PLANNING CONSIDERATIONS FOR TRANSIT INTEGRATION

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PREFACE

The objective of "Planning Considerations for Transit Integration" is to provide a resource document to assist in integrating transit considerations into new and existing land use developments and to insure compatibility with the related infrastructure. The primary focus of this report is on providing information to foster the opportunities associated with transit access and service and to enhance the appreciation of long term benefits of designing for transit compatibility. Information pertaining to the actual design of transit facilities, however, may be found in the supplementary document entitled "Transit Facility Design Guide".

This report and the "Transit Facility Design Guide", both supported by Capital Metropolitan Transportation Authority (Capital Metro), were the products of the graduate students participating in the graduate course entitled "Transportation Planning: Methodologies and Techniques" (CE 391J - Spring 1988). The students, from the Graduate Program in Community and Regional Planning and Civil Engineering (Transportation), were responsible for all aspects of this study including preparation of the final report.

The study process, involving the ten graduate students under the supervision of Dr. C. Michael Walton, consisted of four major tasks:

- Identification and survey of transit operations in areas similar to the metropolitan area of Austin, areas known for their transit service, and areas of special interest.
- Seminar series consisting of invited speakers representing community leaders, engineers and architects, developers, mall managers, transit professionals, and related professionals
- Development of an annotated bibliography used for reference and guidance
- Development and implementation of a study plan reflected in these reports

C. Michael Walton
May 15, 1988

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CHAPTER 1: INTEGRATING TRANSIT

The Capital Metropolitan Transportation Authority (Capital Metro) is a regional transit authority serving Austin, Texas and several surrounding communities. A major goal of Capital Metro is to improve the provision, and increase the patronage, of its public transportation system. The "Planning Considerations for Transit Integration" document is a means by which Capital Metro is attempting to increase and improve the role of public transit in the Austin area. This report provides the citizen and developer with information concerning the general planning aspects of integrating public transportation into new and existing developments. (Note: A supplementary document entitled "Transit Facility Design Guide", which provides specific transit facility design information, is also available through Capital Metro. The "Transit Facility Design Guide" addresses the following major topic areas: design vehicle characteristics, geometric and pavement design, the physical components of transit facilities, and transit facility development.)

The advantages of a well-integrated transit system are many. A well-integrated transit system gives the individual a convenient, alternate form of transportation for work trips, especially into and within the Central Business District or CBD (Ref 18). For the citizen who has no other means of transportation, a well-integrated system allows that individual to interact with the city at-large, thus expanding that person's economic and social interaction within the city.

The benefits to the entire community are directly related to those experienced by the individual citizen. With a well-integrated transit system, the labor pool within the city expands due to the greater mobility of the individual worker. A well-integrated system also provides the city with a convenient, safe, and economical transportation system to offer visitors. Conventions may be better serviced thus encouraging more use of the city's convention facilities, bringing in outside revenue. Another advantage in having a well-integrated public transportation system is that valuable real estate in the Central Business District can be utilized for buildings rather than for parking facilities. With the increased demand for downtown real estate, the efficient use of downtown space will depend on the provision of a well-integrated public transportation system.

The benefits to the developer may be less recognizable than those explained above. The primary benefit realized by the developer is an expanded available market. Because a well-integrated transit system provides mobility to a sector of the society often neglected by modern retail, housing, and entertainment markets, the developer offering an integrated project will profit by patronage from these sectors. A secondary, but no less important benefit realized by the developer is the recognition received for contributing to the community. A voluntary inclusion of integrated transit facilities in new developments is a strong gesture to the community on behalf of the developer.

This document has been developed to provide the citizen and developer with information which will encourage transit integration. The guidelines are presented in chapters which deal with different aspects of public transit integration. In order to facilitate the integration of transit, the developer needs to know what types of design features should be included and what types should be avoided. The developer also needs to know when the planning for transit integration must begin in relation to the rest of the development. These design questions are addressed within this document.

The provision of an integrated development from the standpoint of feasibility and general considerations is discussed in the chapters "Compatible Developments for Transit Integration" and "Planning, Access and Circulation". These chapters characterize developments which can successfully integrate transit. They also characterize the general overall design considerations to be studied when integrating transit with development and the implications of such designs. Chapter 2, "Compatible Developments for Transit Integration", addresses the location of the development on an urban scale while the Chapter 3, "Planning, Access and Circulation", addresses more site specific location questions.

Public sector options to promote the integration of public transportation are presented as alternatives which may be used by a community to ensure that developers consider public transportation as an element in their development plans. The use of any of these options demands cooperation among the City government, Capital Metro, the citizens, and the developer. The use of these options, especially those requiring public funding, is justified by the positive benefits which can be derived by all members of the community when public transit is successfully integrated into development.

In conclusion, it is hoped that this handbook will answer many important questions about transit integration. It is also hoped that the book will encourage further integration efforts in the future. The citizen and developer is reminded that integrating transit into new and existing urban development symbolizes a partnership between the community and development industry. Such a partnership can be a positive commitment to the people of the greater Austin area.

CHAPTER 2: COMPATIBLE DEVELOPMENTS FOR TRANSIT INTEGRATION

ISSUES AND DEFINITION OF TERMS

Land Use and Transit

The purpose of this chapter is to provide a framework within which the suitability of public bus transit for a particular development can be evaluated using land use and population density criteria. One method to increase transit ridership is to develop the city using transit compatible landuse patterns. Transit service that is efficient and effective depends upon complimentary land use policies and designs. Capital Metro therefore has an obvious interest in encouraging and guiding land development in the Austin area that will increase transit ridership. The viability of transit service in the future will be determined by land use decisions made today.

