August, 1995.

<sup>84</sup> Ibid.

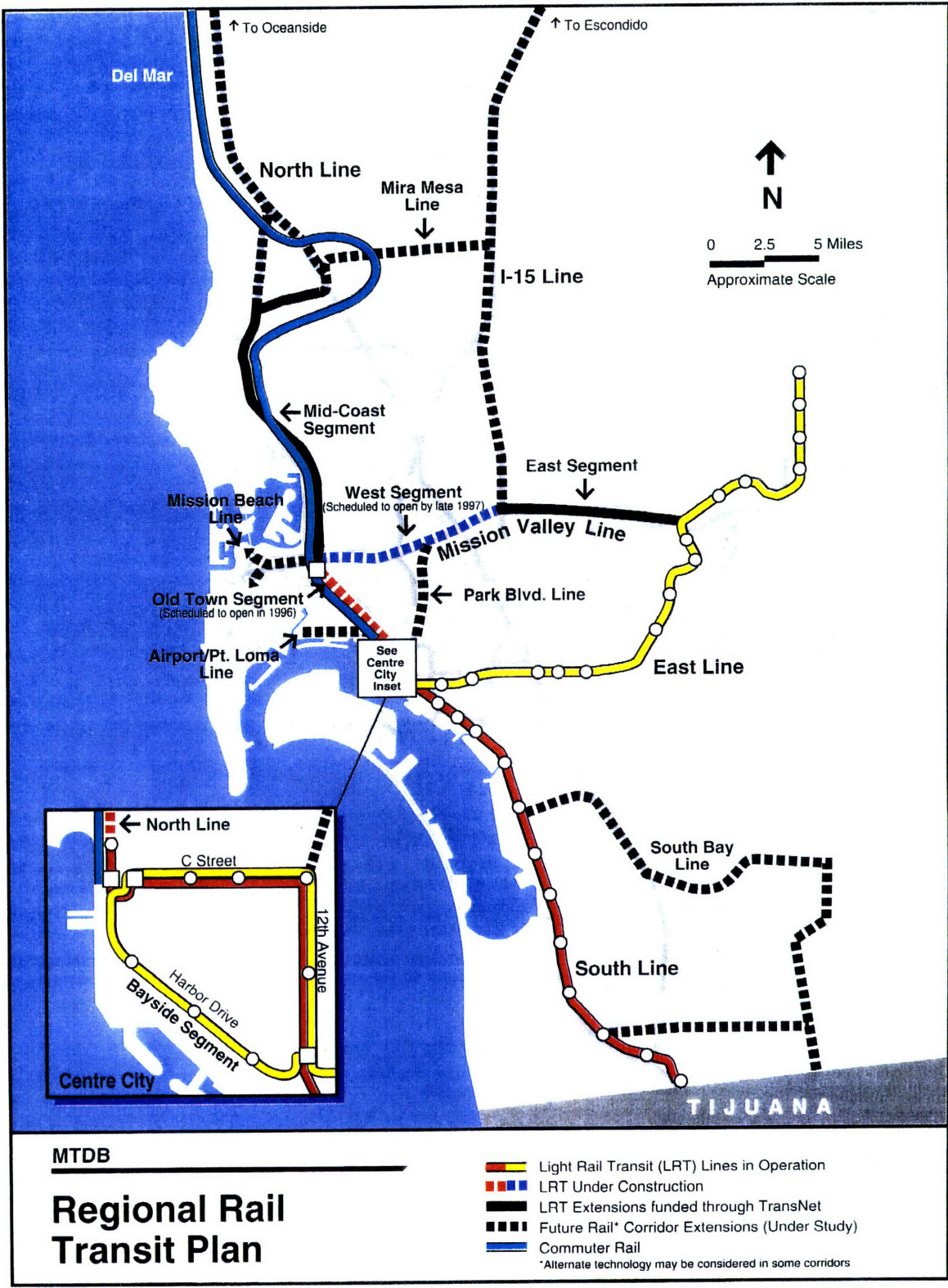


Figure 3-6 San Diego System Map

Line	Segment	Length (km)	From - to	Status	Date opened or Scheduled Opening	Cost (\$ million)	Funding Sources
<b>South Line</b>		25.6	Centre City - Mexican Border	Operational	July, 1981	116.6	Gas tax revenues, Local TDA
		36	Centre City - City of Santee	Operational			
		7.2	Centre City - Euclid Ave.	Operational	March, 1986	33.6	Gas and sale tax revenues, TDA, STA, and sale and leaseback funds
<b>East Line</b>		18.2	Euclid Ave. - El Cajon	Operational	June, 1989	108	Federal Section 3 and 9 monies, state gas and sales tax revenues and local TDA, STA, and sale and leaseback funds
		2.4	in Centre City	Operational	June, 1990	48	Locally funded with San Diego Unified Port District and City of San Diego Transient Occupancy Tax (TOT) funds.
		5.8	El Cajon - City of Santee	Operational	August, 1995	109	Local TransNet (sales tax), State rail bonds, State Transit Capital Improvement funds (TCI), City of El Cajon TDA funds (state source)
		22.5	Centre City - North University City	Part - Operational			
<b>North Line</b>		0.6	Sante Fe Depot - Cedar St.	Operational	July, 1992		Do not have information
		5.2	Cedar Street - Old Town	Under construction	mid - 1996	114	State Transit Capital Improvement (TCI), Prop 108 Monies, County of San Diego monies, City of San Diego, San Diego Unified Port District, and TransNet (the local 1/2% sales tax) monies.
		16.7	Old Town - North University City	Alternatives Analysis/DEIS		up to 354	Mix of federal, state, and local funds
<b>Mission Valley Line</b>		18.8	Old Town - City of La Mesa	Under construction			
		9.8	Old Town - east of I-15	Under construction	late 1997	220	TransNet and State sources
		9	east of I-15 - La Mesa	DEIS underway		236	TransNet and State sources

Table 3-8 Description of the San Diego System

System construction has been funded by a combination of methods as shown in Table 3-8. The South Line, the first which opened in July 1981,<sup>85</sup> was constructed all at once (although originally single-track operation and later upgraded to two-way) and was funded with state monies derived from a percentage of the gasoline tax set aside for guideway transit development and from the local Transit Development Act (TDA). East Line development has proceeded in stages and has been funded by a variety of sources including state gas and sales tax revenues, TDA, State Transit Assistance (STA), sale and leaseback funds and federal Section 3 and 9 monies.<sup>86</sup>

### ***3.5.2 Development of the San Diego Trolley***

#### ***3.5.2.1 Original System Plans, Proposals and Phasing Suggestions***

The first real consideration of rail rapid transit for the San Diego region began in 1971 while the Regional Comprehensive Plan was being developed. In 1974, county voters approved a ballot proposition which permitted up to 25% of the state gasoline tax to be used for the construction of a guideway transit system. A long-range regional transit plan was adopted by the Comprehensive Planning Organization (CPO), which identified a 95 kilometer system of corridors in the region as appropriate candidates for future high level of service/intermediate capacity guideway transit. The MTDB was created by state legislation in 1975 which directed that the planning and design of the system be low cost, pragmatic and incremental in nature. A primary responsibility of MTDB was to carry out plan refinement geared to the determination of technology and overall staging of the system. The evaluation needed to reflect various legal, policy and planning requirements. These included:

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<sup>85</sup> "Trends Before the San Diego Trolley," Interim Report, US Department of Transportation, DOT-I-82-40, July, 1982.

<sup>86</sup> "The Metropolitan Transit Development Board Organization, Jurisdiction and Function," MTDB, June, 1991.

### **3.5.2.1.1 Environmental factors**

The evaluation needed to adhere to the requirements of the California Environmental Quality Act (CEQA) and the National Environmental Policies Act (NEPA). Any evaluation would need to account for visual impacts, noise impacts, open space impacts, water resources impacts, community disruption, displacement and relocation.

### **3.5.2.1.2 Financial factors**

It was recognized that the feasibility of guideway transit in the metropolitan area would be dependent upon the availability of funds to finance transit construction and operation. At that time the available sources for financing transit either for capital or operating purposes were:

1. State of California local transportation fund (LTF)
2. City of San Diego property tax
3. State Constitution Amendment 15 (SCA 15 or Proposition 5)
4. Federal Aid Urban system (FAU)
5. UMTA Section 3 and 5 grants

The LTF funds resulted from 1/4 of 1% of the State Sales Tax proceeds being returned to the County for the primary purpose of enhancing local public transportation services. The SCA 15 monies were gas tax receipts coming to San Diego and placed in the Highway Fund. With regard to transit they were then specifically set aside for fixed guideway construction. Funding was available for Federal Aid Urban (FAU) projects in San Diego County and approximately two-thirds of this amount was available for transit assistance projects in the MTDB area. Section 3 discretionary funds were available from UMTA for capital improvements only, however, the likelihood of Section 3 funding was low at the time of Phase I implementation due to federal commitments for transit starts in Atlanta, Baltimore, Miami, Buffalo and Washington DC. Section 5 funds, allocated on the basis of a formula which accounted for population and population density, could be used for capital purchase or offsetting operating deficits.

The financing of projects using State and Federal monies would require fulfilling State of California (CALTRANS) and Urban Mass Transportation Administration (UMTA)

guidelines. The UMTA policies particularly relevant to Phase I implementation included the following criteria covering the feasibility of a first increment guideway segment:

- provide efficient and adequate service in priority areas
- be justified on fifteen-year projections of ridership
- be economically and logistically sound if nothing else is built
- permit additions, extensions, or technology upgrading
- mesh with the existing transportation system

### **3.5.2.1.3 Policy factors**

Based upon consultant studies of November and December, 1976, a low-cost, low-adverse environmental-impact approach was recommended to the MTDB Board of Directors. As a result, the Board adopted a number of principles regarding Phase I selection:

1. The selected corridor should extend a long distance and offer high-speed operation.
2. It should be designed so that its capital cost would be low.
3. Construction should be primarily at-grade with mostly exclusive rights-of-way.
4. The operating deficits should be minimized.
5. The impacts on residential development should be examined in detail.

Directly related to the adopted principles were requirements contained in SB 101 (Article 4):

- “...the board shall give priority consideration to guideway technology presently available and in use.”
- “Such a guideway system shall be planned in such a manner that it may be constructed and brought into operation, on an incremental basis, so that available fiscal resources may be used as early as possible...”
- “To the extent feasible, transportation rights-of-way of public entities shall be utilized to minimize the cost of construction.”

These principles effectively narrowed the range of corridor alignment alternatives to those that tended to demonstrate early viability in terms of low cost and low adverse environmental impacts. This basically eliminated corridor alignments that utilized arterial streets or subway construction for substantial distances. These adopted principles were key factors in system phasing decisions.

#### 3.5.2.1.4 Analysis of candidate corridor alignments

The purpose of the Guideway Planning Project initiated by the MTDB in 1976 was to refine regional rail transit plans, consider the technology and staging of the system, and identify a first usable segment.

This was an 18-month study with the first of two phases initiated in December, 1976, involving the evaluation of corridors based on the Regional Transportation Plan (see Table 3- 9 and Figure 3- 7). The second phase of the study began in April, 1977 and involved the further screening of corridors, the selection of a corridor for a starter segment, and the technical assessment of transit alternatives within the selected corridor.

**Table 3- 9 Candidate Alignments**

ALTERNATIVE	FROM	LENGTH (KM)
1. North - AT&SF	Miramar Road	25.1
2. North - SR 163	Miramar	22.5
3. East - I-8	El Cajon	32.4
4. East - SD&AE	El Cajon	26.9
5. East - SR 94	El Cajon	23.8
6. South - SD&AE	San Ysidro	23.7
7. South - SD&AE (East)/I-805	San Ysidro	27.7
8. South - SR 54/I-805	San Ysidro	26.1
9. South - SR 252/I-805	San Ysidro	25.9

#### 3.5.2.1.5 Evaluation

Nine corridor alignments radiating from Centre City San Diego were determined to be candidates for guideway transit given the adopted MTDB policies (see Table 3- 9 and Figure 3- 7). The evaluation examined environmental impacts, travel demand analysis, service potential, system flexibility and cost in comparing the alternatives (see Table 3- 10).

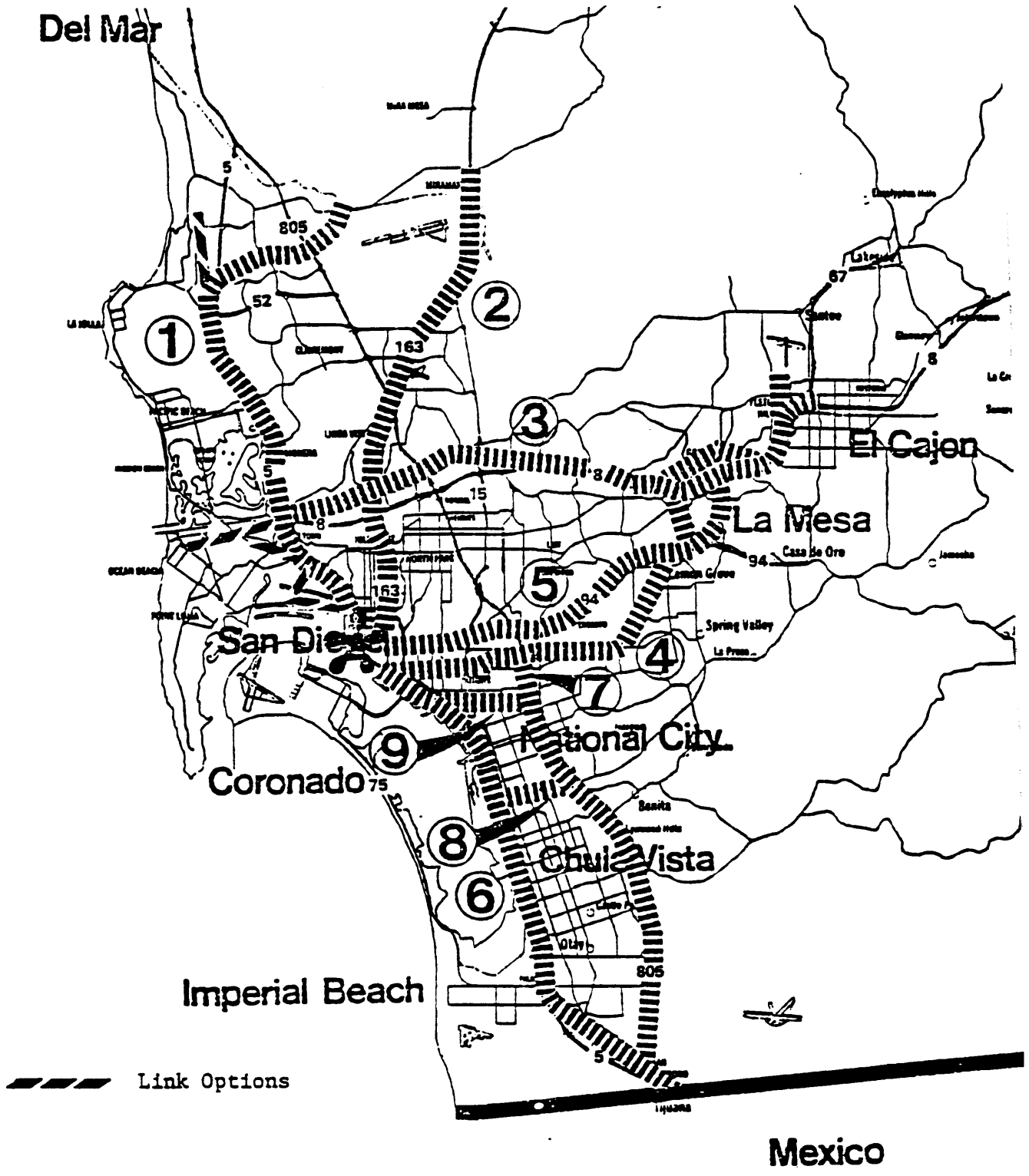


Figure 3-7 Candidate Corridor Alignments (as identified by the "Guideway Planning Project - Phase I: Evaluation of Candidate Corridor Alignments," MTDB, March 1977)



**Table 3- 10 Evaluation Framework**

EVALUATION FACTOR	TYPICAL MEASURES
1. Environmental Impact	Visual impact; noise; open space impact; water resources impact; community disruption; displacement and relocation
2. Travel Demand	Existing travel demand; previous patronage forecasts; vehicle travel forecasts; transportation facility deficiencies
3. Service Potential	Analysis of population in close proximity to the alignments; jobs in close proximity; service to transit dependents; activity centers served
4. System Flexibility	Land available for maintenance facility; station siting and access; flexibility for adding extensions;
5. Cost	Capital costs; capital cost per mile

A ranking was then carried out which attempted to combine all of the analysis results and select a corridor for which initial engineering and detailed planning for a guideway transit line would be carried out.

