

**Getting There Is Half the Problem:
Removing Obstacles to Accessing Rail Transit**

by
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B.S. Civil Engineering
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Submitted to the Department of Urban Studies and Planning in partial fulfillment of the requirements for the degrees of

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and
Master in City Planning

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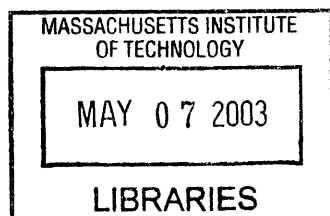
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Abstract

People can arrive at a station using a variety of different transportation modes including walking, biking, taking a bus or driving. Each access mode interfaces with transit in a different way. The layout and design of the station area affect how people reach the station and may attract or dissuade riders from using specific access modes or even whether to take transit at all. Improving transit accessibility benefits those people currently using transit and also makes it more attractive to people who may currently choose another mode for travel by providing another attractive mode choice, helping improve transit ridership and customer satisfaction.

Different features and design elements that affect the safety, security, directness, weather protection and other supportive details of accessing transit are evaluated in this thesis. These elements extend from the station into the surrounding community. Since the transit agency does not control much of this infrastructure, it must work with other agencies to make these improvements. A suggested framework is developed to provide guidance at how a transit agency can effectively prioritize different station area improvements and how they can work with other agencies to efficiently implement these improvements. The number of people that will benefit and the potential for improvement should be considered when prioritizing projects. Projects that have lower priorities should be completed if there is an opportunity to incorporate them into other projects being done either by the transit agency or another agency.

Design cases have been completed for Roosevelt Station in San Juan, Puerto Rico and Jefferson Park Station in Chicago, Illinois. Improving the pedestrian environment, including developing continuous, well-maintained sidewalks, is the most pressing need at Roosevelt Station. Jefferson Park needs to focus on the conflicts between modes created by the current design such as discouraging pedestrians from walking through the bus area, creating a pedestrian crossing in front of the station and improving drop-off access. Working with other agencies is important for both transit agencies.

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List of Abbreviations

AMA - Metropolitan Bus Authority
BART - Bay Area Rapid Transit Authority
CDOT – Chicago Department of Transportation
CTA - Chicago Transit Authority
DPD - Chicago Department of Planning and Development
DTOP - Puerto Rico Department of Transportation and Public Works
FDW - Flashing Don't Walk
HCM - Highway Capacity Manual
HRTC - Hato Rey Transit Center
HTA - Puerto Rico Highway and Transportation Authority
IDOT - Illinois Department of Transportation
MBTA - Massachusetts Bay Transportation Authority
MUTCD - Manual on Uniform Traffic Control Devices
NPTS - National Personal Transportation Survey
RTA - Regional Transportation Authority, Metropolitan Chicago
WMATA - Washington Metropolitan Area Transportation Authority

Chapter 1 Introduction

Rail transit rarely takes riders from their origin directly to their destination. A select few locations have transit stations incorporated into their design and passengers do not need to travel to or from the station and this location. For most trips though, access and egress legs need to be added to the rail segment to make a complete trip.¹ The ease and comfort of these additional legs are incorporated into the decision to use transit.² If traveling to the station is too difficult, For many travelers, this part of the trip may be more onerous than the time spent in the transit vehicle.

People can arrive at a station using a variety of different transportation modes including walking, biking, taking a bus or driving. Each access mode interfaces with transit in a different way. The layout and design of the station area affect how people reach the station and may attract or dissuade users from using one mode or another to access the station. If the station infrastructure is not designed to accommodate a certain mode, very few people will choose to use this mode. Biking to transit is difficult when bicycle parking is not provided. If there is no car parking provided at the station, few people will be able to drive and park at the station. Taking the bus from a station is hindered if the infrastructure provided for waiting is inadequate. Station access can be improved by incorporating the needs of each of the different access modes into the physical design of the station area. If traveling to and from the station are seen as less of a hassle, transit becomes a more appealing travel option. In order to understand the way each individual mode works it is useful to understand what affects our travel behavior.

¹ The access trip is used to refer to both access and egress trip segments throughout the document. Characteristics of egress trips that are different than those of access trips will be noted and discussed.

² This document focuses on access to rail rapid transit or metro systems. "Transit" is used to refer specifically to rail transit. "Station" describes the building designed to link the transit system to the community. Bus transit is explicitly labeled as such and the locations where they pick-up or drop off passengers are described as bus stops or terminals.

1.1 VARIABLES

Travel Choices

There are many different options for urban travel. People make their decisions as to how they get around based on the following factors:

- Time
- Cost
- Effort
- Comfort
- Independence
- Carrying Capacity
- Availability

Time

People generally prefer faster trips to slower, and hence longer ones. Since people decide what mode to use before they know how long it will take, they make decisions based on expected travel time.

Cost

Per trip costs such as parking fees and bus fares have more of an effect on a person's decision to use a specific mode than longer term costs such as purchasing a car or pair of walking shoes, with gasoline and monthly bus passes falling somewhere in the middle.

Effort

Effort relates to the physical effort required. It includes energy exerted to use modes like walking or biking; the number of times a person needs to change activities such as entering and exiting a vehicle, and the amount of planning and attention needed to use the mode.

Comfort

Comfort accounts for how a person perceives their surroundings. A person may consider walking along a visually stimulating street in pleasant weather to be enjoyable, where being stuck in traffic may be very frustrating. Others may prefer the

independence and environment of their car more enjoyable than riding the bus. The perception of comfort is different for each individual and for any given situation can vary based on weather, travel conditions or mood.

Independence

Independence relates to the ease with which a person can make changes to their travel such as leaving at any time, being able to change destinations or stop along the way.

Carrying Capacity

The amount that a person needs to take with them can also affect mode choice. Carrying a heavy box may not be feasible on foot but could be done by any of the other modes.

Availability

Finally, and possibly most importantly is the availability of a mode. If there is no one around to drop a person off at the station, drop-off becomes infeasible. If a person does not feel comfortable riding a bike on major road, then biking is not a viable option. All of these factors affect how we choose to travel.

Mode Choices

Each mode responds differently to the factors that affect our travel choices. In order to understand why people make the choices they do, it is important to recognize the inherent characteristics of each mode.

Pedestrians

Pedestrians are people who walk or, because of a mobility-impairment, travel by wheelchair or other personal mobility device. Walking is the most basic form of transit access because it is readily available to everyone and can be undertaken at any time. It is one of the most physically intense modes, which can be seen positively as an opportunity for exercise or negatively as exhausting. Pedestrians typically walk at a speed between 2.5 and 3.5 miles per hour (Pushkarev and Zupan, p 47), making it the

slowest transportation mode. Often trips by foot are limited in distance because of physical and time constraints. The 1990 National Personal Transportation Survey (NPTS) estimated that 7.2 percent of all trips and 11.5 percent of trips under five miles were made on foot (Hu and Young 4-89).

Pushkarev and Zupan found that 95 percent of walk to transit trips were less than 3000 feet with virtually no trips longer than 3 miles. Stringham (16) and Cervero ("Factors" 5) found that walking to transit dominated access trips up to a distance of just over 3000 feet.

Operator Propelled Devices

Bicycles, in-line skates, scooters and skateboards allow a person to travel faster and with less effort than walking. Wheels allow human exertion to be more efficiently transferred to movement than walking, expanding the physical range of non-motorized access to transit. For many, these modes are considered recreational activities instead of transportation modes and therefore travel statistics are not collected. Statistics for bicycle trips has been collected. The 1990 NPTS found that 0.7 percent of trips were made by bike (Hu and Young 4-58).

Travel speeds for operator-propelled devices fall between those of pedestrians and automobiles, making it difficult to share infrastructure with one mode or the other. In some instances these non-motorized devices are allowed on sidewalks and in others prohibited, either encouraging or requiring travelers to use the roads instead. Travel speeds for these devices vary significantly based on the user, topography and traffic. A regular cyclist may be able to travel between 12-22 miles per hour in flat, unimpeded conditions and may average 15 miles per hour door-to-door (Forester 72). Depending on the city layout and public transportation network, these modes may be used to take a person from their origin directly to their destination. The average bicycle commute trip was 4.7 miles (Forester 72). In other circumstances, distances are too far or travel conditions too difficult and the mode is used to access transit.

In order to use these modes as a part of the transit trip, a person generally needs to own the specific equipment. Although an initial investment is needed, operational costs are minimal other than occasional maintenance. The initial investment in these devices is very low when compared to purchasing a car.

For use in conjunction with transit, the device needs to either be left at the station or carried on the transit portion of the trip. Some rail systems allow passengers to bring bicycles on-board although many agencies limit this to off-peak periods. Bikes can also be left at the transit station if there is some way to secure them so that they are not stolen. Some people who prefer to bike both the access and egress leg of their trip but cannot carry their bike on transit, store bicycles at both ends of the rail segment. Generally in-line skates must be removed for the transit leg of the trip. This requires users to carry additional footwear. In-line skates, skateboards and scooters are generally carried with the individual while on transit, making them available for the egress leg of the trip.

Bus

Most rail systems have bus feeder systems to get people to the transit station. In a survey of transit access, buses were found capture the largest mode share for trips between 5/8 and 9/8 of a mile from the rail station (Cervero, "Factors" 5). While buses have faster travel times than walking, they are limited by their schedule. Bus riders can only leave when the bus arrives and arrive at the station when the bus does. Different routes have different frequencies of service and reliability levels. Buses that come infrequently give less flexibility to the traveler as opposed to other modes that allow people to leave at their own discretion. Those taking the bus can depart only when the bus arrives. In some instances bus routes are coordinated with rail schedules to reduce the wait time at the rail station, otherwise passengers will need to include wait time for the bus and also for rail in their expected travel time. Bus routes that are unreliable require passengers to leave additional time for travel as they do not know when the bus

may come. For a route that is reliable, expected wait time is one half the headway, but when service is sporadic, a person may have to wait up to twice the headway or more before the bus comes. If a person needs to be somewhere at a specific time, this can add much time and frustration to the trip.

Depending on the system coordination, bus transfers may be free or require the users to pay an additional fare for the bus portion of the trip. Some systems discount one segment of the trip for people who have to transfer. The method of providing for transfers and fare collection is a major complexity in transit station and fare policy design and can impact the viability of retail at and near the transit station.

Drop-off/Taxi/Private Shuttle

Being dropped off gives the flexibility of arriving in a personal car without leaving a vehicle at the station, allowing it to be used further. Drop-off requires coordination between the driver and the person using transit with regard to departure and pick-up times but allows more flexibility for trip-chaining. Driving to transit may be the only transit access option for people who live in low-density areas where the station is too far away to walk and bus service is not available. Being dropped-off at transit may provide more flexibility than taking a bus if bus service is infrequent.

While dropping off passengers at transit is better than having them drive all the way to their destination, it may not be environmentally sound. If the trip to drop off the person serves no other purpose, parking at the station would actually be more environmentally correct as only 1/2 of the miles would be driven. This is less of a concern if the person is dropping the passenger off as a part of another trip. Providing space for passengers to be dropped off is less land-intense than parking because multiple travelers can use the same space over the day.

Taxis can also be used in combination with transit although because of cost, it is generally not a consistent choice for access or egress trips. People may choose to hail

a taxi if they have been shopping and have a lot of baggage that is difficult to take on their traditional access mode. People who have just missed their bus transfer or are traveling late at night may not want to wait at the station and may decide to take a taxi. People may choose to take a taxi from transit if their destination is not accessible by rail or bus but they do not want to pay the price for taking the entire trip by taxi. Providing an active taxi stand or access to phone numbers and a telephone are important for people who may not have planned to take a taxi, but desire to do so rather than be stranded at the station.

Private shuttle service can also be incorporated into rail stations. Shuttles are small vans or buses that run between the transit stop and one or a number of popular destinations. The service is privately run either by a single business or by a consortium of businesses to provide transit access to their locations, which may otherwise be difficult to reach by transit. Shuttles that serve offices are generally designed for employee use and may restrict who can use them and/or charge users a fee. Shuttles serving airports or shopping centers are designed to assist in customer access and are generally free services that are open to the public.

While these private shuttles may seem more like bus services, they do not usually coordinate their services with the transit agency. Because of their small vehicle-size and low-frequency service, they often use facilities designed for passenger pick-up/drop-off.

Park and Ride

When parking is readily available, driving and parking gives travelers maximum flexibility in their access trip because they are totally self-reliant and able to choose their departure time and route. As trip length goes up, the ability of cars to travel fast and the relatively low effort required becomes more important. As mentioned, for some, driving is the only way to get to transit. Parking is the most land intensive of the access modes because each car left at the station takes up approximately 250 square feet. These

spots are often used by only one vehicle for an entire day, most of which only provide one passenger to the rail system and can very expensive to provide depending on land prices and lot design. Space used for parking provides no benefit to other station users and displaces other uses that might benefit or be beneficial to transit. Driving to transit is not environmentally sound as most pollution from driving occurs within the first half mile as the car warms up.

Other Transportation

Rail transit can connect to other modes of transportation as well such as airports, commuter rail, long-distance rail, bus or ferry service. Rail transit provides a different scale network than these modes, which provide longer-haul services that are limited in their local distribution capacity. While these transfers are not the most common, connecting rail to other transportation modes increases mobility and reduces the need for cars. When feasible, connections should be made with these modes. Unless expected demand justifies rail service, it may not make sense to make major detours or long extensions just to meet with these other modes because building rail service is expensive. Bus service may be more appropriate. The integration and design of these facilities is not explicitly discussed in this thesis although many of the issues are similar to any other origin or destination. One design issue that should be noted is that the facilities needed for many of these transportation options are extensive and limiting in their nature, making connections with rail more complicated

1.1 IMPORTANCE

Improving access to transit is important for encouraging the use of transit. Transit service is an important link in meeting mobility needs. While demand for transit occasionally overwhelms current capacity, in most cases, transit struggles because of low ridership. Transit is funded both by revenue and government subsidies. Transit agency income comes from fares and to a lesser extent other business transactions such as advertising or land management. When an agency does not have enough money, it is forced to cut services, making transit less desirable. Higher ridership

increases earnings from fares and provides support for transit agencies to request additional funding from government. Increased funding allows the transit agency to improve service so the more trips that are taken by transit, the better transit service becomes. Making transit more attractive by improving access to transit improves the long-term viability of transit.

BENEFITS TO SOCIETY

Congestion

Traffic congestion is a major problem in urban areas. Time stuck in traffic continues to increase, reducing productivity, increasing vehicle emissions and increasing stress levels. Transit is a very efficient mode of moving people. It has the potential to carry three times as many people as an equivalent road corridor. While it has been found that providing transit does not reduce congestion,³ it does provide an attractive alternative for those that choose to use it to avoid congestion and also increases the overall capacity of a region (MIT and CRA).

More Options

One of the largest benefits of transit is that it provides an additional transportation option that is available to almost everyone. Transit provides an additional urban transportation option in addition to the modes described to access transit above, which also serve as independent travel options. Since different people have different needs and wants, providing multiple options for travel allows people to choose the mode that best suits their needs and abilities. Although there is a wide range of transportation options, not all of these options are available to everyone. Legal constraints, economics and physical limitations may limit the transportation options that a person is able to use.

³ There is latent demand on congested roadways. For every person that makes a trip on transit, someone takes his or her place.

Although we often consider driving a right, it is really a privilege. People must pass a driving test and maintain a good driving record in order to drive. Those that are too young, have a bad driving record or have never applied for a license do not have the option of driving. Owning and maintaining an automobile is expensive and is not affordable for everyone. Using non-motorized devices for transportation requires a person to own and be able to securely store the equipment when they are not using it. For others, physical limitations prohibit them from using specific modes. Some trips may be too long to be made by foot. Poor vision, limited mobility or slow reaction times may prevent a person from driving. Someone may not have the strength or coordination to ride a bicycle or skateboard. For those people whose overall transportation options are limited, transit may play a crucial role in their mobility and livelihood. It is especially key to make sure that transit is accessible by modes that are available to those whose travel options are already limited.

Benefits to Transit Agency

Transit agencies have often only concentrated on what passengers experience once they reach the transit station. Since trips by transit require access and egress trip segments, the transit agency needs to consider these portions of the trip as well.

Ridership

Passengers need to be able to access transit in order to use it. There are many decisions that go into the physical layout of a rail system, including the potential market for each station. This process includes a consideration of how people will reach the station, which is heavily dependent on the physical attributes and social characteristics and mores of the surrounding community. By being proactive in the physical design of the community, transit agencies may be able to improve ridership. By recognizing long- and short-term constraints for different transit access modes at a given station, an agency can make informed decisions about how to focus and improve their service.

If a transit agency wants to increase ridership at a station where there are parking constraints, designing the station to encourage people to walk or be dropped off can help increase ridership without imposing the high cost of building more parking. If a transit agency wants to promote use of its feeder bus services to the station, it may be able to encourage passengers who would otherwise choose a different mode to use the bus if waiting for the bus is made more comfortable and convenient.

Customer Satisfaction

Not only can quality transit access increase ridership, it can improve customer satisfaction. Customer satisfaction measures the perceptions of passengers currently using transit. When customer satisfaction is low, passengers may easily be swayed to using another mode of transportation if another option becomes available or a specific negative even pushes their dissatisfaction over a personal threshold. High levels of customer satisfaction represent the fact that the transit agency is providing a high quality service, which is often a goal of the agency. Satisfied customers tend to be loyal and more understanding of fare increases. They may be more willing to experiment with other routes or services the transit agency provides since they have some trust in the agency and are more likely to encourage others to use transit.

Efficiency

Understanding transit access issues and working with other agencies to make improvements is economically efficient for the transit agency. As will be described later, many transit access improvements are not actually in the transit agency's domain. By staying informed and working with other organizations, transit agencies can insure station area projects improve transit access without their needing to do the actual work. Transit agencies may also be able to coordinate their own improvement projects with other agencies to streamline the work and increase the effectiveness of the improvements.

1.2 RESEARCH OBJECTIVES AND METHODOLOGY

Objectives

The goal of this research is to understand how the physical design of a station area can affect station access. This has been broken into two major questions.

What urban design elements provide a superior experience for people accessing transit?

- What are the needs of passengers accessing transit?
- What physical features contribute to the transit access experience?
- Are these features different for different access modes?
- Are there conflicts between different access modes caused by physical design

What can a transit agency do to improve station access?

- Who is responsible for station area improvements?
- What is the most effective way for station improvements to be implemented?

Methodology

While research has been done on the needs of various transportation modes used for transit access, there has not been an attempt to create a framework that looks at integrating all of these modes into a single station area design. This research discusses the pieces of station area design starting with determining priorities and investigating solutions continuing through to proposing implementation techniques.

Design Framework

A standardized framework is developed to look at the various needs of transit access systematically in Chapter 2. Pedestrian, bicycle, bus, drop-off, and park and ride access to the station are considered. Since all users are pedestrians within the immediate station vicinity, a category labeled “All Modes” is used to focus on these shared access needs.

The physical extent for this research includes the public realm from the front door or entrance to the station and extends into the surrounding neighborhood. Where in the neighborhood the boundary for station access was set depended on the specific characteristics of the station area and expected access modes. This focused primarily on the area within one block of the station. Some discussions spread beyond this zone up to 1/4 of a mile while community characteristics may have considered an even broader area.

The discussions regarding how various design features affect transit access are based on background literature and personal observation. The literature includes academic and government sponsored studies, Federal and local design guidelines, and summaries of case studies. Traditional roadway engineering guidelines have focused on moving automobiles. As a response, other guidelines have been developed to focus on the needs of other travelers such as pedestrians and cyclists. The needs of non-auto travelers are now being considered in street design guidelines, but equality between modes has still not been achieved. The biases in current guidelines are recognized and an attempt has been made to balance all users needs equitably and objectively in the development of the station area design guidelines in Chapter 2.

Implementation Framework

Following the discussion of the factors involved in station design, this paper develops an ideal process for implementing station area improvements in Chapter 3. This process was developed based on a basic understanding of how government functions, conversations with various constituents that deal with the station area, and observations of how different agencies work together.

Design Cases

This framework and the design guidelines are then tested by applying them to actual station areas in San Juan, Puerto Rico (Chapter 5) and Chicago, Illinois (Chapter 6) to see how applicable they are in different situations. Tren Urbano is the first modern rail

transit system in Puerto Rico. The first phase a 10.5-mile, 16 station line is currently under construction and is expected to begin service in 2003. Buses and publicós (jitneys) currently provide the only public transportation in Puerto Rico, which has developed a strong car-oriented culture over the past 50 years. In fact, Puerto Rico has 146 vehicles for every mile of paved road, the highest in the world (Mirandez, "Transit" slide 5). CTA has a radial network of rail transit lines that were built a century ago and also runs the urban bus service. Historically, public transportation has played an integral part of both political and social life in Chicago. The political structure encompassing each of the transit agencies is very different. The sample station in each of the design cases, Roosevelt Station in San Juan and Jefferson Park Station in Chicago, were chosen for their relatively high activity levels and reliance on multiple access modes. Choosing two stations with similar characteristics provides an opportunity to see that although the guidelines are standard, station area design is situation specific and highly dependent on both physical constraints and political structures.

The station area improvement process developed in Chapter 3 will provide the framework for looking at each of these cases. Since this thesis is designed to promote high quality transit access, the goals and objectives for design will be set high. The actual conditions in Chicago and plans for construction in San Juan are used as a basis from which specific suggestions for improvements are made. Existing public policy and government structure and current projects relating to transit access in each area will be used as a basis for discussing the state of transit access improvements within each area. Suggestions will then be made for improving station area access within the context of the specific station. None of the quantitative data collected by the author was of adequate sample size to make definitive conclusions but may be used to illustrate and explain the author's thinking.

Chapter 2 Station Area Design

This chapter introduces the station attributes that affect users as they access the station using each mode and describes how different design features affect the quality of each attribute. A framework is developed to organize how different station design elements affect the different attributes, prioritizing the elements by their ability to provide for the specific design feature.

Modes

For this research, some modes have been grouped together. The main station access modes being considered are:

- All Modes
- Pedestrian
- Bicycle
- Bus
- Drop-off
- Park and Ride

All access modes require some part of the trip to be made by foot. “All Modes” is a category that looks at the requirements for all people during their walk within the station area. The features in the pedestrian mode will relate to issues unique to people who make their entire trip by foot. All trips by operator propelled devices are represented by bicycle since bikes have the most constraint due to their size. Drop-off considers not only trips provided by friends or relatives but also taxi and private shuttle service.

2.1 STATION ATTRIBUTES

The five attributes used to organize the features that affect station access are safety, security, directness, weather protection and supportive details. While these categories are not the only way to categorize access needs, they encompass the most important qualities.

Table 2-1 summarizes the design features investigated for each mode. The following is a brief description of these factors.

Safety & Security

Safety refers to exposure to the risk of accidental bodily harm or injury. Security focuses on the degree of protection afforded from crime or assault. Safety and security are important for reducing the transit agency's liability and in making people feel comfortable using a space. Stephen Atkins summarized a 1987 survey that asked 'Why do you feel unsafe?' with regard to a number of alleys and walking paths (27). Of the statements provided, poor lighting was the number one concern. 'Seedy' areas with loiterers or areas that were closed-in and had limited no escape options were also of great concern. Fear caused by isolation was also an important factor in feeling secure. Poor visibility and vandalism were also mentioned as security concerns but to a lesser degree. If people are concerned for their safety or security, they will focus their energy toward these negative aspects of their transit trip, or may choose another mode of travel if available.

Directness

Direct travel takes a person straight from one point to another without any interference. When passengers choose their travel mode, they recognize the travel speed, physical effort required and expected delays associated with that mode. The time and effort required to lock up a bike or wait for a bus are understood to be part of the travel process but are often considered more troublesome than when passengers are moving towards their destination. For rail transit, passengers find the time spent accessing and waiting to be more unpleasant compared to time spent riding (Crockett 20).

Although people understand the need for some delays, they will generally try and avoid any delay that they see as unnecessary. A person may be willing to walk 300 feet if it appears to be the only way to get from one point to another but will choose a shorter path if it seems available. This is especially problematic if keeping different travel

modes separate as they converge on the station is desired for safety reasons. A person may believe it is safe to walk through the bus area because there are no buses currently at the station, but a bus could arrive while she is walking through and may not be able to avoid her, causing an accident. It is important to design stations with as direct paths as possible and to limit the desirability of potentially dangerous short-cuts.

People traveling by rail have committed to make a minimum of two transfers to reach their destination since they have to change modes at both ends of the rail segment of the trip. Making the connections as direct and seamless as possible makes traveling by transit more appealing.

Weather Protection

Weather protection includes defense from precipitation, extreme temperatures and wind. Weather protection is especially important for people who need to wait at the station, but can also be of benefit while traveling.

In the ideal situation a perfect climate would be provided for passengers from the time they exit their access mode to the time they are in the train. Being exposed to extreme temperatures, wind or precipitation while transferring from their access mode is an added discomfort to the travel trip, especially compared to modes that do not require a transfer. Different transit agencies face different climactic conditions based on where they are geographically. Many regions do not face extreme conditions or have limited periods of bad weather and completely isolating passengers from the environment may be expensive and even detrimental to the transit experience. An agency needs to determine how important it is to passengers to have protection from different weather conditions. Some of the techniques and their consequences include:

- Awnings and trees can provide shade and some protection from precipitation but still allow air to circulate and do not provide warmth.

- A continuous street-wall provides some protection from wind and occasionally shade.
- Overhangs provide protection from the sun and precipitation but may make it difficult to find warmth
- Shelters with sides provide additional protection from precipitation and protection from wind.
- Totally enclosed spaces are insulated from outside conditions but do not allow for ventilation when desired.

Supportive Design

Supportive design features are design enhancements to stations that increase station utility and customer satisfaction. Information and signage, surrounding land characteristics, and on-site or local commercial opportunities, make using a station more convenient and pleasant.

The *2000 Transit Station Renovation and Pedestrian Walkway Survey* for the City of Chicago found that a “full package of station improvements” were valued by Chicagoans at \$0.23 per trip (Resource Systems Group 7). The research here does not cover all of the same station improvements, but the idea holds that improved station design can increase customer satisfaction, ridership and willingness to pay for services.

2.2 FRAMEWORK INTRODUCTION

Designing a station to meet the needs of users coming by the various modes can be complicated. Users of each mode have different requirements that may support or conflict with each other. This chapter sets up a framework that can be used to determine the quality of design for users of each mode, which is illustrated in Figure 2-1.

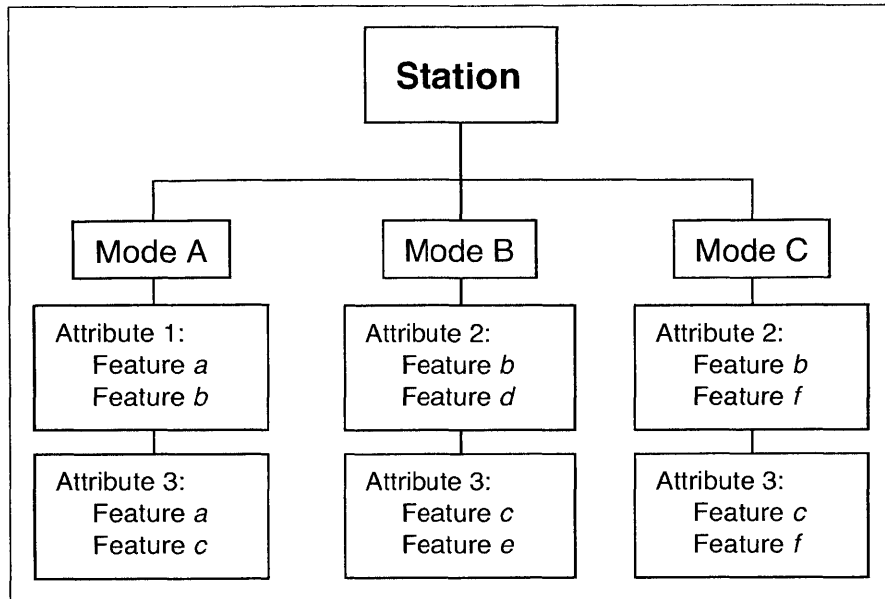


Figure 2-1 Framework for Organizing Design Elements

The station attributes defined above describe the range of needs of passengers accessing transit. Design features describe elements that relate to the attribute. Some design features apply to an attribute across all modes (eg. Feature C in Figure 2-1) while some features may only be applicable to a specific mode (eg. Feature A in Figure 2-1). While many design features are compatible between modes or even multiplicative in their benefit, some conflict. Lighting for example is an important feature of security in any situation. It is likely that improving this feature will positively impact all users regardless of their travel mode. However, providing a short walk distance for one mode, such as pedestrians, may come at the expense of directness for other modes, perhaps if it means that the park and ride lot must be placed behind the station. Some of these conflicts may be easily resolved with effective station design, while others may be irreconcilable. In this circumstance, the transit agency's policies can help weigh the options and determine which to prioritize.

Many of the design features are associated with some type of cost, be it economic, inconveniencing another mode or conflicting with other agencies' policies. A scale has been developed for each feature with descriptions of elements whose designs range from unsupportive to providing optimal accommodation for the specific mode. Various

quality levels for each feature have been identified to provide an understanding of how each element affects the design attribute so that if an agency does have to make choices, they can understand the range of options available and consequences of choosing a specific design element. These scales should be considered to follow current standard multi-modal thinking.

Some agencies and advocates focus their efforts on a single mode. Transportation departments have historically focused their work on improving automobile use while cycling or pedestrian advocates are focused on promoting their own needs. While agencies are becoming more cognizant that there are multiple travel modes that need to share public rights of way, most agencies still have a limited perspective on how to coordinate multiple modes.

In the United States, separating uses and placing strict controls over where they meet has been thought to be the best way to insure safety. While regulation can be used to improve safety, sometimes it can backfire. If regulation causes too much delay or additional effort, people may disobey the rules trading off the risk of injury or being caught with the benefits they see such as convenience or shorter travel times. Consistent disregard can quickly reduce the effectiveness of these traffic regulation tools.

Another strain of thought, being actively developed in The Netherlands and Denmark is to make all modes share the same space and remove traffic controls, making each traveler responsible for their own safety and actions. When traffic of all sorts is heavy each mode is cognizant of the other, but when traffic is unbalanced by mode or sporadic, people may not recognize that additional attention is required. This theory is starting to be considered by planners in the US, but has not been adopted as standard practice. While the author understands that this less structured method may be effective in some circumstances, the consequences of it not working can result in serious accidents and that in most cases, the traditional method should be used. Therefore, this

document analyzes access assuming that separating different modes is preferred, while recognizing that there may be better options available in some circumstances.

As mentioned, different design elements and the process used to implement them can affect the cost of different improvements. Some features can be implemented in a stand-alone manner while others must be done as a part of larger station renovations. For major renovations, improving specific features may not add additional cost to the project. Some improvements will require additional funding, but this level is often less than if the improvement was done independently. Where available, monetary costs for different improvements are included. These costs assume the improvement is done independently from other work and therefore may be reduced by incorporating them into other projects. Where probable, potential mode conflicts are identified, although most mode conflicts will be dependent on the specific layout of the station area. Improvements outside the transit agency's jurisdiction will require coordination with other government and private organizations.

Table 2-1 Features Affecting Design Attributes by Mode

Design Attributes	All Modes	Pedestrian	Bicycle	Bus	Drop-off	Park and Ride
Safety	·maintenance ·mode conflicts	·pedestrian space ·street crossing	·facility ·surface condition	·mode conflicts ·stop location	·drop-off location	·lot design
Security	·visibility ·surveillance ·maintenance	·visibility ·surveillance	·infrastructure ·surveillance	·waiting area	·waiting area	·surveillance ·visibility
Directness	·integration ·wayfinding	·station orientation ·street pattern ·delay	·parking ·pathway	·stop location	·drop-off location	·lot layout ·payment process
Weather Protection	·shelter	·shelter	·parking ·changing facilities	·stop design	·waiting area	·lot design
Supportive Details	·orientation ·retail	·density ·land use	·services ·information	·schedule coordination ·fare integration ·retail ·schedule information	·shuttle service ·taxi	·reserved spaces

2.3 DESIGN ELEMENTS

This next section describes the elements that affect each of the access attributes by mode. For each mode, factors that play a role in access quality have been identified for each design attribute. Elements that providing different quality levels for each factor are discussed. Tables summarizing the range of elements and how well they provide for the specific attribute conclude each section.