Public transit is considered desirable for three basic reasons. First, the auto dominated pattern of developments and cities denies mobility to the economically disadvantaged, physically handicapped, and elderly. Second, public transit provides environmental benefits by reducing traffic congestion and pollution. Third, public transit enhances the attractiveness and vitality of central cities by conserving land resources needed to accommodate private vehicles.

This chapter will focus on the dependence of public transit on the type and density of land use that will make public transit work. Also, it will help in assessing the practicality of including public transit in a particular development.

Density

There is a high correlation between transit ridership and density. The presence of transit can foster more intensive land uses within a given development or urban region. The number of people per unit land area, or population density, must be carefully defined to avoid confusion and erroneous conclusions. Gross population density usually refers to total population divided by the total land area within a given boundary (Ref 20). Dwelling unit density defines gross residential density in terms of dwelling units per unit of land. Household size, occupancy rate, and the amount of vacant land within the development may influence dwelling unit density and should be carefully accounted for. Building and zoning regulations commonly use dwelling units per acre to set standards.

While the population density or dwelling unit density measurements can be used for residential land analysis, they are less applicable in analyzing nonresidential developments. Population density in nonresidential developments varies according to the time of day and particular use associated with it. Therefore, the density of nonresidential development is often calculated in terms of floor to area ratios or FAR's. Two measures of floor to area ratios are nonresidential floor space per square mile and nonresidential floor space per acre. Floor to area ratios are calculated by dividing the floor space of the project or geographical study area by the total area occupied by the project or geographical study area. Generally speaking, larger nonresidential clusters tend to support higher floor to area ratios than do independent nonresidential projects.

Impacts of Development Density on Public Transit

By increasing residential densities from below 5 dwellings per acre to levels between 5 and 15 dwellings per acre, auto trips can be cut by about 30%. Paralleling the decrease in number of auto trips will be an increase in public transit use of 100% or more. About half of the auto trips not being made show up as new transit patronage(Ref 20). A density level of 15 dwellings per acre would be equivalent to a duplex on a 57 x 100 foot lot. Where this density level does occur in such places as Baltimore, Berkeley, and the middle range of development in Queens however, the areas tend to consist of a mixture of structure types and uses. Development at these densities produces a greater orientation of trips toward denser nonresidential concentrations of activities (Ref 20). The resulting mixture of uses fosters the desirability and use of transit.

It has also been found that larger and more dense downtown or secondary central business districts, encourage fewer travelers to choose the automobile as their mode for accessing these areas. This is mostly due to the cost of parking which is connected to the value of land.

Table 2-1 correlates 1980 Census data from representative Austin area census tracts to work related transit ridership. The table illustrates the effect on ridership which population density and location with respect to the CBD have. Other factors such as social and economic characteristics also influence the ridership results. The effects of these socio-economic characteristics are alluded to by the fact that several of the tracts display high transit usage while having lower densities. Current ridership figures show some increases since the 1980 Census and can be expected to continue to increase. Figure 2-1 shows where these tracts can be located in the Austin area. The map can also be used to guestimate the transit ridership that can be expected to be derived from new developments in these census tracts and others not specifically listed in Table 2-1. It should be noted that Table 2-1 does not account for all of the transt ridership presently experienced in these areas. Many transit trips made each day are not work related and therefore do not appear in the table's summary.

Location

The location of land uses affects transit costs which affect the amount of transit service that can be provided. There is a need to provide a balance of attractions on a given transit route or set of routes so that people are attracted to a number of differing activities at points along the route(s). This helps to provide a higher turnover of ridership, and it explains why transit is most successful in the downtown area and areas close to downtown where not only high densities tend to be present, but a large number of differing activities are present as well. The point is to try to balance the amount of residential development which tends to produce the trips with commercial and industrial developments which tend to attract trips.

Table 2-1: Relative Effect of Density on Transit Ridership (Ref 11)

Census Tract	Area of Town	Distance from CBD	Population Density	Number of Transit Riders	% Journey to Work by Transit
6.02	Central	1.5	21.0	219	7.1
23.04	S. East	2.5	11.0	335	16.3
3.01	N. Central	4.2	8.6	244	7.4
18.05	North	7.0	8.6	46	2.3
20.02	South	4.9	8.3	29	1.7
13.05	South	2.1	8.1	219	7.3
18.17	North	8.4	6.2	23	1.1
23.07	S. East	3.2	6.0	90	4.9
21.09	East	3.9	5.6	80	4.6
19.01	S. West	3.3	4.7	33	1.2
23.09	S. East	4.2	3.1	108	4.3
3.03	East	3.5	2.3	119	7.8
17.05	N West	7.0	2.1	0	0
1.02	West	3.4	1.5	12	1.2
23.06	S East	3.8	.8	19	3.2