The most important selection criteria were low cost and high forecast ridership. The South Bay corridor was selected early in the second phase of the study, the alignment of which was heavily influenced by the availability of the San Diego and Arizona Eastern Railway (SD&AE) right-of-way. The MTDB had purchased the entire 174 kilometer railway in 1978 for \$18.1 million.

MTDB deemed the project feasible and the San Diego City Council followed with their approval in 1978. Approval from the California Department of Transportation (CALTRANS) and the California Transportation Commission followed in 1979.<sup>87</sup>

**3.5.2.2 Updating of System Plans, Proposals and Phasing Suggestions**

The development of the 1984 Regional Transportation Plan provided an opportunity to re-evaluate the region’s long-range transit system plans subsequent to the implementation of Phase I of the Trolley system. The primary purpose of the revision was to identify priorities for Trolley extensions. To test the overall feasibility of light rail transit in each corridor, a “maximum” trolley system of nearly 225 kilometers was developed (see figure

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<sup>87</sup> “Guideway Planning Project - Phase I: Evaluation of Candidate Corridor Alignments,” MTDB, March, 1977.

3- 8). As part of the analysis patronage, cost, environmental, congestion relief, equity, regional growth and private participation factors were identified for each of the segments in the test network.

Various phasing options combining the different possible segments were evaluated. Based on measures of capital cost and operating cost per additional passenger, it was determined that the minimum extension should be approximately 24 kilometers in length so as to penetrate residential neighborhoods and facilitate longer distance travel.

The East Urban Line remained the first priority for system expansion because it carried a greater number of transit trips than similar length segments to the north. It also provided additional capacity in the congested east-west (I-8/SR 94) travel corridor, and served the lower income, largely minority Southeast San Diego community. The right-of-way and most station areas on this route were already owned by MTDB, and engineering for this extension was nearly complete, permitting early implementation.

The Airport/Bayside Extension (Point Loma) had high ridership potential for its length but received second priority because of its higher cost per mile and the fact that it did not have the ability to expand to other northern areas.

Two northern extensions of approximately 15-miles were identified for construction prior to 1995. These were the I-5 corridor to North University City and the Mission Valley Line to San Diego State University and La Mesa. Although the I-5 line projected higher patronage, the Mission Valley Line was seen as more favorable because of its potential to relieve existing congestion and maximize private sector participation.

Other extensions were prioritized as the Oceanside extension from North University City to Oceanside along the I-5 corridor, the North County corridor linking Escondido and Oceanside, and the I-15 corridor from Mission Valley to Escondido (see figure 3- 8).<sup>88</sup> Some of these areas are outside MTDB's area of jurisdiction but are within San Diego County and fall under the jurisdiction of the North San Diego Transit District (NCTD).

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<sup>88</sup> "Long Range Transit Element," SANDAG, June, 1984.

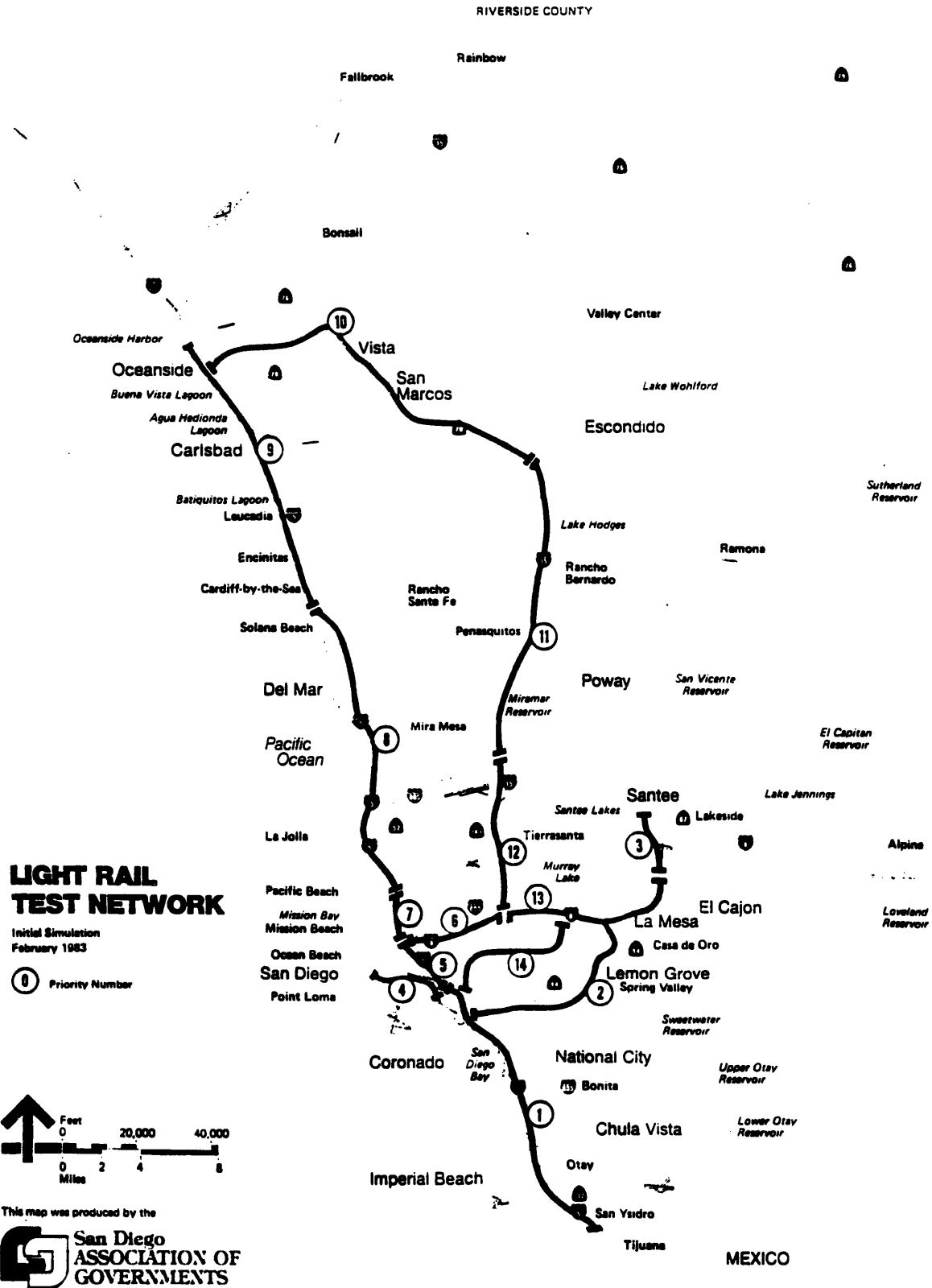


Figure 3- 8 Light Rail Test Network (as contained in the Regional Transportation Plan, SANDAG, June 1984)

**3.5.2.3 Future System Plans, Proposals and Phasing Suggestions**

In April, 1992, the MTDB adopted a procedure and criteria for determining the priority of implementation for the Mid-Coast, Mission Valley East, and I-15 rail lines. The evaluation focused on comparing potential light rail transit lines in each of the three corridors. The strategy in ranking the lines was to ensure full funding of one project before another project would enter the implementation phase.

The adopted LRT extension priority criteria focused on four basic elements: corridor congestion, ridership, project costs (including capital and operating costs), and cost-effectiveness (see Table 3- 11). Various other data were also developed to assist with the analysis including; travel time comparisons for typical trips in each corridor between LRT and auto; station display boards showing the layout of the station sites on the three lines; University of California San Diego (UCSD) and San Diego State University (SDSU) information on current enrollment, number of students living on campus, plans for expansion, etc.; the potential impacts of Transportation Demand Management (TDM) strategies in each corridor were recognized; and letters and comments which were received regarding the extension priorities.

**Table 3- 11 Priority Analysis Matrix**

CRITERIA	MEASURES
1. Ridership	New Daily Regional Linked Trips
2. Cost Effectiveness	Annualized Cost Per New Transit Trip
3. Corridor Congestion	% Lane-Miles Considered Heavily Congested
4. Capital Cost	Annualized Capital Cost Capital Cost Per Mile
5. Operating Cost	Estimated Annual LRT Subsidy (increase over BASE network)
6. Gap Closure	Subjective
7. Ease of Implementation	Subjective
8. Station Access	Subjective
9. Options to Project	Subjective

The analysis concluded that the Mission Valley East Project be the top priority, with the Mid-Coast and I-15 projects follow equally ranked. The basis for this ranking was as follows:

- The cost-effectiveness figures showed all projects being in the same range.
- Mission Valley East ranked highest in terms of:
  - ◊ need for congestion relief;
  - ◊ annualized capital cost;
  - ◊ lowest annual LRT operating subsidy requirement;
  - ◊ closing a gap in the LRT system, and being an extension to one line, as opposed to a new line; and
  - ◊ not having any significant transportation capacity options to the rail project.

### ***3.5.3 Factors influencing system phasing***

#### ***3.5.3.1 Technical***

As mentioned, the San Diego and Arizona Eastern Railway (SD&AE) was purchased by the city of San Diego for the minimal cost of \$18.1 million in 1979. This purchase price included 174 route-kilometers, consisting of all the former SD&AE tracks except the portion in Mexico, plus a branch line to El Cajon. The availability of existing rights-of-way greatly facilitated the implementation of the routes to San Ysidro and El Cajon. Subsequent phases have been more difficult to construct as they have generally involved totally new construction rather than the rebuilding of existing railroads.

The MTDB had also adopted a number of principles including that of constructing at-grade and within existing rights-of-way as well as the prioritization of guideway technologies already available and in use (see section 3.5.2.1.3). These principles influenced the phasing of the present system and the LRT technology employed.

#### ***3.5.3.2 Transportation and Service***

The original analysis identified the high demand corridors and these were accounted for in the prioritization of the initial phases. As described in section 3.5.2.1.5, the initial analysis considered nine candidate alignments (see Table 3-9 and Figure 3-7) radiating from Centre City with the primary selection criteria being cost and ridership. Vehicle travel forecasts indicated that the east and south alignments each had high demand. The ultimate prioritization decisions relied on the influence of other factors in combination with transportation factors.

At present the system is reasonably extensive at about 61.2 kilometers with plans in place to expand the network to 138.5 kilometers by the year 2010. All lines are focused on the downtown and service is provided or planned along the main travel corridors and to many activity centers. Plans are continually being developed for the incremental construction of the system such that service to many parts of the region will eventually be available.

### ***3.5.3.3 Political***

The MTDB was created specifically for the purpose of developing a guideway transit system for the San Diego region. Strong political and public support for transit development was demonstrated even before this when in 1974, county voters approved a ballot proposition which permitted up to 25% of the state gasoline tax to be used for the construction of a guideway transit system. This high degree of local support has been maintained as the system has expanded. Furthermore, early system implementation was conducted largely independent of federal political influences due to the existence of local funding sources. As such, project implementation was not impacted by the uncertainties associated with federal political support.

Federal approval of system elements was not needed, and decision making and implementation was neither delayed nor constrained by this factor. This allowed a lot of flexibility in system phasing decisions. Later phases of the project have sought federal funding participation and will therefore rely on the political support in Washington DC.

### ***3.5.3.4 Social***

The original motivation behind the implementation of a fixed guideway system for the San Diego region arose out of a concern for the possible “Losangelization” of the area through the proliferation of sprawl.<sup>89</sup> The planning work carried out by CPO in 1973-74 combined transportation and land use alternatives to determine which combination might produce the most desirable regional development pattern. They concluded that the construction of a regional network of inter-urban rail lines combined with policies encouraging greater, though more dispersed, densities of residential population and employment activities

within the urbanized area, would produce the most favorable results. These conclusions provided the foundation for the “1995 Transit Development Program” work which led to the selection of regional transit corridors in 1974.<sup>90</sup> The system phasing strategy incorporated these conclusions in combination with the determination that lines should be at least 15 miles in length to penetrate residential areas and provide for longer distance travel.

System expansion was also planned with equity concerns in mind. The East Line of the system serves the lower income, largely minority Southeast San Diego community.

### ***3.5.3.5 Financial***

The guiding principles adopted by the MTDB stressed a low-cost, pragmatic approach to system implementation. The use of existing rights-of-way and available technologies has contributed to the cost containment policy.

The availability of local and state sources of funding was crucial to system development. As described a number of funding sources were utilized. The South Line was funded with state monies derived from a percentage of the gasoline taxes which were set aside for guideway transit development and from local Transit Development Act (TDA) funding. The East Line Euclid segment was funded by state gas and sale tax revenues, TDA, State Transit Assistance (STA) funding, and sale and leaseback funds. The East Line El Cajon segment was funded by state gas and sales tax revenues and local TDA, STA, sale and leaseback funds, as well as federal Section 3 and 9 monies. The Bayside segment was locally funded with San Diego Unified Port District and City of San Diego Transient Occupancy Tax (TOT) funds.

The utilization of these local and state funding sources meant that system implementation did not have to rely on federal funding sources. This allowed more flexibility as implementation was not constrained by the need for a positive political environment in

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<sup>89</sup> “Tomorrow,” AIA National Convention, San Diego, California, June 5-8, 1977.

<sup>90</sup> “Guideway Planning Project - Phase I: Evaluation of Candidate Corridor Alignments,” MTDB, March, 1977.

Washington DC with respect to transit development. Furthermore, the availability of non-federal funds meant that the project did not have to justify itself on the basis of FTA cost-effectiveness criteria and this permitted phasing decisions and indeed technology choices to be governed by whatever criteria local agencies deemed most important.

#### ***3.5.3.6 Environmental***

One of the guiding principles influencing project development was the policy of utilizing existing rights-of-way and avoiding aerial or subway configurations wherever possible. This policy had obvious cost as well as environmental implications and was an important element of the phasing decisions.

Additionally, the fact that early phases of the system were locally funded meant that their implementation did not need to adhere to the requirements of the federal planning process. This expedited the implementation process. Later elements of the system which have relied on federal funding have also needed to comply with the associated federal requirements which creates the potential for delays in the approval of system elements.

### ***3.5.4 Evaluation of system phasing***

#### ***3.5.4.1 Technical***

The availability of rights-of-way for the South and East Lines made the implementation of these lines much easier and cheaper. The ease of early construction and the policy of using guideway technology already available and in use, led to low implementation costs and the smooth introduction of guideway transit. As a result, the system managed to expand to a reasonable extent and became a relevant transportation option. The positive perceptions that this technical facet of the phasing strategy induced, helped motivate later expansion.

However, further construction has not been so straight-forward as illustrated by the controversy surrounding the selection of a suitable alignment for the Mission Valley East segment. The proposed alignment incorporates tunnel and elevated sections to make service to San Diego State University more convenient. This routing caused concern for



the Homeowner's Association of the College area because of the perceived adverse impact that it would have on the quality of life and value of the single-family homes, as well as the disruption that the cut and cover method of construction would cause during the lengthy construction period.<sup>91</sup> Such negative impacts, if not adequately mitigated, would be a failing of the phasing strategy and could have negative implications for the future expansion of the system.

#### ***3.5.4.2 Transportation and Service***

The system has been generally successful in meeting its original ridership projections. The rail lines have not led to any reduction in the number of auto trips however, and the transit share of total trip making has actually continued to decline. Thus, whether the system has really been successful from a transportation perspective and whether the return has been worth the investment depends on the criteria for success.