All Modes

No matter how they arrive at the station, all users are pedestrians within; and in most cases, in the immediate vicinity of the rail transit station. At the point when people enter the general station area, they become pedestrians and face similar challenges as those walking to the station. “All Modes” looks at the challenges faced by all people as they proceed to the rail station itself. The physical space that concerns all modes varies depending on the station layout and location of facilities for other modes. The following are features important to all passengers as they travel to the station.

Safety

Safety is a design factor that is important to users of all systems. Maintenance and conflict created by poor station design are the two major safety concerns.

Maintenance

Dilapidated pavement and, broken lights and slippery conditions increase the potential of an accident. Considering maintenance and potentially dangerous conditions while designing the station and then promptly fixing cracks, drying wet floors and correcting other dangerous situations can help prevent many of these safety hazards. Designing a station with concrete staircases as opposed to wood or metal stairs reduces the risk of people slipping when conditions become wet.

Mode Conflicts

Another major safety concern is conflict between pedestrians and vehicles. Conflicts occur when the station design places one mode in the way of the straightest-line path from another mode to the station entrance. Pedestrians have a tendency to take the most direct route. People who have left their access mode and are making their way to the station entrance may come into conflict with buses and vehicles dropping people off or cyclists making their way to park their bikes.

These multi-modal conflicts are most severe when the pathways are unintentional and unmarked. Conflicts can be made less serious both by better design and also if users of both systems recognize other users of the space. Both directional signage and warnings in multi-modal areas can help keep people safe as they travel to the station. Creating direct and safe paths initially will prevent unintended conflicts and providing direction can make people more aware of their surroundings.

Table 2-2 All Modes: Safety

Design Feature	Worst			Best
Maintenance	physically damaged	vandalized, worn		well maintained
Mode Conflicts	obviously indirect	inconspicuously indirect		complementary, direct

Security

As described in Atkins, being able see what is around and being to access help if needed are important factors for providing security.

Visibility

Good visibility helps make people feel more secure because it provides the ability to see and be seen by people in the surrounding area. Adequate lighting allows a person to size up another individual before they come too close. Using an open station design where there are few sharp corners gives people the ability to view their surroundings. Glass and other transparent materials allow spaces to feel more open, encourage surveillance and permit light to flow from one space to another.

Surveillance

People may feel insecure at transit stations if they feel they are isolated or surrounded by strangers who make them feel uncomfortable. Proper surveillance helps the patron feel that he or she is not alone. Although surveillance was an important attribute at transit, Trench (291) found that closed circuit televisions were decidedly unacceptable. The knowledge that someone was supposedly watching out for them at some remote location did not allay fears that they would be victimized, due to lack of assurance that the monitor would be paying attention or would be able to launch a rapid response in order to prevent the crime. Having station attendants near waiting areas insures that someone is available when there are few patrons of the system. Creating areas where passengers can size up others and have the support of other passengers through strength in numbers are important features in creating a more secure station environment.

In order to make people feel more comfortable, stations should be active centers where loitering is not seen as acceptable and where there are other people around to deter vandals. Having stations near evening activity generators and creating mixed use environments at the station increases evening activity and provides 'eyes on the street' surveillance and can create a more secure environment. Lighting, open station design, having a station attendant or security guard on duty and visible and insuring an active station area are all important elements of creating more secure station areas. Many of these security concerns are best dealt with during initial construction or if the station is undergoing major renovation. Rearranging the station layout may not add additional cost to a renovation project but would be impossible at other times. Depending on what is needed, lighting and the location of the station personnel may be improved without major renovations.

Maintenance

Proper maintenance helps to create a secure environment and reduces the risk of an area becoming seedy. Having a well-maintained station creates a feeling of ownership

and care about a place that is not there when the station is in poor repair. It is much easier to throw trash on the ground when there is already other debris on the floor compared to when a place is clean and debris-free. Environments that appear to be cared about by others, make us care about them as well and people who are up to no good may feel less comfortable in a place that is pampered with attention because people are more likely to be looking out for its well being.

Table 2-3 All Modes: Security

Design Feature		Worst			Best
Visibility	Lighting	dim, infrequent causing shadows			bright, even
	Station Layout	numerous corners, narrow passageways, barriers			open design
Surveillance		none, video monitoring	Station attendant but not nearby	accessible station attendant	direct surveillance, high levels of activity
Maintenance		vandalism, dirty	vandalism	dirty	graffiti-free, clean

Directness

As mentioned earlier people like to take the most direct path to their destination but it is difficult to have everyone immediately adjacent to the station. The volume of passengers using each mode and the impact on other passengers of prioritizing a specific mode should be considered in order to optimize access for all passengers. In addition to reducing access time, considering impacts on other access increases the likelihood of safe and proper utilization of the space.

Integration

Making walkways feel as if they are a part of the station design can make walking distances seem shorter because the distance to “the station” has been reduced even though the total walking distance has not changed. These pedestrian passageways, which are described in detail under Pedestrian Directness, can bring station entrances to bus stops on multiple street-corners or to parking lots that may not be located directly

adjacent to the main station. Making these station extensions can be expensive and add additional mass to the station that can add to maintenance costs.

Wayfinding

Wayfinding refers to the ability to move around within a station and find what one is looking for. Proper signage, straightforward designs and station personnel help direct people to where they need to go. Passengers entering the station should have an easy time purchasing their tickets and traveling to the waiting platform. In-station retail and posted information should be easy to locate. Passengers should be able to determine how to reach their desired location beyond the station area without becoming disoriented or taking a wrong turn. When pathways are sensibly laid out, people will spend less time searching for where they are headed and less signage will be required to direct people to safe routes. Even with good station layout, signage may still be needed for informational purposes such as to describe what lies beyond the station door. This is especially important when there are multiple exits to the station. Station attendants can also play a vital role in directing people to where they need to go.

Table 2-4 All Modes: Directness

Design Feature	Worst Best			
Integration	long, unconnected	direct but separate	short, connected	fully integrated
Wayfinding	no signage	some signage	directionally intuitive design	signage, intuitive design, human assistance

Weather Protection

Relative to the rest of the access trip, travel time between a person’s access mode and the train station is minimal. Since this is portion of the trip covered in All Modes, providing temperature control along the travel corridors is less important. Weather protection for All Modes should focus on preventing exposure to rain since once people are wet, it may take some time to dry. Providing fully enclosed connections or covering a small portion of the access route may be the preferred weather protection solution

depending on the local climate. In regions with severe weather, providing as much enclosure as possible may be desired. In areas that are hot, some shelter from the sun and rain is important but retaining natural air circulation may be desired to keep things cool. In extreme climates, air conditioning or heating may be needed to provide comfortable environments, especially when waiting areas are included within the station.

Table 2-5 All Modes: Weather Protection

Design Feature	Worst	Best
Shelter	open, exposed, rigid	appropriate temperature control for climate, flexible

Supportive Design

Orientation

Station Identification

In addition to being able to find ones way through the station and into the surrounding neighborhood, the station should be highly identifiable as a transit station from the surrounding area. Agencies usually have standardized logos or emblems and colors that identify the system. Using this logo at stations is beneficial because it not only directs passengers to the station but also advertises the existence and convenience of the system to non-users. Signs should be illuminated so that they remain visible at night. System identification is especially important if architectural styles vary throughout the system.

Stations located within other buildings or stations with no headhouse at or above ground level need to make sure that the station entrance is visible from the surroundings. Most of the Washington Metropolitan Area Transit Authority’s (WMATA) Metro stations are subterranean and do not have headhouses at ground level. WMATA uses consistent design standards for all station signage, which helps locals locate stations. Still the low profile of the station can make them difficult to spot for people

new to the area. Figure 2-2 shows the Metro’s Woodley Park-Zoo/Adams Morgan station entrance. The Metro post located behind the approaching car is the only signal that a Metro station is located here since the station is below ground. If a transit station is not located along a main corridor, identification and direction should be given from the main road.



Figure 2-2 Entrance to Woodley Park-Zoo/Adams Morgan Station (WMATA)

Station Surroundings

Information regarding the surrounding community is also an important feature of a transit station. It is often difficult for passengers to get their bearings when exiting a transit station for the first time. Information about attractions surrounding the station help to direct people to their destinations and inform them about other places they can reach via transit. Knowing that there is a library, shopping center or even specific commercial opportunities provides information as to the breadth of trips that can be made by transit. Station area maps are an excellent way of providing this information, but depending on the level of detail, they can be difficult to keep up to date. Signage should be used to direct people to popular destinations. In addition to destination names, basic directions should be provided if the destination is not obvious from just outside the station. “Hospital 2 Blocks South” with an arrow is much more helpful than a sign that just says Exit. WMATA provides maps with streets names, parks and civic buildings in addition to 1/4- 1/2- and 3/4-mile radii to allow people to gauge distances to their destination.

Retail

Having concessions within the station is an important feature of encouraging transit use. This section will discuss retail as a part of the transit station complex. Nearby retail opportunities will be discussed in the pedestrian section.

One common reason given for people choosing to drive over taking transit is the difficulty of trip chaining, or making multiple stops, via transit. A 2001 survey of travel behavior in Chicago showed that while it is true that trips made by automobile are more likely to include a stop than those made by transit, only 18 percent of auto trips include a stop. The benefit of being able to run errands may be more of a perceived, as opposed to a real benefit. Regardless of true travel patterns, perception is the important factor in mode choice decisions. Of the commute trips that do include a stop, 52 percent of stops are made for personal or household business while 25 percent are for social activities or recreation. 19 percent of trips are to drop off or pickup a child at daycare or school (Northwest Research Group 86).

By providing for people's personal or household business, such as dry cleaners, grocery store, fitness centers and child care, the choice of transit as a commute mode can be made with the confidence that other errands can be run if a person decides to take transit. By incorporating retail into the station itself, passengers may be able to use the services while being close enough to recognize when their train or bus is arriving. Information about when the train or bus is arriving makes use of these facilities more convenient.

While dry cleaners, convenience stores, small eateries, and newsstands are all common station concessionaires, larger retail establishments can also be housed at transit stations. A study by the Centre for the Study of Commercial Activity stated that the minimum daily traffic flow needed to be 6,600 persons to support one store, while larger stations, especially downtown or multi-modal transfer stations could support

multiple retailers (Yeates and Jones). Alewife Station along the MBTA red line incorporates a day care facility and popular restaurant into the station with 9,400 patrons a day (MBTA). Since so few people actually trip chain, it is important to recognize that businesses within transit may be less financially viable unless they are able to draw customers beyond the transit base. This can be of additional benefit because it exposes potential riders to transit. A balance should be made between incorporating retail into a transit station and allowing the surrounding community to provide services. Urban stations with high levels of passengers walking to the station often provide are better able to provide retail services outside of the station since people will walk by and there may be high levels of non-transit related pedestrian activity. For suburban stations with high levels of bus and park and ride access, providing the services within the station makes more sense because the stations are more likely to be physically isolated from their surroundings and passengers using these modes are less likely to take the effort to leave the station area.

In order to provide retail, stations will need to be designed with enough space to accommodate the business. While this is an additional cost, rent from the business can offset it or even become a revenue producing mechanism for the transit agency. As discussed, adequate passenger flows are needed to make these spaces attractive to businesses. In some situations, a transit agency may decide to subsidize a retailer because in order provide this amenity to passengers. Having retail within stations may also provide additional security by creating more activity at the station or just having the retailer provide an extra set of eyes at the station.

Table 2-6 All Modes: Supportive Design

Design Feature		Worst				Best
Orientation	Station Identification	unmarked non-descript	visible	system-wide style, recognizable		
	Station Orientation	no connection to surroundings	signs, maps about surroundings	visual connection to surroundings	map and visual connections	
Retail		none	small selection			broad selection

Pedestrians

Pedestrian access to the station considers rail users who walk to the station from where their trip begins or from the transit station to their final destination. While all people become pedestrians when they leave their access-mode vehicle, pedestrians do not have another form of transport to the station. This discussion will look at pedestrian access as they near the station and potential conflicts with other access modes they may encounter. The pedestrian-access environment is almost entirely outside the jurisdiction of the transit agency. They will need to build relationships with other governmental agencies and organizations in order to improve pedestrian access.

Walking is the slowest mode of transportation with speeds ranging from 1.5 miles per hour when people are strolling, are elderly or are in congested conditions to 4.5 miles per hour for those who are almost running (Pushkarev and Zupan 85). The Highway Capacity Manual (18-1) suggests facilities be designed for pedestrians speeds of 4 feet per second, or 2.7 miles per hour, expecting that 85 percent of trips are made at this speed or faster. Slower design speeds (2.5 to 3.3 feet per second) should be used when it is expected that a larger percent of pedestrians will need more time, such as areas adjacent to schools or senior centers.

Safety

Walkways

Pedestrians may face a harsh environment as they travel along sidewalks to transit stations. Poorly designed or maintained walkways can create unsafe conditions. Cracked sidewalks can be tripping hazards and obstructions such as low tree branches, misplaced poles, garbage cans and other street furniture along the sidewalk can also be dangerous. In some circumstances, sidewalks are not be provided at all and pedestrians have to contend with vehicle traffic. Cervero ("Factors" 14) found that passengers were more likely to walk than drive in areas with complete sidewalk

networks. Sidewalk width is based on the number of pedestrians expected but should have a minimum of 5 feet of walkable space to allow access for wheelchairs and for people to comfortably pass each other or walk two abreast (Zegeer et al. 148). Pushkarev and Zupan (130) recommend 3 square feet of space for standing pedestrians and 130 square feet per person to allow people to travel comfortably. In order for pedestrians to walk freely without constantly focusing on avoiding other pedestrians, sidewalks should be designed wide enough to allow flow of 2 people per minute per foot. Above 6 people per minute per foot, walking becomes physically constrained, making it difficult to proceed at ones desired speed (Pushkarev and Zupan 98). Sidewalks adjacent to transit stations need to be designed to accommodate the high volumes of foot traffic and any additional activities such as waiting that typically occur in front of stations.

Vehicles pose a threat to pedestrians even in places that do have sidewalks. Pedestrians may feel more secure if there is a buffer between them and moving vehicles. Having parked vehicles along the sidewalk or planting trees or other vegetation in a buffer strip shields pedestrians from traffic. Sidewalks along major arterial streets should have at least a 4-foot buffer in addition to the necessary sidewalk width needed for pedestrian travel (Zegeer et al. 148). Buffer space is usually the last priority and considered only after space has been allocated for the desired number of traffic and parking lanes and adequate sidewalk width. Purchasing property, especially if built-up to the property line is prohibitively expensive so if buffer space cannot be provided, a low wall or railing can provide protection for the pedestrian from errant vehicles, road runoff and vehicle spray. Using this kind of barrier should be considered a last resort for corridors with high vehicle speeds.

Street Crossings

It is impossible and probably not desirable for pedestrians to stay on exclusive pedestrian infrastructure. At some point, pedestrians have to interact with other modes, such as at intersections, typically a vehicle dominated space. The Uniform Vehicle Code

states that pedestrians are allowed to cross at all street intersections with at least one sidewalk, and at marked crosswalks (1-112). Pedestrians often place directness above whether or not they will cross at legal locations. A study by Sisiopiku and Akin (5) found that 20 percent of pedestrians refused to go out of their way to cross at a designated location and 42 percent were willing to go out of their way only sometimes. Only 29 percent of pedestrians claimed that they “rarely or never” jaywalked while 25 percent jaywalked “often or almost always.” The deviation required for a person to use a crosswalk compared to their preferred travel path played a factor in whether a person would use a designated crosswalk 90 percent of the time. The presence of pedestrian signals affected a pedestrian’s travel path 74 percent of the time. Since pedestrians will take the shortest path, it is important that a safe crossing is provided where people will actually be crossing the street, not only where traffic engineers want them to cross. In order to provide a safe street crossing, there are four main factors that need to be considered: traffic flow; crossing length; traffic control and pedestrian crossing visibility.

Vehicle Flow

Vehicle volume and speed are the most important factors in determining the safety and ease of crossing to the station. If there are lots of fast moving vehicles, crossing an uncontrolled street can be nearly impossible and extremely dangerous since gaps between vehicles may not be long enough to allow a person to cross and vehicles may be going too fast to stop for a pedestrian. Streets where traffic moves slowly, even if they are busy, may not need as much intervention as faster moving streets because drivers are more likely to be responsive to pedestrians, creating breaks in traffic to allow people to safely cross.

Any location where people are likely to cross should have sight lines appropriate for the speed of traffic. If vehicles are speeding down a wide street, pedestrians will need longer field of vision to insure that they have enough time to cross the street. On narrower streets with slower traffic, this distance does not need to be as long because

pedestrians will require less time to cross the street and slower vehicle speeds provide more time for pedestrians and vehicles to react to each other.

While slightly contradictory, one-way streets reduce pedestrian crashes even though they induce higher travel speeds since drivers slow down to insure that they do not hit oncoming traffic (Zegeer et al. 57). One-way streets can be easier to cross since pedestrians only need to focus on traffic coming from one direction. In urban areas vehicle platoons, and conversely gaps in traffic, are often created by signalization. Pedestrians often use these gaps to cross at uncontrolled locations. Adequate gaps are less frequent and predictable along two-way streets, making them more difficult and dangerous to cross. Two-way streets provide the most direct travel routes, make vehicle travel simpler (especially for non-locals), and can slow down traffic: all of which makes pedestrians more comfortable. Where traffic is steady, adequate signalized crossings are needed to allow pedestrians to cross. In areas with heavy congestion, one-way streets may be desirable from a vehicle flow perspective, but speeds should be regulated to insure pedestrian comfort and to provide pedestrians with opportunities to cross.

Street Design

In addition to the amount of traffic on the street, the design of the street can affect the ease of crossing and even the decision to walk. In a study, transit riders were more likely to walk from the station when there were narrower curb-to-curb widths (Cervero, "Factors" 16) and major arterials were found to deter walking (Loutzenheiser 47). Although wide streets negatively affect walking rates, pedestrians may need to cross major, multi-lane streets in order to access transit.

Local municipalities often use the Highway Capacity Manual (HCM) that provides suggestions for street design, which are often used by local municipalities as guidelines. The HCM 2000 has updated many of its recommendations relating to pedestrian levels of service. The LOS guidelines rank pedestrian services by how much they allow for

the free flow of pedestrians, which are reasonable for many pedestrian environments. In some cases though, low densities of pedestrians can actually be less appealing than a crowded sidewalk, which HCM does not consider. Although it is improved, HCM 2000 still considers pedestrians as secondary users of the transportation network and has a long way to go before it has fully integrated them into its service recommendations.

Streets should be designed to shorten the amount of time pedestrians are exposed to vehicles. Narrower travel lanes on roads slow traffic, increase driver caution and reduce the amount of time pedestrians are exposed to vehicles. Narrowing travel lanes can also free up space for bike lanes or sidewalks.

Bulb-outs, which extend the sidewalk through the parking lane to the first travel lane can improve crossing safety. They extend the protected pedestrian area, shorten the distance pedestrians have to walk while exposed to traffic, and give pedestrians better visibility and better sightlines to traffic. In addition, bulb-outs reduce the turning radius for vehicles, which requires them to slow down when making a turn. Even if bulb-outs are not used, minimizing turning radii is important for shortening pedestrian exposure to traffic and slowing turning vehicles.

As discussed above, crossing a single direction of traffic is easier than trying to cross two-way streets at uncontrolled locations. Two-way streets can be designed to allow pedestrians to cross one direction of traffic at a time. At uncontrolled locations, raised pedestrian islands provide a safe refuge for pedestrians so they only need to concentrate on finding a break in traffic for a few lanes at a time. Pedestrian islands can also be used at signalized intersections when signal cycles are short and do not provide adequate time for slow walkers to make it all the way across the street in one cycle. It is important that the crosswalk cut through the raised island so that it can be used by people in wheelchairs. Medians that run the length of a street can also be used to break a street into shorter segments and reduce lane widths. Since medians separate traffic, drivers may perceive that they are on a one-way street, leading to

higher speeds, they are generally less appropriate than other street-narrowing techniques.

Traffic Control Mechanisms

Traffic control devices can be used to clarify priority of the street space when traffic volumes and speeds or the number of pedestrians becomes too high. Traffic control devices include traffic lights, pedestrian lights, crosswalk enhancements, and signage. Placing traffic control devices where they are not needed creates unnecessary delay, which may create a general disrespect for them and reduce their overall effectiveness. The Manual on Uniform Traffic Control Devices (MUTCD) is considered the standard reference on when and how to install traffic control devices and is often used by cities to determine if there is enough traffic to deem control devices appropriate. MUTCD bases its recommendations on the number of pedestrians and vehicles at the intersection. Many pedestrian and bicycle advocates consider the MUTCD to be oriented toward the automobile with little consideration of the pedestrian. Warrant 3 allows consideration of pedestrian volumes and Warrant 4 provides for relaxed standards for signalization at school crossings. It may make sense to have signalization near community centers, transit stations and other areas that may attract pedestrian trips even if they do not meet the minimum criteria to encourage additional and safer pedestrian activity.

Traffic signals control the movements of vehicles. They are most commonly seen at high vehicle volume intersections, although they can be used at any location to direct vehicle traffic. Although these signals are not designed specifically to control pedestrian movements, they provide breaks in traffic and are often used by pedestrians to obtain information about vehicle travel patterns in order to determine safe times to cross the street. MUTCD recommends using traffic signals when there are traffic volumes of 750 vehicles per hour along the main arterial throughout the day (4C.02, Warrant 1). Changing traffic signal timing is a fairly easy task, requiring minimal staff time and no additional capital costs.

Instead of taking cues from the vehicle lights, pedestrian signals should be included along with traffic signals at intersections to inform pedestrians when it is safe to cross. Pedestrian signals are especially important when vehicular traffic is complex because they can refine signalization so that pedestrians are aware of unobvious times when it is safe to cross. When intersections are signalized, with or without pedestrian signals, it is important that the cycles⁴ allow for pedestrians to safely cross the street.

Traffic signals are often set with long cycle times in order to process as many vehicles as possible, which can lead to long average pedestrian wait times. Ideally, traffic signal cycles should be kept under 90 seconds to prevent pedestrians from having long waits. Although vehicle needs at an intersection can create long pedestrian delays, street design and walking speeds also limit the available walk time. Pedestrian wait time is influenced by both the cycle time and the amount of pedestrian green (Walk) time provided as illustrated in Table 2-7. This table compares average and maximum time a pedestrian would have to wait if crossing one leg of a symmetrically timed intersection. Wait time is calculated based on the total cycle time and the amount of Walk time provided for crossing in that direction. The HCM suggests that pedestrians have a low tolerance for waiting and are likely to engage in risky behavior if they experience more than a 30-second delay where vehicle volumes are moderate (18-7). At a minimum, 5 seconds of pedestrian Walk time should be provided to give people time to react to the change of light and enter the intersection.

Table 2-8 has the distance that an average pedestrian (4 ft/sec) and a slower walker (2.5 ft/sec) can cross during the flashing Don't Walk (FDW) signal. It is important to note though that at wide intersections it may be difficult to provide shorter cycles because enough non-green (FDW) time must be provided to allow pedestrians to finish crossing the street. The wider the street, the longer flashing Don't Walk phase must be,

⁴ Cycle time is the amount of time it takes for a signal to change from green to yellow to red and back to green.

increasing the average pedestrian wait time. The need to provide adequate walk time emphasizes the importance of narrow streets.

The distance that can be crossed by slower pedestrians who start at the beginning of the Walk signal is also listed in Table 2-8. If one assumes that slow pedestrians will only start walking at the beginning of the Walk signal, the time needed to insure that all pedestrians can cross the street is reduced.

Streets with four or more travel lanes and minimum cycle times should have pedestrian islands for slower pedestrians. While having to wait at a median is not desirable, it provides a solution for balancing the longer walking time needed for a few pedestrians and the desire to provide minimal wait times for the majority of pedestrians. A balance must be made between minimizing wait times by meeting the requirements for most pedestrians or insuring the slower members of society, often the most vulnerable, are fully protected.

Table 2-7 Signal Cycle & Pedestrian Wait Time

Phase Time (sec)		Pedestrian Wait Time (sec)	
Total Cycle	Walk	Average	Maximum
40	5	16	35
	10	12	30
60	5	26	55
	10	21	50
	20	14	40
90	5	41	85
	10	36	80
	20	28	70

Table 2-8 Signal Cycle & Crossing Distances

Phase Time (sec)		Distance in FDW (feet)		Distance in W + FDW (feet)
Walk (W)	Flashing Don't Walk (FDW)	2.5 ft/sec	4 ft/sec	2.5 ft/sec
5	5	13	20	25
	10	25	40	38
	20	50	80	63
	30	75	120	88
	40	100	160	113
10	5	13	20	38
	10	25	40	50
	20	50	80	75
	30	75	120	100
	35	88	140	113
20	5	13	20	63
	10	25	40	75
	20	50	80	100
	25	63	100	113

Pedestrian countdown signals, which alert pedestrians of how much time they have to safely cross are a new improvement over the traditional Walk/FDW/Don't Walk lights. They give pedestrians enough information to know based on their individual speed whether they should wait for another cycle, stay at the median or have time to cross the entire street, which keeps people safer while helping to reduce wait times. Pedestrian signals should be programmed with an advanced walk phase. This allows pedestrians to enter the intersection before vehicles start to make turns.

For areas with high volumes of pedestrians or many turning vehicles, a pedestrian only phase, also known as a "pedestrian scramble" can be used. Pedestrian scramble phases provide a pedestrian only phase with no conflicting traffic. This allows pedestrians to walk diagonally across an intersection if they choose. Although pedestrian scrambles insure that there will be no vehicle interference, they often require pedestrians to wait longer before being able to cross. They are often used in high

pedestrian areas to assist vehicles in moving through the intersection without conflicts from pedestrians.

Pedestrian signals can be automatically incorporated into every cycle regardless of if there are pedestrians wanting to cross. In cases where pedestrian traffic is minimal and vehicle traffic heavy, pedestrian signals may only be actuated on demand. In a few instances infrared or microwave pedestrian detection has been used to recognize when pedestrians are waiting to cross. This technology has been used with in-street lights discussed below (*Ped Smart*). In these instances, pedestrians do not have to actively prompt the system. In most cases, pedestrians must take the initiative to press a button and then wait for the pedestrian light to change. Self-actuated systems require initiative by the pedestrian and then oblige the pedestrian to wait for the proper cycle, which will be longer than the light cycle if they may have just missed enabling the pedestrian phase.

Many cities refuse to place traffic and pedestrian signals at mid-block locations because they delay vehicle traffic. In order to minimize disruption to the surrounding traffic, mid-block lights can be timed in series with lights at either or both nearby intersections, such as the lights adjacent to the Harrington School in Cambridge, Massachusetts.

Crossing Visibility

At locations with high pedestrian activity that do not meet the warrants needed for signalized crosswalks, other devices need to be used to alert drivers of the potential of pedestrians. Crosswalks may be used to focus pedestrian crossings to a single location that can be highlighted as a likely location for vehicles to encounter pedestrians. The safety of uncontrolled mid-block crosswalks has been questioned. *Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations* tested the safety repercussions of marking crosswalk under a variety of conditions. Marked crosswalks were not found to make a significant difference in safety at many locations but were found to be more dangerous than unmarked crossing locations on high volume, multi-

lane or complicated streets. This may be due to the fact that high-risk pedestrians (the old and young) choose marked crosswalks over crossing at unmarked locations. At these hazardous crossings, high-risk pedestrians were more likely to run into trouble than pedestrians who did not differentiate between marked or unmarked crossing locations. This study proposed that instead of not marking crosswalks, additional tools are needed to draw driver attention to these locations and make mid-block crossings safer.

Improvements over the basic crosswalk design can be used to insure that pedestrians using mid-block crosswalks are safe. In-pavement lights, raised crosswalks, signage, striping design and other techniques can be used to increase the visibility of crosswalks. The added safety benefit of these techniques have not been widely studied but descriptions of these techniques and their theoretical benefits are listed below. In-street lights can be used to increase the visibility of uncontrolled crosswalks. These lights, which are imbedded in the street, flash upwards when a pedestrian is in the crosswalk. Some in-street lights have been designed to be self-actuated, allowing pedestrians to just cross the street. In addition to being self-actuated, in-street lights do not require waiting until a traffic light phase is over before they begin, removing the frustrating delay of traffic signals. Conversely, they do not provide the pedestrian with the same level of confidence of a pedestrian signal while they are crossing, leaving the pedestrian with some of the responsibility for choosing a safe time to cross.

Raised crosswalks can improve pedestrian safety by raising the level of the pedestrian so that they are more visible to cars. Raised crosswalks also act as speed bumps, slowing traffic down and making pedestrian-vehicle collisions less likely and less serious. It is important to make sure that buses and emergency vehicles can navigate the raised crosswalk.

More basic techniques have also been used to increase safety of mid-block crossings. Fluorescent yellow-green signs with pictures of pedestrians or 'PED X-ING' can be used

to bring attention to a crosswalk. Ladder crosswalks are another way to make crosswalks more noticeable. Pedestrian crosswalks made of two parallel strips can be difficult for vehicles to see and recognize as a pedestrian zone because the lines may just be seen as two distinct stripes, especially if the crosswalk is located at the crest of a hill. Ladder crosswalks, or those that paint stripes between the two parallel lines, are easier to see and recognize as crosswalks because the stripes are seen as a whole unit as a car approaches.

Placing vehicle stop lines farther back from the pedestrian crossing provides a bigger buffer between cars and pedestrians by encouraging vehicles to stop well in advance of the crosswalk. At multi-lane locations, where a vehicle in an adjacent lane may not be able to see why the car ahead has stopped, advance stop lines provide additional time for the car to react.

Salt Lake City, UT and Berkeley, CA are known for their programs that provide pedestrian flags at major mid-block crossing locations to increase the visibility of pedestrians. A flag-stand, similar to an umbrella stand is located at both sides of the crosswalk. A pedestrian picks up a 15 inch orange flag, walks across the street and then deposits it in the stand on the other side.

Other traffic calming devices can also be used to improve pedestrian safety. *The FHWA's Pedestrian Facilities Users Guide* gives additional traffic calming and pedestrian tools. Not only do the above techniques make the crossing easier for the pedestrian, but they also slow down traffic by narrowing the road or adding vertical displacement. By varying the roadway, vehicles cannot speed through the area, but instead need to pay closer attention to their surroundings. Many factors go into making pedestrians safe as they walk to transit. The design features discussed above provide a wide range of choices that can be used alone or in combination depending on the current conditions. Coordination with the City Public Works and Transportation Departments will be mandatory to improve pedestrian safety.

Table 2-9 Pedestrian: Safety

Design Feature		Worst					Best
Pedestrian Space		no vertical separation		curb adjacent to road		small buffer strip	parking lane buffer
Street Crossing	Vehicle Flow	high-speed, constant or sporadic		high speed but regularly intermittent		slow, constant	slow, low-volume
	Street Design	multi-lane, two-way	multi-lane, one-way	narrow lanes, pedestrian islands, bulb-outs			narrow street
	Traffic Control	none	traffic signals	self-actuated pedestrian signals	automatic pedestrian signals		
	Crossing Visibility	unmarked	two parallel stripes	ladder crosswalk, additional signage		in-pavement lit crosswalk	raised crosswalk

Security

Security is a concern throughout the entire pedestrian access trip because the entire trip takes place in publicly accessible space. Proper lighting, surveillance and maintenance can help pedestrians feel secure as they travel to and from the station.