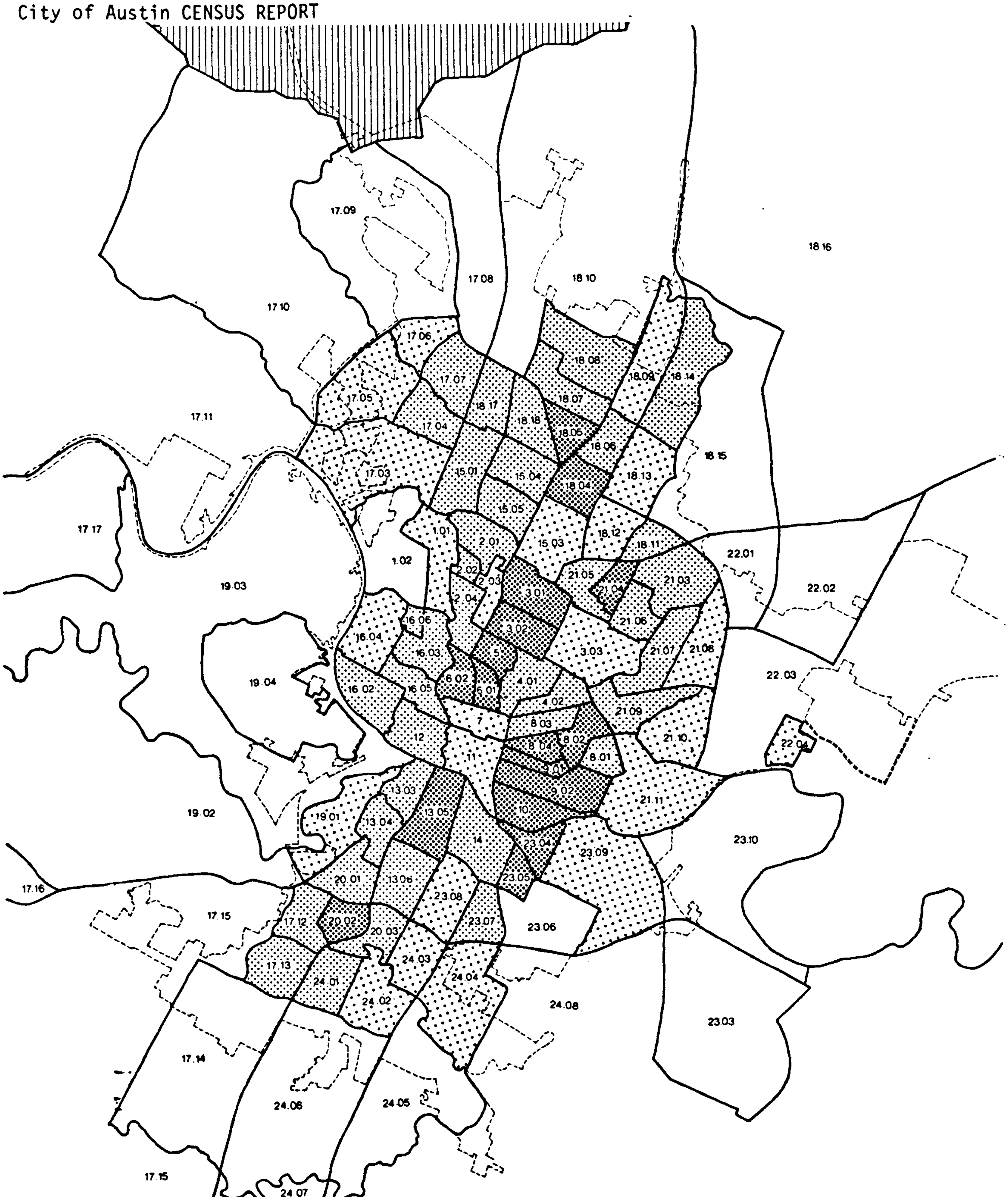

Figure 2-1: **POPULATION DENSITY BY 1980 TRACTS**
TRAVIS COUNTY

Persons Per Acre
- Under 2
- 2 to 4.9
- 5 to 7.9
- 8 and Over
- Outside County

When this balance is achieved, two things will be accomplished. First, trip lengths will be shortened allowing more concentration of service on shorter segments of a route. Second, more reverse direction trips will be produced which will allow more efficient use of transit in the off peak direction (Ref 31).

These concepts and definitions will be helpful in analyzing the Austin area and specific sites for development as plans are developed to integrate transit. These definitions will become a common backdrop for analyzing the appropriateness of integrating transit into a development in Austin. By thinking of density in terms of the individual site and the sites location in the city, the developer can better assess the appropriateness of transit integration in a development and the benefits to the development and Capital Metro.

TRANSIT USE IN THE CONTEXT OF LAND DEVELOPMENT

The first two sections of this chapter delineated the basic factors that decide the supply and demand of public transit service to a given area including location and density. This section explores in greater detail the considerations that should be made to ensure that land development is designed to be compatible with transit service (Ref 31).

Land Development and Compatibility With Transit Service

Planning for transit service compatibility requires forethought. There is no formula for determining transit compatibility, but rather, a range of considerations that the designer of the development should be aware of and the implications they have on transit compatibility. For the most part, development that incorporates the following guidelines will be compatible with transit (Ref 31).

- The development should be located within the urban area of the city. Development that takes place away from existing urban densities will usually not be immediately compatible with transit. Additionally, studies indicate that proximity to the downtown area is as important as density in increasing transit ridership.
- The development should be located near a Capital Metro route with existing seat capacity to service the increased ridership from the development. Moreover, physical proximity of the development to a transit stop is extremely important.
- Land uses on the site should be developed at a medium to high density. Increased urban densities tend to both inhibit automobile usage and to increase transit ridership. Low density development reduces the efficiency of serving an area with transit service and increases automobile dependence. Park-and-Ride lots, however, in low density suburban areas have been found to increase transit ridership to economical levels. Park-and-Ride lots serve to concentrate the demand in low density areas and thus are worth considering in suburban and urban fringe developments.

- It is more efficient to provide transit service to developments that can generate substantial off-peak ridership (midday and night). Off-peak ridership increases can best be achieved by designing a mix of uses into the development such as retail, office, and residential
- Land uses within the development should be capable of generating transit ridership. Clearly, land uses that are exclusively automobile oriented would be inherently incompatible.
- The development should be designed with a street orientation that provides good pedestrian connections to transit stations and adjacent land uses. Automobile parking at the site should not be excessive or designed in such a way as to be a physical barrier between the street and the development.