However, system expansion has proceeded at a reasonable rate and now comprises an extensive network serving many major activity centers. The momentum of expansion was maintained even through the period of the mid-80s with the Reagan administration and its negative view of rail transit. The utilization of local funding sources was a key factor permitting successful expansion at this time.

When Trolley service began on the South Line, bus routes in the South Bay Corridor were reorganized, so that "competing" bus routes downtown were eliminated. The bus routes were reoriented to feed the trolley system with connections available at all stations.<sup>92</sup> In 1985, MTDB acquired the assets of San Diego Transit Corporation (SDTC), the region's largest bus operator. As part of the consolidation, MTDB created the Metropolitan Transit System (MTS) which is a federation of all the fixed-route operators in the southwestern portion of the county. This has facilitated the provision of a unified transit service to the public.<sup>93</sup>

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<sup>91</sup> Letters from the Homeowner's Association/College Area to MTDB of June 10 and October 2, 1992.

<sup>92</sup> "San Diego: An Introduction to the Region," Philip R. Pryde, 2nd edition, 1984.

<sup>93</sup> "Metropolitan San Diego Short Range Transit Plan, FY 1995-2001," MTDB, June, 1994.

In general, the service coverage offered by the rail system in coordination with bus service has built positive perceptions of transit development. Additionally, this motivation to expand the system has been further encouraged through the achievement of project milestones at regular intervals. The opening of new segments of the system consistently over time has preserved the image of an expanding and developing rail transit system in the minds of the general public. As such, this service facet of the phasing strategy has been successful in the provision of a reasonably extensive rail system and associated feeder service.

#### ***3.5.4.3 Political***

Political support for the project has stayed strong throughout implementation. The degree of support was underlined by the renewed commitment to transit investment demonstrated by the introduction of a half percent increase to the local sales tax in 1988 to improve the region's transportation system. This investment is scheduled to continue until the year 2008 and is known as "TransNet." Revenues raised under the TransNet program are divided equally among the three major transportation categories of highway improvements, public transit improvements, and local street and road improvements. The advantages to non-federal funding were demonstrated during the early implementation. Freedom from the constraints associated with acquiring federal funding allows flexibility in system expansion decision-making.

A phasing strategy which has focused on the achievement of incremental goals has resulted in a lot of positive political publicity associated with the opening of new stations and phases. The need for such highly visible accomplishments in the lifetime of a political administration is great and therefore motivates political support for extensions. In addition, the perceived success of the initial phases has helped maintain a positive image for the system. As a result, political support for the project has remained strong.

#### ***3.5.4.4 Financial***

A phasing strategy which utilized railroad rights-of-way helped achieve the completion of both the South and East Lines within budget and on-time. Later phases have not been so

simple due to the unavailability of existing rights-of-way and the associated costs have been higher. This is demonstrated by the Mission Valley West Line whose construction price tag has soared from \$150 million to \$245 million in the last eight years.<sup>94</sup>

The early emphasis on low-cost, available technologies and the use of available rights-of-way has been viewed as successful from a farebox recovery perspective. In the late 80s the percentage of operating costs recovered by revenues was in the order of 90%. The high farebox recovery figure has helped motivate system expansion and has been a successful financial facet of the phasing strategy. This figure has dropped substantially in recent years however, with a 1994 figure of 66%.<sup>95</sup>

The continued search for local and state funding sources has kept the transit development issue at the forefront of the political agenda and has emphasized the importance of the role that transit fulfills. Furthermore, the high local investment in the transit system was an added incentive for successful system development. The sense of ownership and accomplishment that local funding participation imparts has been a successful financial facet of the phasing strategy.

### ***3.5.5 Implications for future phasing***

#### ***3.5.5.1 Transportation and Service***

The phasing strategy has resulted in an in-place network that is reasonably extensive and serves key corridors of the metropolitan area. This has helped promote an image of the system as a legitimate and credible transportation alternative and the support and motivation for its expansion continues to be strong as a result.

The Mission Valley West Line which links Old Town and the San Diego Jack Murphy Stadium is presently under construction and is hoped to be in service for the 1998 Super Bowl. At present the MTDB is studying the feasibility of extending the yet to be constructed Mission Valley West Line through the eastern part of Mission Valley into La

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<sup>94</sup> "Mission Valley trolley line: A transportation Travesty," The San Diego Union Tribune, March 31, 1995.

<sup>95</sup> "Comprehensive Annual Financial Report," MTDB, for the Fiscal Year ended June 30, 1994.

Mesa to connect with the East Line. The motivations behind the implementation are seen as: closing a gap in the system; providing service to SDSU, one of the region's major destinations; and meeting the demands of growing population and employment in the Mission Valley corridor.<sup>96</sup>

Further options for near-term system expansion include the Mid-Coast Corridor. This has recently been the subject of a transportation improvement study exploring Transportation Systems Management measures, High Occupancy Vehicle Lanes, Light Rail Transit, and Commuter Rail options.<sup>97</sup> If selection and implementation proceeds without delays, light rail transit service would begin in 2003.<sup>98</sup>

### ***3.5.5.2 Political***

A phasing strategy which has demonstrated the public and political support for system development in the San Diego region has helped assure Washington DC of the viability of rail transit investments in the area. As such, federal support will play an important role in the future expansion of the system. In 1992, the Mission Valley East Line was converted to the federal planning process to make a transit improvement in the corridor eligible for federal funding. It was considered that TransNet funds could not cover all construction costs. The federal planning process requires Alternatives Analysis including the development of "Best Bus" and "No Project" alternatives in addition to the light rail alternative. The purpose of the Alternatives Analysis is to determine the most cost-effective transit improvement for the corridor.<sup>99</sup>

The Mid-Coast and I-15 alignments are also seeking federal funding<sup>100</sup> and it is clear that the future expansion of the project will be heavily impacted by the rail transit funding environment in Washington DC and the requirements associated with that process. Should federal funding cease to be available, and other funding sources have not been

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<sup>96</sup> "Mission Valley East Transit Improvements," MTDB, June, 1994.

<sup>97</sup> "T-2000, Mid-Coast Corridor Transportation Improvements," MTDB, January, 1995.

<sup>98</sup> "Mid-Coast Corridor Alternatives Analysis," MTDB, November, 1994.

<sup>99</sup> "Mission Valley East Transit Improvements," MTDB, June, 1994.

<sup>100</sup> LRT Project Priorities, MTDB Board of Directors Meeting, December 10, 1992.

investigated, the development of the system will not proceed. Relying upon federal funding introduces an extra element of uncertainty into the phasing strategy.

**3.5.5.3 Financial**

The availability of local and state funding sources was instrumental in allowing the expansion of the in-place system. Further expansion of the system will depend on continued local support as well as state and federal funding (see Table 3-12).

**Table 3- 12 Potential Future Funding Sources**

Local sources	<ul style="list-style-type: none"> <li>• TDA Local Transportation Fund</li> <li>• San Diego Transportation Sales Tax</li> <li>• City of San Diego Transient Occupancy Tax (TOT)</li> <li>• San Diego Unified Port District</li> <li>• Developer contributions (for both right-of-way and facility construction).</li> </ul>
State sources	<ul style="list-style-type: none"> <li>• Transportation Planning and Development (TP&amp;D) Account derived from gasoline tax revenues</li> <li>• Article XIX Program funds also derived from the state motor vehicle fuel tax</li> <li>• Transportation Blue Print Legislation which provides for an increase in state transportation revenues of \$18.5 billion between 1991 and 2000</li> </ul>
Federal sources	<ul style="list-style-type: none"> <li>• Section 3 and Section 9 funds</li> <li>• Surface Transportation Program</li> <li>• Congestion Mitigation and Air Quality Program</li> </ul>

The heavy utilization of local funding sources during early project implementation has been a successful element of the phasing strategy for other reasons also. The availability of these funds has expedited the achievement of a reasonably extensive and comprehensive rail transit service. This has also demonstrated a commitment to rail transit in the area which has been a strong argument in petitioning for the federal funding of subsequent phases. Other funding options such as Public-Private partnerships are also being explored in the development of the Mission Valley Line.<sup>101</sup>

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<sup>101</sup> “San Diego Regional Rail Transit Plan,” MTDB, August, 1995.

#### ***3.5.5.4 Environmental***

The lack of existing rights-of-way will significantly impact future development of the system. This is demonstrated by the Mission Valley West project which has weathered substantial controversy over environmental effects, as well as its impact on the remains of an ancient Indian Village.<sup>102</sup>

Furthermore, the future reliance on federal funding for project implementation will require adherence to the requirements of the federal planning process. Compliance with these requirements has the potential to delay and complicate the implementation of later phases.

#### ***3.5.6 Summary of the Phasing Strategy***

The philosophy underlying the creation of the MTDB was to pursue a low-cost, pragmatic and incremental approach to system implementation. System construction focused on the easiest-to-construct segments initially utilizing available rights-of-way, and low cost and proven technology. The phasing strategy also incorporated the objective of combating sprawl through the penetration of rail transit service to residential areas. Consequently, the policy of limiting extensions to a minimum length of approximately 15-miles was adopted in the initial planning. Additionally, because the initial phases had a large component of local and state funding, this meant that system implementation did not have to adhere to federal planning requirements. All of these facets of the phasing strategy resulted in a successful initial system that was constructed on time and within budget, achieved the forecast ridership, and had a very high farebox recovery ratio. This success fed support for further system development. The next easiest segment - the East Line - was implemented using a similar rationale and with similar results.

The system was now reasonably extensive, had good coverage, and had been implemented at minimal cost using primarily local and state funding sources. Furthermore, a focus on incremental implementation had helped keep the expansion of the project in the minds of the public through the publicity associated with the regular achievement of project milestones. The initial and continued search for local funding sources preserved an

awareness within the public and political spectrums of the goals and the importance of rail transit development. The accomplishment of a system through the use of local funding sources has motivated a sense of ownership and represents a local financial stake which has made the success of the system an imperative.

In general, the planning of the system and the phasing strategy have helped preserve the vision of what the system would ultimately look like, and the constant state of planning readiness has allowed the use of available fiscal resources as soon as possible. The success of the in-place system has shown the viability of the transit alternative in the San Diego region and the significant local funding support has demonstrated the region's commitment to the Trolley alternative. This commitment facilitates the pursuit of federal support to fund Trolley system expansion.

### ***3.5.7 Lessons Learned***

One of the most important factors in the development of a successful phasing strategy was the availability of existing rights-of-way. This made construction simpler, cheaper and quicker, and avoided the negative impacts, costs and possible delays associated with clearing new alignments (see sections 3.5.3.1 and 3.5.4.1). It is clear that early system construction focused on taking advantage of these rights-of-way and the consequent speed of implementation was a primary factor in the early recognition of rail transit feasibility in the region.

Prior to system planning the Board adopted definitive principles to be followed in the alignment choice, design and construction of the system. These principles were detailed in section 3.5.2.1.3 and guided the Board decision-making. The objectives were very much focused on implementing a low-cost and extensive system using existing rights-of-way and technologies (see section 3.5.4.1). The adoption of these principles effectively eliminated any alignments involving tunnel or aerial configurations and maintained a focus on a minimal cost, low-adverse environmental impact, feasible and effective system. The

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<sup>102</sup> "Stadium Valley Pact is awarded," The San Diego Union Tribune, April 14, 1995.

development of support through the successful implementation of early project phases promoted expansion and was an important element of the phasing strategy.

System expansion did not rely solely on federal sources of funding. In fact, local funding sources comprised a major element of system implementation costs (see sections 3.5.3.5, 3.5.4.4 and 3.5.5.3). During the planning of the initial implementation of the system, rail systems were being developed in many other parts of the country resulting in stiff competition for federal funding sources. The San Diego region recognized the difficulty of obtaining federal commitments and opted to proceed with implementing a system using non-federal resources. This demonstrated the region's commitment to rail transit and provided a good argument for the allocation of federal funding to future expansion of the system (see section 3.5.5.2).

Furthermore, the utilization of non-federal funding sources meant that project expansion was not delayed or constrained by the need to comply with the federal planning process, nor did it have to justify project elements on the basis of FTA cost-effectiveness criteria. This element of the phasing strategy meant that project implementation was more flexible and could be achieved faster. As mentioned, this speed of initial implementation helped develop the momentum for system expansion.

Due to the funding constraints and the need to minimize costs, as local sources were being relied on for much of the funding, system implementation prioritized low-cost, high coverage routes. This has resulted in an extensive system serving many major activity centers which also addressed the objective of discouraging urban sprawl. The rail system has also been coordinated with bus service which acts as a feeder to the trolley stations. The coverage of the system and the presentation of a unified transit service has helped promote positive perceptions which in turn encourages expansion (see section 3.5.5.1). To complement this, the achievement of ridership targets and high farebox recovery figures also illustrate how the success of the initial phases in creating support for further phases is an important attribute of the phasing strategy.



The need to develop local funding sources has also helped maintain an awareness of the goals and the importance of the rail transit system. Furthermore, the accomplishment of the system through the use of these funding sources has motivated a sense of ownership as well as creating a greater incentive for the creation of a successful system.

The phasing strategy has focused on the incremental implementation of the system and this has helped keep the expansion of the project in the minds of the general public. The publicity associated with the opening of new elements of the system has been a positive instrument in promoting continued development.

Finally, the phasing strategy and planning of the system has helped preserve a vision of a system under development. This forward planning has also meant that project implementation is ready to take advantage of new fiscal resources as soon as they become available.

**Table 3- 13 Summary of Lessons Learned**

<p>1. The utilization of existing rights-of-way can be a positive element of the phasing strategy which can provide for an extensive, low-cost, low-adverse environmental impact system. This creates positive system perceptions which facilitates system expansion in a speedy manner.</p>
<p>2. The adoption of definitive principles regarding alignment choice and prioritization simplifies the analysis and provides a clear understanding of project direction.</p>
<p>3. The use of local funding sources, allows flexibility, speeds up implementation, and frees project development from the constraints associated with the federal funding process. These constraints include the need to comply with federal EIS standards, or justify project elements on the basis of FTA cost-effectiveness criteria.</p>
<p>4. The coordination of rail transit with bus service as part of the phasing strategy presents a unified, comprehensive and high coverage transit system. This combined with the achievement of ridership and farebox recovery forecasts creates positive system perceptions which contributes to a successful phasing strategy.</p>
<p>5. The use of local funding sources demonstrates a region's commitment to rail transit which heightens the likelihood of obtaining federal support for system expansion.</p>
<p>6. In general, a successful and speedy implementation process builds positive perceptions which in turn encourages continued expansion.</p>
<p>7. The need to develop and pursue local funding sources maintains an awareness of the goals and importance of rail transit development.</p>
<p>8. Successful system implementation through the use of local funding helps develop a sense of ownership and pride in the facility.</p>
<p>9. The opening of new system elements creates positive publicity and reminds people of the importance of transit development.</p>
<p>10. Continued system planning and design helps preserve a vision of a system under development. Forward planning also allows the use of available fiscal resources as soon as possible.</p>

# Chapter Four

## Lessons and Implications

The previous chapter examined the phasing and expansion of five rail transit systems. These case studies have identified the roles that various factors played in influencing phasing including technical, transportation and service, political, social, financial, environmental, and economic facets (see Table 4- 1). This chapter attempts to integrate the lessons and implications of the case studies. The discussion in the chapter focuses on two main issues: first, the identification of the roles specific factors played in system phasing; and second, the identification of issues that should be addressed and steps that should be taken to develop a successful system phasing strategy.