Visibility

Lighting

At night, lighting can play an important role in making pedestrians feel safe. Often city streets are lit in order to provide safe travel for vehicles on the road. These lights are designed to provide a low level of lighting directed onto the street, leaving the sidewalks in shadows, dimly lit if at all. Additional pedestrian oriented lighting is needed to make pedestrians comfortable. These lights should allow pedestrians to identify buildings and the cause of any motion but too much light and exposed light sources cause glare that reduces visibility. All streetlights should have reflectors that direct the light down towards walkways to reduce glare and prevent light pollution from spreading upward. In commercial areas, some of this lighting may be provided by storefronts, which spread light from the streetwall onto the sidewalk.

Surroundings

Creating a comfortable environment is important for making people feel secure. In addition to lighting, the design of an area can affect comfort. A streetwall is the set of building façades and fences that demarcate the line between the public and private space. If the streetwall is a continuous surface such as building after building or solidly fenced areas, people do not have to focus on danger approaching from that direction. When the streetwall is marked with gaps or deep pockets such as vestibules, alleys or parking lots, pedestrians may feel vulnerable from all directions. Creating a continuous and defined streetwall does not mean that it has to be a flat sterile wall. Detail and variation in the street façade are important for making urban space interesting. Buildings or portions of buildings such as entryways that deviate from the standard setback should be as open as possible and be well lit. If glass can be used surrounding these areas, people will be able to see if there is anyone suspicious in the area before they reach it. If gaps between buildings cannot be fenced off, they should be well lit and free of glare to allow people to see well into the area to be able to quickly identify danger. Parking lots should limit entrance and exit locations and create a solid barrier along the rest of the edge to reduce the permeability of the space. Clean, well maintained areas free of refuse, graffiti and neglect can improve the feeling of security.

Surveillance

The other way to increase security is by having people watch over the activity on the streets. Other than the police, there is no one who is obligated to monitor these areas. Since there is rarely someone assigned to watch the area, the most effective way to monitor activity is by having active uses on the street throughout the day. An area that has very little activity can be very isolating for people walking though. Having stores or offices with people inside that are able to look out and people walking on the street to reach these locations, provide eyes that can help deter crime and also a person to call for help in case of an emergency. Having people around also provides stimulation for people walking to their destination, a feature that can make the trip more pleasant and go by more quickly. It is important to recognize that while an area may have activity and passive surveillance at one time of day, it may be very isolated at another. Business

districts are commonly active during the day but are often deserted at night. Mixing uses that are active during different periods of the day provide more constant passive surveillance.

Table 2-10 Pedestrian: Security

Design Feature		Worst		Best
Visibility	Lighting	infrequent street-focused		pedestrian-scale lighting
	Surroundings	bushes, lack of street-wall or dark “pockets” in façade, poorly maintained		semi-protected but open, well maintained
Surveillance		quiet isolated areas	potential for reaching assistance, no direct surveillance	active street or transparent street-wall into active spaces

Directness

As walking distance is a main factor in pedestrian access, it is important to make sure that the station entrance is in the direction of pedestrian travel. Adding distance to a pedestrian trip is more problematic than increasing the distance for auto access because of the slow travel speeds and large amount of energy that are expended while walking. On average, pedestrians walk at a speed of 4 feet per second or 2.7 miles per hour. Cervero (“Transit”) and Stringham, found that most walk to transit trips are 0.6 miles or less, meaning that people are willing to walk for 12 minutes to reach transit. Adding additional minute of travel time due to waiting to cross a street or indirect routing decreases the catchment area 16 percent.

Station Orientation

Development

In order to reduce travel time, major developments should occur at or adjacent to the transit station or the station should be placed within the development. Integrating stations into development directly links transit into the origin/destination of many passengers, basically eliminating the access/egress trip altogether. Placing station entrances in retail spaces like the one connecting Filene’s Basement to the MBTA’s Downtown Crossing Station in Boston makes people feel like they are taking transit

directly into the store. These connectors also provide passengers protection from the elements.

If a direct connection cannot be made between nearby development and the station, then placing a station entrance facing toward the development entrance is important. Stations that turn their back to development, or development that turns its back on transit, make walking between the two unnecessarily unpleasant. If a shopping mall is built near a transit station, placing the parking between the station and the stores adds additional walking time for the pedestrian. Developers should be required to facilitate pedestrian access when they build near transit. Creating car-friendly development around transit is a waste of a precious resource because it reduces the potential trip attractors. Both developers (required by zoning) and the transit agency have a responsibility for making this connection.

Not only do trip producers such as offices, retail and housing need to be oriented toward the street, but the transit agency needs to design its stations to provide direct access. Locating the front door of a station on the street as opposed to behind a bus station or other loading area not only improves pedestrian access, but also provides a continuous streetwall for the community. Although the station location may be constrained by where the tracks are, attempts should be made to stretch the front door of the station as far as possible towards where people will be traveling. This may require providing multiple entrances, which may add additional cost to the station. In some cases, it will also require coordination with other public agencies or private landowners to make changes to their properties.

Passageways

Depending on the size and orientation of the station and distances between popular access points, stations may use passageways to connect the access point to the heart of the station. Pedestrian passageways provide exclusive pedestrian access from locations that would otherwise require long indirect routes or additional street crossings.

For stations in expressway medians this can be particularly useful. By incorporating the space below (in the case of an elevated highway) or above (for depressed expressways) into the realm of the station, the transit agency can insure that pedestrians have a direct comfortable walk. The CTA Medical Center Station along the Blue Line, has three entrances at Damen, Odgen and Paulina which are designed to serve the large medical campus, Malcolm X Community College and the United Center sports arena which is within 1/2 mile. By providing three entrances, the station spreads its centerpoint along 3/8 of a mile, expanding its total catchment area and precludes people from having to walk around to a single access point.

Underground and elevated stations often provide access to the city at multiple points, such as at multiple corners of an intersection. In some systems such as Crystal City in the DC Metro, an entire pedestrian mall is located along underground passageways connecting multiple buildings. The station has managed to combine retail shopping and direct access to transit below ground. Unfortunately, many of the passageways in other stations are not nearly as nice. In the underground BART stations, walking to an exit can be long and uninteresting although the passageways are clean and well lit. Art exhibits can be used to spice up this underused space as the CTA has recently done in the tunnel connecting the Red Line subway platform and elevated platform for the Green and Orange Lines at the Roosevelt/State Station.



Figure 2-3 Stairway Connecting Elevated and Subway Platforms, Roosevelt/State Station (CTA)



Figure 2-4 Passageway to Entrance of Charles/MGH Station (MBTA)

Unfortunately, pedestrian passageways have been given a bad reputation due to many poor examples. Pedestrian passageways have frequently been created solely to move pedestrians around fast moving traffic. They are used to separate pedestrians and vehicles without interrupting the vehicle traffic flow, often at significant inconvenience to the pedestrian. In Chicago, pedestrian subways are used to create pedestrian access from the Lakefront to the rest of the city under Lakeshore Drive, a major arterial. In San Juan, pedestrian bridges are used to move pedestrians over major arterials. Figure 2-4 shows the pedestrian passageway needed to access the Charles/MGH station. The bridge is designed to allow vehicles up to fourteen feet to travel freely below while requiring pedestrians to walk up and then down stairs to reach the elevated station entrance. Pedestrian passageways are designed to increase pedestrian access, but they often include unneeded vertical displacement. In a study relating security to urban mobility, pedestrian pathways were found to be a major problem area because of their isolation from other activity centers (Atkins 27).

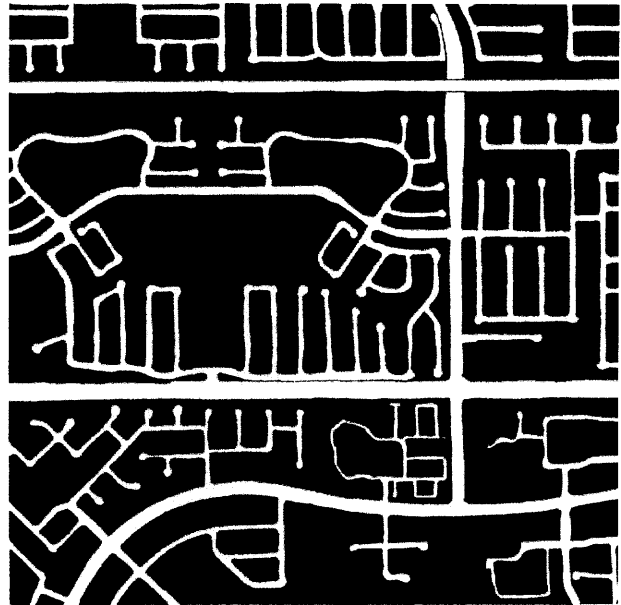
When proposing a pedestrian passageway, one should be aware of the following problems. Pedestrian pathways should not create circuitous routes, they should be an assistance to access, not a hindrance. Pedestrian pathways separate walkers from other traffic, often eliminating the visual connection between people which reduces overall surveillance. Their often narrow and angular design reduces sight lines, makes hiding easier and minimizes potential 'escape routes.' Many pedestrian pathways are dark, smell or otherwise poorly maintained. This may encourage illicit activities, creating uncomfortable conditions for others.

Since pedestrian pathways can create more direct routes, reduce the need to cross intersections and provide weather protection, they should not be eliminated, but should be designed with security as a primary consideration. Creating open spaces without hiding places, using materials that allow visual connections with the outside world and keeping up with maintenance are important in order to make pedestrian pathways comfortable and well used.

Figure 2-5 One-Square Mile (Irvine, CA)

Street Pattern

Beyond the station design, the urban landscape can greatly affect the ability and directness of people to access transit by walking. As mentioned above, people are willing to walk up to 0.6 miles to reach transit. Unfortunately, a 0.6-mile radius cannot be drawn on a map to determine the number of potential walkers. Street patterns that require people to travel out of their way reduce the catchment area.



Providing a network of streets or pedestrian paths that minimizes walking distances can increase the number of people who are close enough to consider walking. Cul-de-sacs and other non-gridded street networks make direct travel less likely. Long block length can also make walking more inconvenient because there are fewer travel corridors provided. In *Great Streets*, Allan Jacobs compared the number of intersections and blocks in a square mile for different urban landscapes. Portland, considered to be a very walkable city, had an average of 370 intersections and 318 blocks within the square mile; where a residential district in Irvine, California, an automobile oriented community, had 119 intersections and 43 blocks. As can be seen from a sample of the Irvine landscape (Figure 2-5), traveling what should be a short distance can actually take a long time following the streets. Having destinations accessible by foot are especially important if people are going to use transit because walking accounts for a higher percent of egress trips (Loutzenheiser 41).

Table 2-11 Pedestrian: Directness

Design Feature	Worst					Best
Station Orientation	located w/o respect to surroundings	set back from street	connected with pedestrian bridges/tunnels	oriented toward development	integrated into development	
Street Pattern	circuitous street network			fine grid-pattern		

Weather Protection

Walking along exposed areas can be unpleasant when weather is harsh. Providing weather protection for pedestrians is difficult because they are constantly on the move. Providing direct connections within buildings removes the need to go outside at all, while covered or enclosed pedestrian passageways can reduce the time exposed to the elements. Encouraging the use of awnings and street trees in the surrounding development may provide some protection from the sun and rain. Even if buildings do not have awnings or overhangs, they do provide some protection creating shade during some parts of the day and blocking wind and rain.

Table 2-12 Pedestrian: Weather Protection

Design Feature	Worst			Best
Shelter	open and exposed	buildings to shield wind	awnings, street trees, arcades	

Supportive Details

Land-use and density have been shown to be significant factors in determining mode choice for travel to transit (Cervero 6-7). The more housing, work opportunities and other attractions within 0.6 miles of the station, the more opportunities for walking and using transit.

Density

Higher density development places more people within walking distance of the station than lower density development. It also may make driving more costly and inconvenient because there are more people vying for limited street and parking resources.

Densities of greater than 50 dwelling units per acre are needed to see significant increases in pedestrian transit access (Deeming). Fifty dwelling units per acre are frequently found in pre-automobile cities and can be provided by structures no more than four stories high (Jacobs 304).

Land Use

Stations surrounded by retail were found to attract the most pedestrians, although having an activity center within the neighborhood also boosted the number of walking trips to transit (Loutzenheiser 47). Having retail, and service businesses mixed with offices and homes near a transit station, provides the opportunity for linking trips when walking to transit. Mixing land uses has been found to encourage transit use both in residential neighborhoods (Cervero, "Factors" 10) and also at employment centers (Cervero, *Suburban Centers*). Knowing a grocery store is near home or transit allows people to link shopping with walking home from transit because they know they will not have to make a separate trip by car, which would be needed if each land use was segregated. Mixed uses at business centers make having a car at work unnecessary because daytime errands such as working out, visiting the doctor and having lunch out can be done on foot.

In addition, mixed uses around the station are more likely to promote 24-hour activity. Single use areas may bustle from 9-5 or in the evenings, but do not provide street activity throughout the day. In addition to increasing security, constant activity helps to spread out the use of transit, making more efficient use of transit resources.

Additional Disincentives

The proportion of and proximity to arterial streets and highways is found to reduce walking (Cervero, "Factors" 9 and Loutzenheiser 47). These auto-focused corridors make driving trips more attractive because they allow higher travel speeds. Higher vehicle speeds and longer and more dangerous street crossings discourage walking on these wide streets. In addition, many arterial streets are designed for cars, with no

pedestrian-oriented lighting, and harsh pedestrian environments with unkempt sidewalks, and no amenities such as benches, shade or pleasant sightlines. Similar conditions occur near highways since use of highway overpasses and underpasses are not attractive for business or other active uses. It is especially important to focus on making conditions more pleasant for pedestrian access to median stations since many rail systems have built lines along highway medians and pedestrians must cross above or below the traffic, often through stark conditions to reach the station.

In one study, stations located in freeway medians averaged 7 percent fewer walk access trips than those at non-median stations after controlling for other factors (Cervero, "Factors" 9). Traditionally highway overpasses have been designed with narrow sidewalks directly adjacent to moving traffic without any sort of buffer zone. Tall chain link fences often edge these overpasses, providing an unattractive barrier between the overpass and the traffic below. Pedestrians are exposed to the elements since there is no protection provided by buildings or overhangs. Vibrations from the highway, noise, dirt and pollution associated with the automobile can make these areas unpleasant for walking.

While it may be difficult and expensive to plant trees or create other substantial buffers on overpasses, sidewalks should be wide enough for pedestrians to stay a comfortable distance from the vehicle traffic when these structures are rebuilt. Railings or other barriers on overpasses are important for the safety of people on the bridge and those below. Many States require these barriers to be designed to prevent people from throwing objects from the overpass onto the roadway or rail alignment below (missile proof). While there certainly have been serious accidents because of objects being thrown off overpasses, not all bridges need this additional protection. Deciding whether a bridge should be missile-proofed should be done on a case-by-case basis instead of at every location. Chain link fence is often used because it is cheap and has small openings to make it missile-proof, but other types of fencing material can and have been used. Figure 2-6 and Figure 2-7 show a before and after view of what was done

with a pedestrian overpass that required a missile-proof barrier. While the first one does protect the rail track below, it does not create a pleasing environment, while the new version is more welcoming. Figure 2-8 is an example of a creatively designed low-railing across the Kennedy Expressway in Chicago.



Figure 2-6 Pedestrian Bridge, Before



Figure 2-7 Pedestrian Bridge, After



Figure 2-8 Decorative Railing on Bridge Across Expressway

Table 2-13 Pedestrian: Supportive Detail

Design Feature	Worst Best			
Density	<10 DUA	10-50 DUA	50-100 DUA	> 100 DUA
Land Use	single-use, auto-oriented	single use, pedestrian friendly	mixed use, auto-oriented	mixed use, pedestrian friendly

Bicycle

People bicycling to transit stations are concerned not only for themselves, but for their vehicle as well.

Table 2-14 Factors Affecting Bike Parking Location¹

Close to destination	86%
Security	16%
Only place available	9%
Space is available	7%
Location is conspicuous/busy	6%

¹ More than one response was acceptable.

Data from a survey asking cyclists what had influenced where they chose to park is shown in Table 2-14. This study demonstrates the importance of proximity for bicycle parking to the destination. Placing bike parking in a far corner of a station will not encourage cyclists to use it. Security was the number two concern, but when followed up,

77 percent of people on commuting, business or education trips who were not prepared to leave their bikes for more than 2 hours, expressed concern about theft or vandalism. This compared with 52 percent of people on shopping, leisure or personal business trips. This indicates that although convenience is the dominant factor in choosing a parking location, security clearly has a significant role to play. It also shows that theft and vandalism are more prominent issues in cyclists' minds when they intend to park for longer periods (*Leaflet*).

People leaving their bikes at transit stations are likely to be gone for a long period of time and will not be in the area to keep an eye on their bicycle, making secure parking critical. In order to encourage bicycle access to transit, parking should be conspicuously located in a well-lit and populated area. Parking located within the station itself is ideal because it provides heightened security and weather protection, but it is important that the bike parking not interfere with other people accessing the station.

Safety

Facility

Bike lanes or bike paths to the station provide dedicated space for cyclists. Segregated bike paths are often preferred for recreational biking but are expensive to build and may be impossible to integrate into developed areas. The street network provides the most opportunities for people to bicycle for transportation purposes, such as accessing transit. Even when no explicit provisions are made for bicycling, cyclists have the right to ride on most roads other than limited access expressways. Most people, including children, can ride comfortably on neighborhood streets and on busier roads if there are well-defined pavement markings such as bike lanes, separating the cyclist from vehicles (AASHTO 6). If there is no room on the street to accommodate separate bike lanes, wide curb lanes give some space to cyclists, although they may also encourage auto drivers to speed. Wide curb lanes allow bicycles and cars to travel at different speeds without having to shift positions to pass each other.

Alewife station has the highest number of passengers arriving by bike of any of the MBTA stations. Between 40-65 bikes were found at the station on various sunny spring days that ranged from cold to pleasant. Not coincidentally, the 16-mile Minuteman Bikeway ends at Alewife Station. Sharonlee Vogel, a WMATA (Washington Metropolitan Area Transit Authority) employee working with bicycle access said that while some of the stations near bike paths did have high levels of bike access, the presence of “bike enthusiasts” was more important than land use. It may be that the number of bike enthusiasts that are willing to battle poor conditions outweigh those that prefer or require improved infrastructure. Signage is helpful for directing cyclists to bike routes and reminding drivers that cyclists have the right to share the roadway.

Surface Condition

Due to the small width of bike tires, the condition of the road is very important. Street elements such as drainage grates, manhole covers, trolley and railroad tracks,

expansion gaps or grating on bridges may catch and pinch tires. Metal street elements and some street markings become slippery when wet contributing to skids and falls while potholes and street debris may puncture tires. Well designed street elements, thoughtfully located bicycle travel zones, proper pavement maintenance and regular street sweeping are important for maintaining a smooth safe place for cyclists.

Table 2-15 Bicycle: Safety

Design Feature	Worst			Best
Facility	narrow lane, no shoulder	wide shoulder, shared lane	bike lane	dedicated path
Surface Condition	potholes, sharp debris	dangerous street elements	cracked or mended	smooth

Security

As determined by the survey described above, bike security is a major factor for cyclists. A bicycle is a large investment, ranging from \$100 to over \$1000. Providing secure parking allows cyclists to feel comfortable leaving their bicycle unattended.

Different levels of security can be provided. The best level of security is provided by attended bike facilities where people valet park bikes and have access to other bicycle amenities. Attended parking is popular in The Netherlands and Japan and has started to make headway in the United States.

As of 1983, there were 100 guarded bicycle parking garages, totaling 90,000 spaces in the Netherlands, where biking to transit rates ranged from 23 percent within the central city to 44 percent in smaller cities. The garages ranged in size from 134 - 3,900 spaces (Replogle 70). In 1981, after a period of huge growth, Japan had 20 stations with over 3,000 bikes parked daily. This high demand and has created a market for various mechanical bike storage systems that can be described similarly to storage devices at the drycleaners (Replogle 56). Although bike access to transit in the United States does not have the same popularity as in The Netherlands or Japan, there are currently three Bikestations® in the US, with more planned.

The Bikestation® located in the unpaid area of the Downtown Berkeley BART station provides space free for 77 bicycles in a secured cage, bike-transit information and bicycle maps, overnight parking, free air for tires and free checkups available weekly. It is open for business Monday through Friday 6 am to 9:30 pm and Saturdays 9am to 6 pm. Bikes can be stored overnight free of charge if picked up by 10 am the next morning, providing service for those using their bike from transit to their destination. Funding for the Bikestations® comes from local city, transit and air quality agencies and local bike stores and other bike supporting companies (*Bikestation*).

If there isn't enough demand for a bike station, secured bike lockers provide the next best level of service and start at \$400/locker (Bike Gard, Inc.) for the unit itself. Bike lockers fully enclose the bicycle, protect bike parts from being stolen and providing weather protection. Most transit systems that provide lockers require people to rent them from the transit agency on a monthly or yearly basis although other systems could be developed.

Bike racks provide the lowest level of security although they can be adequate if they are properly located at the station. Bike racks should be placed so that they give the bikes as much shelter from the elements as possible and are in an active area, preferably one that is visible to a station attendant. Bike thieves have become adept at cutting locks or removing various parts of bicycles. Placing the racks in a visible location makes it more difficult to tamper with the bikes without being observed.

Alewife station on the MBTA Red Line has bike racks located in two locations. One bike rack is located in a high traffic area and is sheltered by elements on all but one side. The second rack is located under a high overhang in a less populated area. Although some of this may be due to people's lack of knowledge of the second bike parking area, less than one fifth of bikers use the second parking area which had a number of vandalized bike skeletons locked to it. Bike racks should be designed to allow the

frame and at least one wheel to be secured to the rack. There are many different styles of rack, some of which are easier to use than others.

Providing no bike parking is a deterrent to many people who might consider riding to the station and people who are dedicated to biking to the station may end up securing their bikes in locations that are a hazard to other station users such as sign poles or hand-rails. Although bike parking is a major security concern, weather protection, and directness also play a part in choosing appropriate parking facilities.

Table 2-16 Bicycle: Security

Design Feature	Worst			Best
Infrastructure	no provision	bike rack	bike locker	tended facility
Surveillance	isolated		activity center	tended

Directness

As mentioned in the introduction, proximity to one’s destination is the most important factor for choosing where to lock one’s bike. Bicyclists are more mobile but lazier than pedestrians. Many people choose to bicycle to take advantage of the speed and compactness of a bicycle. Because of the ease of riding, cyclists are willing to take slightly more circuitous paths to their destinations than pedestrians, but expect to be able to leave their bike very close to their destination. Bicyclists do not like to travel out of their way to use parking facilities, especially if the parking is difficult to see from the station entrance or other major access pathways due to the security issue. Although proximity to the entrance is desired by the cyclist, it may make more sense to place bicycle parking beyond the main pedestrian area to prevent pedestrian-bicycle conflicts.

One major concern regarding bicycles near transit is their use of the sidewalks to access bike facilities. While some cities allow biking on sidewalks, this is especially dangerous in areas with high levels of pedestrian activity, such as transit stations, because pedestrians and cyclists travel at very different speeds. At points where bike use and pedestrian use conflict, bicyclists should dismount their bikes and walk until the

congestion is clear, although they seldom do. Bike parking needs to be located so it can be safely reached on bike with as little bike-pedestrian interaction as possible. If there is no way to provide segregated bicycle and pedestrian space, signage can be used to remind cyclists of proper etiquette or bicycle parking can be placed at the perimeter of heavy pedestrian use.

Table 2-17 Bicycle: Directness

Design Feature	Worst	Best
Parking	located away from entrance	near station entrance
Pathway	conflicts require walking bike	segregated space up to parking

Weather Protection

Due to the nature of biking, providing weather protection for bikers is difficult. Two weather related accommodations can be made for cyclists; providing shelter for their bicycles and providing changing facilities for bike riders. As mentioned earlier, bicycles can be major investments for their riders and bicycles that sit out in the rain will rust and get dirty.

Parking

Indoor parking provides the best level of weather protection because it provides a dry safe place out with less temperature variation. Providing enclosed outdoor parking such as bike lockers protects the bike from precipitation and wind blown dirt. Parking covered by an awning, protects the bicycle from rain but leaves it exposed to ambient weather, while uncovered parking provides no protection.

Changing Facilities

The second area of weather protection for cyclists isn't really weather protection at all, but the ability to clean up after being exposed to the elements. People extend themselves to varying degrees while biking depending on the distance they are traveling, the terrain they cover, the speed in which they travel and local weather conditions. While some bikers travel at a level that allows them to arrive at their

destination presentable on clear days, some people do not bike because they do not want to arrive sweaty and dirty. This can be especially of concern where weather conditions are extreme, such as the warm climate of Puerto Rico or locations that receive plentiful precipitation. Providing changing facilities, with at minimum a sink and changing bench, gives people an opportunity to wash their face and change clothes. Showers and lockers would provide exceptional service. While it may not seem like it is within its job description for transit agencies to provide these facilities, they are ways to encourage transit use and also provide amenities to other transit users. Another way that these facilities could be provided is to attract a fitness center to locate at the transit station. A deal could be made to allow cyclists using transit to use the facilities at a reduced rate.

Table 2-18 Bicycle: Weather Protection

Design Feature	Worst			Best
Parking	exposed	under awning		indoors
Changing Facilities	none	bench to take off rain gear		shower and locker facilities

Supportive Details

In addition to changing facilities, bike rental and maintenance facilities can be provided at transit stations. The Bikestation® in Long Beach includes expanded repairs and accessories, bike rentals, a changing room and restroom and electronic bike lockers for after-hours storage, plus bike permit and licenses for transit and local area use. Bike repair facilities at transit encourage proper maintenance of bicycles allowing frequent bikers to transit to insure that their transit access mode is in good working order. Having bike rental facilities provides bicycle egress to people who do not have a bicycle or could not bring it for the transit-to-destination leg of their trip, a common occurrence in The Netherlands.

Table 2-19 Bicycle: Supportive Detail

Design Feature	Worst			Best
Services	no services provided	occasional		consistent, dedicated personnel
Information	none	bikes and transit		bike/transit and local bike information

Bikes on Rail

When people arrive at a rail station with their bike, they may have two choices, to take their bike onto the rail system and have their bike when they exit the train or to leave the bike at the train station. Having the option to take a bike on transit can greatly expand the accessibility of a city via transit. While this is not the focus of this study there are some important design features that can be provided. Stations should have fare controls that make it easy to take a bike, or any other large item such as a wheelchair, shopping cart, luggage or a stroller, into the paid area. Narrow or revolving gates do not provide access. It should also be easy for a cyclist to reach the platform where they board the train. This may mean providing ramps, convenient elevators, stairs with short segments and broad landings to allow for rests and bike maneuvering. Finally transit vehicles should be designed to accommodate bicycles without inconveniencing other passengers. Many transit agencies limit bikes to specific cars or the ends of cars. Caltrain has specific bike cars that hold up to 32 bikes and provide two bike cars when possible (Caltrain).

Bus

Almost all rail stations have feeder bus routes. Some stations are served by a single bus route, while others have multiple routes traveling through or terminating at the rail station. The volume of buses at a station makes a significant difference in how buses interact with the rail system. If there is a single route or possibly two that do not terminate at the station, on-street transfer facilities may be most convenient. Locations with a high volume of buses, especially those that terminate at the station may require dedicated space in the form of a bus terminal.

Safety

Bus safety relates to the traffic patterns of pedestrians, buses and other potential intersecting traffic and the directness of travel. For on-street stops, buses need to be left with adequate space to pull in and out from the curb in order to move out of the flow

of traffic and allow passenger out directly onto the sidewalk. If traffic on the street is slow or highly congested, it makes sense for the vehicle to stay in the traffic lane. In this case a bus bulb should be designed to bring the sidewalk out to the traffic lane. This not only gives bus users direct access from the bus to the sidewalk, but it also provides additional space on the sidewalk for passengers to wait for the bus without being in the way of pedestrians walking down the sidewalk. The bus bulb also provides space for shelter, service information including current schedules and system or route updates, news boxes and garbage cans as long as they are organized to allow adequate waiting space and room for wheelchairs to maneuver on and off of the bus.

Conflicts also occur when bus riders must cross the street to access the station. If bus users must cross the street, they become pedestrians and should have similar accommodations. Some of the design features for pedestrians are especially appropriate for use with bus users because buses create a surge of users when they drop passengers off or as the train lets people off to catch the bus. One way to avoid requiring bus users to cross the street is to create an additional access point or headhouse on the other side of the street, or route buses so they have access to the far side of the station. The CTA has used some interesting station layouts that allow passengers direct access to the station such as at the 69th Street station, shown in Figure 2-9, which sits above the Dan Ryan Highway.

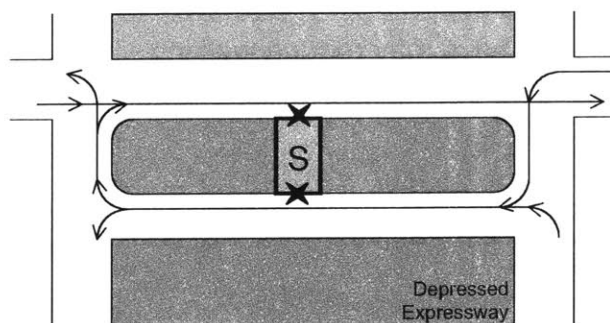


Figure 2-9 Bus Rerouting for Improved Access at 69th St. Station (CTA)

For rail stations with integrated bus stations, pedestrian movements can be complicated, especially if passengers walk through the bus roadways to reach the rail station. Bus drivers need to be extremely cautious of hitting passengers from their own bus, those coming from other buses and other station users. A variety of layouts are traditionally used for bus stations.

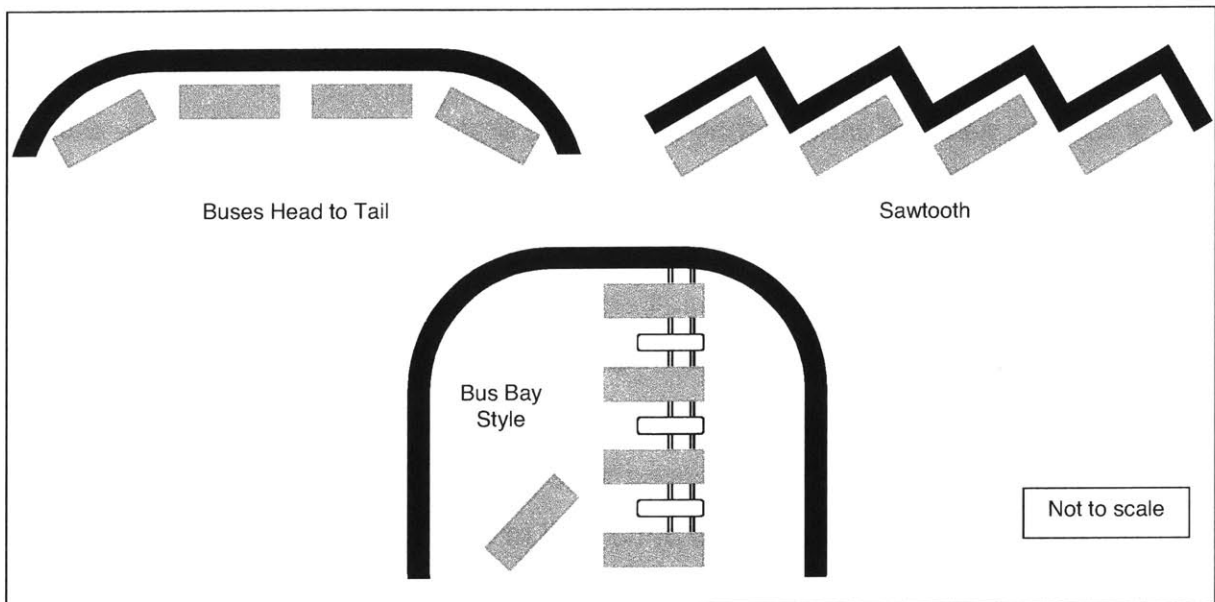


Figure 2-10 Bus Terminal Designs

A long curb allows buses to pull up head to tail. The sawtooth design provides space for more buses or a shorter length. Bus bays can be used for stations with limited space that have a large number of routes. This final design is the most dangerous of the layouts because passengers must pass in front of other buses to reach the rail terminal. Depending on the station orientation, bus bays may reduce walking distances. Pedestrian conflicts with buses should be considered when designing a bus station.