Estimating the Demand for Transit

An accurate estimate of the demand for transit requires the consideration of numerous site specific factors. In general, the key factors that determine the demand for transit service and whether a development is transit compatible are:

- housing unit density
- overall demographic characteristics of residential household size, income, and labor force participation rate
- non-residential floor area density and size
- proximity of the development to Capital Metro service lines
- distance from the city's central business district
- the intended market of the development and their demand for transit service
- the orientation of the development to different transportation modes

One quick method to project transit ridership is to estimate the total trip generation for the development and apply the percentage of mode split for transit ridership in the area. Information regarding transit ridership in Austin is available either by census tract through the 1980 United States Census Report or by transit service line through Capital Metro.

Table 2-2 was developed fo provide a quick assessment of the potential trips that could be generated from a given type of development. For a detailed projection of automobile and transit trips generated from a development it is recommended that a civil engineer or transportation planner be retained to conduct a site specific comprehensive traffic impact assessment (TIA).

RESIDENTIAL LAND DEVELOPMENT

Residential development in the United States has mirrored the changes and evolution of the nation's transportation system. The typical city in the late 1800's and early 1900's was developed along radial

Table 2-2: Trip Generation Summary (Ref 35 and 46)

Residential Land Use	Average Vehicle Trips To and From Per Day Per Dwelling Unit	Typical % of Transit Trips of Total Person Trips
Single Family Detached	10.0	3.2
Apartment - Medium Density	6.1	5.6
Apartment - High Density	4.0	12.4
Condominium	5.2	9.0
Mobile Home	4.8	1.0
Retirement Community	3.3	6.0
Planned Unit Development	7.8	7.1

Nonresidential Land Use	Average Vehicle Trips To and From Per Day Per 1,000' of Gross Floor Area	Typical % of Transit Trips of Total Person Trips
Office Building -		
under 100,000 g.s.f.	8.1	5
over 100,000 g.s.f.	10.0	5
Shopping Center -		
50,000 - 99,000 g.s.f.	82.0	3
500,000 - 999,000 g.s.f.	37.2	3
Industrial -		
Manufacturing	3.9	5
Industrial Park	7.0	5

transit corridors with varied land use patterns and concurrent high urban densities. Usually, people lived close to their place of work and either walked or rode the trolly for transportation.

Today, land uses are largely separated by municipal zoning regulations. Urban densities have decreased with the advent of the automobile because of the mobility options it provides in choosing a residential location. In Austin, the average 1985 urban residential density was approximately 4.7 dwelling units per acre. By comparison, the City of Montreal, Canada, where public transit is relatively successful, averages 35 dwelling units per acre in the inner city (Ref 37).

Changes are taking place within Austin, and the nation, that point to a greater demand for housing that is affordable, yet closer in to the central city. Factors in this trend include the aging of the American population and subsequent decline in household size, increased automobile travel costs and limits on the willingness of people to commute, higher land costs, redevelopment of downtown areas and the emergence of suburban traffic congestion. Because of these factors, the market for housing in Austin may in the future reflect a greater demand for moderate density (7 to 15 units per acre) inner city housing, especially that which is serviced by transit.

Studies have found that in areas where densities are between 1 and 7 dwelling units per acre, transit use is low. Furthermore, a density of above 7 units per acre is cited as a threshold in which transit use increases substantially. At densities above 60 dwelling units per acre, transit use accounts for more than half the total trips (Ref 37). Some rules of thumb regarding the level of service that might be economical at a given level of residential density are listed in Table 2-3.

NONRESIDENTIAL LAND DEVELOPMENT

For nonresidential development, the larger its size and density, the more attractive it is as a transit ridership generator. This tendency is especially pronounced for downtown areas. As city size increases, so does traffic congestion, travel time, and transportation costs such as parking. The personal automobile thus becomes less attractive as a means of transportation to these areas because of the associated costs. Generally, transit ridership to a downtown area shifts in relation to the size and density of the area and its proximity to residential areas (Ref 37).

Outside of the downtown area, many communities including Austin are experiencing suburban traffic congestion, but existing land development patterns will not efficiently support transit service in many of these areas. Suburban developments tend to be isolated, single use facilities, with little pedestrian connections. This causes an almost total car orientation for transportation in these areas.

The integration of transit with nonresidential development outside the central business district requires more changes in density and site layout than is typical for these areas. In almost all cases, suburban employment and land use densities are much smaller than that of the city's central business district. Suburban office developments, for example, have on average, one-twenty fifth the floor area ratio (FAR) of downtown office buildings (Ref 8).

Table 2-3: Transit Service Levels Related to Residential Density (Ref 37)

	Transit Service	Minimum Residential Density Required in Mode Dwelling Units Per Acre
Local bus	hourly service	4
Local bus	half hour service	7
Local Bus	15 minute service	15
Express bus (pedestrian boardings)	5 buses during peak hours	15 average density over a two mile square area
Express bus (Park-and-Ride)	5 buses during peak hours	3 average density over a 20 mile square area
Light rail	5 minute headways during peak hours	9 average density within a 25 to 100 mile corridor

The keys to successful integration are a mixture of uses within the development, with good pedestrian connections and higher than average size and density. Developments that can provide work, shopping, personal services, and restaurant options within walking distance of the site will help stimulate transit demand. A mixed use site design can reduce the need for employees to drive to work as their employment and housing needs can be served within the development.

The City of Austin is attempting to overcome the problems of serving suburban development with transit service by becoming more flexible in its land use regulations. Austin's new comprehensive plan, for example, recommends that the city consider higher density land uses within walking distance of transit corridors and allowing a greater mix of land uses within a single development.

CREATING TRANSIT ACTIVITY CENTERS

The most common motivation for building major transit facilities such as transit and pedestrian malls is the hope that such facilities will help stimulate growth in the central business district (Ref 33). This growth can come in many forms such as increased retail sales, more jobs, or increased public and private investment. In many cases, the particular motivation will determine the location of a major transit facility. This could be along a street in a retail district or office district. If both of these or other districts are being considered, an intersecting point might provide a focal point to such a project.