**Table 4- 1 Summary of the most important elements of the phasing strategies**

	Buffalo	Miami	Calgary	Caracas	San Diego
<i>Phasing issues</i>					
1. Utilizing available rights-of-way		✓	✓		✓
2. Implementing the system as fast as possible				✓	✓
3. Implementing most likely to succeed phases initially			✓	✓	✓
4. Prior upgrading of bus service			✓	✓	✓
5. Coordination of feeder services	✓		✓	✓	✓
6. Integrating system development with improvements to the urban environment				✓	
7. Low cost approach to system development					✓
8. High use of local funding sources					✓
9. Getting high coverage for low cost					✓
10. Prioritizing low-income areas				✓	
11. Long term planning			✓	✓	✓

## **4.1 What makes a successful phasing strategy?**

At the outset (in Chapter 2), the question was posed as to how the success of a phasing strategy should be assessed. As we have proceeded through our analysis, we have attempted to address this question.

Although closely linked, determining the success of a phasing strategy is not the same as determining the success of a system. The assessment of a phasing strategy cannot be determined purely on the basis of the system's success in achieving goals such as high ridership, low operating subsidies, low construction costs, or high economic development. These measures do not necessarily indicate the success of a phasing strategy, but the accomplishment of these goals may well be more difficult in the absence of an effective phasing strategy.

### ***4.1.1 Overall success of a system***

But how does one even measure the success of a system? Do we look at the rail system's impact on total transit ridership, air pollution, economic revitalization, area rejuvenation, or congestion reduction? For most systems an examination of these indicators would suggest a failure to achieve all objectives. What then are the functions and objectives of rail transit development? Rail systems are unlikely to reduce congestion and indeed are more likely to benefit from increasing congestion. Often their function will more likely be to act as an overflow capacity and as a means of increasing accessibility in and to congested urban centers, thereby helping change the dynamics of decline in many urban core areas.

Furthermore, over what time-frame should the success of a system be assessed? Because rail transit systems are a product of long-term planning and have implications that extend many decades into the future, it would seem appropriate that their success should be gauged over a similar span of years. In reality however, judgments of the success of systems are made much earlier. Inevitably, measures such as the degree to which the system achieved ridership goals, the farebox recovery ratio, capital costs and operating subsidies, number of jobs created directly or indirectly, all combine to form an almost

immediate image of the success of the system. However, the total contributions of a transit system can be viewed as being much broader than these measures alone would indicate. The substitution of transit for highway development, the impact on land-use and development trends, the influence on community development and social integration, long-term economic revitalization and area rejuvenation, all represent other benefits of a rail transit system not necessarily captured by the commonly utilized short-term measures.

Ideally these long-term effects should be accounted for in the assessment of system success. In reality this is difficult and instead short-term measures influence people's perceptions of the success of systems. These perceptions of success in turn influence the potential for system expansion.

But even defining the success of a system on the basis of the commonly used short-term measures is open to debate. Such measures would include the success of a system in achieving forecast ridership levels. However, if a system does not achieve the predicted ridership, does this imply a failure in this category? Perhaps the forecasts were over-optimistic and inaccurate to begin with. Given two identical systems with the same costs and ridership, one of which did not achieve the ridership forecast, while the other surpassed the predicted patronage: does this imply that one is a failure and the other is a success? Another commonly used measure is the farebox recovery ratio. Systems with high farebox recovery ratios are often termed successful, and those with low figures are seen to be unable to pay their way or justify their existence. But is this a fair measure given that systems have much broader financial implications than those captured by the farebox recovery figure? The transit system's impact on commercial and retail development opportunities, the general economic and social rejuvenation of an area, and its long-term contribution to the promotion of a higher standard of living are all elements not easily captured by a single measure and are certainly not represented by the farebox recovery ratio. Furthermore, as we do not expect public highways to pay their own way why should we expect transit to do so? Other figures such as capital cost overruns can similarly be viewed as indicators of a system's failure to accomplish objectives, but may in

actual fact merely represent inaccurate initial forecasts or a change in program elements that included valid additional costs.

The use of these measures without recognizing their limitations and without an appreciation for the wider implications of transit development can be very misleading. Nevertheless, although informed observers recognize the less easily measurable benefits of rail transit, these short-term measures inevitably surface. Even the FTA uses a specific measure of project cost-effectiveness to determine whether projects merit “discretionary” capital funding. The cost-effectiveness measure is supposed to be a critical deciding factor as to whether a project is accepted into alternatives analysis for possible federal funding and ultimately to compete with other projects nationally for federal funding. This cost-effectiveness measure is calculated as the net cost per new rider attracted to transit relative to a best bus/transportation systems management alternative. It incorporates ridership, amortized capital costs, operating costs and discounted time savings.<sup>103</sup> Thus, in reality, to obtain funding transit systems need to be justifiable on the basis of these short-term measures. This introduces an obvious incentive to have high ridership and low cost predictions while seeking funding. Of course, when funding has been assured, the incentive exists to lower the ridership expectations such that the operational system can more easily achieve apparent goals.

Ideally, systems should not be judged solely on the basis of these short-term objectives. In reality however, peoples’ perceptions of the success of systems are highly influenced by these measures. Given the present environment the success of a system is not judged by idealistic notions of what really constitutes success, but rather by what people perceive as successful. Regardless of measures, if a system is perceived as successful, the support for its expansion will exist and the system will be more likely to expand.

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<sup>103</sup> “Review, Analysis and Evaluation of the Tren Urbano Rail Transit Project,” Final Report, Multisystems, July, 1993.

#### **4.1.2 Success of a phasing strategy**

Although the ultimate objective of designing a phasing strategy is to help bring about the implementation of an extensive system, successful expansion is not the only indicator of the success of a phasing strategy. It may be the case that a successful phasing strategy was adopted although full system implementation was not accomplished as originally intended. In the implementation of a system, it does not necessarily have to be the case that the whole network must be constructed exactly as originally envisioned. Although specific plans for a full system may have existed at the outset, the phasing strategy may be such as to permit the revision of these plans at some point during the implementation process.

There are a host of reasons why the plans for system development could warrant alteration. Revisions could be based upon the experience gained from the implementation of earlier phases. This experience may have suggested that the development of an extensive rail transit in a particular region was not viable. In such a case, plans for further system development might be abandoned. Experience might also suggest that certain aspects of prior development were successful whereas others were not. For instance, perhaps lines serving low-income areas were found to be worthwhile but service to high income areas was not successful. In general, lessons learned from the early implementation of project phases may suggest a change in approach for subsequent expansion.

Alterations to the development plans might also be inspired by the impacts of early phases of the system. Such impacts may have resulted in a change in the urban structure, the development of new high demand routes, or the decline in importance of other corridors. Under such circumstances, the priorities attached to the implementation of certain project phases may shift, the need for new phases may be created, or the importance of other phases may be eliminated entirely.

There are a range of possible causes or changing circumstances which could suggest the alteration or the halting of development plans. Aside from this however, the consideration

of a phasing strategy also involves thinking about questions such as: What are the implications of federal and non-federal sources of funding? How does the speed of implementation impact prospects for successful system development? What steps can be taken to motivate public and political support of project phases? What policies should be adopted to guide system implementation? The answers to questions such as these help guide the design of a successful phasing strategy. As such, we can define a successful phasing strategy as an approach to the implementation of a system that best facilitates that process of implementation.

## **4.2 Analysis of the case studies**

### **4.2.1 Technical**

The availability of rights-of-way greatly influenced the phasing strategies adopted in the development of the Miami and San Diego systems. The existence of the Florida East Coast Railroad right-of-way in the case of Miami, and the San Diego and Arizona Eastern Railway rights-of-way in San Diego, greatly facilitated expansion plans. In each case, the easy availability of the rights-of-way provided the momentum to get the projects up and running and, indeed, their existence may have suggested the development of rail transit to begin with. In Calgary, long-range planning had resulted in the preservation of rights-of-way for the implementation of the south and northeast lines. This factor helped make the south line the obvious priority for initial implementation.

An important consideration in the implementation of rail systems is the prevention of disruption during construction. These problems were generally not such an issue in Miami and in the early construction of phases of the San Diego and Calgary systems due to the availability of the existing rights-of-way. However, the lack of available rights-of-way has complicated subsequent expansion of these systems. In the case of the Buffalo and Caracas systems, abandoned rights-of-way were not available and the difficulties in finding suitable alignments resulted in primarily tunnel construction. Adequate steps to prevent disruption due to construction were not taken in the Buffalo case and this factor is considered by some to be partly responsible for the population reduction, decline of retail



activity and movement of business out of the downtown which occurred. These impacts created negative perceptions and discouraged further system development. In Caracas, great care was taken to minimize disruption, additional congestion and environmental problems during the construction stages and this has been a positive element of their phasing strategy.

In general, the availability of existing rights-of-way is very desirable. It greatly simplifies the construction process and allows the implementation of substantial service with minimal disruption to the community. This creates positive perceptions which helps promote system expansion. As such, the use of existing rights-of-way can be a valuable tool in the development of a phasing strategy.

Related to this is the issue of 'at' or 'above-grade,' lower-cost construction versus 'below-grade,' higher-cost construction. As demonstrated in Buffalo, tunnel construction is much more expensive and can severely compromise system coverage. This lack of system coverage led to negative perceptions of the system and was another factor discouraging expansion. In Caracas, the financial support existed to construct an extensive system underground and as such it did not suffer the same fate as Buffalo. In San Diego, funding constraints dictated a phasing strategy which concentrated on extensive, low-cost, at-grade construction. This resulted in greater system coverage which benefited a greater proportion of the community. The positive system perceptions that this induced, helped promote system development.

Another issue in the consideration of a phasing strategy is the role and expense of technology. Buffalo adopted a high-tech, high-cost approach designed to support what was hoped would eventually become an extensive system. However, the expense of this approach was difficult to sustain and the system never did succeed in expanding. San Diego, on the other hand, had more expansion success with a policy of utilizing existing, available and lower-cost technologies and upgrading the fixed facilities (e.g. moving from single track with passing sections to double track operation) over time as demand warranted.

An issue common to all systems was the location of a suitable site for the maintenance/storage yard which was a fundamental factor in the prioritization of system segments .

#### ***4.2.2 Transportation and Service***

In general, transportation and service issues are important elements in the development of any phasing strategy. High ridership and good service coverage project the image of a successful and viable system and these positive perceptions can motivate expansion. As such, the phasing of any system often begins with identification of the high demand corridors. The Buffalo system had envisioned a number of lines and prioritized the Buffalo-Amherst corridor linking downtown to the high demand generator represented by the North Campus of the State University of New York (SUNY). The planning and phasing of the Caracas system involved linking the principal city nodes, the locations of the greatest concentrations of population, employment and public services, recognizing that these destinations represented the highest user demand. Similarly, the Miami long range planning identified the corridors of highest traffic demand and prioritized the North-South segment for technical and social reasons. In San Diego, the initial analysis considered nine candidate corridor alignments radiating from the downtown, with the primary selection criteria being cost and ridership. Preliminary system planning for the Calgary system began in 1966 and two of the high priority corridors identified by the studies were protected at that time. The high ridership forecast for the south line, made it the obvious priority for initial implementation.

However, a review of ridership figures indicates that neither the Buffalo nor Miami systems achieved the patronage forecasts. In Buffalo's case, an average weekday ridership of 29,000 fell well short of the 40,000 passengers predicted, and Miami's ridership of 50,000/day represented less than a quarter of the forecast. Although these lines increased accessibility and reduced travel times for those who used the service, the shortfall in expected ridership labeled these systems as failures. This aura of failure made the funding of extensions more difficult to justify.

In contrast, the San Diego Trolley and the Calgary C-Train are considered quite successful from a ridership perspective because of their closer adherence to forecast figures. The Caracas Metro is an example of an overwhelming success story. The system carries 1.2 million passengers per day which is 10% more than planned, and the travel time savings over the congested highway alternative have been very significant. In these cases, the perceived success of these systems were highly influenced by the high ridership numbers. This platform of success then encouraged the further development of these systems. As such, an initial concentration prioritizing the implementation of high ridership routes is likely to be a vital element in any successful phasing strategy.

Another item relevant to phasing decisions is the issue of system and service coverage. Once again, the Buffalo and Miami cases are examples of systems that failed to meet their service objectives. The Buffalo Metro Rail is only 10.3 kilometers long, about half the length of the originally proposed Phase I and falls well short of the intended final destination station of the suburban University campus. The lack of coverage has resulted in a rail transit system that is irrelevant to much of the urban area. The situation is similar in Miami. Although at 33 kilometers it is much longer than the Buffalo system, Phases II and III of the project have not materialized. The lack of service destinations has been compounded by the failure to coordinate feeder buses as originally envisioned. The result in both cases were systems that failed to achieve their service objectives and the poor perceptions that this created made system expansion harder to promote.

In Caracas, the approach of expanding the network as quickly as possible was adopted. As a result, the benefits of the system became more apparent for all to see and created support for extensions. Furthermore, in Caracas the policy of specifically serving the low-income areas and high demand centers is seen to be successful and the implementation of bus feeder services to the metro helped identify and create corridors for rail transit extensions. This policy of integrating bus and rail to produce a unified, comprehensive and high coverage transit system also proved to be successful in San Diego and Calgary. In Calgary, an initial concentration on rehabilitating the public transit bus system proved to be a successful element of their phasing strategy. The upgrading of the bus system formed

a prototype for the eventual rail system and developed an awareness of transit service in these corridors.

As such, San Diego, Calgary and Caracas, all of which adopted a phasing strategy which maintained a focus on implementing extensive system elements integrated with other transit services, have succeeded better from a service perspective. Each of these systems have expanded through several phases and now comprise multiple branches serving many destinations. They have become integral and important components of their urban transportation systems and their close coordination with other transit services such as bus have enhanced their stature as credible alternatives to the automobile.

### ***4.2.3 Political***

Political factors are fundamental to the phasing of any rail transit system. The prioritization of the Buffalo-Amherst corridor as the initial phase of the Buffalo system was a result of studies conducted by the New York State Office of Planning Coordination. The motivation to proceed with implementation arose in part out of Governor Rockefeller's need for the political support of upstate legislators to obtain approval of a state transportation bond issue. In Miami it was necessary to have a system extensive enough to serve, and thus obtain the political support of, both the city of Miami and the surrounding Dade county. As such, largely through positive political relations with Washington DC, they succeeded in developing an unusually extensive 33 kilometer first phase system. Political and public support ran high in San Diego as demonstrated by the voter-approved allocation of gas taxes for the purpose. This support facilitated implementation and influenced the phasing of their initial system despite the lack of federal funding. Similarly, politically supported funding programs in both the city of Calgary and Province of Alberta first encouraged Calgary to consider rail transit development and played a large role in the phasing of their system. The location of the 1988 Winter Olympics in Calgary also provided the political push required for system completion in 1987.

Both the Buffalo and Miami systems developed a phasing strategy which was dependent upon federal funding. This reliance upon federal funding and the Reagan Administration's policy against new rail starts effectively froze any expansion plans. In San Diego, the local political support for system expansion was such that they chose not to be restrained by the lack of federal funding and instead a phasing strategy utilizing local and state funding sources was adopted. The success of the initial system and the demonstrated local interest in promoting the rail transit alternative has also encouraged federal support for future expansions and as such, will play an important role in future phasing decisions. Early implementation in Calgary was primarily motivated by the provincial government. Since then, however, the recognition of the importance of the system for the future of the city has prompted the maintenance and development of the facility. Early implementation of the Caracas system was not constrained financially and this facilitated a phasing strategy which prioritized subway construction along the most desirable routes. The consequent success of the system has resulted in continued political and financial support.

In general the political facet of phasing decisions can be positive or negative. Although federal support can be the kick start necessary to get a project up and running, adhering to the federal planning process introduces uncertainty and can also constrain phasing decisions. Of course, fundamentally, ensuring the success of initial phases is the most important issue when addressing the political facet of a phasing strategy.

#### **4.2.4 Social**

Successful phasing of rail transit becomes much more likely if it is responsive to the desires of the public and the nature and development of the urban environment. In Calgary, long-term planning permitted the reservation of rights-of-way and allowed public comment and acceptance of pending rail transit development. Similarly, in Caracas, great efforts were made to induce urban transformations (including pedestrian malls, parks and plazas) to complement and enhance the transit system and encourage its expansion. Caracas also demonstrates the importance of modifying the phasing strategy in response to changes in the urban structure as a result of rail transit development.