Table 2-20 Bus: Safety

Design Feature	Worst		Best
Mode Conflicts	other vehicles or pedestrians in bus areas		bus area free from unsanctioned traffic
Stop Location	no sidewalk adjacent to bus	need to cross street to reach station	no exposure to vehicles, direct path to station entrance

Security

Waiting for a bus can leave people feeling exposed and vulnerable. Providing a well-lit and visible location in view of other station users, street traffic or ideally, a station attendant can make people waiting for the bus feel more secure. Waiting in a secluded area can be uncomfortable, passengers waiting for the bus should feel connected to their surroundings so that they have people watching out for them and feel that they can get help if needed.

Table 2-21 Bus: Security

Design Feature	Worst			Best
Waiting Area	isolated, dark	sightlines with active area, well lit	integrated into rail station, employee nearby	

Directness

Directness can take on many attributes for bus rail transfers. In her thesis “A Process for Improving Transit Service Connectivity,” Crockett combines safety and directness into four applicable design features: changing levels, road crossing, walking distance and fare control. Depending on the fare structure and fare media, patrons could potentially walk from one side of a rail platform directly onto a bus. While this was not an unusual layout for rapid transit terminals 100 years ago, it is rarely the case today. More often the bus stations are adjacent but not incorporated into the rail system and regardless of fare policy, the passenger needs to enter the rail station through the rail fare control mechanism. Although stations can be designed to allow passengers to transfer without passing through fare control, this is a policy decision that the transit agency needs to make. This research assumes that the bus passenger will need to pass through the rail fare control mechanism.

As with other modes, the bus stop should be as close to the transit station entrance as possible. If the station entrance is located mid-block, it does not make sense for the bus stop to be located at the corner. If the bus travels parallel to the rail line and cannot

detour to the station entrance, the stop should be placed so that the passenger crosses as few streets as possible. Having a headhouse on each side of the street prevents passengers from having to cross the street to travel between the bus stop and rail station. For more detail refer to page 35. While routing buses so that they can stop as close to the station entrance as possible benefits transfer riders, for buses that do not terminate at the rail station, it is important to consider how the additional time required for the detour affects passengers who are traveling through. In addition, the bus terminal needs to be designed to minimize inconvenience to those traveling by other modes. If the bus station is placed directly in front of the main entrance, others traveling to the station may walk through the bus area increasing the risk of an accident.

Table 2-22 Bus: Directness

Design Feature	Worst Best			
Stop Location	not oriented to station, level change, across street	requires crossing road	some distance from entrance	adjacent to station entrance

Weather Protection

Waiting for the bus can leave a person exposed to the elements for a long period of time because buses feeding transit generally run at lower frequencies than the train. In order to provide superior protection from the elements, an enclosed, temperature controlled environment is desirable where weather conditions are extreme. Ideally, bus waiting should occur inside the station where full protection and insulation can be provided easily and seating should be available. For on-street bus stops people may not wait inside the station because they may worry that the driver will not stop for passengers who are not waiting at the curb. Ideally, waiting passengers would be able to signal to the bus from inside but this is not usually the case. Although it may not be as warm, an overhang from the station entrance can be expanded to cover the walk in front of the station, providing protection from the rain while waiting outside or walking to the bus as shown in Figure 2-11.

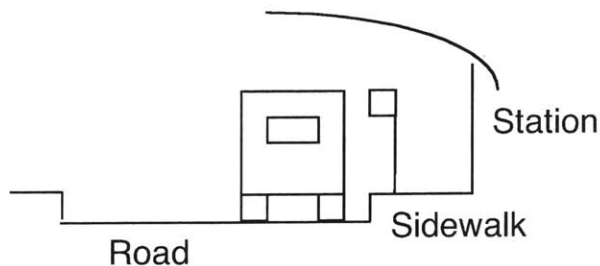


Figure 2-11 Protected Bus Stop 1-Sided

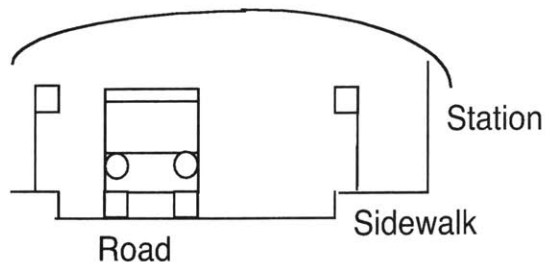


Figure 2-12 Protected Bus Stop 2-Sided

In order to protect passengers who must travel across the street to take the bus, it would be desirable to provide coverage all the way across the street, however placing an awning over the street can be controversial because of the multiple agencies that control those spaces and the need for vehicles to be able to pass under. In colder environments, bus shelters that provide shielding from the environment from at least three sides is preferable, especially if heating is provided. In warmer climates, an open design may be more appropriate to provide a breeze, but a roof is paramount to provide some shading from the sun and rain.

Table 2-23 Bus: Weather Protection

Design Feature	Worst				Best
Stop Design	open, exposed	building to shield wind	open-sided, covered shelter or building awning	three-sided, covered shelter	indoors, temperature controlled

Supportive Details

There are many non-design features that make coordination between rail and bus run smoothly. Transfers should be made as easy as possible in order to minimize the inconvenience of transferring. Schedule coordination between bus routes and transit can minimize wait time. Fare policies should be designed to minimize cost penalties from transferring. Crockett discusses these techniques in detail. When people do have to wait for buses, they should be provided with seating to make the wait more comfortable.

Locating retail at the transit station is almost more important for bus riders than pedestrians. Since there is a forced transfer at the rail station, it is a convenient location for bus users to run errands. Retail within the station may be more convenient than if it were adjacent because bus riders do not have to leave the station and may be able to watch to see if their bus has arrived. Having accurate printed schedules or even better, real-time arrival information, can help passengers decide if they have time to run errands beyond sight of the bus terminal without missing their transfer. Information such as route maps, names and numbers should be provided so that passengers can easily identify the bus that they want.

Table 2-24 Bus: Supportive Design

Design Feature	Worst				Best
Schedule Coordination	none	off-peak only	all-day coordination	scheduled and real time	
Fare Integration	separate fare and media		discounted transfer	free transfer	no barrier
Retail	none		beyond immediate station area	located to allow surveillance of bus activity	
Schedule Information	no information		current schedules, routes	real-time information	

Drop-off

Drop-off is the name applied to people who are driven to the station from their point of origin or picked up from the station and taken to their final destination, typically by a friend or relative. In this document, taking a taxi or a private shuttle van will be included in the drop-off category. Facilities for drop-off and pick up of passengers can range from the multi-use curb outside the station to a specific drop off area. These drop-off areas are often designed similar to circular driveways but when they are not included in the station design, people will pull over wherever they can.

Safety

If a person is being dropped off along the street, it is important that the car have a safe place to pull over out of traffic. In order to have safe on-street drop-off areas, the curb lane should be designated as short term stopping space. If space for drop-offs is adjacent to the bus stop, it is important to make sure that there is enough curb space and areas designated for each use are clearly labeled to make sure that private cars do not interfere with bus operations which serve a larger population. It is also important that drop-offs do not use crosswalks as loading zones. Where people are dropped off is difficult to impossible to control since people are there for only a short period of time. Cooperation of city is usually necessary if the police are to be used to enforce traffic regulations such as no stopping zones.

Multiple cars maneuvering in and out of a small space all at once at drop-off zones can be dangerous. Similar to problems of multiple vehicles at airport curbs, drivers may be preoccupied and not see pedestrians, doors opening or other vehicles pulling in or out. Providing enough space for vehicles to move in and out of the curb smoothly is important for busy drop-off locations. Space is a more important for picking up passengers where taxis, private vehicles and shuttle buses may all need to wait for passengers. On-street facilities are often not designed with enough capacity to allow for multiple vehicles to wait. If more than 20 drop-offs during the peak hour are expected for each "on-street space," or there is currently congestion from drop-off activity, off-street facilities should be built.

Table 2-25 Drop-off: Safety

Design Feature	Worst				Best
Drop-off Location	in high volume traffic	not separated from vehicle space	congested, dedicated space	spacious, dedicated space	

Security

Security concerns for people using drop-off services are similar to those waiting for buses; being alone in a potentially quiet and segregated area. Proper lighting and visual connectedness are important provisions for drop-off areas. Unlike waiting for a bus, passengers being picked up can wait in the station if they can see the drop-off area. Providing a telephone is an important feature for passengers waiting to be picked up. Being able to call for a ride can reduce waiting time for both passengers and drivers. A phone also allows someone to call for help in the case he feels threatened.

Table 2-26 Drop-off: Security

Design Feature	Worst				Best
Waiting Area	isolated, dark	access to phone	sightlines with active area, well lit	integrated into rail station, employee nearby	

Directness

The person who is driving the transit passenger to the station may either be making a specific trip to drop the person off or may be incorporating the drop-off as an additional stop on their trip. Being able to walk only a few steps from the car into the station is beneficial, but because of the convenience of the mode, not essential. Providing safe, clearly marked pathways from the drop-off area into the station is important for passengers not familiar with the facility. If drop-off facilities are inconvenient, it is likely that they will be ignored and unplanned locations used instead.

Table 2-27 Drop-off: Directness

Design Feature	Worst			Best
Drop-off Location	required to cross street or in front of moving/stopping vehicles	step into street to reach sidewalk	direct connection to station entrance	

Weather Protection

Being picked up from transit may require waiting for a ride, similar to taking the bus. Protection from rain, wind and temperature variations are also important for people waiting to be picked up. Unlike buses, people being dropped off are not as constrained

to being at a single location at just the right time since it is likely that their ride will be looking out for them⁵. If visual or phone contact can be made between the driver and the person being picked up, the person being picked up can wait within the station instead of outdoors exposed to the elements. More details about protecting passengers waiting at the train station can be found in the guidelines for bus weather protection.

Table 2-28 Drop-off: Weather Protection

Design Feature	Worst Best				
Waiting Area	open, exposed	building to shield wind	open-sided, covered shelter or building awning	three-sided, covered shelter	indoors, temperature controlled

Supportive Details

For those passenger who need to wait for their ride, seating should be provided to make the wait more comfortable. Phone numbers for taxi services should also be made available. Displaying information about where private shuttles go and their schedules as well as where to pick up private shuttle services at the station can be useful for new users of the system and advertises that transit is a viable option to the locations served by the shuttles. The success of these private routes is beneficial to the transit agency because it allows people to take transit for trips that they could not reach by another access mode, increasing ridership.

Potential benefits to companies who run these services include providing access to people who could not otherwise reach their facilities and reducing the amount of parking that they need to provide both for employees and customers. Companies can advertise these shuttle services to employees as a part of new employee orientation, office memos and by sponsoring transit pass programs. Including these services in advertising the sponsor does for their product is a way to let customers know that their business is accessible by transit.

⁵ This may not be true of private shuttles since they may not know who or how many people to expect.

Table 2-29 Drop-off: Supportive Details

Design Feature	Worst			Best
Shuttle Service	no program	service provided	information available	company support
Taxi	no information	taxi phone numbers available		taxi queue

Park and Ride

Transit agencies have different views on the benefits of providing parking and have a variety of policies regarding whether to build structured parking or use surface lots and whether or not to charge for parking. The decision to provide parking is often made based on the surrounding land uses, expected demand, availability of land and cost. Stations with large parking lots are generally found at more suburban stations where other access modes are less feasible. Parking structures are significantly more expensive per space (\$7,000-\$30,000) than surface lots (\$1,000-\$8,000), but sometimes acquiring enough land for a surface lot is not feasible. The price of building parking varies significantly because of differences in land values and differences in city requirements for their construction.⁶

Some agencies charge for parking while others do not. Once the decision to charge for parking has been made, another policy decision must be made to decide on charges and how the fee will be collected. Some transit agencies have parking attendants to collect fees and either validate tickets or control the access gate. Others require passengers to purchase tickets that they place in their vehicle or put money in a box that correlates to their parking space.

Safety

Distracted drivers looking for open parking spaces or vehicles backing out of spaces are the main safety concerns in parking lots. Providing walking paths within the parking lot is important for keeping pedestrians safe from distracted drivers. Marking vehicle travel

⁶ Construction costs per space for the MBTA range from \$5,000-\$6,000 for surface lots and \$15,000 and up for multi-story garages or underground lots. (CTPS, xx 6-13)

directions helps keep vehicles from making unusual travel patterns that can be dangerous if unexpected. The use of traffic calming mechanisms such as speed humps reduce speeds and make drivers pay more attention to their surroundings, not just finding a space.

Table 2-30 Park and Ride: Safety

Design Feature	Worst			Best
Lot Design	no directional markings or pedestrian zones	raised pedestrian path	traffic calming, pedestrian path	

Security

Stolen or damaged cars and personal security are both important security concerns. Stations that require you to pay as you leave provide increased security for the vehicle because someone is less likely to steal a car if they must pay to remove it from the parking lot. Needing a ticket to exit the lot adds an additional level of difficulty to stealing a vehicle from a monitored lot. Lots with unregulated parking are less likely to have surveillance beyond other passengers using the station, creating potentially frightening conditions at night. Surveillance cameras, proper lighting and an open design can increase security at a station, although as mentioned earlier, cameras were not the preferred method of surveillance.

Parking structures can cause increased insecurity when lighting and layout make it hard to see. It is important to design parking structures that do not create secluded nooks or “hiding places.” Adequate lighting is important for both surface lots and structures.

Table 2-31 Park and Ride: Security

Design Feature	Worst			Best
Surveillance	isolated	active location	attended	
Visibility	Lot Design	partitioned by floors, corners		open design
	Lighting	dim, gaps in lighting create shadows		bright, steady

Directness

Because of the space that an automobile takes up per transit ride, prioritizing parking over other modes does not make sense. A bus space can service 200 to 1600 passengers per day,⁷ while a parking space provides between 1 and 5 transit riders per day. Designing the parking lot to maximize spaces and insure the safety of its users should be the primary concern of lot layout.

Lot Layout

Parking lots can be situated to improve convenience by locating parking spaces nearer to the station entrance and placing lot access towards the main roads, reducing the amount of looping around required of the driver.

Parking Payment

Payment facilities, if there are any, should be located conveniently for the driver. If the parking is attended, payment should occur as a person drives out of the lot, or should be able to have their tickets validated close to the transit station so it can be stamped as they walk back to their car. Locating the ticket office in a remote corner of the parking garage makes payment inconvenient.

If parking is unattended, payment boxes should be placed near or within the station so that people can pay as they walk to the train. If windshield validation is used, ticket vending machines should be located throughout the parking structure.

Table 2-32 Park and Ride: Directness

Design Feature		Worst	Best
Lot Layout		indirect and looping access	parking spots near station, lot entrance near street
Payment Process	Attended Parking	located without regard to station entrance or parking lot exit	at station entrance or lot exit
	Unattended Parking	located without regard to station entrance	near station entrance

⁷ 4bus/hr*10hr*(5-40)pax/bus

Weather Protection

Automobiles need the least amount of weather protection because the automobile provides so much of its own environment. Although a car can heat up dramatically if left in the sun, almost all have air conditioning and heating to change the air temperature quickly within the vehicle. Parking structures can provide some weather protection for the walk from the car to the station especially if they are directly connected to the station. In surface lots, trees can provide some shade although it moves throughout the day. Trees also provide environmental and visual benefits to the lot. It is important that these trees are tall enough to insure that they do not hinder surveillance or lighting.

Table 2-33 Park and Ride: Weather Protection

Design Feature	Worst			Best
Lot Design	exposed blacktop	shading by trees	covered, connected to station	

Supportive Details

Reserved carpool spots located closest to the station can be used to encourage carpooling, which increases the number of transit passengers per vehicle space. For lots where payment is not the norm, providing reserved spots for a fee can raise funds for the transit agency and encourage passengers to use transit who may become frustrated if parking availability is tight.

Spaces for car sharing programs and electric vehicle charging are other amenities that a transit agency can provide. Providing spaces for ‘shared cars’ allows people to make trips by transit even if the destination cannot be reached by another egress mode. The MBTA in Boston has sponsored “shared cars” at four of their stations and have cars close to many of their other stations and in Washington DC there are at least 17 cars at or near Metro stations (Zipcar).

Table 2-34 Park and Ride: Supportive Details

Design Feature	Worst		Best
Reserved Spaces	no segmentation		reserved spaces

2.4 CONCLUSION

Each access mode has different features to consider for each design factor. Safety and security are the most important factors and should always be included in the station design. Fortunately, these design features are generally supportive of each other for all modes. Directness, weather protection and supportive details are important for encouraging transit use. Ignoring these factors in station design can deter people from choosing to ride transit. It is important to think about all these issues and incorporate them as best as possible into the station design. The next chapter will provide a framework for how to take all of these different station elements and efficiently improve station access.

Chapter 3 A Process for Designing Station Areas

Transit agencies must be committed to providing quality transit in order to be successful. A transit agency needs to understand that transit access is important to its system as a whole and that providing for that access trip is a part of their responsibility. This includes looking at a variety of transit access modes, not just a single trip type. Once an agency has set a goal of having good station access for multiple access modes, movement towards improvement can begin. Part of the access trip relates to the physical infrastructure surrounding the stations since people have to travel through this space to reach the station. A transit agency needs to understand how the station area surroundings affect travel but before looking at specific stations, the agency needs to step back and set system-wide objectives of what it would like to accomplish in the realm of station access. A customer survey may determine the attributes that are important to users. A survey of current station access conditions may uncover elements that the agency is particularly weak in providing.

Once an agency has decided upon the broad set of objectives, an iterative process is begun to determine which policies and projects will be undertaken. In order to come up with specific projects, the transit agency needs to define what design features it would like to implement under which conditions and create a preliminary prioritization of these areas. Since the transit agency must rely on other agencies to make many of these improvements, it needs to make sure that there is agreement between agencies on fundamental policies. At minimum, discussion should be held on what types of projects should be coordinated, how they will be implemented and how conflicts over specific design elements will be resolved. This process is iterative because the objectives and projects will be affected by other agencies' level of willingness to participate and the amount of funding available for implementation.

After the various agencies come to agreement on how the objectives will be implemented, projects should be initiated. Once these projects have been finished, an

analysis either by observations of changing travel behavior or surveys of customer satisfaction should be completed to see the affects of the improvements.

While most agencies will say that they want to have good access, in reality efforts rarely go beyond talk. A conscientious effort needs an explicit statement of intent and actual follow-through such as:

“We are going to show our commitment to improving transit access by spending \$X specifically for transit access projects and will be willing to increase the cost of our other capital projects by up to Y% of the initial project cost to make sure they provide good connectivity. For areas beyond our jurisdiction, we pledge to keep up-to-date with other agencies’ projects, advocate for elements that improve station accessibility and oppose projects that make access worse. If necessary, we will provide additional funding for these elements in projects up to Z distance from the station.”

3.1 AGREEING ON THE GOAL

A transit agency needs to agree that quality station access is a goal and responsibility of the transit agency. People will not use the transit system if they have trouble reaching it, so it makes sense that designing for improved access should be considered an essential responsibility of the transit agency. Even without agreement that station access should be an agency-wide goal, various station access design elements and features might be worked into projects if an agency planner or designer makes an explicit effort to include these design features. In reality, designing for good station access is likely to be ignored if there is no stated agency commitment since operations and maintenance are traditionally the primary considerations when looking at station infrastructure.

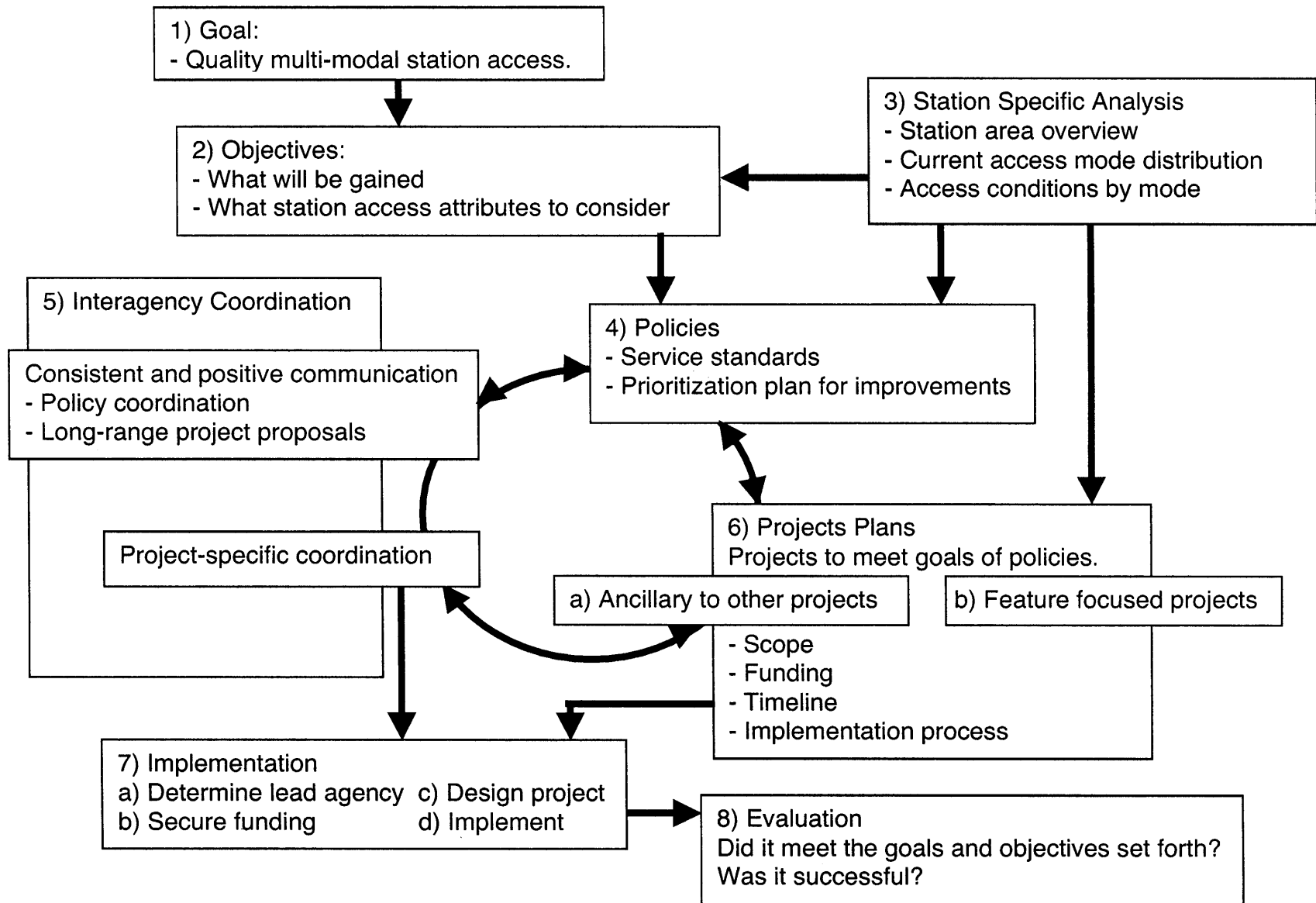


Figure 3-1 Process for How a Transit Agency Can Improve Station Access

3.2 SETTING OBJECTIVES

Once a transit agency has recognized its responsibility for station access improvement, it needs to decide what it would like to gain from station improvements. Is it looking to keep current customers by improving their station access experience or is it trying to encourage a specific type of access mode to increase the station catchment area, or is it trying to reduce reliance on a specific mode such as park and ride. An agency may decide that that since there are extreme weather conditions, providing a high level of weather protection is important. If the city is struggling with crime, security may want to be highlighted. A survey of current station conditions may expose particularly weak elements of that system. For example an agency may find that it does a bad job at providing station information or that new passengers have difficulty locating stations. A system-wide analysis of current access/egress trip modes categorized by neighborhood characteristics may be of assistance in determining weak areas, especially if these results can be compared to other transit agencies mode-splits. The agency should list all of the station design elements that it feels will be beneficial. Objectives can be broken into long- and short-term priorities and will need to be updated occasionally to make sure that they are still applicable.

3.3 STATION SPECIFIC ANALYSIS

At this point a transit agency should identify the riders it hopes to serve at different stations throughout the system. The station specific analysis is used to understand the current characteristics and potential for improving various access modes system-wide. Different access mode splits should be estimated to get a better understanding for the system and help prioritize projects. A station that is built in a dense urban area expects a high percentage of its riders to walk to the station. Stations that are built in lower density areas may plan to attract riders through feeder bus services and park and ride lots. These characteristics should

be used to focus improvements, but should not be used to exclude other access modes.

For existing stations, current mode split characteristics can be measured. While a station may see ridership lean toward one access mode or another, the transit agency needs to look at more than just current access rates to determine potential future access mode levels. The original station design could have left an unmet demand for a specific mode and improvements would make this a popular access mode. By designing stations that support a variety of access modes, we encourage transit use rather than discouraging riders that rely on one mode or another.

Surrounding land uses, available land, regional travel habits, and agency policy should all be used to estimate how people will access a station. Demand modeling techniques and past experiences can help determine likely access modes. These models are in their infancy for many of the travel modes discussed and may or may not be able to deal with the level of detail required to accurately predict travel behavior changes due to physical station improvements. High precision is not required although the volume of buses and the number of parking spaces desired can affect station design. Collecting access-mode data is important in setting access policies and preparing an effective project improvement strategy.

3.4 STATION ACCESS POLICIES

Creating policies to implement the agency's objectives is the next step. Once an agency has decided on which station design elements it is going to focus, it needs to determine how it wants to achieve its objectives. As discussed in the previous chapter, there are a variety of elements that provide different levels of service for each design attribute. Since funding and other resources are limited, it

is unlikely that an agency will be able to provide the highest levels of accessibility for all modes at all stations. A policy for distributing funding and prioritizing projects should be defined to insure the best use of resources. Minimum design standards should be created for pedestrian, bicycle and drop-off facilities because regardless of whether or not specific infrastructure is provided, people may use these modes to access the station.

Prioritization

Since it is unlikely that all policies can be met at the outset, a prioritization scheme should be developed for tackling projects. The following four techniques should be used to prioritize station area improvements.

- The number of people served
- Potential for improving conditions
- Incorporation into other projects

Depending on the politics of an agency, it may choose to use a combination of these techniques. Making improvements at locations with high number of patrons will benefit the most people. Similarly, locations with the lowest quality levels of each element are prime candidates for improvement because the improvements will have the largest increase in benefit to the users or allow for a new user group that previously had no access. A systematic approach to making these improvements can be used to insure that improvements are being made in a fair and clearly understood manner. Examples this approach would be improving street crossings at stations along roads that are 4-lanes or wider one at a time based on a predefined list or installing five bus shelters per month. While this method is the most comprehensive, it may also be the most expensive and least rewarding since the improvements occur in isolation.

While systematic improvements can focus on high impact projects, there may be opportunities to make additional improvements if they can be cost effectively incorporated into other projects.

Design Standards

An agency needs to set up access objectives and policies as to how it will provide for people getting to its stations. In order to focus improvements on where they are most needed, the transit agency should differentiate level-of-service policies based on current or potential ridership levels. A minimum level of service for each access mode is necessary at all stations regardless of how many users there are of a given mode. While minimum standards should be created for all access modes, many modes will deserve better levels of service. Ideal service standards should be used for primary station access modes at key stations. An intermediate level of service should be established for modes that receive a moderate share of passenger use.

As mentioned earlier, minimum levels of service should be designated for each mode, especially those that will be used by people who have no other alternatives. Even if there are stations that where pedestrian access is not expected, there will be some people for whom this is the only access mode. Pedestrian access should be incorporated into station design regardless of expected ridership trends because pedestrians are among the most vulnerable station users. There are low cost solutions that can be implemented to make cycling and being dropped off safe and feasible options. Whether or not bus access is available at the station is a policy decision up to the transit agency or another transit operator that provides bus service. If bus service runs within one-half mile of a rail station, the bus should be considered a potential access mode. Providing parking is appropriate at some stations, but not at others.

Different policies for the provision of weather protection for bus passengers are listed below as an example of how an agency might differentiate the level of service it provides.

- a) **High Use:** Passengers should not get wet while waiting for the bus at transit stations with peak service over 10 buses per hour. When feasible, the bus waiting area should be included in the station.
- b) **Standard:** Stations that are served by three or more routes must have a waiting area that is enclosed on at least three sides and provides a source of heat during the winter months.
- c) Based on the large number of bus-rail transfer locations with infrequent service, it was decided that focusing on weather protection at the remaining locations was not a priority.

While the policies may be reasonable, there may be multiple ways to address these policy goals. For example, if the bus stop is in front of the station door, the transit agency can install a temporary awning or build an extension of the station, but if the bus stop is not adjacent to the transit station, it may need to work with the public works agency to install shelters, or it may be able to work with the planning department to require or provide incentives for buildings to have awnings or vestibules. Different choices have different cost, time frames and levels of effectiveness, which may be strongly correlated to the amount of support provided by municipalities and resident or business organizations. In order to keep passengers dry at high transfer locations where buses do not leave the adjacent road, providing entrances to a station on both sides of the road would allow passengers to access buses heading both directions without getting wet while crossing the street. Another option may be to build a canopy that crosses the road as shown in Figure 2-12.

While meeting all objectives should be attempted, it may be impossible to provide a specific level of a feature at a specific station because of physical constraints. One-way streets may make it too difficult for buses to detour to drop passengers off in front of a transit station instead of at the adjacent corner.

3.5 INTERAGENCY COORDINATION

The physical realm that affects station accessibility stretches beyond the jurisdiction of the transit agency itself. Different city and state agencies and private landowners can also affect the access trip to transit. In defining the project constraints, the level of support from other agencies needs to be considered. It is easy for both transit agencies and others to place the responsibility of transit access accommodation solely on the transit agency, but this may prevent the best levels of access from being attained. The transit agency needs to have support from these other agencies, either in the form of finances or labor; or at minimum to tacitly agree, allowing the transit agency to make the changes itself.

Some of the preferred design elements described in Chapter 2 may contradict current policies set by other agencies or even the transit agency itself. Some agencies are focused on specific constituencies or follow standards or guidelines that are designed from a single user's perspective. Even when an agency-wide goal is set, it may take some time to insure that all the agency's policies agree with the goal, either because no one has considered what might need to be changed or because a specific department has policies that make it unwilling to allow the changes.

It is important that the transit agency and the other agencies that it works with have policies that do not conflict. A single agency's unwillingness to work on a project or allow a certain design features to be used may greatly affect the scope

of the project. The idea of the guidelines in this thesis is to take a multi-modal perspective, balancing the needs of different users. I have tried to set up a continuum of options, focusing on each mode individually to optimize each. If a certain agency is unwilling to compromise, and a design solution is not found, lower levels of service may be provided. Some iteration between the policies and projects may be required depending on the ease of collaboration between agencies. It is possible that agencies may agree on a policy level but may have difficulty on a specific project.

Table 3-1 lists the agencies that may need to be consulted and typical responsibilities of these agencies related to improving transit access. While the list is meant to be complete, it is not exhaustive and depending on the municipality, responsibilities may vary from department to department. Some cities have a single agency that is responsible for transportation and public works. In cities that have two separate departments, the transportation department is generally responsible for engineering and planning and the public works department often builds and maintains transportation infrastructure, but the line between responsibilities varies from city to city.