In the case of malls in retail districts, the merchants will need to be convinced that it will be good for their business. They often worry about the impact of the mall on automobile and goods access. On the other hand, mall promoters hope for more stable and higher quality retail outlets, expansion of current retail outlets, or at least encouraging major department stores to remain in the central business district (Ref 33).

A transit mall may be used to compliment or reinforce ongoing development or redevelopment activity. Such efforts have been tried in Mineapolis, Philadelphia, Denver, Montreal, Ottawa, and Toronto.

Another critical factor in considering development of a transit mall is the condition of the existing transit system. Only cities such as New York, Philadelphia, and Toronto can be considered to be transit oriented. Most other cities are substantially more automobile oriented. A predominance of automobile orientation becomes even more true when looking at shoppers in comparison to central business district office workers because shoppers are less definite in the places they will go and the time they will spend at any one given place.

To remedy these problems, a transit mall should help make improvements in increasing the speed, accessibility, user orientation to the transit system, and turnover of transit ridership. The facilities should also help decrease loading and unloading time, waiting time, and obstacles that might be encountered by bus drivers.

A transit mall should also ameliorate problems associated with the imposition of policies aimed at discouraging or limiting the use of automobiles in the central business district. In turn this will not only help to alleviate congestion, but it will also help limit environmental pollution.

If a developer is considering creating a transit mall, the developer must work closely with Capital Metro and local governments as such a project will require commitments from each of these entities.

CHAPTER 3: PLANNING, ACCESS AND CIRCULATION

A central question in the transit - development integration issue is when should mass transportation be considered in the overall design process. It is clear that if mass transit is to be a viable component of project development and not just an added amenity, it must be considered early on in the design process. Many problems which are caused by retrofitting mass transit into existing developments can be avoided if this course of action is pursued. Innovative design schemes, such as passenger shelters and new security techniques can be incorporated into the overall project design at much lower costs.

Two key factors in determining whether transit will be extended to a development are the design of the development, and the financial resources available to Capitol Metro. Since the latter is largely out of the developer's control, special emphasis must be placed on the overall design to reduce transit impedances.

This section will examine access and circulation systems within overall subdivisions and large projects which facilitate transit integration. It will examine design considerations which encourage transit use at the site plan level as well as those which discourage it. The purpose of this section is to prompt the developer, architect and engineer to recognize the implications of designing for transit integration, and to encourage innovative designs to promote transit use.

DEVELOPMENT LOCATION

For successful transit integration into planned development, two central issues must be examined. First, the location of the development within the existing and future transit network must be considered. Second, the location of the individual project within the development and the development's circulation system must be considered.

When planning for transit it is nearly impossible to change long established route systems. Established routes serve both captive and choice riders and are therefore rarely moved. When routes are moved, they are seldom moved out of their original transit corridor. If a developer wishes to increase a development's chances of eventually being integrated into the transit system, it is important to locate it near existing routes. In areas where routes do not currently exist, it is advantageous to locate near larger arterial and collector roads. A developer interested in transit integration should contact Capitol Metro for a listing of the existing routes and latest long range expansion plans.

BUILDING LOCATION AND CIRCULATION

Once the developer has decided to place the development on or near a transit route, the question of building location and circulation must be addressed. Transit users will seldom walk more than one quarter mile to access a transit facility as can be seen from Figure 3-1. Figure 3-1 presents typical diversion curves for pedestrian movements. The curves illustrate the willingness of patrons to walk various distances to access transit . With good access (good weather or protection from the weather, safe streets,