An important issue in the development of a phasing strategy is the identification and targeting of the markets to be served. The Caracas system was developed under a phasing strategy which prioritized serving primarily low-income areas. This group was highly transit dependent, numerous, and represented guaranteed demand. Higher income areas were considered to be able to afford alternatives and so were not served. In other cases however (e.g. Washington DC), the prioritization of initial phases of system implementation to serve higher income, more affluent areas have enhanced perceptions of the system and thereby develop support for further extensions. The strategy to be adopted should depend upon the characteristics and equity concerns of the urban area in question.

In Miami, equity considerations in serving minority areas were fundamental to phasing decisions. As a result, the northern segment of the present system serves primarily Black and Hispanic communities. The phasing of the San Diego Trolley was linked to the greater urban development objective of preventing urban sprawl. Equity concerns were also influential in the prioritization of the East Line which serves the lower income, largely minority Southeast San Diego community.

In general, social impacts should be an important element of phasing decisions as people's perceptions are critical to future expansion. In Buffalo, construction disruption and the negative perceptions it induced discouraged future expansion, and poor perceptions due to lack of coverage also impacted Miami's rail development prospects. As described above, this contrasts with the other systems studied. Indeed in Caracas, people were educated to respect and have pride in their system and the efforts to minimize impacts due to construction meant that expansion was not viewed negatively from a construction disruption perspective.

#### **4.2.5 Financial**

Obviously financial factors heavily impact rail system phasing decisions. In Buffalo, the difficulties in obtaining federal funding and the need to put the line underground with higher associated costs resulted in a shortened 10.3 kilometer first phase system. Furthermore, the system cost \$550 million to implement which closely matched

projections but was expensive considering the modest extent of the line. These factors combined with a low farebox recovery ratio of 30% fed public disillusionment and resulted in a system that failed to expand further. In Miami, a 33 kilometer first phase with 77% federal funding was implemented. This elevated system which also utilizes the cheaply-acquired Florida East Coast Railroad right-of-way was adopted to save on construction spending. However, the Miami system suffered bad publicity due to a \$150 million cost overrun and at 40%, the farebox recovery ratio has done little to suggest a financially successful system. These negative perceptions of first phase implementation made future expansion more difficult to promote. Another financial phasing issue relates to the high operating subsidies required for operation of the Buffalo and Miami systems which have discouraged their expansion. These systems which are already finding it hard to develop funding sources to cover their existing operating deficits, would find it even more difficult to meet the capital and operating costs associated with system extensions. Additionally, the negative perceptions that funding deficits create further undermines political support. This contrasts with Caracas where the wealth of the country during the oil boom made the financial phasing of the Metro less of an issue. In San Diego, the phasing of the Trolley focused from the start on a low-cost, pragmatic approach to system implementation, using existing rights-of-way and available technologies. The phasing strategy focused on the use of local and state funding sources. This allowed greater flexibility in phasing decisions as project implementation was freed from the constraints of the federal funding process. The high farebox recovery figures of the initial phases, as high as 90% in the late 1980s, encouraged system development and demonstrated the viability of the system. This encouraged federal funding participation in the subsequent development of the system. The phasing of the Calgary system was greatly influenced by funding programs initiated by the Province of Alberta which provided continued financial support for system development.

Preserving the speed and momentum of expansion allows the benefits of the system to become more apparent for all to see thereby creating support for further extensions. This also maintains a public awareness of the expansion of the system and utilizes the experience already gained in construction and development. Clearly the availability of

federal funding can speed the pace of system implementation and, as demonstrated by San Diego, the use of local sources can also aid and hasten the implementation process. Local funding also helps infuse an understanding in the public and political spectrum of the goals and value of rail transit development. This involvement also represents a financial stake in the success of the system which motivates greater caution in rail system phasing and development and greater pride in its achievement.

#### ***4.2.6 Environmental***

All federally funded projects need to satisfy the associated environmental impact analysis requirements and this inevitably influences the phasing of the system. In Buffalo, the original plans proposed a 20.1 kilometer system with 58% in aerial configuration. Public opposition to an overhead system and the displacement of residents resulted in a shorter modified subway alignment. Although the tunnel construction was much more expensive, nevertheless the environmental review process was useful as it helped identify items that might have derailed the implementation of the system at a later stage. Unfortunately, the review process did not adequately account for the environmental impacts that the construction process would impose which led to poor perceptions of the system. Phase I of the San Diego Trolley was locally funded and as such did not need to adhere to the federal planning process. Nevertheless, other requirements imposed by the California Environmental Quality Act (CEQA) and the National Environmental Policies Act (NEPA) resulted in a need to account for visual, noise, open space, water resources and community impacts.

#### ***4.2.7 Economic***

The role of rail transit development in promoting the economic growth of downtown areas is a universally stated objective. City centers are generally locations of high density office and retail activity and to maintain prosperity, access to this area from the suburbs is essential. This goal often prioritizes the implementation of those phases likely to increase the accessibility of residential areas to the downtown or to other areas in need of economic stimulation.



In general, the development of rail transit has positively impacted all of the cities from an economic perspective. These benefits have included the creation of construction jobs, system operation staffing, and the encouragement of retail and business activity with the associated employment. The construction of the Miami Metrorail is considered to have contributed to the relative prosperity that the city enjoyed at a time when the country as a whole was in the midst of recession. The Caracas Metro is believed to have contributed significantly to the economic revitalization of the city through increased accessibility, and the resultant increase in business and recreational activity. Similar results are also apparent in Calgary and San Diego, although the success of the transit/pedestrian mall in downtown Buffalo is debatable.

### **4.3 Summary of phasing strategies**

All of the case studies revealed system plans that ultimately envisioned rail transit service to many parts of their metropolitan areas. In general, the phasing strategies adopted were those of initially implementing those segments of their proposed systems seen as the most likely to succeed. This often involved prioritizing phases which demonstrated the highest ridership potential and greatest coverage at the lowest cost and least community disruption, which in many cases meant the use of existing rights-of-way. The likelihood of network expansion beyond Phase I seems to be a function of the perceived success of this initial phase. Those systems that achieved a reasonably successful first stage as indicated by measures such as ridership, construction cost, operating cost and system coverage, tended to draw support for further expansion. However, those systems whose initial stages were perceived as unsuccessful failed to expand. A review of the Miami and Buffalo case studies supports this perspective. In both cases, the perceived failure of the initial phase did nothing to foster the expansion of the system. In the Caracas, San Diego and Calgary cases, the success of initial stages fed system expansion.

In Caracas however, expansion was not solely based on a strict adherence to the initial plans as was demonstrated by the recent proposal to construct a new line parallel to the first. Similarly in San Diego, decisions regarding the subsequent expansion priorities were

based upon a complete review of the alternatives. The successes of the in-place systems in Caracas, San Diego and Calgary have shown the viability of the transit alternative in these regions, thereby encouraging further expansion. On the whole, it appears that phasing strategies which focus on successful system increments are more likely to accomplish the implementation of an ultimately extensive network.

Obviously the success of these systems was evaluated through the accomplishment of the short-term measures detailed before such as achieving ridership, limiting costs and subsidies, etc. However there were many elements of their phasing strategies which facilitated this success. In Caracas, the phasing of their underground system was coordinated with phasing improvements to the surface of the urban area. As such, the implementation of the system became associated with a general improvement of the urban environment and of the standard of living. The positive perceptions that this induced encouraged system expansion. This integration of transit, transportation and land use planning was also a successful feature of Calgary's phasing strategy.

Another feature of successful phasing strategies was the integration of other transit services as a complement to the rail system. The experience of Calgary, Caracas and San Diego shows that efficient bus transit operation generally paved the way for rail transit implementation initially and later was oriented to function as a feeder service to the in-place system and as a complement in areas where rail service did not exist.

The Caracas, Calgary and San Diego cases demonstrate that preserving the speed and momentum of expansion is important in maintaining a public awareness of the expansion of the system as well as utilizing the experience already gained in construction and development. To this end, San Diego developed a great deal of local funding to aid and hasten the implementation process. This also infused an understanding in the public and political spectrum of the goals and value of rail transit development.

Another issue shown to be important in maintaining the momentum of expansion is long term planning. This was a conscious policy objective of both the San Diego and Calgary systems which allowed the identification and protection of rights-of-way, permitted public

input into rail transit development, and meant that expansion plans were ready to take advantage of funding opportunities as soon as they arose.

Table 4- 2 provides a summary of the main lessons learned from the case studies. There are a total of 26 points categorized under the headings: Technical, Transportation and Service, Political, Social, Financial, and Environmental.

**Table 4- 2 Summary of Lessons Learned from the Case Studies**

<b>Technical</b>	
1	Future phasing decisions should consider how to limit and mitigate disruption due to construction.
2	When developing a phasing strategy, the role and expense of technology should be carefully considered.
3	The issue of 'at-' or 'above-grade', lower-cost construction versus 'below-grade', higher cost construction, can affect phasing and the success of the system which in turn has implications for future construction.
4	A phasing strategy which utilizes existing rights-of-way provides for an extensive, low-cost, low-adverse environmental impact system. This creates positive system perceptions which encourages system expansion.
<b>Transportation and Service</b>	
5	Compromising on the extent of phases mean that they do not fulfill the role intended of them. This makes it more difficult for them to be successful and if unsuccessful system expansion is harder to promote.
6	Successful rail transit phasing, particularly in the initial stages of implementation, relies heavily on its integration into a total transportation system spanning all public transit modes.
7	The policy of locating stations on the main city nodes and only serving the areas of highest demand, ensures good patronage of the system. This success facilitates the expansion of the system.
8	A phasing strategy should consider the characteristics of an area and identify the markets to be served recognizing that targeting lower or higher income areas in particular may be an appropriate approach to system development.
9	Feeder services identify or create corridors of high demand which can be assessed and ranked for potential rail system expansion.
10	Prior phasing of bus service along proposed rapid transit alignments serves as a prototype for rail transit implementation, and develops ridership and promotes an awareness of transit service along the corridor.
11	Constructing and expanding the network as quickly as possible is a good phasing strategy as the benefits of the system become more apparent for all to see and this creates support for further extensions.
<b>Political</b>	
12	Political support is the main factor responsible for getting projects started. The lack of political motivation is the main reason why systems do not expand further.
13	The perceptions of the existing system influence support for future expansion. The failure of initial phases, whether real or perceived, makes system expansion more difficult to accomplish. Negative perceptions can be due to:
	- Ridership failing to meet projections.
	- Poor farebox recovery ratios and operating deficits much larger than projected.
	- Large initial costs of construction.
	- Low coverage and a lack of service destinations.
	- Poor management and technical problems during construction.
	- Disruption due to construction.
14	External factors (e.g., Olympic Games) can be used to motivate the expansion of a system and can influence phasing decisions.
<b>Social</b>	
15	A phasing strategy which also attempts to develop and induce urban transformations enhances the success of the project and encourages its expansion.
16	The phasing of the project must account for changes in the urban structure while the system is under development and due to changes induced by the implementation of the system itself.
17	The adoption of definitive principles regarding alignment choice and prioritization simplifies the analysis and provides a clear understanding of project direction.
18	Long-term planning recognizing future transportation needs allows the reservation of rights-of-way and permits public comment and acceptance, which in turn facilitates system expansion.
19	An extensive public involvement process promotes an awareness of system development which contributes to a successful phasing strategy.
20	Educating people to respect and have pride in the system creates positive perceptions and facilitates the expansion of the system.
<b>Financial</b>	
21	The availability of large financial support (from federal, state, local or other sources) allows the flexibility to make the most desirable alignment choices and phasing decisions.
22	The use of local funding sources, allows flexibility and frees project phasing from the constraints associated with the federal planning process. It also motivates and demonstrates a commitment to the rail transit alternative.
23	Long-term planning also allows the utilization of funding sources as soon as they become available.
24	Phasing decisions should consider carefully the issue of securing funding to cover the operating deficits to be incurred.
<b>Environmental</b>	
25	When a phasing strategy which focuses on minimizing the impacts due to construction is adopted, expansions of the system are not viewed negatively from a construction disruption perspective.
26	The environmental impact assessment process is important in detecting and correcting concerns which could de-rail a process at a later stage.

# Chapter Five

## System Phasing for Tren Urbano

In this chapter the development of a phasing strategy for the implementation of the Tren Urbano Rail Transit Project in San Juan, Puerto Rico is examined. In working towards this goal an initial discussion of the existing system implementation plans and proposals and the phasing approaches suggested will be presented. The rationale for the present Phase I alignment will be discussed to provide some background on the decision environment and an attempt will be made to identify those factors particular to San Juan which are likely to have a strong bearing on the subsequent phasing approach to be adopted. The discussion will incorporate the lessons learned from the case study analysis of other transit systems as we consider how these lessons apply to Tren Urbano.

### 5.1 The San Juan Region

In the 1940's and 50's, only 30.3% of Puerto Rico's population lived in urban areas. Historically, metropolitan San Juan was comprised of a number of small, compact centers such as Old San Juan, Río Piedras and Bayamón. From the 50s onwards, however, typical suburban development has filled in the areas between these centers and has extended the borders of the metropolitan area. This development was made possible by rapidly increasing rates of auto ownership and use. Today, 71.2% of the island population live in urban areas. Car ownership is among the highest in the world rising from 141 cars per 1000 inhabitants in 1964<sup>104</sup> to 476 per 1000 inhabitants today.<sup>105</sup> The SJMA suffers from severe traffic congestion and this has also impacted the performance of the public

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<sup>104</sup> Final Environmental Impact Statement, Tren Urbano, San Juan Metropolitan Area, Puerto Rico, November, 1995.

<sup>105</sup> Anibal Sepúlveda, "Río Piedras: A Town in Convalescence, The Tren Urbano as an Urban Generator", in a presentation given at the UPR/MIT Second Encounter in Puerto Rico on January 11, 1996.

transportation system which presently consists of buses and públicos. Patronage on these services fell from 37% of total regional travel in 1964 to only 10% in 1990.<sup>106</sup>

The suburban style of urban development which has been traditionally associated with progress, is now more subject to criticism. The building of highways has contributed to lower density development and greater car dependence, as has the long-term decline of public transportation. Urban planners worldwide now recognize the negative aspects of suburban sprawl and generally advocate a strengthening of urban centers. Among the key roles of Tren Urbano is to serve as a catalyst in the revitalization of the urban centers and to act as a countervailing force to out-migration commercial activity. Within this context, the issue of extensions beyond the first phase of Tren Urbano, and their role in shaping the future of San Juan becomes highly relevant.

## **5.2 System Plans, Proposals and Phasing Suggestions**

In 1967, a Regional Transportation Study conducted by Wilbur Smith, Inc., proposed a rail transit system for the San Juan Metropolitan Area. The proposal consisted of a 43.5 kilometer rail system including two routes; a north-south route in the Santurce-Río Piedras corridor and, an east-west route linking Bayamón and Carolina via Hato Rey.<sup>107</sup>

The 1979 alternatives analysis of transit options for the metropolitan area, conducted by Consultores Tecnicos Asociados/Alan M. Voorhees and Associates, Inc. recommended a 24 kilometer rail system extending from Miramar, south through Santurce and Hato Rey, to Río Piedras and then west to Bayamón. This was known as the Bayamón Crescent route and became part of the 1981 Regional Transportation Plan.<sup>108</sup>

More recently, the March 1993 San Juan Regional Transportation Plan prepared by Barton-Aschman Associates Inc., included a 31.5 kilometer rail system which prioritized

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<sup>106</sup> Final Environmental Impact Statement, Tren Urbano, San Juan Metropolitan Area, Puerto Rico, November, 1995.

<sup>107</sup> Wilbur Smith Associates/Padilla & Garcia, San Juan Metropolitan Area Transportation Study: Transportation Plan, June, 1967.

<sup>108</sup> Consultores Tecnicos Asociados/Alan M. Voorhees & Associates, Inc., Metro for San Juan: A Study of Transit Alternatives for the Metropolitan Area of San Juan, June, 1979.