Table 3-1 Responsibilities by Organization

Constituent	Responsibilities Relating to Transit Access
Transit Agency	<ul style="list-style-type: none"> • Insuring quality access to station • All physical improvements on transit agency lands • Transit operation and bus coordination
City Department of Transportation ¹	<ul style="list-style-type: none"> • Distribution of public way and street striping • Traffic signal installation and timing • Specific transit-oriented projects • Bike rack programs
City Department of Public Works ¹	<ul style="list-style-type: none"> • Street and sidewalk construction and maintenance • Lighting • Street amenities <ul style="list-style-type: none"> - trash receptacles, news racks, public restrooms, street trees²
City Planning and/or Redevelopment Agency ¹	<ul style="list-style-type: none"> • Zoning • Development incentives • Specific redevelopment projects
Local Elected Representatives	<ul style="list-style-type: none"> • Procure funding and set policies • Promote projects • Monitoring community response
State Department of Transportation	<ul style="list-style-type: none"> • Infrastructure related to state roads³
Local Business & Neighborhood Groups	<ul style="list-style-type: none"> • Business improvement districts • Streetscape improvements • Local scheming and lobbying • Maintenance • Surveillance⁴

¹ They may have their own street/sidewalk guidelines.

² May be the responsibility of Parks Department

³ Similar responsibilities to C DOT and DPW.

⁴ Major responsibility of the Police Department

An example of an interagency conflict may be with regards to leaving a buffer between traffic and the sidewalk. As a general policy, the transit agency may desire a buffer between pedestrians and moving traffic. While the planners may not object to having parked cars provide protection, bus operations may be adamantly opposed to parked cars near the station entrance because it makes dropping off bus passengers difficult. The department of transportation may not want cars parked along the street because it reduces the roadway capacity and vehicle speeds. Another option would be to have a landscaped buffer but this option may make the sidewalk too narrow. The public works

agency may also object to a planted strip if they do not have money to maintain the trees. While some of these issues, such as parked cars can be decided on a larger policy level based on the amount of retail surrounding the location and the roadway capacity, whether a tree can be planted in a certain location may need to be done on a site by site basis throughout the life of the project.

In addition to policy agreement, it is very important for agencies to have open lines of communication regarding their short- and long-term projects in order to take advantage of the efficiency of combining projects. This is described in more detail in Project Plans.

3.6 PROJECT PLANS

Throughout the development of policies, the transit agency should be thinking about how its policies can be implemented in the form of projects. Conducting the station specific analysis will help to create a picture of current conditions leading to an understanding of the scope of work to be done and provide direction for potential solutions and initial project list. As discussed in the policy section, projects should be prioritized. Based on site conditions, plans can be developed to tackle the most pressing policies or those that can be met during projects designed with another main purpose in-mind. As an example, a transit agency may decide to develop the following projects to meet the weather protection policies and prioritization issues described earlier.

To improve conditions to the **High Use** and **Standard** stations a bus shelter program will be initiated. The transit agency will work with the city to develop bus bulbs to insure there is enough sidewalk space for these facilities. This program will focus on locations with high demand and be completed in a systematic fashion except where street improvements will be completed within the next three years.

- a) For **High Use** stations, additional improvements will be made when stations are renovated. Improvement options include:

- i. Incorporating the bus stop into the station.
 - ii. Building additional station entrances.
 - iii. Creating covered walkways between the station and bus stop.
- b) The transit agency will promise that up to 20 percent or of the renovation budget will be spent to insure the weather protection policy is met. This provides incentive to improve weather protection in the renovation process but recognizes that some stations it may be very difficult to accommodate.

For projects focused specifically on station access improvement, a process for implementation, a funding source and timeline should be developed. Funds should also be set aside for projects that will be incorporated into other projects so that funding is available when the project come to fruition. The details of these processes are beyond the scope of this thesis.

3.7 PROJECT IMPLEMENTATION

After deciding on projects, funding and timeline, projects are ready to be implemented. It is important to make sure that the standard is recognized and internalized by the department that will be responsible for implementing it. Projects can be completed directly by the transit agency, another supporting agency or may be contracted out. Oversight is needed to insure the timeline and design standards are met.

3.8 PROJECT EVALUATION

The final stage of improving station area access is to analyze the project once it has been completed, or in the case of a standard, been implemented. It is important to look back at the project to see if it has met the set objectives. Did the projects unfold so that the objectives were actually met or were there problems? Should more or fewer people have been served by the policies and did the improvements cause unintended consequences on other system users? For example, did the bus shelters take up sidewalk space, making it difficult for pedestrians to navigate the system? If behavior

data was collected before the changes, a follow up study can determine what impact the changes had. Passengers can be surveyed to gain their perspective on the changes to see if the project was worthwhile.

Chapter 4 Tren Urbano: Roosevelt Station

4.1 SYSTEM OVERVIEW

Tren Urbano is a rail transit system being developed in the San Juan metropolitan region of Puerto Rico. For the past 50 years Puerto Rico has rapidly developed as a car oriented metropolis and has the highest density of automobiles of anywhere in the United States. Tren Urbano is being developed with the goal of relieving congestion and improving travel times. The route connects many of the major trip attractors in the San Juan region including the Medical Center, University of Puerto Rico and the major business district of Hato Rey. The alignment of the system is shown in Figure 4-1, runs through three municipalities, Bayamon, Guayanabo and San Juan. Phase one includes 16 stations and is 10.5 miles long. When it opens by the end of 2003, it is expected to provide 113,000 trips per day (Cambridge Systematics). Since Puerto Rico does not have a recent history of rail transit, Tren Urbano will initially be run by a private contractor for at least 5 years. After this time, Puerto Rico may choose to continue to contract for this service or may decide to run it as a government agency.

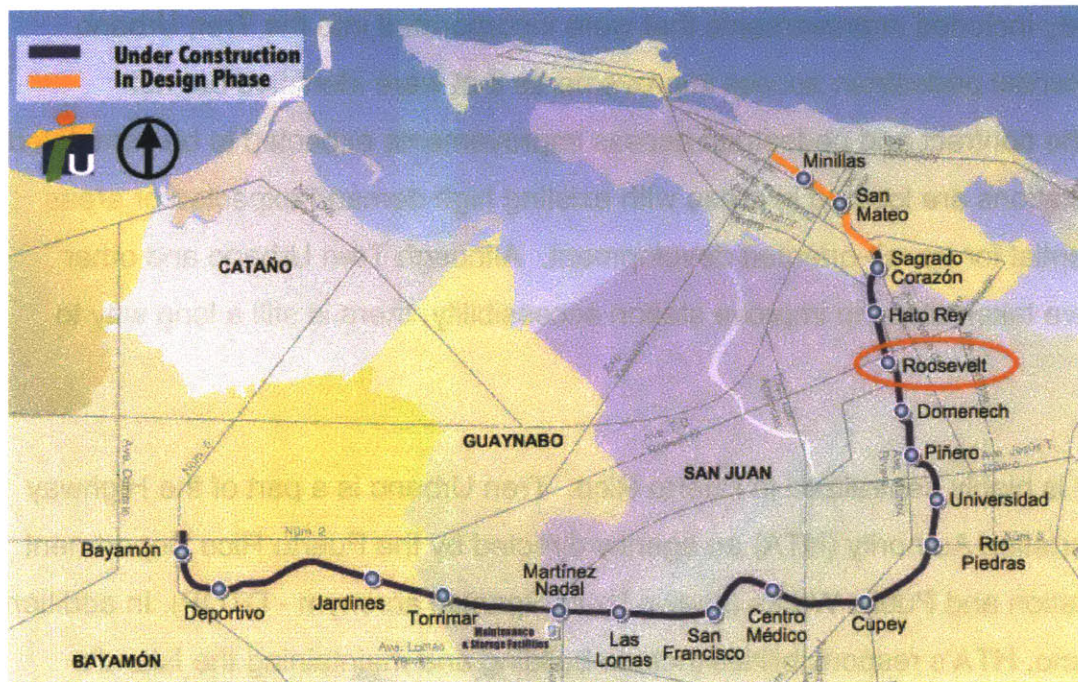


Figure 4-1 Tren Urbano Alignment

This analysis focuses on Roosevelt Station, the second station from the northern terminal of the first phase of construction at Sagrado Corazon. Roosevelt lies in a mixed-use area within the Hato Rey business district and is expected to attract a diverse set of riders. The Hato Rey Transit Center (HRTC), one of X major bus transfer facilities, is located across Avenida Muñoz Rivera from the station. Roosevelt is expected to have the 7th highest ridership of the 16 initial stations. With 6,800 boardings daily, 6 percent of Tren Urbano passengers will use Roosevelt Station (Estudios Technicos 103).

4.2 POLITICAL BACKGROUND

Until recently, transportation modes other than driving were all but ignored both by citizens and government. When Tren Urbano was envisioned, it was understood that an effort would need to be made to provide access to the stations and not just to run the trains. As the stations have been designed, attention has been paid to pedestrian access. Pedestrian Access Improvement Plans were developed for each of the stations. They included improvements that were incorporated into the Tren Urbano Contract, potential pedestrian access improvements that were identified but not included in the contract and pedestrian access improvements expected to be completed by others. Stations are located in areas with existing high demand expected or areas with the potential for transit-oriented development. Although Tren Urbano and other agencies have taken steps to improve station accessibility, there is still a long way to go.

Government is highly centralized in Puerto Rico. Tren Urbano is a part of the Highway and Transportation Authority (HTA) an agency directed by the Puerto Rico Department of Transportation and Public Works (known by its Spanish acronym - DTOP). In addition to Tren Urbano, HTA's responsibilities include building and maintaining the Island's roads and overseeing Metrobus, a privately contracted service operating the major bus

route along Avenida Ponce de León. HTA has struggled to make progress on pedestrian improvements around stations.

The Metropolitan Bus Authority (known by its Spanish acronym - AMA) provides the majority of service. AMA is run as an independent agency directed by DTOP. To stem losses in ridership and in anticipation of the opening of Tren Urbano, AMA has gone through major planning and service changes, streamlining service in 1995 and totally reorganizing it in 1997. A final planning process was completed in 2000 to develop the *Tren Urbano Feeder Service Plan* (Multisystems) to be implemented in stages including changes on opening day of Tren Urbano although none of the early phases has been completed as of January 2002. Fare media integration and schedule matching have not yet been detailed.

As both the transportation and public works agency, DTOP has a large role to play in improving transit access. Therefore, DTOP will need to make sure that all of the agencies it oversees are working collaboratively to support Tren Urbano in addition to working cooperatively with the other state agencies and municipal governments.

Públicos, privately operated fixed route services, provide twice as many rides as the AMA and Metrobus lines. They do not have fixed schedules and are organized around route associations that are regulated by the Public Service Commission.

The Planning Board oversees planning of the entire island. The Autonomous Municipalities Act of 1991 created a framework for municipalities to take over planning and zoning responsibilities. As of January 2002, there were 4 cities in Puerto Rico that had obtained autonomy of which Bayamon was the only city within the Tren Urbano alignment. San Juan was at the 4th of 5 stages and was expected to get autonomy within the next year (Garcia). Regardless, Ordenación Territorial, the island-wide zoning regulation, designates the 500-meter radius surrounding the stations as transit accessible districts with regional importance. This means that even in autonomous

cities, the 500-meters surrounding transit stations are under the control of the regional Planning Board.

Luis Garcia, an associate member of the Planning Board described their proposal for insuring a better development surrounding the station. The Planning Board proposes to deal with land within the 500-meter radius transit zones with a 2-pronged approach. The Board proposes working directly with other government agencies to negotiate good transit-oriented design on the many government-owned properties. It is unclear as to how effective this negotiation tactic will be. Negotiations failed to affect the construction of a State Insurance Building. The State Insurance offices were moved from a site within walking distance of San Francisco Station to a new building just far enough from Cupey to make the walk inconvenient. The new building has a large parking garage that further reduces the attractiveness of using Tren Urbano to reach the office, since there is adequate parking adjacent to the office. Specific zoning for private property was being developed at the time of the conversation. Garcia expected it to include transfer of development rights into the transit areas and a focus on mixed use and increased density. The Land Use Plan for Metropolitan San Juan developed in October of 2001 included regulations for encouraging housing and reduced parking. The plan also included Special Area Plans for each of the Tren Urbano station areas.

The San Juan 2025 Plan Metropolitano de Transportación does include a section on non-motorized transportation that focuses on pathways and facilities for pedestrians and cyclists. Martha Bravo, the Bicycle/Pedestrian Coordinator within DTOP, said that bicycle use was minimal both because of the lack of infrastructure, but also because it is not even considered as a transportation option for much of the public. In order to change attitudes, the focus of the bicycle programs in Puerto Rico is on improving recreational bicycling opportunities such as the Piñones Trail, an 11-kilometer trail boardwalk and asphalt trail providing access to mangroves and wetlands just east of San Juan. The hope is that once people become comfortable biking in general, biking for transportation may become more popular.

Discussions between Tren Urbano and HTA are still going on with regard to bicycle access to the rail system. Puerto Rico is currently in a chicken and egg situation with regards to biking. People will not start biking if the infrastructure is not there, but the government has been and is not yet willing to spend the money until the demand is there. While improvements to other access modes are probably more timely, bicycle amenities are not expensive and can stand as a statement of intent to change attitudes towards biking in Puerto Rico.

4.3 GOALS & OBJECTIVES

DTOP has committed to making multi-modal transportation improvements. In a talk given at the Massachusetts Institute of Technology, Secretary of Transportation, José Miguel Izquierdo Encarnación, stated that one DTOP's goals was to develop "A safe, integrated, efficient and reliable system, that provide a diversity of travel alternatives for the majority of citizens." Tren Urbano has considered accessibility in their station design process and pressured HTA and DTOP to make additional improvements.

Since construction of the stations is coming to an end, major access improvements at the station itself are unlikely in the near future but there is still an opportunity to make improvements in the station vicinities, for which DTOP as a whole should take responsibility.

Based on current conditions in San Juan, the author believes that reasonable short-term objectives for Tren Urbano with regard to station access improvements are:

Create a project wish list

Since it will be difficult for Tren Urbano to fund additional capital improvements immediately after Tren Urbano opens, it will be important that station access concerns are identified and accepted as issues within the department. By internally raising

awareness of these problems, they can be prioritized with the other agency needs and attended to when funds become available. If there is not a general awareness of what specific access problems need to be fixed, they will not happen.

Pressure other agencies to support transit access

Puerto Rico still has a long way to go before transit access is equal to the service quality that Tren Urbano is expecting to provide. Tren Urbano has an interest in developing an interest in station access by other agencies and if necessary, pressuring them for assistance because the success of Tren Urbano relies on people being able to travel to their stations. Since Tren Urbano is a politically visible project and DTOP has ultimate responsibility for its success, small amounts of pressure may be effective in instigating action from other agencies, especially those overseen by DTOP. Working with other agencies including HTA, DTOP, the Planning Board and the municipalities within the alignment will be important in changing San Juan into a transit-friendly place.

Create a culture that is positive about transit

Rail transit will be a new type of transportation option when the system is running. The large scale of this project provides an unparalleled opportunity to teach Puerto Ricans the value of alternative modes of transportation. By making trips, or even segments of their trips without a car, the public may realize that they do not need to rely on cars for all of their transportation. Advertising, quality access and a positive attitude from public officials can convince people that the car is not “king.” As attitudes change, political support may increase for spending money on non-auto related projects, and potentially even on those that may negatively impact drivers such as removing travel lanes to widen sidewalks, add bike lanes or create exclusive bus lanes.

4.4 STATION AREA OVERVIEW

Physical Characteristics

Roosevelt Station is located on Avenida Muñoz Rivera and Avenida F.D. Roosevelt. Avenida Ponce de León, one short block to the east, and Avenida Muñoz Rivera are paired one-way arterial streets with contraflow bus lanes. Plaza spaces will provide access to the major streets as well as Calle O'Neill and Parque Gandara, which is adjacent to the southern station headhouse. The Hato Rey Transit Center (HRTC) is located across Avenida Muñoz Rivera from the station.

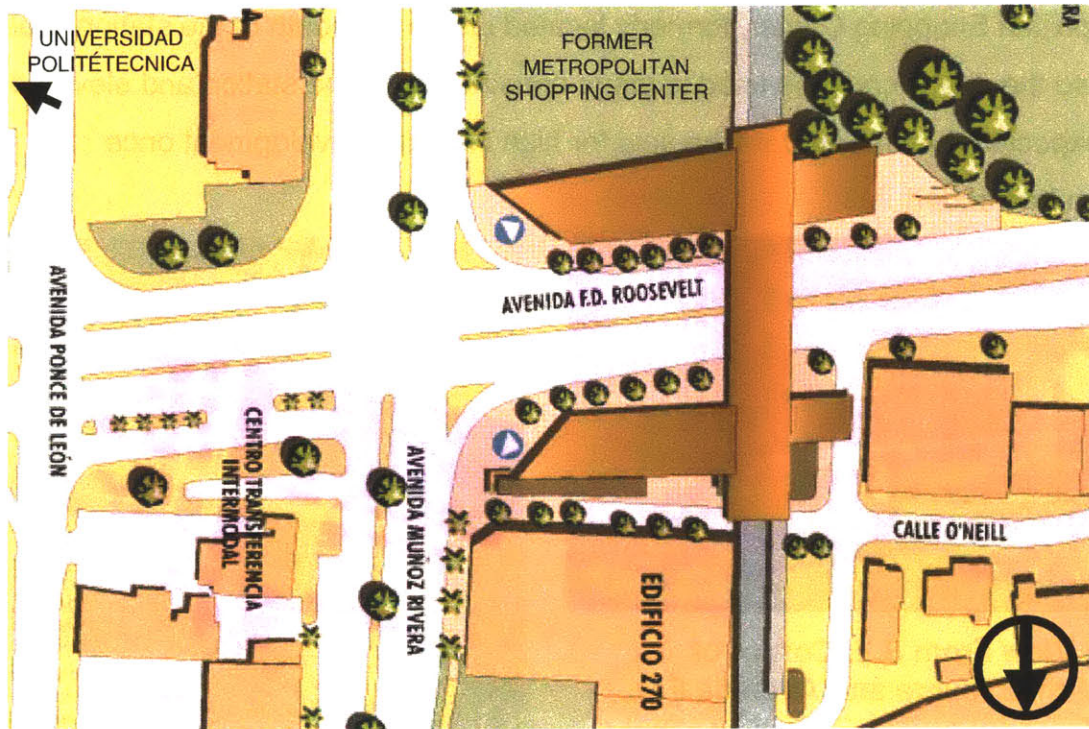


Figure 4-2 Planned Station Area Improvements

The station is elevated and has two side-platforms that span across Avenida F.D. Roosevelt, a major cross-street. There are station entrances facing Avenida Muñoz Rivera on both sides of Avenida F.D. Roosevelt. The station envelope is dominated by two angular roofs that slope up from ground level at the entrances along Muñoz Rivera to reach the elevated platforms to the west. The station walls consist of two parts. From the ground up to twelve feet, the walls of the station are made of glass panes supported

by a metal framework. The walls are made of perforated porcelain enamel panels above 12 feet, which allows for air transfer between the station and outside. This aspect is not represented in Figure 4-3. The plane of the roof extends over the station entrances, providing shelter in front of the station. A plan for station identification has not yet been formalized, but the Tren Urbano symbol will be visible when approaching the station. Trees are to be planted along some building and property edges, along the street in front of Edificio 270 and by the vehicle pull-in along the southern edge of Avenida F.D. Roosevelt.

The Metropolitan Shopping Center, formerly located just to the south of the station, was torn down so the space could be used to stage construction of the station and elevated line. It is expected that this land will be sold for high intensity development once construction has ended.



Figure 4-3 View From S.E. Corner of Avenida Muñoz Rivera and Avenida F.D. Roosevelt

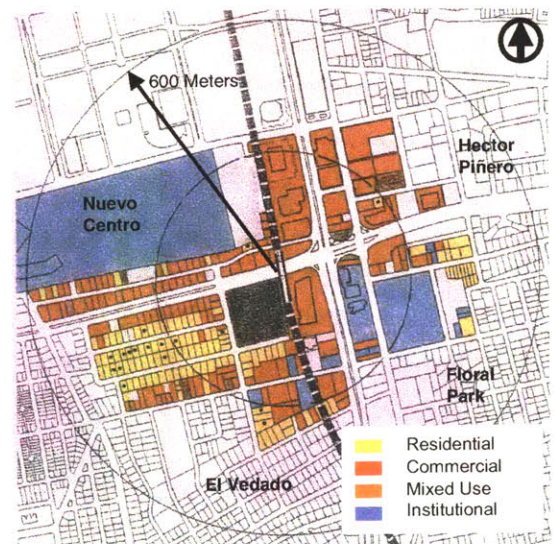


Figure 4-4 Station Area Land Use

Neighborhood Characteristics

Roosevelt Station is located on the edge of Hato Rey Centro and Hato Rey Norte, which are characterized by a strong mix of uses. Avenida Muñoz Rivera and Avenida Ponce de León make up the city’s preeminent business district, “Milla de Oro,” or Golden Mile, which begins south of Roosevelt Station and extends north. Chase Manhattan Bank, Citibank and Banco de Fomento all have

their headquarters within 250 meters of the station. Universidad Politécnica, which has 3000 students, occupies the blocks south and east of the station.

Avenida F.D. Roosevelt is an important commercial corridor. Former small-scale residential buildings along this corridor have been converted to retail and office space, including many restaurants. This arterial street connects Roosevelt Station with Plaza las Americas, the largest shopping mall in the Caribbean, located one mile to the west of the station. Avenida Eleanor Roosevelt and Calle O'Neill share similar development patterns to Avenida F.D. Roosevelt but are smaller in scale. Behind the main commercial corridors lie residential neighborhoods. The neighborhoods of Héctor Piñero, Floral Park and Nuevo Centro are expected to be large feeders for Roosevelt Station. The dense, low-rise residential neighborhoods surrounding the station house 2,226 people just within the 600-foot radius. Most of the neighborhoods are middle class with an average household income above the island average. There are a few neighborhoods to the north that are less well to do. Since the 1960's, Nuevo Centro to the northwest has been developed into a mixed-use neighborhood that includes many governmental offices (RJA Group).

While Hato Rey Station to the north is expected to focus on business passengers traveling to the Golden Mile, Roosevelt will benefit from the business district, local residential and commercial markets and the Hato Rey Transit Center located across Avenida Muñoz Rivera from the station (*EIS* 3-15).

4.5 ACCESS MODE DISTRIBUTION

Table 4-1 Roosevelt Station Access Characteristics

The San Juan Metropolitan Regional Travel Demand Model was enhanced to incorporate proposed transportation changes including

Mode	Mode Share (%) ¹	Access and Egress Trips	
		Total	AM Peak Hour
Walk	74	9,557	1,374
Bicycle	0	-	-
Bus	20	2,583	371
Público	1	129	19
All Car	5	646	93
Total	100	12,914	1,856

¹ (Cambridge Systematics)

Tren Urbano and a new bus feeder service plan. The most recent ridership projections at Roosevelt for 2010 expect there to be 6,800 boardings and 6,100 alightings for a total of almost 13,000 access and egress trips (Estudios Técnicos 103). Ridership at this station is expected to be locally oriented, with 77 percent of trips originating within 600 meters of the station and 93 percent of alighting passengers staying within this zone. Plazas las Americas is expected to be the most popular origin for trips beyond the immediate area drawing 10 percent of trips (Estudios Técnicos 103). It is expected that 14 percent of station activity will occur during the morning peak period, with 80 percent being alighting passengers (EIS 4-7).

Pedestrians

Pedestrians will be the majority of station users at Roosevelt creating almost 10,000 access and egress trips daily. The morning peak period is expected to create 1,370 pedestrian trips to and from the station with another 371 passengers transferring between HRTC and Tren Urbano. Based on a breakdown of trip origins and destinations (Estudios Técnicos 103-104) and expected modes split (Cambridge Systematics), the largest concentration of pedestrians is expected to cross Avenida Muñoz Rivera using the northern

crosswalk, making this an area of critical concern. During the peak AM hour, it can be expected that on average 16 people per minute will use this crosswalk just to travel to and from the train station. Compared to other stations in the system, walking has a very high share of riders because of the high density of living and working opportunities.

Bus

The Hato Rey Transit Center (HRTC) is located across Avenida Muñoz Rivera from the station entrance. Eleven buses currently stop at HRTC, but based on the *Tren Urbano Feeder Service Plan* (Multisystems) service will be streamlined, leaving four trunk bus routes all providing headways between 10-20 minutes.⁸ It is expected that over 1000 passengers will transfer daily from bus to rail as this is the major transfer site in Hato Rey. Figure 4-5 shows the bus vehicle flow at the HRTC. Vehicles travel in contra-flow bus lanes along Avenida Muñoz Rivera and Ponce de León.

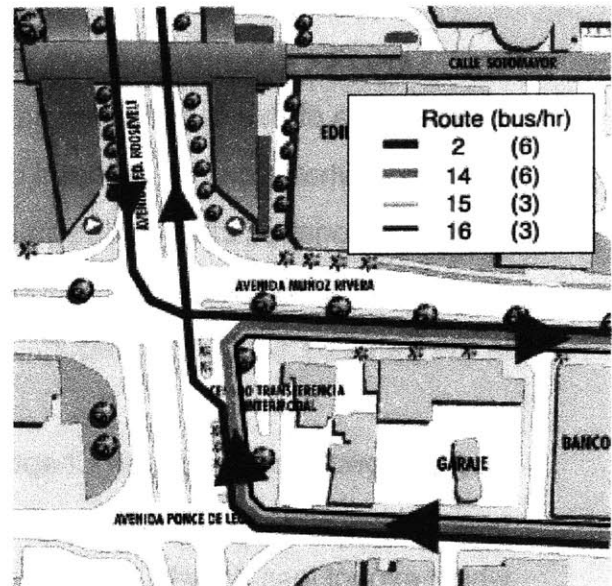


Figure 4-5 Bus Routes at HRTC

Other Modes

Públicos, privately owned vans, while an integral part of public transportation throughout the island, are not expected to have much impact at Roosevelt because of the strong AMA presence in this area. It is unlikely that other shuttle services will be popular at this location because of its urban location and plentiful bus service. Bicycle use to transit stations all along the Tren Urbano corridor is

⁸ This analysis has been completed assuming that the Tren Urbano Feeder Service Plan (Multisystems, 12/2000) will be implemented although many of the earlier phases have not been completed as per the schedule.

expected to be minimal because bicycling is not a popular means of transportation. Bicycle transportation is not currently seen as an alternative due to the lack of bicycle infrastructure (roadspace and storage facilities) and the Puerto Rican heat. Of the 5 percent of access trips expected to be made by car, it is likely that most of these will be drop-off as opposed to park and ride due to the lack of parking. Driving is not expected to have a large share of trips because of the heavy congestion in the area and the attractiveness of other modes.

4.6 ACCESS CONDITIONS BY MODE

The purpose of this section is to analyze the current station conditions to determine what areas are in need of improvement. Because Roosevelt Station is still under construction, the design analysis is based on construction drawings and photographs provided in October 2002 and an illustrative drawing provided in the Estudios Técnicos Report.

The framework developed in Chapter 2 is used. Access for All Modes, pedestrians and bus are analyzed attribute by attribute. For the other modes, which expect less activity, a shorter summary of conditions is included.

Summaries of the current or expected provision of each design feature can be found in Appendix A. All of the individual attribute tables have been combined for each mode. The current or expected condition of each feature has been highlighted. When multiple conditions exist, only the more dominant one is highlighted. Those features that cannot be analyzed because planning or construction has not occurred have been left blank.

All Modes

The physical area included in the All Modes analysis is constrained to the station and surrounding patio since most passengers will interface with their mode at the

edge of the patio or beyond the station boundaries. Although both people using the bus and walking to the station use the intersection of Avenida Muñoz Rivera and Avenida F.D. Roosevelt, it is not included in All Modes because the majority of the vehicle traffic is not accessing the station.

Safety

The station entrances and surrounding patios will mainly be used by people on foot, except for the occasional cyclist or skateboarder. Since bicycle use is expected to be minimal, most people will be walking, making inter-modal conflicts rare within the area included in the All Modes analysis. One area that may prove problematic is the plaza area adjacent to the vehicle pull-in along the south side of Avenida F. D. Roosevelt. The trees planted adjacent to the pull-in narrow the walkway further. At one point, there is only about seven-feet between the station wall and the edge of the planter. This area may become congested with people waiting for the bus or to be picked up blocking pedestrians who want to travel past. The bollards and light poles situated every ten-feet along the edge of the pull-in may make getting into or out of buses or private vehicles difficult, especially for people in wheelchairs. Vehicles will need to make sure that their doorways are clear of trees when they pull up to the curb.

Security

The compact nature of the station area and exposure to the main avenues makes this station relatively secure. The station configuration is generally open, but there are a few places where potentially insecure conditions have been created. The garbage collection area behind the south headhouse is isolated from the street and main activity centers. The intersection of Calle O'Neill and Sotomayor under the tracks will be lit with two streetlights but is remote and hard to watch, especially at night. Additional lighting and replacing the existing trees with low planters would encourage surveillance of this area.

Public surveillance is generally good. The glass façade on the station should provide visual connectivity between the station attendant and those outside. The busy surrounding streets should provide eyes on the street, however the adjacent land uses are primarily daytime activities. Nearby residences, restaurants and nightclubs can help provide adequate numbers of pedestrians during the evening if a non-auto culture for moving about the city develops. Lighting around the station is focused on the street, but there are a few lighting fixtures directed at the station plaza area.

Directness

The stairs from the platform to the each of the headhouses will need to be labeled so people will know which staircase to use to reach the desired corner. The various access modes are not well integrated into the transit station and signs will be needed to direct people, especial passengers traveling by bus. These issues will be described in more detail for each access mode.

Weather Protection

The main climate concerns in Puerto Rico include hot and humid weather and plentiful rain. The station area provides a range of weather protection options. Outside the station, the broad roof overhang in front of the station will provide shade and protection from the rain. The rest of the plaza will have a mix of direct sunlight and tree shade. The stationhouses will be fully enclosed and will not have air conditioning. Hopefully the perforated paneling and station entrances will allow enough fresh air to circulate into the station to keep it cool. Sun screens and fans may need to be installed if the passive cooling at the station is not adequate.

Supportive Detail

The specific signage plan for directing people to the station has not yet been defined although a system-wide design and policy is planned. Signage will be

particularly important since the system is new and not yet part of standard travel patterns. Station markers that can be seen from Avenida Ponce de León will be especially important because it is not visually connected to the station but has high pedestrian and vehicle traffic levels that may need direction to the station.

Since there are many large businesses, government offices and educational facilities near the station, permanent maps indicating the locations of these facilities would be helpful for directing people to where they want to go once they have reached the station. This will be especially important for passengers looking for Plaza Las Americas who will need to take the correct bus to reach the mall. Designing the maps with just the major destinations reduces the likelihood of them becoming outdated but may render them less useful. Customer assistants can play a crucial role directing people to less popular destinations.

Pedestrian

Pedestrian access to the station will look beyond the station area to the travel corridors that will be used to reach the station. The analysis includes the intersection of Avenida F.D. Roosevelt and Avenida Muñoz Rivera. Transit passengers using other modes may also have to deal with this intersection and will be considered as pedestrians for this part of the trip. This intersection is not included in the All Modes analysis because the majority of pedestrian traffic is not station related.

Safety

In general the pedestrian infrastructure in Puerto Rico was designed to minimum standards⁹ and then encroached upon even further. In many places, utility poles and other obstructions block the sidewalk where cars have not turned it into additional parking space or landowners have not enveloped it into their private

⁹ Most sidewalks in Puerto Rico are 1-meter wide with a 1-meter buffer although in some commercial areas, they are wider.

property. The use of sidewalks for parking is particularly rampant in this area of San Juan, especially along Avenida F.D. Roosevelt. Bollards will surround the station area to prevent vehicles from driving onto the plaza surrounding the station. The sidewalk is being rebuilt along Avenida Muñoz Rivera in front of Edificio 270 and will be 8 feet wide and further protected from vehicles by a landscaped buffer strip of trees, which is a minimum for an urban commercial district and will likely cause congestion during peak periods.