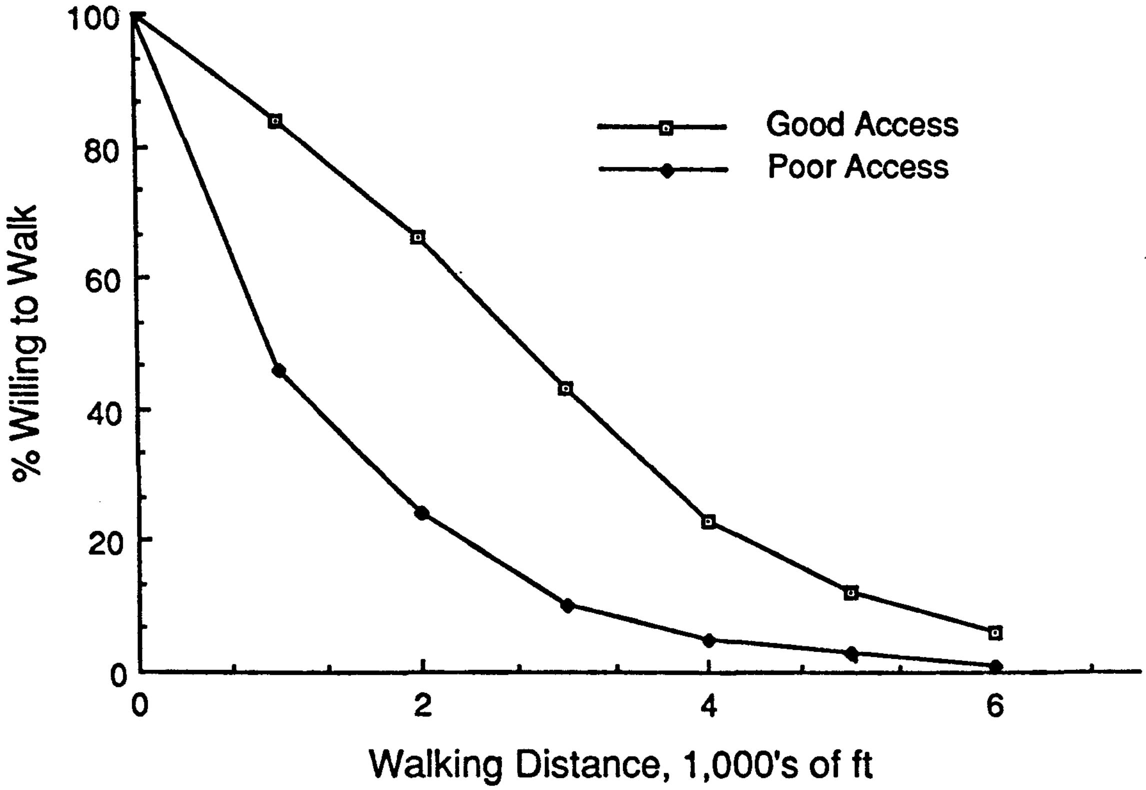

Figure 3-1: Willingness to Walk vs. Distance from Transit Facilities

sidewalks,flat grade, good lighting) people will be willing to walk as far as 1/2 mile; while under poor conditions (foul weather, poor lighting, bad sidewalks, or steep grades) they will be reluctant to walk two blocks or 1000 feet. It needs to be emphasized that the distance being discussed is walking distance and not straight line distance. Obstructions preventing direct access between the user's origin and a transit facility will add to a user's walking distance. Several notable obstructions often encountered by transit users are: walls, fences, and hedge rows; cul-de-sacs which increase walking distance by blocking straight line paths; and streets paralleling main arterials with a lack of pedestrian access paths to the main street.

If a developer hopes to bring eventual transit service through a development, special emphasis should be placed on designing adequate circulation systems for both transit vehicle and transit user which connect with the overall Austin arterial network. Adequate arterial and collector road systems within the development should be designed so that buses will not be forced to operate on local neighborhood streets. Other notable design features which decrease the likelihood of transit integration and should be avoided when planning for transit integration are:

- walled developments lacking pedestrian access points,
- excessive use of cul-de-sacs,
- circuitous street patterns,
- undulating street plans,
- speed bumps on collectors and arterials, and
- unaligned street layouts

These aspects of designing for transit are illustrated in Fig. 3-2.

BUILDING ORIENTATION

To further promote transit integration the developer needs to examine the individual building plan and how it relates to the transit facilities on the site. The developer can encourage transit use by making the pedestrian access-ways direct and uncomplicated. Orienting at least one main entrance of the project to a transit stop sends a strong message to transit users that they are valued patrons of the project. Bringing transit stops close to buildings instead of pushing them to the outside edges of large parking lots, further encourages transit use. The inclusion of covered transit facilities near entrances of major centers such as regional shopping malls will encourage greater transit patronage of the facility. These and other amenities leading to higher transit use are shown in Fig. 3-3. Also, located in Appendix A are examples of successful integrated developments now existing in the Austin area which have employed many of these design features.

CHAPTER 4: BUS STOP AND TRANSFER STATION CONSIDERATIONS

Bus Stops

A bus stop is an area located in, or adjacent to, the outside traffic lane created for the purpose of loading and unloading transit passengers. The Transportation Research Board (Ref 28) suggests that the goal for proper planning and design of bus stops is to maximize passenger convenience and safety while minimizing traffic interruption. It is the purpose of this section to discuss advantages and disadvantages of various bus stop locations, proper spacing and lengths of bus stops, and note additional considerations desirable to achieve this goal.

There are basically two types of roadside bus stops: curbside and bus turnouts. Curbside stops are located next to the curb of the outside traffic lane. Turnouts, which are discussed in the supplementary document "Transit Facility Design Guide", can be useful on high volume roadways since they remove the buses from the traffic lanes. Although removing buses from the traffic lanes reduces the number of conflicts and traffic delay that occurs when a bus is stopped in traffic, the use of turnouts presents the bus operator with the problem of re-entering the traffic lanes. Due to the size of the bus, this can be a difficult maneuver even at lower traffic volumes. Operational problems such as this are a function of the type of stop, the location of the stop relative to the intersection, and the physical and operational characteristics of the intersection(s) and roadway within the vicinity of the bus stop. Therefore, the decision to use either a turnout or a curbside stop should be made only after the site location under consideration has been studied. Capital Metro staff and The City of Austin should be contacted during the planning stages of any bus stop located within the public right-of-way.

Location of Stops. A bus stop may be placed in one of three locations relative to an intersection: farside, nearside, and mid-block. Farside and nearside stops are located within the vicinity of the intersection where the farside stop is located on the outbound lanes of the intersection and the nearside stop is located on the inbound lanes of the intersection. Mid-block stops are located, as the name implies, between two intersections. Figure 4- 1 illustrates the various locations of bus stops. The decision as to the exact placement of the bus stop should be based on a study of the site under consideration. The following is a partial list of factors that should be considered when determining bus stop placement:

- patronage,
- transit operational requirements and routing,
- convenience to passenger in terms of bus stop accessibility, proximity to origin/destination, ease in passenger transfers,
- roadway and intersection geometric constraints,
- location of existing stops,

- parking restrictions,
- traffic flow (average daily traffic volume (ADT) and turning movements),
- direction of intersecting streets (one-way or two-way), and
- traffic control.

The following three subsections describe some of the advantages and disadvantages of farside, nearside, and mid-block bus stop locations and list situations in which a certain location would be preferred. It should be noted that some of the advantages and disadvantages of stop locations will not apply to both curbside stops and turnouts.