Tren Urbano Phase I in the Bayamón Crescent as well as proposing extensions of the system to serve Carolina to the east and Caguas to the south (see figure 5.1).

In the 1993 Plan, Phase I of Tren Urbano was proposed to be an 19 kilometer transit line from Sagrado Corazón on the edge of Santurce to Luchetti in Bayamón via Hato Rey and Río Piedras (see figure 5.2). It was considered that this route should be the top priority for initial construction for a number of reasons. First, both now and through 2010, it is estimated that a larger share of the region's population will be located to the west of San Juan than to the east. For the year 2010 the percentages are projected to be 41% to the west, 28% to the east, and 31% in San Juan itself. Second, it was considered that the Phase I system would be a more attractive option than the congested highways - particularly the PR2 corridor. Third, this line could be implemented more quickly and at lower cost, as it would utilize the right-of-way originally reserved for the PR-21 expressway. And fourth, this line was more attractive for initial implementation as the Bayamón Crescent alignment was already contained in the official transportation plan.

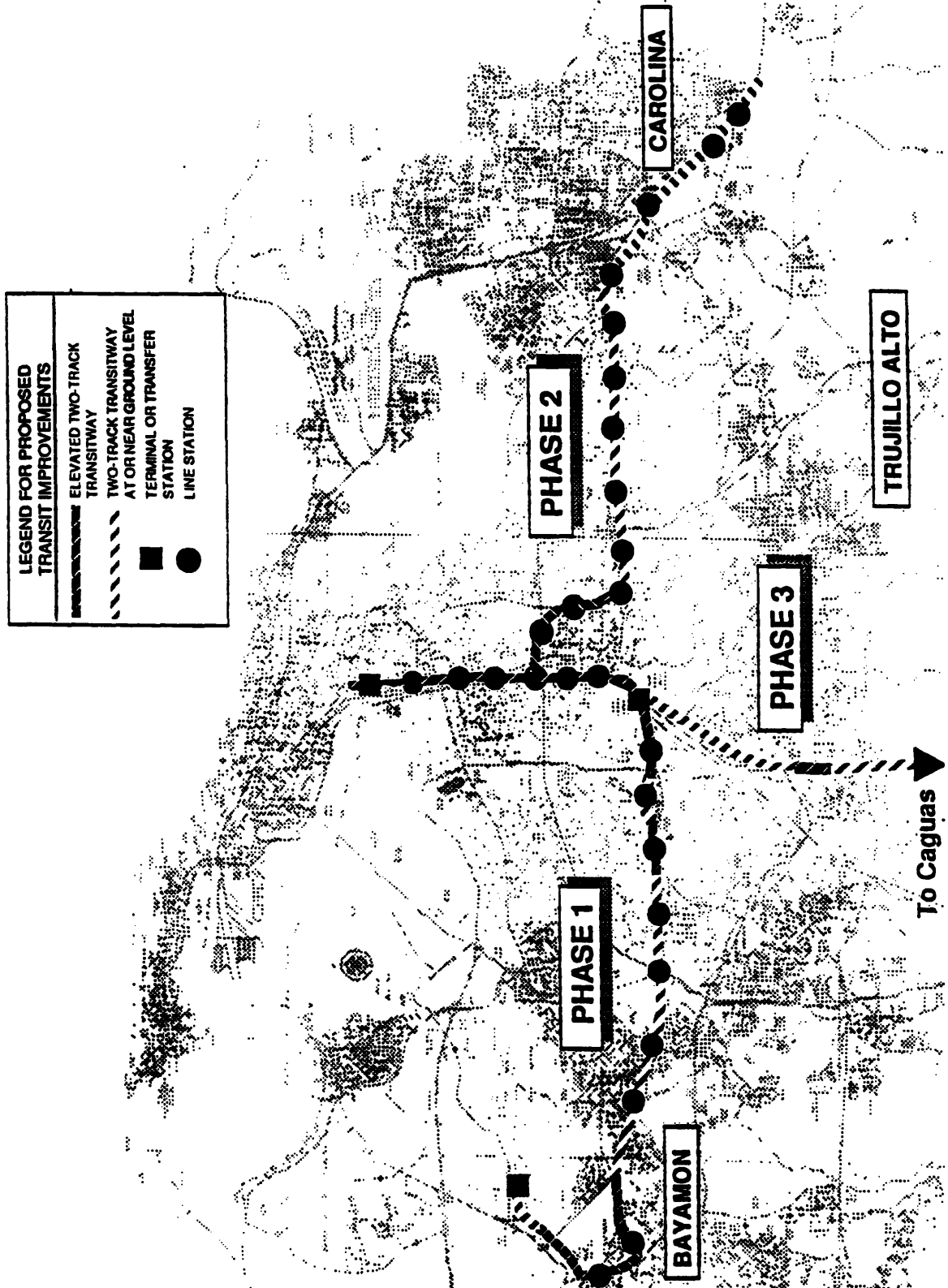
In addition, the 1993 Plan recommended that Phase 2 be a 12.6 kilometer link between Río Piedras and Carolina to the east. Phase 3 was thought of as a possible extension of service from Río Piedras south to Caguas within the PR-52 right-of-way.

Capital costs and patronage forecasts were also conducted for Phases 1 and 2 at this time. Phase I was estimated to cost \$670 million (in 1992 dollars) excluding right-of-way costs. Phase 2 capital costs were put at \$566 million. If only Phase I of the project was built it was estimated that it would serve 105,800 daily passengers by 2010. The addition of Phase 2 by 2010 would raise expected daily system boardings to 228,600. These volumes were based upon an assumed average fare of \$0.50 per rail boarding.<sup>109</sup>

The phasing strategy for this proposed Tren Urbano system considered that Phase I would begin revenue operation between Santurce and Bayamón in late 1998. Subsequently Phase 2 would add service to Carolina perhaps by 2008 while Phase 3 would bring service

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<sup>109</sup> Barton-Aschman Associates, Inc., San Juan Regional Transportation Plan, March, 1993.



**Figure 5-1 Tren Urbano Phases 1 - 3 (as contained in March 1993, San Juan Regional Transportation Plan)**



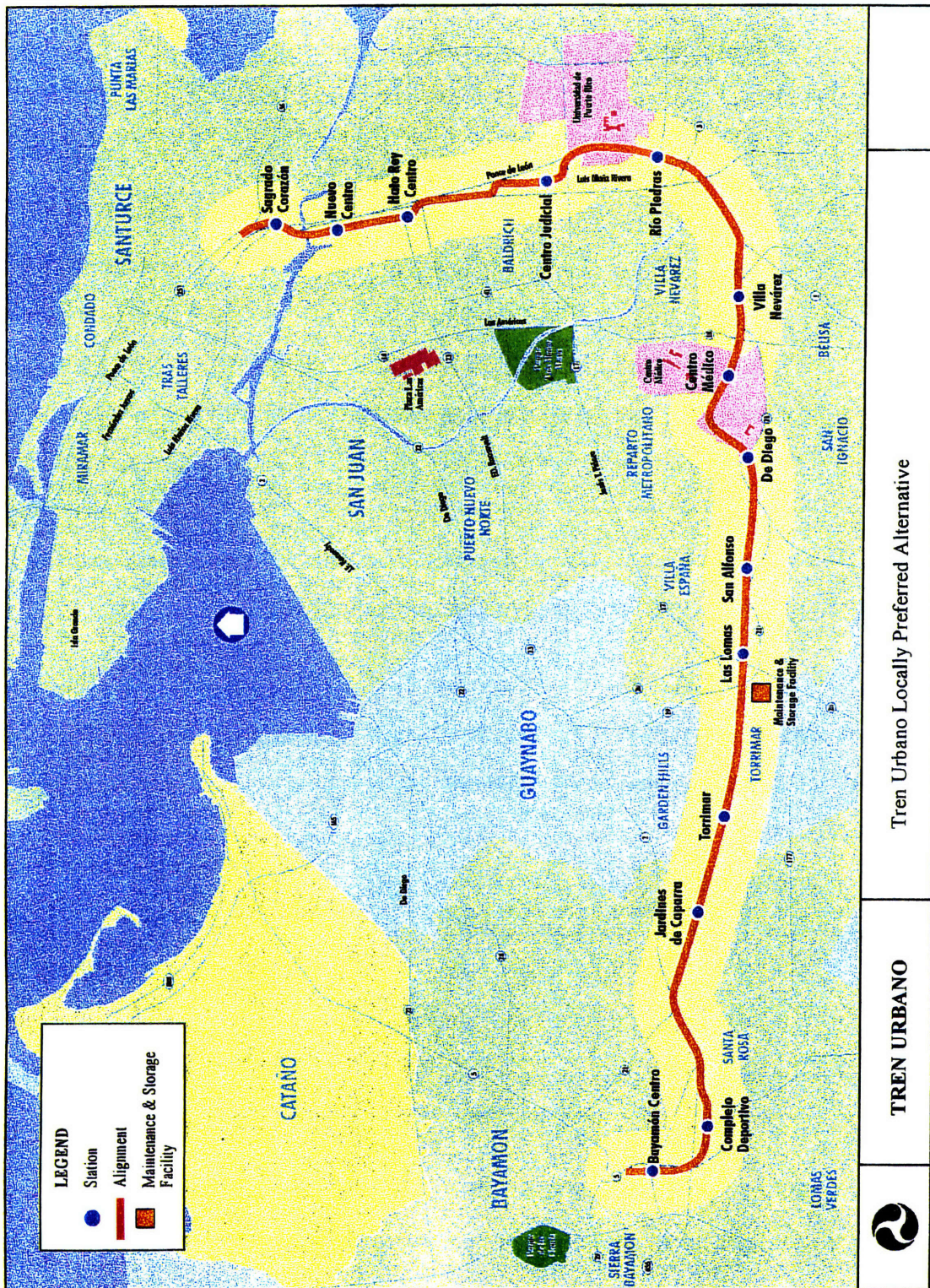


Figure 5-2 Tren Urbano Phase 1 (as conceptualized in March 1993, San Juan Regional Transportation Plan)



to Caguas sometime after 2010. It was also recognized at this time that funding availability might dictate staging Phase 2 by constructing the segment from Avenida Muñoz Rivera to PR-181 initially, leaving the remainder of the link to Carolina for a later implementation phase.<sup>110</sup>

By the time of release of the Tren Urbano Draft Environmental Impact Statement of March 1995,<sup>111</sup> the proposed system configuration and phasing strategy had been further refined. Plans for future extension of the Phase I system now considered an extension north from the Santurce terminus into Minillas as the most important next step. From Minillas possible extensions east to Old San Juan and west to the International Airport were visualized. The branch from Río Piedras to Carolina was also being contemplated, however, no mention of the previously proposed connection to Caguas was contained in the DEIS. The resulting full system configuration, resembling a “sideways-H,” was also incorporated into the Final EIS published in November of 1995 (see figure 5.3).<sup>112</sup>

The idea of extending Tren Urbano to Caguas was dropped for the purposes of Phase I planning. A three branch rail system is difficult to operate for a number of reasons. If the demand on each of the branches varies greatly in volume and peaking, then scheduling problems arise, as well as the issue that the construction of such a junction would encounter space constraints. Furthermore, it was considered that the demand generated by Caguas, and the fact that it would primarily be commuter traffic, may not justify this extension of the system at this time. It appears that Caguas is not dense and concentrated enough to make it a prime area for a metro connection. It was considered that as the potential for future expansion is explored, additional alternatives, such as a rubber tire approach, for serving demand in the area should be explored.

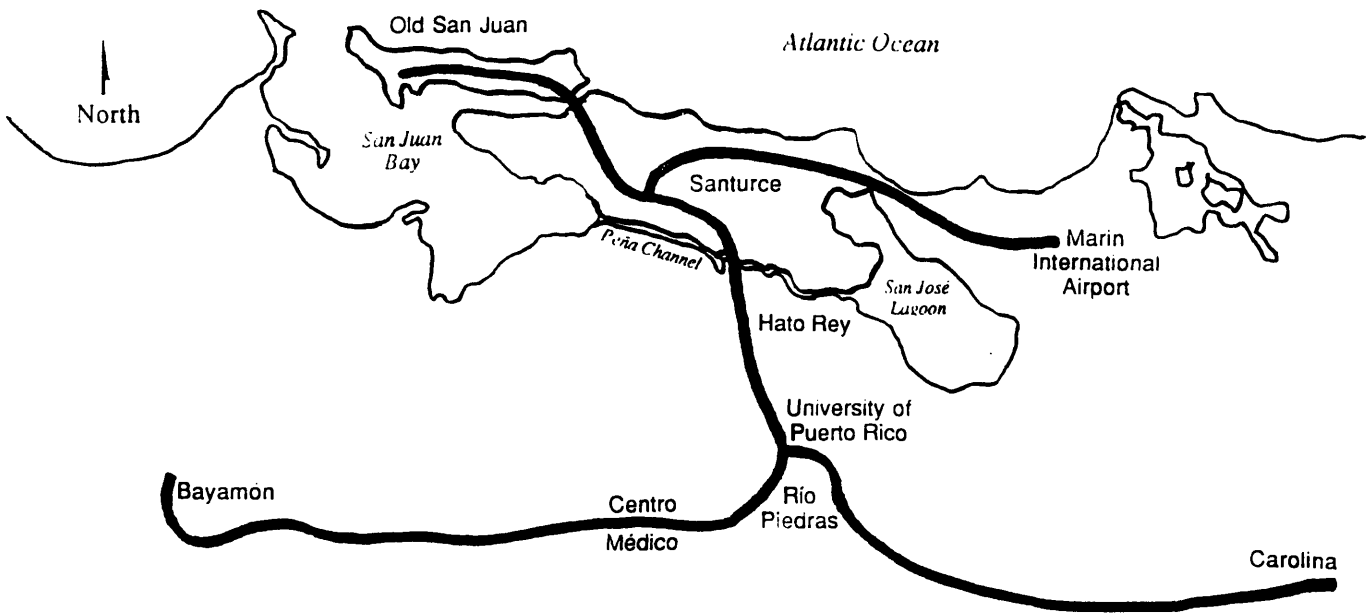
The ‘sideways-H’ system configuration was first proposed in early 1994. It must be recognized however, that the completion of such an extensive system could only occur

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<sup>110</sup> Parsons De Leuw, Inc.: System Description and Operating Specifications, December, 1992.

<sup>111</sup> Draft Environmental Impact Statement, Tren Urbano, San Juan Metropolitan Area, Puerto Rico, March, 1995.

<sup>112</sup> Final Environmental Impact Statement, Tren Urbano, San Juan Metropolitan Area, Puerto Rico, November, 1995.



**Figure 5-3 Tren Urbano Full System Build-Out**

over an extended period. Phase I of Tren Urbano will connect Bayamón to Sagrado Corazón on the edge of Santurce via Hato Rey and Río Piedras, a distance of 16.9 kilometer (see figure 5.4). This will be operational in 5-6 years but there could be a significant gap before completion of future phases. In the interim many factors could change which could have a bearing on future expansion. Over time, there will be life cycle costs associated with maintenance of the system, ridership changes as the system matures, technology advances which will influence decisions and funding which will always be an issue.

### **5.3 System Phasing for Tren Urbano**

#### ***5.3.1 Concerns over the present Phase I system***

There are those who hold the view that the present proposed terminus of Phase I of Tren Urbano at Sagrado Corazón does not represent the most appropriate location. It is argued that the line should extend to Minillas as part of Phase I. Minillas, deeper in the heart of Santurce, is the biggest governmental center in San Juan and, as such, is a significant travel demand generator and well worth serving. Minillas also represents a logical site when one considers that future elements of Tren Urbano are envisioned to include links to Old San Juan and the Luiz Muñoz Marín International Airport. These phases would be well served by a junction at Minillas linking to the first phase of the system. Furthermore, Sagrado Corazón is located on the edge of Santurce and does not represent the most convenient access/egress point for those in Santurce.