Avenida F.D. Roosevelt and Avenida Muñoz Rivera are major traffic arteries. Avenida F.D. Roosevelt has three westbound and five eastbound lanes separated by a median. The section east of Avenida Muñoz Rivera also includes roadway for the Hato Rey Transit Center. Avenida Muñoz Rivera has four southbound lanes to the west of a planted median and two more lanes plus a contra-flow bus lane to the east of the median. All right turns occur in slip lanes, which use pedestrian islands to create a segregated right turning lane by cutting into the corner of the block. Slip lanes increase the length of the pedestrian crossing in order to provide a larger turning radius for the cars so that they can make the turn at higher speeds and do not need to stop at the signal. Although the importance of vehicles is recognized, slip lanes are a major obstacle to pedestrian convenience and safety.

The most serious mode conflicts arise for pedestrians walking from the Hato Rey Transit Center who need to cross Avenida Muñoz Rivera. The high pedestrian flow at the northern crosswalk across Avenida Muñoz Rivera between Tren Urbano and the HRTC makes this a key crossing. Based on ridership projections it can be anticipated that 760 people will cross in the eastbound direction and 200 will cross in the westbound direction during the AM peak hour¹⁰. Because of

¹⁰ These figures are based on trip origin information and traffic volumes from Estudios Técnicos (103), Access mode breakdown from Cambridge Systematics and the proportions of passenger boardings and alightings by station from the EIS (4-7).

the nature of bus and rail service, platooning or pulsing of pedestrian activity is expected. While this may not prove a problem on the western side of Avenida Muñoz Rivera because of the plazas and large slip islands, it may create congestion on the eastern side where there is less pedestrian queuing space.

Pedestrian signals will be used at the intersection but the cycle pattern and timing is currently undetermined (Mirandez, e-mail). The cycle time can be expected to be fairly long because as this is typical highway design strategy in Puerto Rico (Kruckemeyer) the high traffic volumes and the extraordinary width of the street. Compromises will need to be made between vehicle traffic flow and shorter cycle times and between providing sufficient crossing time for slower pedestrians and the desire to provide as much pedestrian Walk time as possible. (See p 50 for greater detail.) If shorter cycle times or FDW phases are used to reduce pedestrian wait time, the raised concrete medians along both Avenida Muñoz Rivera and Avenida F. D. Roosevelt could be used by slower pedestrians who cannot travel across the entire intersection in one light cycle. These medians are currently narrow and in many cases do not extend all the way to the crosswalk. They would need to be widened if they were to provide a safe waiting location for slower pedestrians.

Pedestrians crossing Avenida Muñoz Rivera at the northern crosswalk will have to contend with turning vehicles in both slip lanes and any vehicles making left turns from Avenida Muñoz Rivera to Avenida F.D. Roosevelt eastbound. All this vehicular traffic have the right of way at the same time as pedestrians are crossing from the HRTC to Tren Urbano. The slip lanes should be removed and pedestrians signals programmed with advanced Walk signals that allow pedestrians to enter the intersection before vehicles traffic begins. Wider and more protected median space should be provided for those pedestrians who may not be able to cross in one cycle. The pedestrian island at the HRTC should be

expanded to provide enough waiting room for the large numbers of pedestrians who will be transferring from HRTC to Tren Urbano.

Security

Physical provisions for pedestrian security are mediocre. While pedestrian lighting will be provided at the station, there appears to be little pedestrian lighting beyond, with only tall highway style lights focused on the roadways. Many of the buildings on Avenida F. D. Roosevelt are setback from the sidewalk with parking in front. This means that people will need to spread their attention around to all sides and that there is less connection between people in the buildings and pedestrians. With offices, restaurants and nightclubs all nearby, it is likely that there will be places to go for help throughout the day, if needed. Security could be improved by providing pedestrian focused lighting and working to create and maintain clear sidewalks. This would involve enforcing prohibitions on parking on sidewalks and illegal curb cuts. Any future development should be built with zero setback.

Directness

The station is located as to meet a number of different user groups and focuses the front doors where it expects to have the most traffic. It was decided early on, that there should be two headhouses, rather than just having one on the northern side of Avenida F.D. Roosevelt. This reduces the number of passengers required to cross the street to reach the station. It would have been better if the station could have been developed with additional entrances on the western side to reduce the walking distance from people coming from the west, however it would have increased the complexity of station operations.

Density surrounding this station is fairly high, composed of a mix of high-rise buildings and densely packed single family homes or former homes converted for commercial uses. Increased dense multi-use development should be

encouraged in the area. The former Metropolitan Shopping Center site and undeveloped land in Nuevo Centro would be good catalyst projects for demonstrating high-density mixed use in this area. The street network, while not necessarily pedestrian friendly, is generally well connected, with only a few large impermeable blocks. Block lengths range from 50 meters by 50 meters up to 300 meters long. Nuevo Centro has very few streets but is generally accessible on foot.

Weather Protection

Rain and heat are the two major weather concerns in Puerto Rico and difficult to control for pedestrians. Trees adjacent to Parque Gandara and Edificio 270 provide some shading, both along the access corridors and within the station patio. Tree coverage becomes sparse in the residential neighborhoods and heavy commercial areas, especially those that have parking in front. During early morning and in the late afternoons shadows from buildings may provide some shade when the buildings are near the sidewalk or very tall. Buildings set back from the street provide less protection both from rain and sun. Planting trees and encouraging buildings to be built on the up to the lot line and have awnings or pedestrian arcades would make walking in the Puerto Rican heat more comfortable.

Supportive Detail

The surrounding land uses are ideal, incorporating a mix of uses including retail and residences, which will provide around the clock use of the station and convenient connections to services.

Bike

Neither Roosevelt Station, nor any of the other stations are being built with bicycle access in mind. There are no bicycle paths or lanes near Roosevelt Station although Martí Coll Parque Linea intersects with Hato Rey Station less

than a half mile to the north. The major streets adjacent to the station have high traffic volumes, which may make it uncomfortable for biking. The level and open design of the station and lack of nearby parking meters make it difficult to find even unauthorized locations to park a bike. Bicycle racks, ideally located within one of the station headhouses or the Edificio 270 parking lot, are needed to promote bicycle access to this station. Bike lanes and better promotion of biking as a transportation mode are also needed encourage bicycle more bicycle use both to transit and in general.

Bus¹¹

Safety

Most bus passengers must cross Avenida Muñoz Rivera's northern crosswalk to reach the station. An analysis of this is described under pedestrian safety. Bus passengers traveling towards Santurce on Route 2 do not have this concern because the bus stop is located adjacent to the station. Buses using this stop will require a special "bus signal" in order to cross from the southern lane of Avenida F.D. Roosevelt to the contra-flow bus lane since it is not a standard turning movement at the intersection.

Security

Security of HRTC may be of concern both because it is remote from the rail station and because there no other uses on that side of the block, leaving it very isolated. In addition, HRTC is exposed from behind, which means that people must keep alert to potential trouble approaching from this unused and sheltered area. Multiple pedestrian-scaled lights at HRTC help illumine the waiting area.

¹¹ The analysis for bus access has been done assuming that Tren Urbano Feeder Service Plan Final Report (Multisystems, 12/2000) will be implemented and not with current bus activity.

Directness

As has been mentioned before, having the HRTC across Avenida Muñoz Rivera from Roosevelt Station means that people transferring from bus to rail or vice versa have a fairly tedious and difficult connection to make. The Route 2 bus travels past the station along Avenida F. D. Roosevelt and a vehicle pull in has been provided for the eastbound direction. No such provision has been made for buses traveling westbound, which is one of the main transit services to Plaza Las Americas.

Assuming that the changes recommended in the *Feeder Plan* are implemented and no bus service continues south of Avenida F. D. Roosevelt, one option for improving connectivity between bus and rail passengers would be to move the HRTC from its present location to the northwest corner of the intersection. In order to allow buses to stop in front of the station, the contra-flow bus lane currently located on the east side of Avenida Muñoz Rivera, could be relocated along the west side of Avenida Muñoz Rivera or could be replaced with non-contra-flow bus lanes on the right side of the street. Although both of these options would allow buses to stop in front of the station, they both require buses to cross multiple lanes of traffic while turning. Bus-specific turning lights could make this option feasible, but one would first want a better understanding of bus passenger travel characteristics. Placing the Transit Center at this location may inconvenience people coming from the west, requiring either another stop on Avenida Ponce de León or people coming from that direction to walk farther to the bus stop.

Weather Protection

Open-sided covered bus shelters provide protection from rain and sun while allowing the breeze for passengers once they have reached the bus stop. For passengers transferring from Tren Urbano to Route 2 eastbound, benches are provided under a narrow awning that is not expected to provide much weather

protection. Incorporating the bus area into the station would be necessary to further reduce exposure to the elements since most of it occurs as the passenger travels from one to the other.

Supportive Detail

It has not been determined as to whether bus services will be scheduled for convenient transfers from one mode to the other. Bus headways are expected to be between 10 and 20 minutes (Multisystems). If bus and rail service can be made reliable, schedules between the two systems should be made. It is unclear whether or not there will be fare coordination between the two systems. This is an extremely important feature of integrated service, especially since feeder bus service is expected to play a significant role in bringing people to Tren Urbano.

Drop-Off

Publicós are not expected to use Roosevelt Station as a terminal staging area though publicós may drop passengers off similarly to other vehicles. Since Puerto Ricans are well versed in finding creative places to park, bollards will be placed along the curb at 10-foot intervals to prevent people from parking or waiting for passengers along most of the station boarder. The vehicle pull-in along the eastbound direction of Avenida F.D. Roosevelt provides an ideal drop-off facility as passengers can walk a short distance from their car to the station headhouse without needing to cross the street. Since this 65-foot pull-in is actually designed to serve buses that are scheduled for 10-minute headways, it will be important that passenger cars and taxis do not interfere with bus use of the facility. Signage should be provided to remind drivers to evacuate for buses. If passenger cars persistently block the pull-in, more dramatic measures should be taken such as painting the curb red and using police to try and enforce no-stopping zones. Without constant enforcement, these tools are unlikely to work. Alternatively, the pull-in could be extended, especially if the right-turn slip lane was removed from Avenida F. D. Roosevelt to Avenida Muñoz Rivera. Drop-off

space along Avenida F.D. Roosevelt allows passengers to wait inside the station until their ride arrives since they will be able to see directly from the station to the pull-in.

Since the pull-in is not an ideal location for drop-off activity, Tren Urbano many want to encourage drop-offs to occur along the Sotomayor and Calle O'Neill behind the northern headhouse, which would be more useful than the pull-in for passengers coming from the north or west. In order to encourage the use of the area to the northwest of the station as drop-off area, signage would be needed to direct people to this area since it is not as obvious from the main roads.

Removing the slip lanes would provide additional space for vehicle drop off in front of the station.

Park and Ride

Downtown transit stations seldom have much need for parking as residents are close to the station and well served by bus. Since there are no parking lots associated with Roosevelt Station and any park and ride use is not expected, the standard design analysis is not applicable. Some potential park and ride options are discussed. While parking is not being provided at Roosevelt Station, it is possible that patrons could use the parking lot under Edificio 270 or the parking structure along Sotomayor. Potentially the former Metropolitan shopping center could be use for parking until it is redeveloped. This is not recommended though, since it might make it more difficult to redevelop the site later because parking in the area is a valuable commodity.

4.7 FINAL RECOMMENDATIONS

After completing the above station review, it is believed that the focus of station area improvements at Roosevelt should be on pedestrian access because of the dense, mixed-use nature of the surrounding communities. It is clear that if walking is to be seen as a viable mode for accessing transit, many changes to

the pedestrian realm need to be made. While plans have been developed to restructure bus routes to provide feeder service to Roosevelt and other Tren Urbano stations, the two transit agencies need to better synchronize schedules and fares in order to serve the large number of passengers expecting to transfer between the two.

Although the current land development around the station promotes transit, its proximity to the Golden Mile make this an ideal place for continued growth of the business district as well as high density residential uses. Zoning regulations should be changed to encourage mixed-use developments and require developers to build all the way up to the property line. These regulations may take some time to produce results but will eventually help to create a better pedestrian environment. For faster land-use changes the government may need to provide additional incentives since mixed-use is not considered a comfortable development style and the parcel aggregation needed for larger projects can be difficult for private developers. The former Metropolitan Shopping Center would be an ideal catalyst project as it is a large site that is already owned by Tren Urbano.

The Planning Board has added a Tren Urbano overlay district that allows for higher density and lower required parking levels near the station. In addition, Special Area Plans were developed (*Plan de Ordenación Territorial de San Juan*). These plans focus on each Tren Urbano station area, key commercial corridors, important natural resources and struggling residential neighborhoods. Follow through on these plans is important if changes are to actually occur.

Improvements in the physical pedestrian realm are a key part in providing access to rail transit stations. In the short term, authorities need to eliminate the practice of parking on sidewalks. This habit not only makes it difficult for walking, but

reinforces the notion that automobile is the most desirable transportation mode by allowing it to invade the infrastructure designed for other modes.

In addition to improved zoning, the government needs to take the lead in improving pedestrian infrastructure. Reglamento de Planificacion Numero 22, mandates the design of public space throughout the island of Puerto Rico, including setting minimum standards for sidewalk widths of 5 feet (8 feet on streets wider than 42 feet). Unfortunately most sidewalks, when there are any at all, do not meet these minimal standards. In urban commercial districts, sidewalks need to be wider than 8 feet. Regulations should be changed to require minimum sidewalk widths of 12 feet in commercial areas and limits should be placed on the use of curb cuts in all neighborhoods. Parking should not be allowed in front setbacks of properties and commercial properties should have limited setback standards. No exemption should be allowed for buildings being converted from residential to commercial use. All new construction or redevelopment projects should be required to meet the recommended regulations above.

Streetscape improvements surrounding the station were included in the Tren Urbano contract. Additional suggestions were made for pedestrian improvements along important access arteries within the entire 400-meter radius surrounding the station. HTA is responsible for this program but has been very slow to move forward. HTA turned it over to the Tren Urbano staff who created detailed plans for streetscaping around the Martinez Nadal station, which currently under construction. Martinez Nadal was expected to be a prototype for consultants who will design the streetscape improvement plans for the other stations. HTA has reclaimed responsibility for these projects, but they are all still in the design phase, except for Piñero, Domenech and Roosevelt Stations, which have not been started at all (Kruckemeyer).

At Roosevelt Station, pedestrian improvements extending along the face of Edificio 270 and at the intersection of Avenida F.D. Roosevelt and Avenida Muñoz Rivera were supposed to be included in the construction contract. The design of the intersection of Avenida F.D. Roosevelt and Avenida Muñoz Rivera is key to insuring the safety of the many pedestrians that use this busy intersection, and the additional traffic expected from people transferring from Tren Urbano to buses at the HRTC.

An e-mail from Tren Urbano Architect Javier Mirandez from December, 12, 2002, provides the current situation on the streetscape improvements at the station,

The Station Area Improvements effort in Hato Rey is not going forward due to the complexity associated with Roosevelt Ave. All the money budgeted is being distributed on other stations. Planning and community participation efforts may begin in order to have some consensus by the time HTA establishes its 5-year Capital Improvement Program budget.

It appears that the changes needed in the area could not be developed in time for the contracts to be signed. It will be important that it is not neglect but instead, that additional effort should be focused on this area and included in HTA's upcoming budget. Tren Urbano will need to continue to monitor the construction work to make sure that improvements are being built to specifications all along the alignment.

Improving the bus-rail connectivity overall is important for attracting riders to Tren Urbano. Integrated fare media and cost structures will provide a smoother transit trip. At Roosevelt Station, the transit center was built without much thought toward the bus-rail transfer experience. While improving the intersection will benefit bus riders, relocating HRTC to integrate it into Tren Urbano would be a major undertaking, requiring more research, high levels of coordination and public input.

The following is a list of specific projects that would help improve access to the station:

1) Sidewalks - General

- d) Widen and improve all sidewalks. Wider minimums should be required in commercial districts.
- e) Prevent parking on sidewalks through police enforcement.
- f) Restrict parking in front of commercial businesses.
- g) Reduce curb cuts.

2) Intersection of Avenida Muñoz Rivera and Avenida F. D. Roosevelt

- h) Remove right turn slip lanes.
- i) Widen median strips.
- j) Increase size of the pedestrian island adjacent to HRTC.
- k) Signal timing at this intersection needs to be carefully thought out to accommodate vehicle flows, minimize pedestrian wait time and insure the safety of slower pedestrians.

3) Land Use

- l) Use the Metropolitan Shopping Center as a demonstration high-density mixed-use project to encourage similar development patterns.
- m) Reduce the allowed setbacks for buildings in commercial districts, including redevelopment projects.

4) Bus

- n) Integrate fares and schedules.

5) Drop-off

- o) Use signage to warn private vehicles to give way to buses.
- p) Encourage use of intersection of Sotomayor and Calle O'Neill.

6) Bike - General

- q) Develop a network of bike lanes or recommended street routes.
- r) Add bicycle routes at stations with safe bicycle access.

AMA, HTA and the Planning Board have all made steps toward better connectivity to transit. While these initial steps are good, follow through and continued effort towards implementing plans is needed to insure that connectivity to transit will really be easy. While the Planning Board has focused planning efforts on improving the station areas, there is some concern as to whether or not these regulations will produce changes. Zoning regulations still need some work to shift the city from a car-oriented culture towards full integration of multi-modalism. Continued improvements to streetscapes and tightened enforcement of current regulations are important to really shift attitudes away from disregard for the public realm.

Chapter 5 Jefferson Park Station, Chicago Transit Authority

5.1 SYSTEM OVERVIEW

The Chicago Transit Authority (CTA) is the second largest transit provider in the nation and transit use is well established. Seven rail lines and 134 bus routes provide five hundred thousand rail and one million bus rides daily to Chicago and 38 surrounding suburbs with the majority of service within the Chicago city limits. Rail services focus on bringing people into downtown Chicago. The CTA is an independent agency created by the state legislature and overseen by the Regional Transportation Authority (RTA). RTA distributes public funds to the three transit-service providers in the 6-county Chicago metropolitan area, which as a total population of 7.3 million (RTA).

Jefferson Park Station is located along the O'Hare branch of the Blue Line as is shown in Figure 5-1. This line runs along the Kennedy Expressway between Belmont and O'Hare Airport. The station was built as the line terminal in 1970 and the extension to O'Hare was built 14 years later. Although the area is primarily residential, the station is located within a neighborhood shopping district. Jefferson Park serves as one of the cities largest

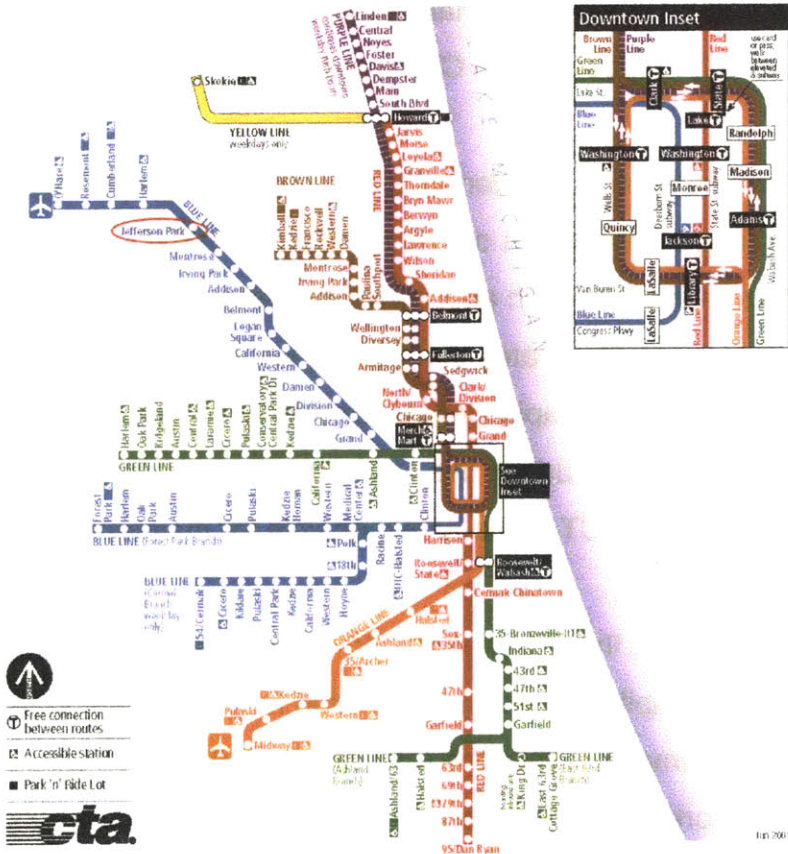


Figure 5-1CTA Rail System Map

bus terminals. On an average weekday 6,500 passengers board the rail system at Jefferson Park, making it the 21st busiest station of the 143 in the CTA system (Czerwinski).

5.2 POLITICAL BACKGROUND

While the CTA is an independent agency, it needs to work with many other agencies to maintain its facilities and improve transit access. The CTA has developed a coordinated bus and rail network, with bus service at 90 percent of the rail stations (Crockett 111). Systemwide, 32 percent of passengers ride both bus and rail on their typical trip (Northwest Research Group 67). CTA relies very lightly on park and ride for rail access, providing parking at only 11 percent of stations, half of which are branch terminals. There has been some discussion of building parking along the southern portion of the Green Line, similar to that along the Orange Line, but this has not been supported by the CTA. Recently, the CTA has been working on a bicycle to transit program.

Ownership and maintenance of CTA rail facilities is shared between CTA and the Chicago Department of Transportation (CDOT). Station ownership is based on historic factors that led each agency to own different lines. An Operations and Maintenance agreement designates that the city will maintain the downtown stations and the CTA is responsible for capital improvements and maintenance for stations on the rest of the system.¹² Because of this, Jefferson Park station is actually owned by CDOT, but leased to the CTA who is responsible for maintenance and improvements.

Historically, the CTA has had to defer needed maintenance due to under funding. The current capital budget has provided funding for the CTA to make many long-needed improvements. While the CTA has undertaken an aggressive rehabilitation program, this work has focused on the rail infrastructure, signaling and the stations themselves but has rarely looked beyond the station entrance.

¹² The City of Chicago maintains the Loop stations and State and Dearborn Subway stations.

The CTA has not taken a particularly proactive role in improving the physical amenities of those accessing transit. A monthly interdepartmental meeting is supposed to occur between CDOT and Planning and Development, but rarely actually occurs. Unofficial contacts with the CDOT and Illinois Department of Transportation (IDOT) and the City Department of Planning and Development (DPD) provide opportunity for the CTA to provide input on projects that are brought to their attention. The CTA has been involved in development and land use surrounding their stations, providing input on specific projects and making recommendations for the new zoning regulations.

CDOT is responsible for streetscape improvements including road and sidewalk design, traffic signals, crosswalks, lighting and street furniture. While there are different departments that look at each of these areas on a site-specific basis, CDOT also has moved toward integrated streetscape projects. Streetscape projects range in scope from 4-6 blocks up to 8.5 miles. Funding for these projects comes from a variety of sources and is often related to redevelopment projects proposed by the community or DPD or to major corridor improvement projects. Depending on where the funding comes from, streetscape projects are managed from a variety of different departments.

The Bureau of Streets works on planning smaller scale projects that are requested by community members, including aldermen, business associations and DPD. These projects average 6 blocks but can be up to 16 blocks long and the Bureau of Streets acts as a consultant and coordinator for the neighborhood in developing a plan.

The City Streetscape Commission, headed by Janet Attarian in the Bureau of Streets created a "Street Palette" to provide a condensed set of street amenities that can be used for streetscape improvements. This palette is used by all agencies working within the public space in order to simplify requisition and maintenance of these amenities while allowing for individual neighborhood character. This has proved to be a powerful

tool for the city allowing various departments to facilitate streetscape improvements on their own.

Other CDOT bureaus incorporate streetscaping into their projects. The Bureau of Highways is in the initial phase of the Milwaukee Avenue Plan, which will overhaul 8.5 miles of Milwaukee Ave from Grand Ave North to Jefferson Park. Funding for the project is coming 75 percent from federal funds and 25 percent from the state. Every aspect of the road from signal timing, sidewalk width, lighting and street furniture will be analyzed and improved as needed. Work in the Jefferson Park section is planned for 2008 but is expected to only go up to but not include the bridge over the Expressway and tunnel under the rail tracks.

The bridges over the expressways are owned by IDOT and maintained by the City's Bureau of Bridges and Transit. IDOT funds projects to meet its *Standard Specification for Road and Bridge Construction*. Different opinions have been given on the flexibility of IDOT to approve and pay for variations from the design standards.

Zoning determines what can be built around transit. Chicago is currently rewriting its zoning code for the first time since 1957. The CTA is following this zoning rewrite and requested changes that will help transit. Citywide parking requirements for detached housing and larger apartments are planned to increase from 1:1 to 1.5 or 2 per unit. Plans are to allow residential development built near to continue to meet the 1:1 requirement. Commercial space adjacent to transit is expected to request reductions on parking of 10-25 percent (City of Chicago 47).

Aldermen, elected officials that represent a specific portion of a city, wield significant political power in Chicago. Aldermen review the capital improvement budget, propose additional projects and generally advocate for their communities.

The Jefferson Park Neighborhood Association and Chamber of Commerce are heavily involved in preserving the neighborhood character of Jefferson Park and keeping the commercial district stable. The Chamber, led by Glenn Nadig, has been working to emphasize the area's namesake, Thomas Jefferson, by placing a bronze statue in the plaza in front of the transit station.

While more density may improve the economic prospects for Jefferson Park, community members are not in support of additional density. Jefferson Park Neighborhood Association President Peter Conway recently wrote a letter to a developer of a proposed mixed use development stating, "The majority of the community will not support seven stories" (Nadig, "Developer"). This project is slated for the middle of the commercial district on the corner of Milwaukee and Lawrence, just two blocks from the transit station and the residential aspect would benefit transit.

Coordinating different improvement projects can lead to cost savings and a "complete" change for the area being renovated. In order to do this, different agencies need to communicate and coordinate their work plans for capital improvement projects. Although each agency may have different projects at the top of its list, reprioritizing projects may be worthwhile if different agencies can coordinate projects in a given area of the City.

5.3 GOALS & OBJECTIVES

One of the objectives behind the CTA's Service Standards is to "encourage intermodal services and connections that maximize the trip-making options available to customers" (CTA Transit Operations). It is clear that the CTA understands that inter-modalism is an important aspect of transit provision.

Based on the background knowledge of the CTA and other relevant organizations, the author believes that the following objectives are pertinent in order for the CTA to improve access to their stations.

Insure that all departments consider transit access within their specific context

While some CTA staff recognize the importance of access as a part of the transit experience, it is not an aspect that gets incorporated into the thinking of all departments. Planning, Bus Operations, Real Estate, Engineering & Construction and Intergovernmental Affairs are all important players in improving station access. These departments all need to recognize the role they play and the affects that they have on transit accessibility.

Meet the needs of the primary access mode(s) at each station and then areas of unmet demand

For most stations, primary access modes will be clear based on current access rates. A cursory survey of each station should identify any access modes with sub-standard conditions. Where there is a demand for a certain mode, a few creative and dedicated people will invent ways of accessing the station by that mode. Pedestrians may walk along the edges of roads or down embankments to reach a station if infrastructure is not provided. Unless public agencies or neighbors take action to prevent it, cars will park on sidewalks and plazas near the station if the demand for parking is not met in a more appropriate way. Cyclists will lock bikes to sign poles if there are no other options. Drop-off patrons may stop in the middle of traffic or double park if space is not provided.

Focus efforts on non auto-oriented modes

While there are a few CTA stations with high levels of park and ride¹³, the majority of stations have little available land for parking and good connectivity for other modes. Since the CTA provides service in a fairly dense area, providing automobile access is generally counterproductive in encouraging transit use because the space that goes toward parking cars is then not used for transit-oriented uses. Also, in dense locations, where vehicle travel is already high, any additional vehicle trips will make access by bus or walking more difficult. For stations in less dense areas where additional vehicle travel can be accommodated, providing drop-off areas can be considered, providing that they do not interfere with other travel modes. Since one of the goals of transit is to reduce vehicle trips and the congestion and pollution related to them, encouraging automobile access to CTA stations does not make sense.

Create standards for each access mode

Minimum standards should be developed for each access mode as described in Chapter 3 in order to insure equitable service to all passengers. Once minimum standards have been set, enhanced levels of access provision should be set based on current and potential use of the mode at each station.

Improve coordination beyond CTA

Planning is ongoing for projects both within and outside the CTA. It is important that agencies talk not only about their current projects, but also projects that they are thinking about for the future. While coordination is fairly good on projects that are in progress, it can be difficult for other agencies to provide significant assistance or integrate projects because budgets are limited and resources are usually committed to projects long before they actually commence.

¹³ Cumberland, Forest Park, Linden and Skokie have park and ride modes shares of 30% or more.

5.4 STATION AREA OVERVIEW

Physical Characteristics

Chicago generally follows a very strict grid pattern, but at Jefferson Park the grid is disrupted by the Kennedy Expressway (Interstate 90); Metra and Union Pacific tracks; and N. Milwaukee Avenue, complicating travel. The Expressway creates two distinct neighborhoods within 1/4-mile of the station.



Figure 5-2 Map of Transportation Corridors in Jefferson Park

Jefferson Park has a single center-platform design. The platform is partially covered and sits in the median of the Kennedy Expressway, which runs in a depressed corridor. Jefferson Park station is located at ground level with stair, elevator and escalator access down to the platform. The main station area floats above the platform in the middle of the Expressway. The commercial district and bus terminal are located

adjacent to the station along Milwaukee Ave to the west of the Expressway. A passageway provides access from the commercial district and bus terminal by burrowing through the embankment supporting the Metra tracks above ground level. There is no direct entrance from the transit station to the residential neighborhood to the east of the station.

N. Milwaukee Ave and W. Lawrence are the two main thoroughfares in the area. W. Ainslie provides additional vehicle access across the Kennedy Expressway and W. Higgins provides access from areas northwest of the station. On and off-ramps from the Expressway are Located at N. Central and W. Lawrence.

Neighborhood Characteristics

N. Milwaukee Ave. and to a lesser extent, W. Lawrence and the Northwest Highway are the major commercial and

business oriented streets in the area. Residential neighborhoods fill the surrounding area.

Residential densities are range from 10-25 DUA. In 1996, the median household income was estimated at \$42,324, consistent with the surrounding middle class neighborhoods of Chicago.¹⁴

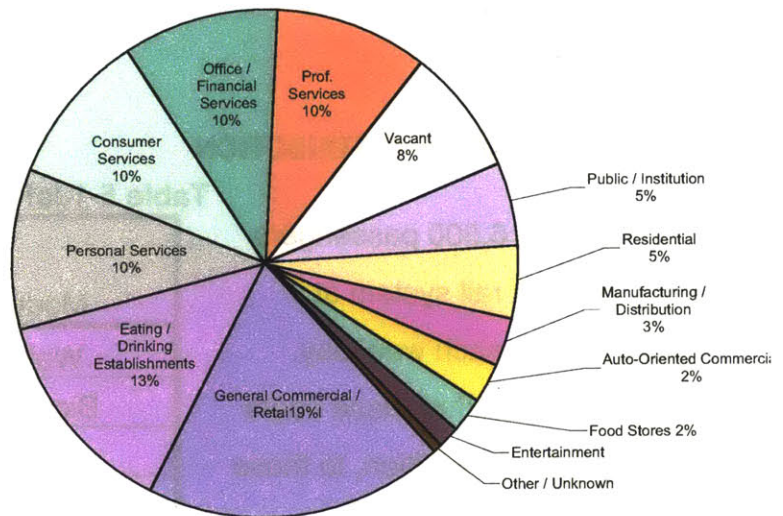


Figure 5-3 Jefferson Park Commercial Land Use Distribution

The shopping district south of the Expressway is comprised of small pedestrian oriented storefronts adjacent to the sidewalk. The shopping district has struggled recently as more people have chosen to shop at the larger shopping malls within the city and out in

¹⁴ The study area comprised a 4-square mile area centered on the rail station.

the suburbs. There still remains a large variety of shopping opportunities, as can be seen by the land use composition breakdown along the commercial corridor shown in (Camiros).