(1) Farside Stop Locations. A farside stop location offers the following advantages:

- Capacity of the nearside intersection leg is not reduced since the curb lane of the intersection approach is available for traffic.
- The conflict between buses and right turning vehicles is reduced.
- Sight restrictions created by buses stopped at the intersection are reduced for traffic travelling along the bus route.
- Pedestrians crossing behind the bus is encouraged.
- At signalized intersections it is easier to re-enter the traffic stream because of the presence of more available gaps and the absence of queueing traffic.

A farside stop location presents the following disadvantages:

- Sight restrictions created by stopped buses are increased for cross street traffic entering from the right.
- The bus may be forced to make more stops since the operator must now stop at the traffic signal before the intersection, and at the bus stop beyond the intersection.
- Queueing buses may obstruct traffic on the crossing street.

A farside stop is preferred when (Ref 12 and 19):

- the bus must make a left turn (The bus stop should be located on the farside of the intersection after the completion of the left turn.),
- the intersection experiences heavy right turns onto the crossing street,
- the traffic on the inbound intersection approach is heavier than across the intersection on the outbound lanes,

- the crossing street is one-way to the right, has a transit route, and there is a high transfer rate between routes (The stops should be placed on the farside of both routes to minimize pedestrian movement through the intersection.), and
- the intersection is complex (A farside stop may be advisable so that bus traffic is removed from the complicated activities occurring within or near the intersection.).

(2) Nearside Stop Locations. A nearside stop location offers the following advantages:

- The number of stops made by the bus may be reduced since the red phase of the signal cycle may now be used to load and unload passengers.
- Queuing created by stopped buses will not back into the intersection.

A nearside stop location presents the following disadvantages:

- Pedestrians must cross in front of the bus.
- Buses conflict with right turning traffic.
- Sight distance for right turning traffic is diminished.
- Traffic control devices are often hidden from view by stopped buses.

A nearside stop is preferred when (Ref 12):

- the crossing street is one-way to the left, has a transit route, and there is a high transfer rate between routes (The stops should be placed on the nearside of the crossing route and the farside of the other route so that pedestrian movement through the intersection is minimized.),
- traffic volume is higher on the farside than on the nearside, and
- traffic control devices require the bus to stop at an intersection, and safety and sight distance requirements are not compromised.

(3) Mid-Block Stop Locations. A mid-block stop location offers the following advantages:

- Sight distances are not obstructed by stopped buses.
- Bus stops may be located near major passenger generators.
- The problem of negotiating a sharp right turn after leaving a nearside stop is reduced.
- The problem of entering a farside stop which is located beyond a sharp right turn is reduced.

- Pedestrian congestion at adjacent intersections is reduced since passengers now assemble at less congested portions of the sidewalk.

A mid-block stop location presents the following disadvantages:

- Pedestrians from across the street must either jaywalk or walk farther to reach the stop.
- A considerable amount of area available for curb parking is removed.

A mid-block stop is preferred when (Ref 12):

- traffic or physical street characteristics prevent the use of farside or nearside stops and
- a large passenger generator exists and heavy loading makes the location desirable.

Bus Stop Spacing. Refer to Capital Metro Service Standards for appropriate bus stop spacing.

Bus Stop Lengths (curbside stops only) (Ref 28). The length of a bus stop is a function of the length of the bus, the operational characteristics of the vehicle, and the expected number of buses stopped during the peak period. The expected number of stopped vehicles is dependent on the arrival rate of the buses during the peak period, the nature of the arrivals, and passenger service times at each stop. The values presented in Table 4-1 illustrate the expected number of buses during the peak hour based upon a Poisson (random) arrival type and a 95% confidence level. It should be noted that when parking is restricted during peak hours, off-peak volumes should be used in determining bus stop length. Figure 4-1 illustrates the recommended bus stop lengths for farside, nearside, and mid-block bus stops as required by a single 40 ft. design vehicle. For longer or shorter buses, the lengths should be adjusted accordingly. An additional 45 ft. should be added for each additional vehicle in the stop.

Additional Considerations (Ref 28). When constructing a bus stop, it should be the goal of the designer to maximize passenger convenience and safety while maintaining efficient traffic operations. In order to achieve this goal, the following factors must be considered:

- enforcement (Enforcement of no-parking restrictions in the bus stop area is essential for efficient and safe bus operation.),
- delineation (The bus stop should conspicuously display pedestrian information signs and parking restriction signs. All pavement markings and signs regulating parking should conform to the Texas Manual on Uniform Traffic Control Devices for Highways and Streets. Such signing should also be approved by the relevant local authority),

- passenger amenity (Amenities should be provided so as to maximize passenger safety, comfort, and convenience. Bus shelters, adequate lighting, sidewalks, and curbs of constant height should be provided whenever possible),
- maintenance (The bus stop should be inspected for deterioration on a periodic basis), and
- curb adjustments (When the bus is required to make a right turn, a longer curb return radius may be required at the turn. Refer to the "Curb Radii" section of this chapter for additional information.).

Transfer Stations

In most cases a transfer station serves as a joint bus stop where several routes intersect. It is expected that passengers will be transferring between routes, and thus the station should be capable of facilitating this movement.

At street intersections, transfer stations should be located to minimize pedestrian street crossing maneuvers. Shelters and paved waiting areas should be provided. At high volume stations, several shelters may be installed in order to provide adequate cover for the expected number of passengers. Transfer stations should contain signs which indicate all bus routes which stop at that station and all other pertinent information relating to those routes.

CHAPTER 5: PUBLIC SECTOR OPTIONS TO ENCOURAGE TRANSIT INTEGRATION

Public sector options to encourage transit integration can be broadly divided into two categories - flexible policies and mandatory policies. Flexible policies are implemented through various forms of public/private partnerships, while mandatory policies are implemented through local land use ordinances.