Another query of the present alignment concerns Plaza Las Americas. This is the main shopping mall on the island and the largest in the Caribbean. The area is also the location of sports facilities, office parks and regional facilities including Police offices. Considering that the area is such a significant destination, its failure to be served by Phase I of Tren Urbano is questioned by some.



Figure 5- 4 Tren Urbano Phase 1 (as of 30 November 1995)

### **5.3.2 Technical**

Originally, Tren Urbano was envisioned to be a light rail system. The system was to incorporate some higher cost elements in order to deal with obstacles such as traffic lights on Muñoz Rivera. However, late in 1992 the system patronage estimates suggested that a heavy rail system would be more appropriate and this idea was officially adopted in 1994. The Draft Environmental Impact Study of 1994 still referred to both technologies but with a greater weighting towards the heavy rail option with the associated necessity of having an exclusive right-of-way. It is clear with the publication of the Final Environmental Impact Statement of November 1995, that Tren Urbano will be a heavy rail system powered through an electrified third rail rather than overhead catenary.

This choice of technology has implications for phasing decisions as it affects the cost of construction, the design of junctions, and where the alignment can go. For instance, it was simply not practical to use light rail technology to enter Santurce at grade as the building blocks are so small in this area that two intersections would be closed at the same time by the passing of the train. The choice of heavy rail might also impact the previously discussed idea of extending the system to Caguas. Although it would be worthwhile to serve this region with some sort of transit service, depending upon the amount and nature of the ridership to this region, the construction of a metro to serve it may not be warranted.

The location of a maintenance and storage facility is another important consideration. The alignment for Phase I originally extended north of Bayamón to Luchetti. The only real reason for the extra track length was the location of a suitable site for the maintenance yard. With the relocation of this facility to a site near the Las Lomas station, the need to extend the system to Luchetti was eliminated. When extending the system beyond Phase I, access to the maintenance yard will have to be considered. This might require connecting up additional segments to the existing system. Also, a more extensive system would require additional cars which might necessitate building a new maintenance facility.



From the point of view of encouraging future expansion, it is very important that Phase I of Tren Urbano is constructed with a minimum of disruption. Construction impacts have the potential to create a great deal of anti-rail feeling and the perception that rail development is a bad thing. This would make future expansion difficult to promote. With regard to this, the EIS for the Hato Rey area referred to the possibility of an additional station between Hato Rey Centro and Centro Judicial at Domenech Street. If developed, a piece of the present alignment would shift from being elevated to an alignment along the side of the street. Such a change would eliminate the negative perceptions associated with an elevated segment as well as encouraging the economic development of that area through the provision of transit access.

A related issue is that of economical, at-grade construction versus more expensive, below-grade approach. Under limited funding conditions this issue can significantly affect system coverage and success, which in turn has implications for further expansion. The utilization of existing rights-of-way provides for an extensive, low-cost, low-adverse environmental impact system. This creates positive perceptions, which obviously facilitates expansion, but the question of whether the right-of-way is really providing service to relevant destinations also needs to be considered.

### ***5.3.3 Transportation and Service***

Population in the San Juan metropolitan area is rising steadily and is expected to increase by 20% to 1.55 million by 2010. At present 60% of the region's population resides in San Juan and in the Municipality of Bayamón to the east and Carolina to the west. When one considers that these areas also account for 83% of the region's jobs it is clear that accessibility to these municipalities is a priority which will influence the phasing approach adopted.<sup>113</sup>

We have described the existing plans and proposals for system extension and implementation phasing in San Juan (see section 5.2). However, at present in San Juan,

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<sup>113</sup> Final Environmental Impact Statement, Tren Urbano, San Juan Metropolitan Area, Puerto Rico, November, 1995.

the focus is very much on making Phase I a reality and this is consuming the current political, financial, planning and engineering resources. It is not clear whether the general public's conception of Tren Urbano consists just of Phase I or whether it encompasses a broader view of an extensive system serving much of the metropolitan area. As described previously, many ideas concerning possible system extent have been suggested in the past, however the variations of the basic Santurce - Hato Rey - Río Piedras - Centro Médico - Bayamón corridor also referred to as the 'Bayamón Crescent' route have always received the greatest attention. Since 1982 the Puerto Rico Planning Board, the agency responsible for guiding the development on the island, has incorporated the Tren Urbano alignment recommended by the 1979 alternatives analysis process in its Regional Land Use Plan.<sup>114</sup> As discussed already, the 'sideways-H' system concept now being proposed has only come into being very recently and has not been studied in detail. The planning and processing of Phase I was already well advanced before the new full system concept existed.

Some issues arising from this relate to whether or not a full system concept is a useful tool. In the case of San Juan, should more emphasis be placed on the total network idea which would serve all of the metropolitan area, as a means of creating public support and facilitating the reservation of rights-of-way for the implementation of future project phases? If not, do the extensive system plans merely serve as useful guidance for planners and engineers as they more carefully consider project direction. At present, there exists a great deal of support for the extension of the Phase I system to Minillas, known as Phase IA. However, any decisions concerning the appropriate alignment to Minillas will be heavily influenced by where the system proposes to expand beyond Minillas. As mentioned in section 5.2, Phase II of the system was envisioned as a link to Carolina. However, the implementation of the eastern section of the proposed PR 66 highway could affect the prioritization of this phase of the rail system.

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<sup>114</sup> Final Environmental Impact Statement, Tren Urbano, San Juan Metropolitan Area, Puerto Rico, November, 1995, (Page 3-18, 3rd paragraph).



Perhaps a stated policy of serving all of the metropolitan area by rail would be useful. This could be stated as a project objective such as “maximize the number of people within walking distance of a transit station.” A criteria such as this is a specific public transportation service objective and would have a bearing on the phasing strategy adopted. It is not clear that a policy such as this exists in the case of Tren Urbano. Another issue may be whether to adopt a policy of constructing a lower coverage but higher quality system, or a larger, more extensive system but of a lower quality. As described in Section 5.3.4, initially the emphasis was on an extensive, lower quality system. Since then the emphasis has shifted somewhat towards higher quality elements. Time constraints however, have limited the number of major alignment revisions that could be carried out.

Tren Urbano’s objectives include reducing congestion and improving accessibility. As described before, Phase I of Tren Urbano will follow the general alignment of the Bayamón Crescent, connecting Bayamón to Centro Médico, Río Piedras and the University of Puerto Rico (UPR), Hato Rey and the edge of Santurce. Project planning and FTA requirements are such that the proposed system should be an independently viable rail project that does not depend on any future extensions of the system. Achieving a reasonably extensive first phase that has good service destinations will greatly affect expansion prospects. If the system does not have sufficient coverage it will be irrelevant to much of the urban area. This will induce negative perceptions of the system and will not encourage its further development. Phase I of Tren Urbano serves a large number of strong destination stations (the financial district of Hato Rey, Río Piedras, the University of Puerto Rico, and Centro Médico), even though, as mentioned before, the alignment does not incorporate Plaza Las Americas. It is recognized that while this area is a significant destination, the demand in this area does not compare to that of the Hato Rey corridor. When one considers the alignment, the notion of connecting to Plaza Las Americas as part of Phase I is not realistic. This destination really represents a different corridor with very different travel characteristics perhaps worthy of service in a future phase of the system. Nevertheless, at 16.9 kilometer, the first phase is a significant step on the road to providing a substantial rail transit system. Compromising on the extent of the initial phase could result in a line that effectively ‘goes nowhere,’ serves few, and develops

a perception that rail transit is a high cost option that achieves little. As such, it is important that Phase I is implemented in its entirety such that it fulfills the role intended of it and demonstrates the viability of rail transit.

However, Tren Urbano can not be a stand alone facility and to be successful it must be integrated with other components of the transportation system. As such the coordination of Tren Urbano with the existing AMA, Metrobus and público services is vital to the success of the system, as it is estimated that about 55 percent of all riders will arrive at rail stations via these modes.<sup>115</sup> The question of público integration with the rail system however, will not be easy to control and the answers are not obvious. The públicos are individually owned and operated and while they are subject to regulation by the Public Services Commission (PSC) the ultimate control of their routing is in the hands of their owners. A phasing strategy which aids in the smooth coordination with these other services is essential to the provision of a comprehensive transit system that can effectively address the region's transportation goals. Given the long lead time associated with the implementation and reorganization of these transit services, the upgrading should begin now in anticipation of the opening of the rail system in five to six years time.

Additionally, these feeder services can identify and create corridors of high transit demand with possible potential for rail system expansion. Their role in promoting the future expansion of the network therefore becomes very relevant. Similarly, the prior implementation of bus service along proposed rail transit alignments, such as the present Metrobus I and II routes, develops transit ridership and promotes an awareness of transit service along the corridor. This is an important element of the phasing strategy as it ensures a smooth and natural transition to rail service.

Integration with other transit modes is essential to the provision of a coherent transit system in the short-term. However, to achieve this goal, the construction and expansion of the rail network as quickly as possible is also a good strategy to adopt. In this manner,

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<sup>115</sup> Final Environmental Impact Statement, Tren Urbano, San Juan Metropolitan Area, Puerto Rico, November, 1995.

the benefits of the system will become more apparent to the community at large and this will create support for further extensions.

Another service issue relates the question of who will use Tren Urbano. Originally, the provision of transit access to the UPR campus was for later consideration. However, the University has now approved a more concentrated development plan to complement the transit option. This suggests that the University development and the construction of a new station to serve the campus could proceed concurrently. Additionally, if bus and público feeder services are oriented towards serving the student demand and making transit an attractive option, this could enhance the service potential of the rail transit system in general.

The possible relocation of the Villa Nevárez station to a point slightly east and south of its present position also addresses service issues. The existing location has low ridership potential and serves a prison which could create a negative image of the system. The proposed new location would serve the Metropolitan University and could create a potentially high student transit patronage. Generally speaking, transit services must be oriented to meet customer desires and expectations if they are to penetrate the market.<sup>116</sup>

At present, Phase I of Tren Urbano projects approximately 115,000 riders per day in the year 2010. This high ridership figure has resulted in a very high cost-effectiveness index and has been a strong argument for project implementation. These projections rely upon a 20% increase in population and a 21% increase in the rate of trip-making.<sup>117</sup> Development potential and its impact on ridership has not been incorporated into the model yielding somewhat conservative estimates. However, the degree of development or the rate of increase of population or trip-making will be irrelevant unless issues such as the development of bus and público feeder services are addressed. From the perspective of judging the success of the in-place system, the attainment of this ridership goal will be important. A failure to achieve this stated figure will lead to questions concerning the

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<sup>116</sup> See "Toward a Positioning Strategy For Transit Services in Metropolitan San Juan," Alan S. Hoffman, M.I.T., Master's thesis, February, 1996.

viability of the rail transit alternative in the San Juan metropolitan area. Such questions would not encourage support for expansion.

#### ***5.3.4 Political and Financial***

In the period 1990-91 the funding for Phase I of Tren Urbano did not rely on any discretionary federal assistance. The policy of those involved in the planning of the system was to provide a reasonably extensive service but at a minimum cost. Thus, the idea of going deeper into Santurce was not economically viable. Such an extension of the system was assumed to be a tunnel that would have required construction under Ponce de León, and would cost an estimated \$250 million which were not available. The presently planned tunnel section under Río Piedras also did not exist because of the perceived cost constraints.

In January, 1993 there was a change in administration for the government of Puerto Rico. Although the alignment was not changed, discussions were begun with the FTA exploring the idea of discretionary federal funding. The new Secretary of Transportation and Public Works, aware that the project was a good one and potentially eligible for federal funding, set about improving the alignment. The idea of the tunnel section under Río Piedras was introduced at this time (see section 5.3.6). The higher spending that these changes would necessitate therefore placed more emphasis on obtaining increased funding either from local taxes or from federal sources.

During this period an extension to the airport was first suggested. Such an extension would require making a curve somewhere in Santurce and so the idea of extending Phase I from Sagrado Corazón to Minillas to facilitate an airport link first emerged. In 1993 the consultants began working on the details involved. However, an alteration to the design would very likely have required that the permitting process be restarted. Such an action would have delayed project committal by at least a year. When one considers that the term of any one administration is four years, such a delay could mean that the project

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<sup>117</sup> Final Environmental Impact Statement, Tren Urbano, San Juan Metropolitan Area, Puerto Rico, November, 1995.

could not get to the point of full commitment within the lifetime of the administration. For this reason it was decided to proceed without the Minillas extension initially in order to get the project up and running. It was considered that once a Record of Decision (ROD) had been obtained for Phase I, attention could then be given towards a possible extension to Minillas (Phase IA).<sup>118</sup>

The new administration basically accepted the recommendations of previous planning studies and the Bayamón Crescent alignment as proposed. The limited duration of the term of office of the administration meant that sufficient time did not exist to undertake any major project changes such as extending the system to Minillas. However, some attempts to improve the system were made which included the tunnel section under Río Piedras, which was considered necessary in order to bring the station closer to the town center as well as avoid the negative impacts that would have resulted from elevated construction. Other improvements included the better transit access for the UPR campus, the relocation of the Centro Médico station, and the shifting of the location of the maintenance yard. Although the need to get the project fully committed within a short time-frame was the key driving force behind the implementation of Phase I, nevertheless many improvements were made to the alignment.

The present funding of Tren Urbano basically is comprised of 1/3 Federal Highway “flexible formula” funds (which is a bond offered by the Commonwealth backed by future federal support), 1/3 state and 1/3 discretionary, Section 3, FTA funds. The Federal Highway Administration and local funding sources are reasonably assured. Additionally, the full funding agreement for \$307 million announced in March, 1996, constitutes a commitment that will be included in future appropriations for Tren Urbano. While these funds are subject to Congressional actions, the strong support for the project in Congress to date makes this funding highly likely.

Project approval has required the identification of adequate funding sources to cover the capital and operating costs associated with project implementation. At present, although

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<sup>118</sup> Interview with Gabriel A. Rodríguez, Special Assistant to the Secretary, DTOP, and Larry Berkowitz,

the in-house estimates of the Tren Urbano operating deficits are forecast to be in the range of \$26-\$29.5 million per year in the period 2002 - 2006<sup>119</sup>, the expectations of the STTT contractors are for an actual figure below this amount. The importance of controlling the operating deficit and financing those deficits which do exist will have a large bearing on future expansion beyond Phase I. Any system with large operating deficits and difficulties financing these shortfalls will find system extensions difficult to implement. However, in the case of Tren Urbano, because the operating deficit estimates are an element of the turnkey contract, this helps reduce the ambiguity of these figures

Clearly, future phases of the project will likely have similar funding sources with their associated uncertainties. Of course the ultimate financial/funding issue relates to the amount of money available. Under tight funding constraints the Puerto Rico Highway and Transportation Authority (PRHTA) would wisely go for the most financially implementable section or phase. They clearly would not want the embarrassment of being unable to complete a project and as such the choice and extent of a phase would be very dependent on financial resources.

The case studies have illustrated that the most important elements of any future rail extensions are political and financial support. Presently Tren Urbano relies on federal support for project implementation, and system expansion and phasing decisions are subject to the constraints imposed by the federal process. It is very important that Phase I of the system is successful to justify the federal investment and promote further financial support. If the public and political support existed at the local level then it may be such that local funding would be more attainable. This funding could cover future capital and operating costs which would provide more flexibility in system expansion decisions. Nevertheless, in the case of Tren Urbano, the utilization of federal funding represents a faster approach to project implementation. Under such circumstances, the public must be educated as to the costs of system development and the importance of federal funding in ensuring speedy implementation.

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Manager of Transportation Planning, Tren Urbano, GMAEC, January 22, 1996.

Clearly, the support of the municipalities through which future proposed phases would go; the support of the political leaders; and the support of the rest of the island, politically and financially in the form of taxes paid, will all impact project phasing. At present the Mayor of Bayamón and the Governor, who also comes from Bayamón, are both affiliated with the Statehood Party. The Mayor of San Juan is affiliated with the opposing Commonwealth Party, however the project is seen to be of such importance that support is strong from both sides. Factors other than party politics, such as the availability of rights-of-way, can have a much greater bearing on the support that exists for the project.