For the most part, buildings in the Jefferson Park commercial district are one story and have glass fronts. Just south of the station is the Veterans Square Plaza, which has small commercial spaces, seven-stories of office space and underground and surface parking. The Northwestern Business College, located two blocks from the station is expanding from its current enrollment of 900 up to 1500.

The character of Milwaukee Ave changes dramatically as one proceeds north across the Expressway. Milwaukee Ave widens from 45 feet to 80 feet and auto-oriented businesses predominate. Most front doors are set back from the street to allow for parking in front of the building.

5.5 ACCESS MODE DISTRIBUTION

Approximately 6,500 passengers board the CTA rail system at Jefferson Park each weekday. About 50 percent¹⁵ of these riders come by bus. In addition, to those transferring from bus to rail, passengers also use Jefferson Park to transfer make bus-to-bus transfers.

Table 5-1 Jefferson Park Station Access by Mode

Mode	Mode Share (%)	Access Trips Total
Walk	25	1,600
Bicycle	0.3	19
Bus	50	3,250
Drop-off	18	1,200
Park and Ride	7	450
Total	100	~ 6,500

¹⁵ 45% in March 2001 (Czerwinski), 52% in May 2002 (O'Malley)

Based on estimated ridership from other modes, 25 percent or about 1,600 passengers per day walk to the station. This agrees with the *1995 Passenger Travel Survey*, which had 22 percent of Jefferson Park passengers walking to the station. It is believed that 40 percent of these pedestrians come from the eastern side of the Expressway¹⁶ and 60 percent traveled from western areas or cross the Expressway at Ainslie.

This station has no parking directly associated with it although there is a parking garage associated with Veterans Square Plaza that has a sign advertising “Park and Ride” that is used by 60-80 CTA riders a day (Estimation by attendant). The \$7 daily fee is paid to a station attendant as a customer exits the garage. There use to be monthly rates but those have been discontinued. Metered parking dominates the limited on-street parking. There are a significant number of private lots in the area and it is unknown how many of these allow commuters to use their lots either for free or by renting them. The residential neighborhood to the east of the Expressway has on-street permit parking within 1/4 mile of the Metra Station, but not on the west side.

The *1995 Passenger Travel Survey* estimated that 13 percent of passengers in the AM period drove to the station, with a smaller proportion driving during the midday. In 1994, the Veterans Square Plaza parking garage had opened, but the office tower had not been built. It is expected that some of the parking that was being used by commuters has since been transferred to employees of the office building as suggested by the fact that monthly parking passes are no longer available. In addition, 25 parking spaces along Veterans St. which had illegally been used by CTA passengers and employees were converted to 2-hour meters, eliminating the park and ride scenario (Nadig, “Parking”). An estimate that 7 percent, or 450 passengers per day park and ride at this station seems more likely.

¹⁶ 27 of 261 passengers leaving the station during 15 minutes of the evening peak used the escalator up to the inbound Metra platform. (12/12/02)

The *1995 Passenger Travel Survey* estimated that 10 percent of passengers were dropped off during the morning. After surveying the station area, it is believed that more passengers that are dropped off at the station since 24 passengers were seen being dropped off at one of the two drop-off areas during a 15-minute period in the morning peak period. It is believed that the number of passengers being dropped off is 18 percent, or 1,300 passengers per day.

Surveys of the bike facilities have shown that 19 people per day, or 0.3 percent of rail users bike to the station. Although this is a small proportion of riders, Jefferson Park has the fourth highest bicycle use throughout the system (Young).

5.6 ACCESS CONDITIONS BY MODE

The purpose of this section is to analyze the current station conditions to determine what areas are in need of improvement. The framework developed in Chapter 2 is used. Access for “All Modes,” pedestrians, bicycles, bus and drop off are analyzed attribute by attribute. A summary of park and ride conditions is included although the CTA does not operate parking facilities at this location. Summaries of the current or expected provision of each design feature can be found in Appendix A.

The term the “bus terminal” is used to describe the general area between Milwaukee Ave and the station entrance. “Bus space” is used to describe the space that is designed for use by buses only. This encompasses the concrete pad that covers the bus terminal other than the areas raised by curbs such as the walkway along the edges and through the middle, the planted berms along Milwaukee Ave and the raised waiting islands at each of the bus bays. The bus drive includes the bus-only road south of the station beyond the fenced in area. None of the bus space is supposed to be used by pedestrians or private vehicles.

All Modes

The “All Modes” analysis focuses on pedestrian walkways connecting from Milwaukee Ave to the station. Connectivity issues from the areas surrounding the station are also discussed in a broad sense.

Safety

The main safety concern at Jefferson Park is the fact that people walk through the bus space to walk from the street to the rail station. This is a concern because neither the pedestrians nor buses follow specific travel routes and have seemingly random travel patterns, making it difficult for pedestrians or bus drivers to anticipate where to expect each other. This is especially troublesome during the peak hours when bus traffic is heavy and in the evening when the bus terminals are poorly lit, making it difficult to see pedestrians.



Figure 5-4 From Milwaukee Ave. Toward Station Entrance

The bus terminal provides bus riders with direct access but blocks direct access routes for many pedestrians. Although the walkways provide safe pathways, pedestrians consider them indirect because they must travel the two perpendicular legs of a right triangle, instead of taking the hypotenuse. A break in the wrought iron fence encircling the station allows passengers to take the most direct route through the bus area, which often appears to be a clear path. Although the path seems clear, the high volume of

buses using the station means that there is likely to be a bus entering or exiting while a person tries to cross through the area. There is signage at the station that tells people to stay out of the bus terminals, but it is not very large and has been difficult to enforce. As can be seen from Figure 5-7 and Figure 5-8, pedestrians take the most direct route through the bus terminal. This is one of the major design issues with the station. These areas need to be redesigned to discourage pedestrians from cutting through.



Figure 5-5 Sidewalk Along North Station Boundary (From Milwaukee)



Figure 5-6 Walkway From Station Entrance to Lipps Ave.



Figure 5-7 People in Distance Cut Through Bus Space (NW From Station Entrance)



Figure 5-8 Person Cuts Through South Bus Space (From Milwaukee Ave.)

The open design of the bus terminals provides good sight lines and few dark corners but also creates a large dark gap in the street wall. Adequate lighting is provided below the covered walkways but the area is otherwise dark at night. Lighting along Milwaukee Ave is focused on the street. Due to the location of the platform, the station attendant is

not able to monitor what goes on outside. From 5 AM to 10 PM a bus supervisor monitors activity in the bus terminal. There are some concerns with vagrants who sleep at the station. Charlie Crump, a landscape architect working in the area believes that the shrubbery on the embankment of the Metra tracks provide shelter for this group.

Directness

The fact that the alignment lies in the Expressway median makes accessing this station a challenge. A bridge has been built from the median station over the southbound traffic (Figure 5-9). The bridge then tunnels under the Metra tracks, which are also supported over the Expressway. This passageway is designed to feel like part of the station and provides space for the ticket machines and a community information board, making passengers feel like they've entered the station when in reality they still have to walk 200 feet to reach the paid area. Stairs and escalators connect the passageway to the Metra tracks, making it easy to transfer from Metra to either CTA bus or rail. While it is useful that this connection has been made, the station entrance is still set back 260 feet from N. Milwaukee Ave and only provides access at one point, requiring users coming from all other directions travel around to this location, which can be very circuitous.



Figure 5-9 From Walkway Under Metra Embankment Toward Station



Figure 5-10 From Station Entrance Toward Milwaukee Ave.

The bus terminal fills the space between the rail station entrance and N. Milwaukee. A walkway breaks the bus terminal into a northern and southern section, which provides a

direct connection between the station entrance and the street (Figure 5-4). Another walkway wraps around the northern boundary of the bus terminal to the station entrance and continues along the retaining wall to Lipps. Ave. (Figure 5-5 and Figure 5-6) Signs are located along the passageway directing people to local streets; the Metra platforms; and listing which buses use each of the terminals. The station design is fairly straightforward and directs people to the main entrance.

Weather Protection

Jefferson Park provides a variety of weather protection accommodations. The actual station in the Expressway median is heated during the winter although the platform is not enclosed. The passageway connecting the station to the bus terminal is enclosed except at the bus terminal. Radiating heating elements, which heat directly below them but are not designed to heat the surrounding air, are provided at the entrance to the passageway so that passengers can stay warm while being able to see outside.

An overhang provides protection across about two thirds of the walkways leading to the station, allowing passengers to transfer between bus and rail without getting wet. The plaza at the tip of the central walkway is not covered but has trees, allowing people stand and absorb the heat of the sun. Two 10 by 20 foot bus shelters provide protection from the wind and rain and also have heating elements that can be turned on for short intervals by pressing a button, similar to those at the entrance to the passageway. Potentially, the entire bus terminal could be enclosed providing weather protection from the street into the station, but this would require ventilation for bus exhaust and additional lighting for both day and night. Unless this was done as part of a commercial development, enclosing the bus area does not make sense.

Supportive Details

There is no signage announcing that the station is in fact the Jefferson Park CTA rail station and bus terminal. The CTA logo on the side of the buses is the only mention of

the agency's presence. Still, the station is considered to be a landmark in the community (Crump).

Little information is provided about the surroundings. There are few major trip attractors at Jefferson Park, which makes placing commercial buildings on a station area map difficult. Northwestern Business College is the exception to this. The Chamber of Commerce could post a business directory at the station informing people of local commercial opportunities since they are more able to follow the changing commercial landscape.

A food counter within the stationhouse serves hot dogs and snacks and there are many other commercial opportunities surrounding the station. The community is supportive of the architectural design and scale of the station. Artwork or panels describing the history of the neighborhood would help to spruce up both the tunnel under the Metra tracks and the walkways bordering the bus terminal.

Pedestrians

Pedestrian access will look at the network of walkways and sidewalk connecting to the station and the crossing of Milwaukee Ave. The pathways within the bus terminal are not discussed as they are included in the All Modes analysis.

A number of pedestrian passageways have been developed in this area to create direct routes to the station area (Figure 5-11). For people coming from the east, a pedestrian bridge connects the corner of W. Argyle to the eastern Metra platform from which the CTA can be accessed. For passengers coming from farther north, a second staircase just south of the Metra stationhouse also connects to the eastern platform, which then connects to the CTA passageway. While these access routes are crucial for pedestrians walking from east of the Expressway, they are minimal in their design.

A pedestrian path connects W. Edmunds St. to N. Milwaukee for pedestrians walking from the area between Gale and the Expressway. A tunnel runs from just south of the Metra stationhouse to N. Milwaukee at the southeast corner of the bridge over the Expressway providing a pedestrian crossing from one side of the Expressway to the other. A staircase leads from this tunnel to Metra's western platform. While this tunnel is not a major primary path for CTA passengers, it provides the fastest access for wheelchair passengers coming from the eastern neighborhood.

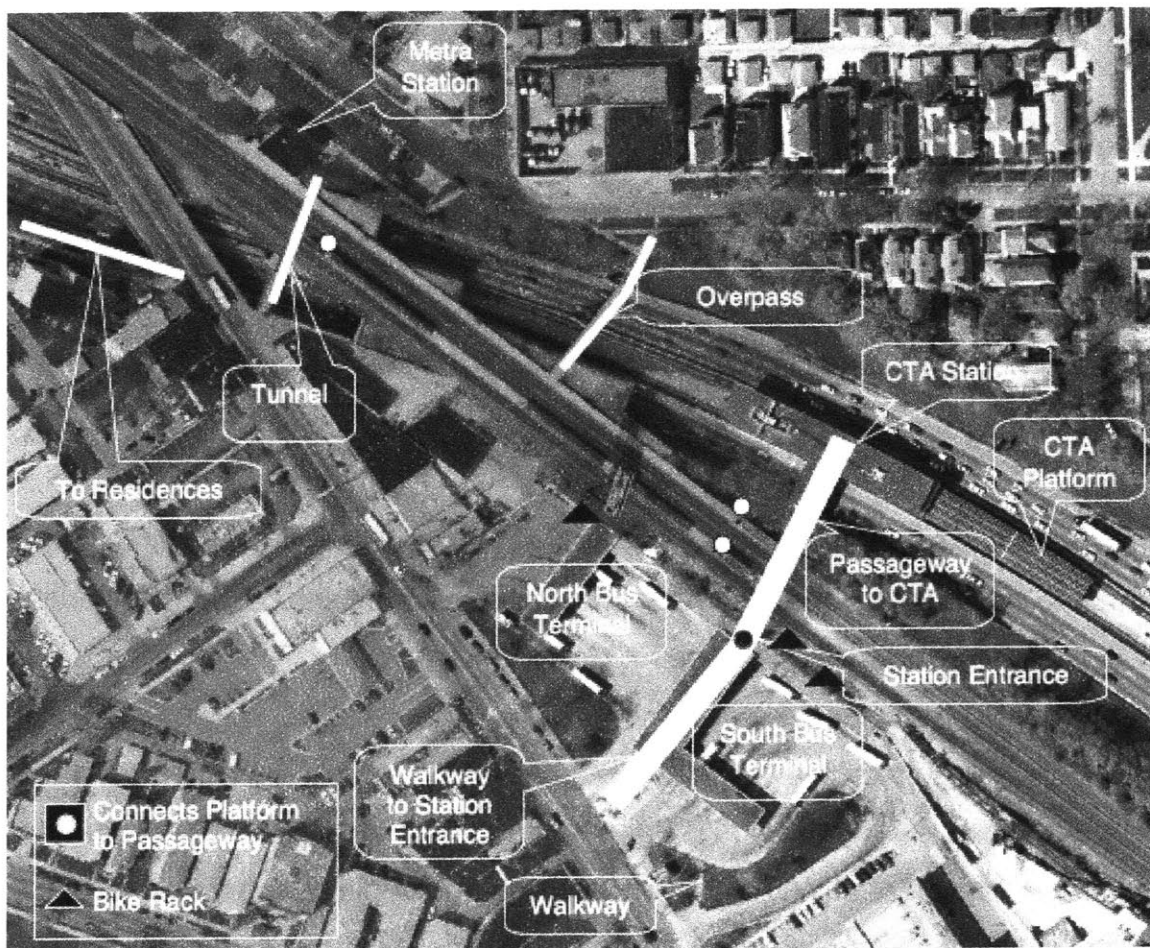


Figure 5-11 Map of Access Corridors

Safety

The sidewalk infrastructure around the station is robust with most sidewalks at least 8 feet wide including at least 6 feet of walkable space and the additional space used for street amenities and buffer space. The sidewalks are smooth even. There are a few

areas that need improvement. Sidewalks included on the bridge section of Milwaukee Ave as it crosses over the Expressway north of the station have sidewalks that are only 5.5 feet wide with no buffer. The chain link fence lining the bridge is in good condition. The sidewalks along both sides of Veterans St. are narrow and easy to overlook. Improvements should be made to these sidewalks to encourage their use rather than cutting through the station.

The major pedestrian safety concern beyond the station area is crossing Milwaukee Ave. Although there are two crosswalks near the station at Gale Street and Higgins approximately 430 and 350 feet from the central station walkway, pedestrians tend to cross somewhere in between. Pedestrians were seen crossing mid-block at a rate of 100 pedestrians per hour during one morning rush hour. Vehicle traffic was 1170 vehicles per hour northbound and 760 southbound. It is difficult to time these lights together because the Higgins/Ainslie/Milwaukee intersection is much more complex than the Gale/Milwaukee intersection. According to the MUTCD Warrants 3 and 5 this location is not appropriate for a traffic signal because of the proximity of the other lights and the pedestrian flow is not quite high enough. While a traffic signal is not appropriate, some emphasis should be placed on the fact that pedestrian traffic is high.

While many pedestrians are not willing to go out of their way to cross at designated crossing locations, there is currently no marked crosswalk in front of the station. Creating a significant crossing adjacent to the main station entrance would provide additional protection for people desiring a designated crossing location. The more prominent is, the more likely to attract users who might not otherwise walk out of their way for a crosswalk. Bulb-outs, a raised crosswalk, textured surface, and in-street flashing pedestrian lights would create an appealing crossing location that would warn drivers of the potential for pedestrians. If a raised crosswalk were used, one would need to be sure that a bus could handle the bump as it turns into the station.

Security

Jefferson Park is considered a fairly secure neighborhood with low crime rates. Milwaukee Ave has a strong street wall but unfortunately, most businesses are only open into the early evening and the area is quiet at night. Lighting focuses on the street although storefront signs provide some additional albeit colored lighting. The pedestrian-only passages are isolated from any surrounding activity and have corners where potential attackers could hide.

The pedestrian tunnel running from Milwaukee to the Metra station is particularly bad. Although the tunnel is short at 185 feet, there is a slight turn 28 feet from the eastern end, which prevents people from being able to see from one end to the other. The stairway up to the rail tracks also provides a potential hiding place. While sufficiently bright, the yellow tint of the sodium vapor light is unpleasant and the paint on the walls is peeling. This tunnel is included in current station area improvement plans.

Another area where security could be improved is along Lipps Ave. Additional lighting should be provided along the east side to provide light along the sidewalk on this dark and isolated street.

Directness

The issue of directness is a complex one. As mentioned earlier, there are a number of pedestrian pathways in and around the station, making an otherwise frustratingly long walk a little less tedious. Still a walk from the corner of West Strong Ave and N. Lockwood Ave is a 1400-foot trip even though a person can see that the platform is only 200 feet away. A direct connection to the eastern side of the Expressway would help improve connectivity but would be extremely expensive, especially considering only about 650 people per day currently walk from this direction¹⁷. Because of the configuration of the station headhouse, the internal uses would need to be redesigned

¹⁷ This number represents the people who currently use the Metra bridge to cross from the east. Additional patrons may walk down to Ainslie and then come north on Lipps.

to provide a connection from northwest of the station, closer to the Metra station and more heavily trafficked residential streets. Otherwise the connection could be made the corner of N. Laramie Ave. and W. Gunnison St.

Weather Protection

While providing weather protection for pedestrians is not easy, Milwaukee Ave provides a fairly consistent street wall that provides some protection from wind. The transit center and parking lots north of Higgins provide the major breaks. Facade designs vary throughout the district. Some stores have awnings, others have articulations that create a bit of overhang and others provide little shelter.

Supportive Detail

Jefferson Park has an ideal land use mix for a transit station. Densities are not high, averaging approximately 10 DUA, although slightly higher to the west of the station. The commercial area, while struggling, provides a wide range of opportunities as described in the neighborhood characteristics section. Increasing residential and business densities within the commercial areas of the neighborhood would benefit transit and also help the retail community.

Bicycle

There are bicycle racks located along the retaining wall under an overhang. Bike parking was expanded from 18 to 30 spaces late in 2001, with an average of over 19 bikes per day using the station since the additional racks were installed (Young).

Safety

Lawrence east of Milwaukee Ave has the only bike lane in the area although the Milwaukee, Central and Higgins have wide shoulders, which provides space for safe biking. The road conditions are generally smooth along the shoulder and not interrupted by multiple manhole covers or cracks from street work.

Security

The bike racks are located within site of the bus supervisor. While his job is not to watch the bikes, he is able to keep his eye out for any suspicious behavior, discouraging theft or vandalism. Bike lockers would provide additional security and weather protection. They would also allow bikers to keep a few supplies such as a helmet, water bottle or change of clothes at the station. There is plenty of space under the overhang adjacent to the racks. Bike lockers are just over 6 feet deep, leaving 14 feet of walkway free for pedestrians.

Directness

The bike racks are located along the station entrance wall but beyond most of the bus traffic. There is considerable sidewalk width remaining to provide clear access for pedestrians walking south. Cyclists can bike into the periphery of the bus area to park their bikes and then walk directly to the station entrance, with little interference with either bus operations or pedestrian access to the station. Their obvious locations make them easy to find and reminds people that they are available. No bicycle provisions are made at the Metra station to the east of the Expressway. Cyclists coming from the east must travel around to find secure bike parking.



Figure 5-12 Bike Racks South of Station Entrance

Weather Protection

The overhang provides some protection for the bikes but enclosed or indoor parking would be better. Indoor racks could be located along the passageway to the station and lockers could be placed next to the racks. If racks are placed inside the station, there is a higher likelihood of conflicts between bikers and pedestrians from bikers trying to ride as close as possible. Bike lockers adjacent to the current racks are recommended.

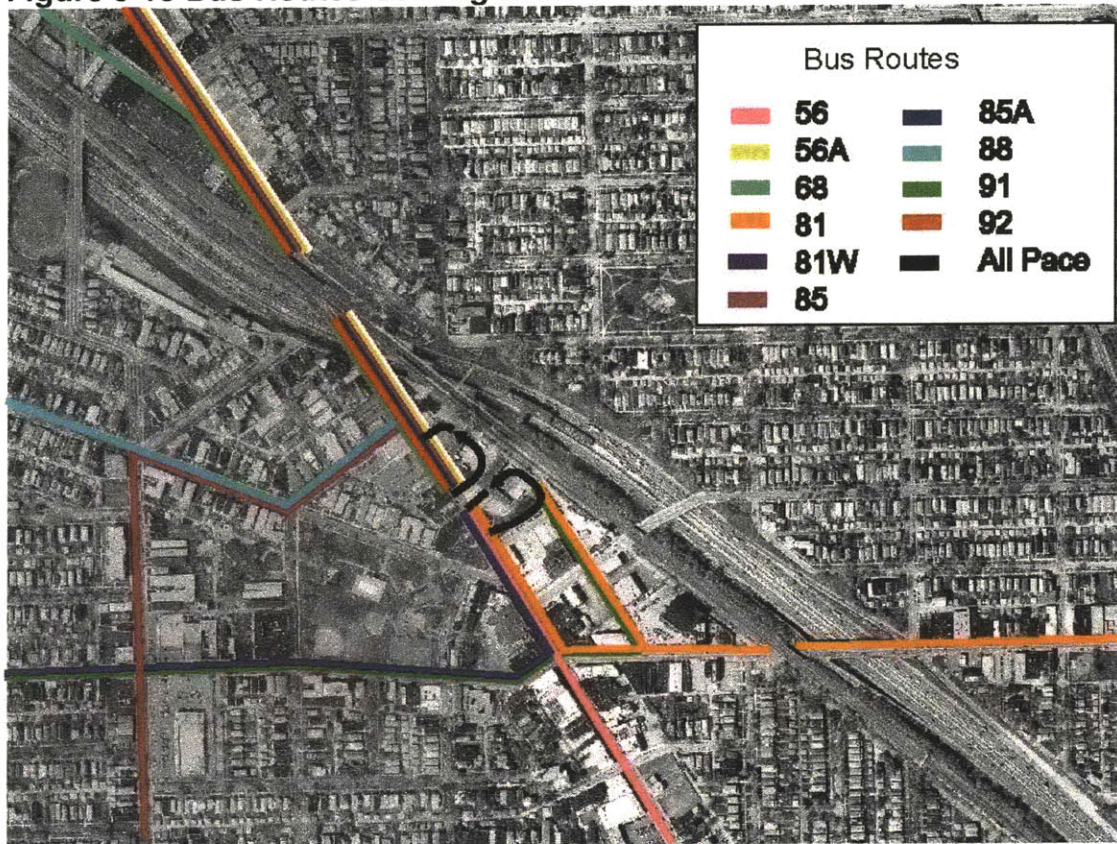
Supportive Details

There are currently no bike services at the station, and it is likely providing any would require additional bike patronage. Bike information such as pamphlets about local bike routes, stores and clubs could be provided either in a poster format or available for people to take. These pamphlets would need to be updated and replenished periodically which would require a small effort.

Bus

The station is served by 10 CTA bus routes and 3 buses run by the suburban bus agency, PACE. During peak periods over 80 buses per hour use the station. The large volume of buses and the need for layover space for routes terminating here require that the bus terminal be large. While it might be possible to reduce the depth of the terminal slightly, most of the space is used. To provide space for pedestrians and people waiting for the bus, the bus terminal has been broken into two separate bus spaces. Buses traveling from the North travel down N. Milwaukee Ave, under the highway and rail tracks or travel from Higgins to Gale to N. Milwaukee Ave. and use the north bus terminal. From the south, buses travel up Milwaukee except for the 81 and 91, which enter from Lipps and exit the south bus terminal via N. Milwaukee. All routes except for the 85 terminate at Jefferson Park.

Figure 5-13 Bus Routes Serving Jefferson Park



Safety and Directness

The bus station layout has attempted to provide safe passages within the bus space. As mentioned before the bus terminal is broken in two with a northern and southern terminal. While both have the same design, their orientation is offset by 90 degrees. The bus areas are designed with separate passenger drop-off and pick-up locations. Buses enter the terminal and drop passengers off along the adjacent walkway and then pull into a bus berth. Dropping passengers at the walkway allows them to walk directly into the station without having to cross in front of other vehicles and allows those buses that are not making another run to pull out of service. Buses continuing in service pull into a bus berth dedicated to that route. Passengers are supposed to walk from the walkway along the bus bays to the walkway and then make a 90° turn towards the station entrance as the man in Figure 5-14 is doing. Unfortunately many passengers

prefer walking directly across the bus terminal to the station entrance in the way of incoming buses as is being done by the two women in Figure 5-7.

Potentially, the bus bays could be rotated or staggered with the “outside” bay, the one closest to the pedestrian walkway, placed closest to the entrance. This would create a diagonal walk radiating from the station entrance. Staggered bays may prohibit drivers and pedestrians from seeing each other approach. Another option might be to create longer bus bays that would allow multiple routes to line up head to tail. Extending the bus bays would provide secure crossing locations closer to the station. Capacity analysis of these options would need to be completed in order to make sure that the high levels of bus traffic could be accommodated.



Figure 5-14 Man Using Walkway Across Bus Bays



Figure 5-15 Crowded Bus Bay

Another concern with this design is the size of the bus islands, although many passengers wait on the main walkway for their bus to arrive, the islands can get crowded with as few as 11 passengers as is shown in Figure 5-15

Supportive Details

Bus schedules are not coordinated to rail service. Although both provide frequent service during the day, buses that run less frequently than every 20 minutes should be matched to the rail schedule to reduce waiting times. Bus schedules are posted at the terminal, allowing people to shop at the local stores if they have time. The majority of buses leaving Jefferson Park should be on schedule since it is the beginning of their route.

Drop-Off

Jefferson Park does not have a dedicated drop-off facility although many people access the station this way. Milwaukee Ave right in front of the central walkway and the parking spaces just to the north are a popular drop off location. The road widens at this point from 45 to 60 feet allowing vehicles to pull out of traffic. There are parking meters along this block, which prevent people from parking all day. At least during the morning peak, they are not used; leaving the area open for drop off's to occur. Some passengers are

also dropped off across the street and then jaywalk across Milwaukee to get to the station.

A second area that is used as a drop off zone are the parking spaces perpendicular along Veterans St. between Lipps Ave and Milwaukee, just to the south of the station. Until recently, the 15-minute parking zone had been used by long-term parkers but was difficult to enforce (Nadig, "Parking"). The new 2-hour meters provide adequate disincentive for long-term parking and now serve people waiting to pick up passengers and those running quick errands at the adjacent shopping center.

Safety

Passengers dropped off northbound on Milwaukee only need to cross the bus driveway and are then protected all the way down the walkway to the station entrance. Those passengers dropped off on Milwaukee southbound have to negotiate the street crossing without a right of way. Passengers using the parking area along Veterans St., use the sidewalk along the southern edge of the station. The intersection of Lipps Ave and Veteran's place can get congested as people maneuver in and out of the shopping center and wait for passengers. Traffic speeds are slow which reduces the chance of injury. Nevertheless, making this road one-way and placing signs directing people to move out of the way would help clear up some of the congestion that occurs at this location. Improving the sidewalks, widening the bulb at the end and creating a crosswalk would help to focus pedestrian paths.

Security

The lighting near both of the drop off areas is poor, but waiting passengers can see these areas from within the station can come out and meet their ride when it arrives. The Milwaukee drop of area is more secure because it is more closely connected to the bus terminal.

Supportive Detail

The curb just south of the station entrance is set up as a taxi stand during the morning and evening peaks. While there were generally 2-4 taxis queued, no passengers were seen taking rides. The high level of bus service and lack of major business developments around the station do not make it a good candidate for private shuttle services.

5.7 FINAL RECOMMENDATIONS

In the late 1990's there was a push by the city and local business groups to "improve" the district. Two plans, the 1996 Visioning for Transit Supportive Neighborhood Revitalization Case Study of Jefferson Park and the 1997 Jefferson Business District Improvement Plan looked at ways to reinvigorate the neighborhood and included new designs for the transit station. A Tax Increment Finance (TIF) district was set up as an outcome of these efforts. Both plans recommended placing retail buildings along Milwaukee Ave, and significantly redesigning the bus terminal. One design suggested placing it in a tunnel.

There are currently a number of projects going on around Jefferson Park. DPD has sponsored a streetscape improvement project to help invigorate the commercial district. Working with the community and Jefferson Park Chamber of Commerce, it was decided to focus on improving the green space at the transit station using all of the \$75,000 in available TIF money. As a separate project, Metra had been in the process of spending \$2.7 million to make their station ADA compliant, rebuild the station headhouses and improve their parking lot. Glenn Nadig, publisher of Nadig Newspapers and a member of the Chamber of Commerce board of directors, pulled together the leaders of the various projects proposed for the area during a chamber meeting in the winter of 2001.

This meeting prompted Alderman Levar to work with Representative Lyons to secure \$2 million of "Build Illinois" funds from the Department of Commerce and Community Affairs. A single architect was hired to work on an integrated landscape plan for this

area, which will include improvements to the pedestrian tunnel, streetscape enhancements at the Metra parking lot and along Milwaukee between the Metra tunnel and the end of Gale Ave that abuts the CTA bus terminal. Additional landscape work will be done to the grass knolls and plaza in front of the CTA station.

The CTA through both the department of intergovernmental affairs and planning department is working with DPD, Metra and the architect to make sure that the work will not negatively affect its bus operations. This interaction appears to this author to be more of a preventative check than collaboration. The CTA should work proactively with the architect to see if a plan can be developed that would discourage the use of the bus space as a cut-through. Planting larger bushes or creating a higher berm at the southwest corner where the opening in the fence is now would create a barrier that would block the sight line to the station entrance that makes the cut through attractive. A station identifier at the south-west corner of the station would make up for the blocked view by announcing the stations presence.

The author believes that the additional funding procured by Representative Lyons was possible because the community had shown an integrated approach by combining Metra improvements with redevelopment. While communication has occurred, if the dialogue had occurred earlier, more elements could have been included.

The CTA, who has Jefferson Park Station on the their top 10 list for facility improvements, is not actively integrating their needs into the area redevelopment plan. Needs that CTA has identified for their station include widening the bus bays, improving lighting and repaving the bus terminal (Fahrenwald). No explicit plans have been made as to how and when this project will be funded although it is expected to occur within the next 5 to 10 years.

The following improvements have not been included as a part of the current project: Improving Milwaukee Ave where it passes under the rail tracks. The pedestrian bridge

connecting W. Argyle to the transit station should be rebuilt. Bike lockers could have been incorporated into the station improvements adjacent to the current racks.

Changes should be made to improve the circulation at the drop off area at Lipps and Veterans St. The sidewalk adjacent to Veterans St. should be improved to encourage people to use this walkway to access the station. Streamlining circulation and marking pedestrian crosswalks would help to clarify the use of the space.