There are some particular factors motivating the implementation of Tren Urbano besides combating the growing congestion in the region. One such factor is that Puerto Rico is competing to be the site for the Olympics in 2004. Although an event such as the Olympics is not in itself an adequate reason to promote the implementation of the project, it does however, generate some urgency for the on-time completion of Phase I of a project that has already been deemed a necessary component of the transportation infrastructure. The availability of Phase I of the system will also provide an international platform to demonstrate what rail transit can do, build a positive image and gain international visibility. Furthermore, as future phases could include extensions to serve Minillas, the airport, Carolina, Old San Juan, the provision of transit service for an event such as the Olympics may also have an influence on which of the future alignments are prioritized for initial implementation.

Furthermore, constructing Tren Urbano develops technology transfer opportunities. The expertise gained in developing Tren Urbano will be exportable to other central and south American countries and opportunities are already being looked at in this area.

Additionally, as Tren Urbano represents the first example of a Design-Build-Operate rail transit project undertaken in the United States, the possibility exists of transferring the experience gained back to the mainland. Tren Urbano could also represent an important

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<sup>119</sup> Final Environmental Impact Statement, Tren Urbano, San Juan Metropolitan Area, Puerto Rico, November, 1995.

element of an overall strategic plan for the city of San Juan to position itself as the gateway between North and South America.

The present development of Tren Urbano has been aided by the availability of previous work including alternatives analyses and preliminary environmental impact studies. The existence of this work sped up the implementation of Phase I of the system. However, future development of Tren Urbano will be subject to federal regulations concerning the conduct of Major Investment Studies which were not a requirement for Phase I implementation.

### ***5.3.5 Social***

Rail transit is only one component of the transportation system which in itself is only one component of the urban area. Each shapes the other and it is necessary to consider system implementation in tandem with the development of the urban area. The necessity of developing the urban structure to enhance the success of the system and encourage its expansion must be considered. Furthermore, the phasing of the system must account for changes in the urban area which could have been induced by the implementation of the system itself. In this context, long-term planning which recognizes future transportation needs and the development of the urban area becomes beneficial. This allows the reservation of rights-of-way and provides direction and public understanding and acceptance of the necessity of system expansion. Public involvement aids in the development of a successful phasing strategy.

However, little urban development is likely to occur along the alignment until Phase I is already in place. This is because other options exist for development within the SJMA and the transit system does not exist as of yet, combined with the uncertainty about whether or not the project will reach full completion. At present no other areas compare to the Hato Rey corridor in terms of employment density. It is the case however, that congestion is dampening the pace of commercial growth. There are still large amounts of land available for development in this area which will become more attractive once the access issues are addressed by Tren Urbano.



Naturally, as the prospects of project completion increase, the interest in development would also be expected to be greater. This expectation of project implementation has been heightened by the receipt of the full funding agreement and the award of the Systems Test Track and Turnkey (STTT) contract. In some ways the planning of Phase I has already inspired some development as demonstrated by the University of Puerto Rico (UPR), which has altered its expansion strategy in order to favor higher density development close to a Tren Urbano station. Additionally, the development of the Roosevelt station will promote the redevelopment of the existing shopping facilities in this area to higher densities.

As we consider expansion beyond the initial system, a possible future phase of Tren Urbano might include a link between the Phase I system and Old San Juan via Minillas with the objective of reinforcing, and providing tourist access to, the historic center of San Juan. Another phase could link the initial system and the International Airport. However, an additional factor in the choice of phase relates to the fact that many cruise ships depart from the Old San Juan harbor area, the passengers of which arrive from the International Airport. This would suggest that a link between Old San Juan and the International Airport could have a very useful function. The system would facilitate San Juan workers serving the tourist and transportation industries as well as serving the tourists themselves. To integrate this idea with Phase I would suggest that the system should initially be extended to Minillas to form a sort of T-junction to Old San Juan and the Airport.

Of course, it is not obvious that people will use rail transit service even if it is available. The existing public perceptions of transit service are shaped by the existing AMA and público service. These services are viewed as being very poor and have been declining in importance over time. Personal security concerns are very high in San Juan as illustrated by the existence of numerous 'gated' communities. These gated communities are designed to seal off estates from intrusion by non-residents. Their existence demonstrates the non-transit-friendly environment represented by many areas of the San Juan Metropolitan Region. Furthermore, when one considers the personal security concerns of most Puerto

Ricans, the question of safe transit access and use will be extremely germane to the success of the system.

As referred to before, it is not entirely clear that a stated policy of providing rail transit accessibility to all of the metropolitan area exists. The equity issue in the implementation of the system and the question of whether or not people feel an entitlement to public transportation service is not clear-cut. This issue is somewhat impacted by the existence of the público service which may affect equity concerns and the public's perception of a "right to service". Furthermore, at present, there exists a negative perception of public transit brought about by the poor bus service provided by AMA and the unreliability of públicos. These factors as well as the issue of how the públicos and existing transit services integrate with Tren Urbano need to be addressed and could potentially influence phasing decisions.

Future expansion of Tren Urbano will rely heavily upon the perceived success of the initial phase. As demonstrated by the case studies, perceived success is influenced by factors such as the achievement of ridership goals, the degree to which operating costs are recouped through the farebox, the coverage and service offered by the system, the disruption caused by construction, and the control of construction spending. Of course, the time-frame for implementation of the various phases will have a bearing upon the factors that will impact perceptions. For instance, if the Phase IA extension to Minillas is planned and approved before Phase I is even operational, then the ridership of Phase I will not be an issue. In this case, public perceptions will be formed by their views of the success of the Phase I construction process and the upgrading of the AMA and público services. However, if Phase IA implementation is delayed until Phase I is already operational, then additional factors will combine to form perceptions of the system. These additional factors would include the achievement of ridership goals, the amount of operating subsidies required, and the service coverage offered. If expansion subsequent to Phase I is delayed for some time, then the success of the initial system in encouraging development would be an added factor which, combined with the already mentioned

issues, would impact perceptions. As such, the expansion time-frame will determine the factors which can impact the public perceptions of success.

It is important while the project is under construction and when in place that people are educated to respect and have pride in their system. If such pride exists, the future of the rail option as a viable transportation alternative in the San Juan metropolitan area will be enhanced. With public support the prospects for expansion will also be stronger.

Furthermore, public pride in the system will also be generated by the implementation of an efficient bus and público transit service as a complement to the transit service. Steps to build such pride can begin now with the upgrading of these services to a high quality.

### ***5.3.6 Environmental***

Another argument for the present alignment is the fact that it takes advantage of the 65<sup>th</sup> Infantry right-of-way originally reserved for a highway, thereby eliminating the temptation to build such a highway which would only further encourage car use and have detrimental effects on the urban form. Furthermore, the availability of the right-of-way facilitates the implementation of about one-fourth of Phase I without the risk of causing significant community disruption due to construction.

In the Río Piedras area, the original plans proposed an elevated alignment along Muñoz Rivera Avenue. Alternative subway alignments were developed out of an attempt to optimize service to the Río Piedras traditional town center and the University of Puerto Rico, and also because of a concern that the base alignment might have significant visual impacts. Nevertheless, there is much of Phase I with potential for creating significant disruption during construction. Such construction impacts, if not adequately mitigated, could affect the success of the first phase of the system as well as creating negative perceptions of potential rail development in other areas. As such, limiting and mitigating disruption due to construction is important in enhancing future expansion prospects.

### **5.3.7 Economic**

The Federal Transit Administration utilizes a cost-effectiveness measure to assess and rank transit projects and aid in their decisions concerning which ones merit funding. Cost-effectiveness is calculated as the net cost per new rider attracted to transit relative to a best bus/transportation systems management alternative. It is clear that a good cost-effectiveness measure would be essential in seeking FTA support and thus federal funding. The FTA's established threshold for the cost-effectiveness index is \$6 per new rider. The cost-effectiveness index for Phase I of Tren Urbano is much lower than \$6 and in fact rests at \$3.50 per new trip.<sup>120</sup> This establishes Tren Urbano as one of the best projects nationwide and is a very positive factor in seeking federal funding. It is also very clear that the prioritization of future phases will rely heavily on the ease of obtaining federal funding and therefore the strength of the cost-effectiveness indices for these proposed elements. The cost effectiveness index is a useful measure in helping prioritize system extensions and may have a much greater bearing on phasing decisions than any internal criteria that would have been used were the funding issue not present.

## **5.4 Summary of important issues**

Clearly the implementation of the Phase I system will heavily impact future expansion prospects. A successful first phase will demonstrate the viability of the rail transit option in the San Juan metropolitan area and will develop the federal and local support necessary for subsequent system extensions. To help ensure the success of Phase I it is essential that steps are taken to upgrade the bus and público services beforehand. The rail system will rely upon positive perceptions of transit service and the coordination of these modes to act as feeder services. Subsequent system development would also benefit from the existence of rights-of-way which would significantly aid the implementation process. As such, the detailed planning of future system phases must begin now. Furthermore, long term planning maintaining expansion plans in a state of readiness permits the utilization of funding sources as soon as they become available. Finally, any future extensions will rely

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<sup>120</sup> Draft Environmental Impact Statement, Tren Urbano, San Juan Metropolitan Area, Puerto Rico, March, 1995.

upon the availability of funding sources. Funding requirements should be recognized now and the public must be informed of the costs of further system development. This will facilitate public participation in the process, promote an understanding of the realities of transit development, and prevent any possible misconceptions of rising costs.



# Chapter Six

## Conclusions

When one looks at the goals of rail transit development of many metropolitan areas, it is not always clear that these goals were part of a longer term vision of urban development in these regions. Systems appear to have evolved out of notions of “a city’s need to have a rail transit system,” without a clear idea of why it was needed. It would seem that the solution often came first i.e. “the answer is rail transit,” and then the questions to justify the solution were posed: “We need to reduce congestion, improve air quality, increase accessibility, increase development densities, etc. - how do we do this? - why not a rail system.” But, a rail transit system by itself is unlikely to achieve any of this, and certainly not an isolated first phase of a proposed system. However, rail transit can be an element of the solution approach and its successful expansion is a target complementary to greater societal goals.

### 6.1 Goals of this thesis

This thesis has considered the subject of system phasing and expansion with a view to establishing what makes for an appropriate phasing strategy and how it can contribute to the ultimate success of a system. The purpose has been one of discerning how systems develop and expand, how phases are prioritized for implementation, and what factors need to be addressed to facilitate system expansion in the most effective manner.

### 6.2 Defining a successful phasing strategy

Initially, we established that determining the success of a phasing strategy is not the same as determining the success of a system. Furthermore, in practice, the success of a system is not judged by idealistic notions of what really should constitute success, such as the rail system’s influence on urban development or the revitalization of the economy. Instead, the success of a system is often gauged by what people perceive as successful, often

governed by measures of the achievement of ridership and cost recovery goals. These measures of system success do not necessarily indicate the success of a phasing strategy, but the accomplishment of these goals may well be more difficult in the absence of an effective phasing strategy. Thus, we can define a successful phasing strategy as an approach to the implementation of a system that best facilitates that process of implementation.

### **6.3 Findings of this research**

In general, the likelihood of network expansion beyond Phase I of any proposed system seems to be a function of the perceived success of the initial phases. Those systems that achieve a reasonably successful first stage tend to draw support for further expansion. However, those systems whose initial stages are perceived as unsuccessful fail to expand. Perceptions are governed by factors such as the success of the system in achieving ridership goals, the degree to which costs are recovered through the farebox, the cost of construction and compliance with budgetary constraints, the quality of project management and the efficiency of the construction process, the coverage and service destinations offered by the system, the scale of community disruption caused by the construction process and through the operation of the in-place system. The greater the perceived success of the initial phase, the higher the likelihood of support for system expansion. Under such circumstances, public and political support can be harnessed to aggressively pursue extensions of the system and maintain the momentum of expansion. When the initial phases are deemed to have failed however, an aggressive approach to further system development is neither appropriate nor possible.

The integration of other transit services as a complement to the rail system serves as another feature of successful phasing strategies. The experience shows that the prior existence or implementation of efficient bus transit operation generally paves the way for later successful rail transit implementation. Such a strategy promotes an awareness of transit availability and encourages transit use. After rail system development the orientation of other transit modes to function as feeder services enhances the in-place system and acts as a complement in areas where rail service does not exist. Such



integration of transit modes combines to present a comprehensive and viable transportation option to the public. Furthermore, feeder services help create transit demand and identify corridors for possible rail transit expansion.

Another successful strategy is the coordination of system expansion with the phasing of developments and improvements of the urban area. In such a manner, the implementation of the system becomes associated with a general improvement of the urban environment and of the standard of living. The positive perceptions that this induces encourages system expansion. In general, the integration of transit, transportation and land use planning can be a successful feature of phasing strategies.

Preserving the speed and momentum of expansion allows the benefits of the system to become more apparent for all to see thereby creating support for further extensions. This also maintains a public awareness of the expansion of the system and utilizes the experience already gained in construction and development. Clearly the pursuit of federal funding can speed the pace of system implementation and the associated environmental review process can help identify issues having the potential to derail system development. The use of local funding can also aid and hasten the implementation process as well as infuse an understanding in the public and political spectrum of the goals and value of rail transit development.

An important issue in the development of a phasing strategy is the identification of the markets to be served. In some cases the targeting of low-income, transit dependent sectors of the community can be an appropriate strategy which allows the development of an extensive and effective transportation service. In other cases, the prioritization of initial phases of system implementation to serve higher income, more affluent areas can enhance perceptions of the system and thereby encourage and facilitate further extensions. The strategy to be adopted depends upon the characteristics and equity considerations of the urban area in question.

Another issue shown to be important in maintaining the momentum of expansion is long term planning. Such a conscious policy allows the identification and protection of rights-

of-way and permits public input into, and acceptance of, rail transit development. Long term planning also means that expansion plans are ready to take advantage of funding opportunities as soon as they arise.

In general, it is clear that rail systems are only really successful when they have become extensive. This would suggest that policy should really be aimed at implementing all of the system such that the substitution of other modes of travel by rail transit is truly realistic. However, such a commitment to rail transit development often does not exist and a clear goal of implementing a full system and ultimately reaping the benefits that only an extensive system can provide is usually not apparent. Obviously, bit parts of systems are not the solution as a single phase cannot change or reorient the functioning of a city? Of course, not all areas are suitable for rail development and in such cases urban development must be reoriented or the first phase will merely demonstrate the non-viability of rail transit for that area.

#### **6.4 Areas for further research**

It has been demonstrated that the phasing of a rail system is important to the success of the system and the achievement of greater societal goals, but other complementary issues must also be addressed. Further research could look at the rail transit system phasing process incorporating not only the system implementation itself, but also the phasing of the technologies and technology enhancements associated with the system, the phasing of bus and other transportation options with the hope of integrating modes and achieving a total transportation system, and the phasing of land use development and improvements to the urban structure. This thesis has also touched upon the importance of the public involvement process in the development of long range transit plans, and the need to educate the public and create support for projects such that they are publicly and not just technically or financially driven. Further examination of this issue could also contribute to successful rail transit development.

# Appendix A

Early research involved contacting all of these sites with a view to establishing which cities constituted good case studies. Those chosen have been highlighted by *bold italics*.

## Heavy Rail

1. Washington, DC
2. Atlanta, GA
3. Baltimore, MD
4. *Miami, FL*
5. San Francisco, CA
6. Los Angeles, CA
7. *Caracas, Venezuela*
8. Santiago, Chile

## Light Rail

9. Portland, OR
10. Sacramento, CA
11. San Jose, CA
12. Pittsburgh, PA
13. Los Angeles, CA
14. *Buffalo, NY*
15. *San Diego, CA*
16. Saint Louis, MO
17. Denver, CO
18. Baltimore, MD
19. San Francisco, CA
20. Seattle, WA
21. *Calgary, Canada*
22. Vancouver, Canada
23. Edmonton, Canada
24. Toronto, Canada



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