Had the CTA had more warning about the work, they could have secured funds to do some of their larger projects at the station in coordination with the DPD and Metra projects. Potentially, the CTA can coordinate its work with CDOT's streetscape renovation to improve the drop off facilities, the Milwaukee Ave crossing and find another configuration for the bus terminals to decrease bus vs. pedestrian conflicts. Hopefully the landscape work that is going on now won't eliminate potential solutions. Working on a problem all at once, provides the opportunity to air all the desired outcomes and leaves the most flexibility in finding a solution that maximizes all areas of concern.

In conclusion my list of projects would be as follows: (in descending order of importance)

1) Prevent Pedestrian Access Through Bus Space.

- ***NORTH TERMINAL***
 - Narrow the bus terminal's exit.
 - Create a more "solid" corner by elevating and enlarging the berm and adding thicker vegetation.
 - Widen the sidewalk along Gale St.
 - Place low attractive railings along walkways adjacent to the station entrance.
- ***SOUTH TERMINAL***
 - Block cut-through at southwest corner.
 - Fix fence and place bench or large station plaque at this area with thick shrubbery behind.
 - Improve sidewalks along Veterans Street.
 - Place low attractive railings along walkways adjacent to the station entrance.

2) Create crosswalk adjacent to central walkway.

- Add bulb-outs to both sidewalks. (This will require removing a parking space from the southbound direction.)
 - Create a raised crosswalk/table across Milwaukee Ave. (Insure it does not interfere with bus activity.)¹⁸
- or**
- Install in-street flashing pedestrian lights.
 - Locate significant station identification marker at head of walkway.

3) Improve traffic flow and activity at the corner of Lipps Ave and Veterans Street.

- Make Veterans St. one-way westbound.

¹⁸ It should not interfere with bus turning because they turn before or well after this location.

- Enlarge island at the west end of the Veterans St. parking strip.
- Add benches and shelter and lighting.
- Add crosswalk from sidewalk to walkway adjacent to station.

4) Install 8-12 bike lockers adjacent to current bike racks.

5) Improve lighting

- Along Lipps Ave.
- In the bus space.
- Along Milwaukee Ave. under the Metra tracks.
- For all pathways.

6) Add art and/or local historical information to passageway and walls along embankment.

7) Improve or replace walkway from W. Ainslie Ave. to Metra Platform.

8) Add a direct connection from the CTA station to the east side of the expressway.

9) Provide real-time bus information.

Chapter 6 Conclusion

This chapter generalizes the key concepts that were highlighted by the San Juan and Chicago design cases. Applying the design and implementation frameworks developed in Chapters 2 and 3 to the design cases provided an opportunity to test these frameworks and reveal key issues and potential pitfalls for improving access to stations that are likely affect many transit agencies as they consider transit access improvements.

The physical landscape plays a large part in determining how people travel to transit and how convenient these trips are; which, in turn, affects whether or not rail transit will be chosen as the travel mode for the trip. In order to improve transit access, the transit agency needs to make sure that the physical infrastructure is as welcoming as possible regardless of what mode is used to reach the station.

6.1 INVOLVING EVERYONE

Fortunately or unfortunately, many different players are involved in creating accessible station areas. The multi-jurisdictional nature of station access means that a wide range of economic and human resources are available for transit access improvements. Unfortunately, many of the responsible agencies, including the transit agency, often consider transit access needs as a “special interest” since transit accessibility is not the agencies’ primary function; transit agencies often focus on train operations and transportation agencies on mobility as a whole.

The degree to which any individual organization has the ability to affect accessibility is based on the scope of its responsibility and the funding available. Equally important in whether or not an agency has the capacity and resources to make improvements, is the level of interest the agency has in making these changes. Since station area design plays a limited role in any agency’s scope of responsibility, it is often ignored and quite frequently station access needs are preempted by other goals the agency may have.

The idea of “livable communities” has become a popular movement in many cities. This idea recognizes that daily activities are affected by the physical landscape and that governmental decisions incorporate trade-offs that may be unintentional or not explicitly recognized. Single-use or low-density developments that require people to drive reduce the amount of exercise and social interaction provided by non-motorized travel, which many consider to be detrimental. Many of the design features that improve transit access are consistent with the objectives of livable communities. Considering the broader consequences to society of a given project provides additional justification for making choices that improve transit access. Agencies are slowly expanding their scope of responsibilities, but transit agencies must still be proactive to make sure that station access needs are considered in any project completed within 1/2 mile of transit.

Since no one agency has all of the expertise needed, coordination between agencies is extremely important. Even when an agency considers or even focuses on station area issues, its limited scope of authority may prohibit it from making major improvements independently.

Working with other agencies is key in making a significant impact on station area access. Common goals, supportive policies and open-lines of communication with regard to current projects and long-term plans are key. By working together, agencies can provide their expertise and resources, providing a larger framework to build from. As can be seen from the Chicago example, one project plus one project can become more than the sum of them individually when additional grant money became available. Although the coordination of the Metra and DPD projects created an impetus for additional funding, coordinating projects that do not receive additional support still makes sense.

Coordinating projects reduces inefficiencies or overlap between projects. Overcoming the inward looking nature and rigid structure of prioritization that epitomize individual government agencies is the largest challenge towards improving station access.

In conclusion:

- All applicable agencies need to recognize the role they play in improving access to transportation.
- A set of standards for transit accessibility should be developed that all agencies agree to support.
- Integrate transit accessible features into other projects, consider the breadth of additional benefits from improvements beyond transit accessibility.
- Agencies need to keep their lines of communication open both for current and potential future projects.

6.2 AGENCY RESPONSIBILITIES BY MODE

Although agencies need to work together, it is imperative that agencies understand what aspects of transit accessibility they impact. The following section highlights elements important to each access mode and which agency is responsible for implementation. Details about each of the elements are included in Chapter 2.

Pedestrian

Directness, safety and land use have the largest impact on the decision to walk. Walking to transit is an option for a limited zone around transit due to the slow speed of this mode. Providing infrastructure (sidewalks, crosswalks, ect.) for people to reach the station safely reduces the amount of effort that needs to be spent on staying out of harm's way. Travel origins and transit stations need to be located close to each other and have direct travel routes connecting them to reduce speed constraints. The following improvements should be made to facilitate pedestrian access:

Planning Department

- Allow higher density development adjacent to transit.

- Reduce parking requirements for development near transit.
- Allow only minimal setbacks for commercial development.
- Encourage mixed-use development.

Department of Transportation or Public Works

- Provide safe sidewalks.
- Ensure safe street crossings to station.

Transit Agency

- Place station entrances conveniently for walkers.

Bicycle

Safety, security and weather protection are the principal physical design attributes that effect people’s use of bicycling. Adequate on-road provisions are needed to make people feel safe riding to the station. A secure place to leave a bike is necessary if people are going to bike to transit. Sheltered bike parking increases the likelihood that people will bicycle even in adverse weather conditions. The following elements improve bike access to transit:

Transit Agency

- Provide secure, visible and sheltered bike locker or rack.
- Supply benches and restrooms.

Department of Transportation or Public Works

- Develop a network of bike lanes or other safe on-street biking facilities.

Bus

Routing, frequency and reliability are the most important factors in whether people will choose to take the bus to or from transit but security, directness, weather protection and transfer information also contribute towards improving trip continuity. Integrating bus

stops into rail stations is important because it allows for improved surveillance, weather protection and directness. Bus stops at stations should:

Transit Agency

- Eliminate the need to cross the street from the rail station to bus stop
- **or**
- Provide a safe and convenient street crossing.
- Provide accurate schedule and route information.

Drop-off

The decision to be dropped off at a station is less affected by the physical design than other modes. Drop-off locations should be designed so that they do not block bus stops, crosswalks or vehicle travel lanes while waiting to pick up passengers, obstruct other access modes or tie up traffic. Creating a designated drop-off location makes it easier to provide amenities for drop-offs and decreases the likelihood of errant vehicles.

Transit Agency or Department of Transportation

- Provide adequate space.
- Include a phone booth.

Park and Ride

Parking availability, direct vehicle access and security concerns affect whether a person will park and ride at a station. In order for a person to park and ride, all-day parking must be available and secure enough that a person does not have to worry that their car may be stolen or vandalized. If the station is in a congested area or does not have direct vehicle access, people will choose to drive to another station instead. For stations that are likely to attract park and ride users designated park and ride facilities should be provided or there is a good chance of drivers parking in unmarked on-street locations, which can be problematic in residential and commercial neighborhoods. For stations where substantial amounts of parking are provided, security can be a major concern.

Large parking facilities, both surface lots and to a greater extent parking garages can be isolated since they create very little activity. It is important to design parking so that it is well lit and open to maximize surveillance. Parking facilities should have the following attributes:

Transit Agency

- Provide open and well-lit parking facilities.
- Locate parking unobtrusively.

Department of Transportation or Public Works

- Roadways should be able to support traffic generated by park and ride facilities.

All Modes

Travelers converge by foot on the station entrance as they transition from their access mode to rail. All of the station attributes are important at the station entrance because it serves all passengers, each of whom has varying needs. Some features that will benefit all station users include:

Transit Agency

- Create multiple access points to the station.
- Design stations that are open and intuitive.
- Provide signage
 - Identifying the station from the neighborhood.
 - Directing people within the station to appropriate exits.
 - Informing people about points of interest in the neighborhood.

6.3 CONTRIBUTIONS OF RESEARCH

This paper has sought to provide a framework for station design managers seeking to improve multi-modal access. This research has consolidated the design features that

play a role in the many modes used to access transit and created guidelines for how to prioritize and implement station access improvements in the most efficient manner.

The framework illustrated in this paper draws on the assigned jurisdiction of multiple organizations, including transit agencies, planning and the various departments of transportation. Each of these agencies plays a critical role in some aspect of ensuring ridership safety, security, and comfort. Communication between agencies leading to project coordination is crucial in attaining optimal benefits from capital improvements.

6.4 FUTURE RESEARCH

This research attempted to cover many aspects of station access that are affected by the physical realm. Due to the breadth of material covered, elements listed below were not fully explored. More research needs to be completed on the effects of different station attributes explored in Chapter 2 to determine the degree to which each element is important. This would lead to a better understanding of the actual changes that occur for different projects on both total transit use and transit access mode split, which would help focus resources on projects that provide the most benefit. This research would also be useful for comparing ridership expectations for different extension alignment proposals.

An area of interest that was not discussed in this thesis is the benefits and consequences of different design philosophies regarding station area design. This thesis takes a very traditional approach that requires each mode to have segregated infrastructure, allowing different travelers to focus less attention on their fellow travelers. Another theory currently being tested and implemented in some locations in the Netherlands and Denmark is the idea that individuals will take responsibility of insuring safe travel for all if there is no delineation of space for different modes, allowing space to be used more efficiently. Research should be completed to determine the number and severity of accidents and the ability to process traffic should when there are

different ratios and volumes of various travel modes. Are there differences in effectiveness of the two design theories when pedestrian flow overwhelms automobile traffic or when pedestrians flows are only heavy during certain times of day, such as the morning and evening commute periods.

Bibliography

- AASHTO Task Force on Geometric Design. *Guide for the Development of Bicycle Facilities*. Washington, D.C.: American Association of State Highway and Transportation Officials, 1999.
- Atkins, Stephen T. *Critical Paths: Designing for Secure Travel*. London: Design Council, 1989.
- Bike Gard Bike Locker Systems*. 1996. Bike Gard, Inc. October 2002
<<http://www.ida.net/users/bikegd/>>.
- Bikestation Home Page*. Bikestation Coalition. 24 Oct. 2002
<<http://www.bikestation.org>>.
- Boston Metropolitan Planning Organization. *Boston Region MPO Transportation Plan 2000-2025 Update*. Mar. 2002. 20 Jan. 2003
<<http://www.ctps.org/bostonmpo/resources/reports.htm>>.
- Bravo, Martha. Bicycle and Pedestrian Coordinator, Commonwealth of Puerto Rico. Personal interview. San Juan, P.R. 16 Jan. 2002.
- "Caltrain's Bicycle Program" Caltrain. 20 Nov. 2002
<http://www.caltrain.com/caltrain_bikes2.html>.
- Cambridge Systematics. Regional travel demand forecasting model (unpublished). "Mode of Access Report, G29 Model Run Alternative." 01-29-99.
- Camiros, Ltd. *Jefferson Park Business District Improvement Plan*, Draft. Prepared for Jefferson Park Business District Core Planning Group and City of Chicago Dept. of Planning and Development. [Chicago]: Camiros, Ltd, 1 Dec. 1997.
- Cervero, Robert. "Walk-and-Ride: Factors Influencing Pedestrian Access to Transit" *Journal of Public Transportation* Vol. 3, No. 4, 2001: 1-23.
- Cervero, Robert. *America's Suburban Centers: The Land Use-Transportation Link*. Boston: Unwin-Hyman, 1989.
- Chicago Transit Authority. (CTA) Transit Operations Division; Planning and Development; Service Planning. *Chicago Transit Authority Service Standards*. [Chicago]: CTA, July 2001.
- City of Chicago. Mayor's Zoning Reform Commission (ZRC). *Principles for Chicago's New Zoning Ordinance, Recommendations for Preserving, Protecting, and*

Strengthening Chicago's Neighborhoods. [Chicago]: City of Chicago, May 2002
<<http://www.ci.chi.il.us/Mayor/Zoning/>>.

Crockett, Cordelia Elizabeth. "A Process for Improving Transit Service Connectivity." Thesis MIT, 2002.

Crump, Charlie. Associate, Director of Landscape and Planning, DLK. Personal interview. Chicago. 13 Dec. 2002.

Czerwinski, Dave. CTA Systemwide AFC data including average weekday, Saturday and Sunday boardings by station entrance and Monthly total bus to rail transfers for March 2001. Received September 2001.

Deeming, Eryn. "Growing with Transit: Creating Transit Supportive Development in an Automobile-Focused World." Thesis MIT, 1994.

Estudios Técnicos Inc. *Estudio del Impacto de las Estaciones del Tren Urbano en San Juan*. Prepared for the Dept. of the San Juan Metropolitan Region. San Juan, PR: Estudios Técnicos, 1999.

Farhenwald, Peter. Dept. of Planning and Development, CTA. Personal interview. Chicago. 12 Dec. 2002.

Federal Highway Administration. *Manual on Uniform Traffic Control Devices: For Streets and Highways*. (MUTCD) Washington, D.C.: U.S. Dept. of Transportation, Federal Highway Administration, 1988.

Forester, John. *Bicycle Transportation: A Handbook for Cycling Transportation Engineers*. Cambridge, Mass: The MIT Press, 1994.

Garcia, Louis. Associate Member, Planning Board, P.R. Personal Interview. San Juan, P.R. 23 Jan. 2002.

Hu, Patricia S., and Jennifer Young. *1990 NTPS Databook.: Vol. 1*, Report No. FHWA-PL-94-010A. [Washington, D.C.]: U.S. Dept. of Transportation, Federal Highway Administration, 1993-1994.

Izquierdo Encarnación, José Miguel. "Integration of Mass Transportation Services" Massachusetts Institute of Technology. 12 Oct. 2001.

Jacobs, Allan B. *Great Streets*. Cambridge, Mass: The MIT Press, 1993.

Kruckemeyer, Kenneth. Research Associate, MIT. Personal interview. Cambridge, Mass. 17 Jan. 2003.

- Loutzenheiser, David R. "Pedestrian Access to Transit: Model of Walk Trips and Their Design and Urban Form Determinants Around Bay Area Rapid Transit Stations." *Transportation Research Record* 1604 (1997): 40-49.
- Massachusetts Bay Transportation Authority (MBTA). *MBTA Ridership and Service Statistics*, 8th ed. Boston: MBTA Service Planning Dept., 2002.
- Massachusetts Institute of Technology and Charles River Associates (MIT and CRA). *Mobility 2001: World Mobility at the End of the Twentieth Century and Its Sustainability*. [Conches-Geneva, Switz.]: World Business Council for Sustainable Development, 2001
<<http://www.wbcscdmobility.org/publications/mobility2001.asp>>.
- Mirandez, Javier. "Transit in San Juan." Massachusetts Institute of Technology, Cambridge, Mass. Oct. 2002.
- Mirandez, Javier. "RE: questions." E-mail to Frances Switkes. 19 Dec. 2002.
- Multisystems. *Tren Urbano Feeder Service Plan: Final Report*. Multisystems, Dec. 2000.
- Nadig, Brian. "Parking Meters Installed." *Chicago's Northwest Side Press* 11 Sept. 2002: 1.
- Nadig, Brian. "Developer Responds to Association Letter." *Chicago's Northwest Side Press* 17 Jul 2002: 1.
- National Committee on Uniform Traffic Laws and Ordinances (U.S.). *Uniform Vehicle Code and Model Traffic Ordinance*. 1992 rev. Evanston, IL.: National Committee on Uniform Traffic Laws and Ordinances, 1992.
- National Research Council (U.S.) *Highway Capacity Manual*. (CD-ROM) 2000 ed. Washington, D.C.: Transportation Research Board, National Research Council, 2000.
- Northwest Research Group, Inc. *Traveler Behavior and Attitudes Survey: CTA Riders and Nonriders*, CTA Technical Report MR01-09. Prepared for the Chicago Transit Authority. Boise: Northwest Research Group, July 2001.
- O'Malley, Kevin. Jefferson Park AFC data from May 2002 for both transfers from bus and total boardings and total boardings from October 2002. Received, Dec 17, 2002.
- "Overview." 2002. Regional Transportation Authority. 27 Dec. 2002
<<http://www.rtachicago.com/aboutrta/overview.asp>>.

- Ped Smart*. 1999. Pedestrian and Bicycle Information Center, UNC Highway Safety Research Center. Jan. 2003 <<http://www.walkinginfo.org/pedsmart/plport.htm>>.
- Plan de Ordenación Territorial de San Juan*. (CD-ROM.) Planning Board. San Juan: Planning Board, Oct. 2001.
- Pushkarev, Boris, and Jeffrey M. Zupan. *Urban Space for Pedestrians: A Report of the Regional Plan Association*. Cambridge, Mass: The MIT Press, 1975.
- “Rehabilitation of Constitution Beach, East Boston, Mass” 2000. Metropolitan District Commission. 7 Jan. 2003 <<http://www.state.ma.us/mdc/ConstBeachRehabil.htm>>.
- Replogle, Michael A. *Bicycles and Public Transportation: New Links to Suburban Transit Markets*. Washington, D.C.: The Bicycle Federation, 1983.
- Resource Systems Group, Inc. *Transit Station Renovation and Pedestrian Walkway Survey, Chicago, IL*. Prepared for the Chicago Department of Transportation. [White River Junction, Vt.: Resource Systems Group, 2000.
- RJA Group, Inc. *Tren Urbano Estación Hato Rey: Estudio de las estaciones y sus vecindarios*. Prepared for the Department of Transportation and Public Works. [San Juan]: RJA Group, Oct. 1994.
- Sisiopiku, Virginia, and Darcin Akin. “Pedestrian Perceptions Toward Various Pedestrian Treatments.” Paper presented at the 79th Annual Meeting of the Transportation Research Board. Washington, D.C., 1999.
- Stringham, M.G.P. “Travel Behavior Associated with Land Uses Adjacent to Rapid Transit Stations.” *ITE Journal* Apr. 1982: 16-18.
- United States. Dept. of Transportation.; United States.; Federal Transit Admin..; Puerto Rico.; Dept. of Transportation and Public Works.; Puerto Rico Highway Authority. *Final Environmental Impact Statement: Tren Urbano, San Juan Metropolitan Area, Puerto Rico (EIS)*. Nov, 1995 <<http://www.dtop.gov.pr/TU>>.
- Traffic Advisory Leaflet 07/97: Supply and Demand for Cycle Parking*. Jul. 1997. Department for Transport (U.K.) Oct. 2002 <http://www.roads.dft.gov.uk/roadnetwork/ditm/tal/cycle/07_97/index.htm> .
- Trench, S, et al. “*Safer Cities for Women: Perceived Risks and Planning Measures.*” *Town Planning Review*, Vol. 63, No. 3 (1992): 279-296.
- Vogel, Sharonlee, WMATA, Customer Support, Department of External Affairs. Telephone interview. 2 Dec. 2002.

Vlecides Schroder Associates, Inc and Market Facts Inc. *CTA Passenger Travel Survey: Northwest Corridor*. Prepared for CTA. [Chicago: Market Facts] 1995.

Yaetes, M. and K. Jones. *Rapid Transit and Commuter Rail Induced Retail Development*. [Toronto]: Ryerson Polytechnic University, Centre for the Study of Commercial Activity, 1998.

Young, Kristina. *Bike to Transit Program: Progress Report, Draft*. Chicago, IL: CTA, Nov. 2002.

Zegeer, Charles V., et al. *Pedestrian Facilities Users Guide: Providing Safety and Mobility*, Report No. FHWA-RD-01-102. McLean, Va.: Federal Highway Administration, 2002.

Zeeger, C., J. Stewart, and H. Huang. *Safety Effects of Unmarked vs. Marked Crosswalks at Uncontrolled Locations*, Report No. FHWA-RD-01-142. McLean, VA.: Federal Highway Administration, 2002.

Zipcar Web Site. Zipcar. 2002. Dec. 2002 <www.zipcar.com>.

Appendix A Roosevelt: Physical Analysis for Station Access

All of the individual attribute tables have been combined for each mode. The current or expected condition of each feature has been highlighted. When multiple conditions exist, only the more dominant one is highlighted. Those features that cannot be analyzed because planning and construction have not occurred, have been left blank.

Table A-1 All Modes Design Elements

	Design Feature	Worst				Best
Safety	Maintenance	physically damaged	vandalized, worn		well maintained	
	Mode Conflicts	obviously indirect	inconspicuously indirect		complementary, direct	
Security	Visibility	Lighting	dim, infrequent causing shadows			bright, even
		Station Layout	numerous corners, narrow passageways, barriers			open design
	Surveillance	none, video monitoring	station attendant but not nearby	accessible station attendant	direct surveillance, populated	
	Maintenance	vandalism, dirty	vandalism	dirty	graffiti-free, clean	
Directness	Integration	long, unconnected	direct but separate	short, connected	fully integrated	
	Wayfinding	no signage	some signage	directionally intuitive design	signage, intuitive design, human assistance	
Weather Protection	Shelter	open and exposed	appropriate temperature control for climate, flexible			
Supportive Details	Orientation	Station Identification	unmarked non-descript	visible	system-wide style, recognizable	
		Station Orientation	no connection to surroundings	signs, maps about surroundings	visual connection to surroundings	map and visual connections
	Retail	none	small selection	broad selection		

Table A-2 Pedestrian Design Elements

Design Feature		Worst				Best	
Safety	Pedestrian Space	no vertical separation		curb adjacent to road	small buffer strip	parking lane buffer	
	Street Crossing	Vehicle Flow		high-speed, constant or sporadic	high speed but regularly intermittent	slow, constant	slow, low-volume
		Street Design		multi-lane, two-way	multi-lane, one-way	narrow lanes, pedestrian islands, bulb-outs	
	Traffic Control		none		traffic signals	self-actuated pedestrian signals	automatic pedestrian signals
	Crosswalk Visibility		unmarked	two parallel stripes	ladder crosswalk, additional signage	in-pavement lit crosswalk	raised crosswalk
Security	Visibility	Lighting				infrequent street-focused	pedestrian-scale lighting
		Surroundings				bushes, lack of street-wall or dark "pockets" in façade, poorly maintained	semi-protected but open, well maintained
	Surveillance		quiet isolated areas	potential for reaching assistance, no direct surveillance		active street or transparent street-wall into active spaces	
Directness	Station Orientation		located w/o respect to surroundings	set back from street	connected with pedestrian bridges/tunnels	oriented toward development	integrated into development
	Street Pattern		circuitous street network			fine grid-pattern	
WD	Shelter		open and exposed		buildings to shield wind	awnings, street trees, arcades	
SD	Density		<10 DUA		10-50 DUA	50-100 DUA	> 100 DUA
	Land Use		single-use, auto-oriented		single use, pedestrian friendly	mixed use, auto-oriented	mixed use, pedestrian friendly

Table A-3 Bicycle Design Elements

	Design Feature	Worst				Best
Safety	Facility	narrow lane, no shoulder	wide shoulder, shared lane	bike lane	dedicated path	
	Surface Condition	potholes, sharp debris	dangerous street elements	cracked or mended	smooth	
Security	Infrastructure	no provision	bike rack	bike locker	tended facility	
	Surveillance	isolated	activity center	tended		
Directness	Parking	located away from entrance		near station entrance		
	Pathway	conflicts require walking bike		segregated space up to parking		
Weather Protection	Parking	exposed	under awning	indoors		
	Changing Facilities	none	bench to take off rain gear	shower and locker facilities		
Supportive Details	Services	no services provided	occasional	consistent, dedicated personnel		
	Information	none	bikes and transit	bike/transit and local bike information		

Table A-4 Bus Design Elements

	Design Feature	Worst				Best	
Safety	Mode Conflicts	other vehicles or pedestrians in bus areas			bus area free from unsanctioned traffic		
	Stop Location	no sidewalk adjacent to bus	need to cross street to reach station		no exposure to vehicles, direct path to station entrance		
Security	Waiting Area	isolated, dark	sightlines with active area, well lit		integrated into rail station, employee nearby		
Directness	Stop Location	not oriented to station, level change, across street		requires crossing road	some distance from entrance	adjacent to station entrance	
Weather Protection	Stop Design	open, exposed	building to shield wind	open-sided, covered shelter or building awning	three-sided, covered shelter	indoors, temperature controlled	
Supportive Details	Schedule Coordination	none	off-peak only	all-day coordination	scheduled and real time		
	Fare Integration	separate fare and media		discounted transfer	free transfer	no barrier	
	Retail	none		beyond immediate station area	located to allow surveillance of bus activity		
	Schedule Information	no information	current schedules, routes		real-time information		

Table A-5 Drop-off Design Elements

	Design Feature	Worst				Best
Safety	Drop-off Location	in high volume traffic	not separated from vehicle space	congested, dedicated space	spacious, dedicated space	
Security	Waiting Area	isolated, dark	access to phone	sightlines with active area, well lit	integrated into rail station, employee nearby	
Directness	Drop-off Location	required to cross street or in front of moving/ stopping vehicles		step into street to reach sidewalk	direct connection to station entrance	
Weather Protection	Waiting Area	open, exposed	building to shield wind	open-sided, covered shelter or building awning	three-sided, covered shelter	indoors, temperature controlled
Supportive Details	Shuttle Service	no program	service provided	information available	company support	
	Taxi	no information	taxi phone numbers available		taxi queue	

Appendix B Jefferson Park: Physical Analysis for Station Access

All of the individual attribute tables have been combined for each mode. The current or expected condition of each feature has been highlighted. When multiple conditions exist, only the more dominant one is highlighted.

Table B-1 All Modes Design Elements

		Design Feature				Worst			Best
Safety	Maintenance		physically damaged		vandalized, worn		well maintained		
	Mode Conflicts		obviously indirect	inconspicuously indirect			complementary, direct		
Security	Visibility	Lighting	dim, infrequent causing shadows				bright, even		
		Station Layout	numerous corners, narrow passageways, barriers				open design		
	Surveillance		none, video monitoring	station attendant but not nearby	accessible station attendant	direct surveillance, populated			
	Maintenance		vandalism, dirty	vandalism	dirty	graffiti-free, clean			
Directness	Integration		long, unconnected	direct but separate	short, connected	fully integrated			
	Wayfinding		no signage	some signage	directionally intuitive design	signage, intuitive design, human assistance			
Weather Protection	Shelter		open and exposed	appropriate temperature control for climate, flexible					
Supportive Details	Orientation	Station Identification	unmarked non-descript	visible	system-wide style, recognizable				
		Station Orientation	no connection to surroundings	signs, maps about surroundings	visual connection to surroundings	map and visual connections			
	Retail		none	small selection	broad selection				

Table B-2 Pedestrian Design Elements

Design Feature		Worst				Best	
Safety	Pedestrian Space	no vertical separation		curb adjacent to road	small buffer strip	parking lane buffer	
	Street Crossing	Vehicle Flow	high-speed, constant or sporadic		high speed but regularly intermittent	slow, constant	slow, low-volume
		Street Design	multi-lane, two-way	multi-lane, one-way	narrow lanes, pedestrian islands, bulb-outs		narrow street with bulb-outs
		Traffic Control	none		traffic signals	self-actuated pedestrian signals	automatic pedestrian signals
		Crosswalk Visibility	unmarked	two parallel stripes	ladder crosswalk, additional signage	in-pavement lit crosswalk	raised crosswalk
Security	Visibility	Lighting	infrequent street-focused			pedestrian-scale lighting	
		Surroundings	bushes, lack of street-wall or dark "pockets" in façade, poorly maintained			semi-protected but open, well maintained	
	Surveillance	quiet isolated areas	potential for reaching assistance, no direct surveillance		active street or transparent street-wall into active spaces		
Directness	Station Orientation	located w/o respect to surroundings	set back from street	connected with pedestrian bridges/tunnels	oriented toward development	integrated into development	
	Street Pattern	circuitous street network			fine grid-pattern		
WD	Shelter	open and exposed		buildings to shield wind	awnings, street trees, arcades		
SD	Density	<10 DUA		10-50 DUA	50-100 DUA	> 100 DUA	
	Land Use	single-use, auto-oriented		single use, pedestrian friendly	mixed use, auto-oriented	mixed use, pedestrian friendly	

Table B-3 Bicycle Design Elements

	Design Feature	Worst				Best
Safety	Facility	narrow lane, no shoulder	wide shoulder, shared lane	bike lane	dedicated path	
	Surface Condition	potholes, sharp debris	dangerous street elements	cracked or mended	smooth	
Security	Infrastructure	no provision	bike rack	bike locker	tended facility	
	Surveillance	isolated	activity center	tended		
Directness	Parking	located away from entrance		near station entrance		
	Pathway	conflicts require walking bike		segregated space up to parking		
Weather Protection	Parking	exposed	under awning	indoors		
	Changing Facilities	none	bench to take off rain gear	shower and locker facilities		
Supportive Details	Services	no services provided	occasional	consistent, dedicated personnel		
	Information	none	bikes and transit	bike/transit and local bike information		

Table B-4 Bus Design Elements

	Design Feature	Worst				Best	
Safety	Mode Conflicts	other vehicles or pedestrians in bus areas			bus area free from unsanctioned traffic		
	Stop Location	no sidewalk adjacent to bus	need to cross street to reach station		no exposure to vehicles, direct path to station entrance		
Security	Waiting Area	isolated, dark	sightlines with active area, well lit		integrated into rail station, employee nearby		
Directness	Stop Location	not oriented to station, level change, across street		requires crossing road	some distance from entrance	adjacent to station entrance	
Weather Protection	Stop Design	open, exposed	building to shield wind	open-sided, covered shelter or building awning	three-sided, covered shelter	indoors, temperature controlled	
Supportive Details	Schedule Coordination	none	off-peak only	all-day coordination	scheduled and real time		
	Fare Integration	separate fare and media		discounted transfer	free transfer	no barrier	
	Retail	none	beyond immediate station area		located to allow surveillance of bus activity		
	Schedule Information	no information	current schedules, routes		real-time information		

Table B-5 Drop-off Design Elements

	Design Feature	Worst				Best	
Safety	Drop-off Location	in high volume traffic	not separated from vehicle space	congested, dedicated space	spacious, dedicated space		
Security	Waiting Area	isolated, dark	access to phone	sightlines with active area, well lit	integrated into rail station, employee nearby		
Directness	Drop-off Location	required to cross street or in front of moving/ stopping vehicles		step into street to reach sidewalk	direct connection to station entrance		
Weather Protection	Waiting Area	open, exposed	building to shield wind	open-sided, covered shelter or building awning	three-sided, covered shelter	indoors, temperature controlled	
Supportive Details	Shuttle Service	no program	service provided	information available	company support		
	Taxi	no information	taxi phone numbers available		taxi queue		

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