Although Capital Metro has the power to negotiate transportation agreements with local developers, local governments hold authority over land use. Local transportation consultants argue that the only "guaranteed" way to integrate transit is to mandate it by ordinance (Ref 48). Through local zoning ordinance, cities may provide zoning incentives, create transit zones, collect transit impact fees, or mandate transit facility provision.

While local ordinance mandates private sector contribution to local transit provision, many flexible, "ad hoc" arrangements also provide for private sector involvement. Through public/private partnerships , like negotiated transportation agreements and cost-sharing arrangements,developers assume all or part of the costs for transit improvements.

Cities across the United States are engaged in innovative and cooperative arrangements to foster the private sector contribution to public transit. There are many variations of cooperative provision of transit . Described below are examples of both flexible and mandatory policy options that are successful, current, and common mechanisms for jointly financed local transportation improvements.

PUBLIC/PRIVATE PARTNERSHIPS

Public/private partnerships are cooperative arrangements between the public and private sectors to provide transportation improvements. While these partnerships are varied in nature, they generally involve the local transit authority, the local government, interested developers, and neighborhood groups.

Negotiated Transportation Agreements

Negotiated transportation agreements are made between local officials and developers in an ad hoc manner. This is the most common form of public/private partnership. Developers provide transportation improvements in conjunction with new development, but may also provide capital infrastructure in areas where they have a vested interest. A transportation improvement negotiated with a developer may be as small as the construction of a bus shelter or as large as a multi-million dollar highway improvement.

Especially with large scale projects, developers are aware of the traffic/transit impact created. Single developers, groups of developers, as well as private developers and landowners agree to fund transit improvements through their own initiative or to help insure development approval. Transit improvements which relieve congestion and improve access to local projects benefit the developer directly, while benefitting the community as well (Refs17 and 41). Table 5-1 lists U.S. cities where significant transportation improvements have occurred through negotiation.

TABLE 5-1: Negotiated Transportation Agreements for Selected U.S. Cities (Refs 17 and 41)

Cities	Negotiated Transit Improvement
Irvine	$60 million in total improvements: 3 freeway off-ramps, 2 parkways, 14 traffic control projects
Denver	$20 million in highway improvements
Los Angeles	$4 million to relieve traffic congestion
Costa Mesa, Irvine, Santa Ana	$1 million to relieve traffic congestion

Cost-Sharing Arrangements

While the developer assumes all costs for transit improvements in negotiated transportation agreements, in cost-sharing arrangements construction and modernization of transit facilities are cooperatively financed by developers and local transit authorities. The combined resource of local public and private funds is also advantageous in competing for federal funding of transit projects (Ref 17). Cities where cost-sharing arrangements have been used to fund large scale transit projects include: Denver, Atlanta, Washington, D.C., Philadelphia, Portland, St. Paul, Miami, San Francisco, and New York (Refs17 and 41). Table 5-2 lists several cities and amounts of private dollars spent in cooperatively financed arrangements.

TABLE 5-2: Cost-Sharing Arrangements in Selected U.S. Cities (Ref 17)

Cities	Private Sector Contribution
New York	$30 million
Miami	$27 million
San Francisco	$12 million

Special Benefit Assessments

Benefit sharing in a local transit system is analogous to the concept of user fees. Developers pay local transit authorities for direct connections to existing service networks; or properties near or adjacent to transit facilities are assessed fees based on the transit benefits to their property (Refs17 and 41). Differential assessments can be levied based on distance from the transit station (Ref 29). Legal mechanisms must be in place in order to create special assessment districts. Both state and local enabling legislation are generally required (Ref 41). Cities using special benefit assessments to finance local transit are listed in Table 5-3.

TABLE 5-3: Selected U.S. Cities with Special Benefit Assessments (Refs 17, 29, and 41)

Cities	
Brooklyn	Minneapolis
Chicago	Pittsburgh
Denver	Rochester
Fresno	San Francisco
Los Angeles	Syracuse
Louisville	Toledo
Madison	Washington, D.C.

Transit Funds

Transit funds are capitalized through development fees. Like special benefit assessments, development fees placed in transit funds are authorized by local statute with authority from state law (Ref17). Project developers are required to pay into a transit fund to pay for costs of transit improvements needed to mitigate the impact of individual developments (Ref 41). This method of assessing a transit impact development fee is most common in cities throughout Florida and California.

Lease or Sale of Development Rights

Transit authorities can lease or sell development rights to air space above or below property owned by the transit authority (Ref 47). This option is an aspect of joint development, whereby the transit authority participates in planning and implementation phases of a project but not the actual development (Ref

29).When air rights are leased a steady stream of income to the transit authority is generated. Long term leasing is the preferred arrangement. This option has been used in Boston, Miami, and Washington, D.C. (Ref 29).

SECURING DEVELOPER INVOLVEMENT

Developer involvement in transit provision is secured by a range of mechanisms. These include mandatory compliance to local regulations, voluntary initiatives, and practices which involve aspects of both compliance and initiative on the part of the developer. Local government plays a key role in securing developer involvement for transit provision through its authority over local land use regulation (Refs 29 and 41).

Zoning for Transit

Mandatory requirements for transit provision are enacted through local zoning ordinances. Legal authority for zoning must be derived from state law (Ref17). Zoning practices take three forms: mandatory zoning (without incentives), zoning incentives, and performance zoning. Higher densities, created through zoning increase ridership and tax benefits in station areas. UMTA supports transit zoning efforts, and has funded local planning required to rezone for transit provision in Los Angeles, Portland, and Washington, D.C. (Ref 29).

Mandatory Zoning. Mandatory or mandatory-as-of-right zoning provides transit facilities without any zoning bonuses. Transit districts or transit zones are created in densely populated urban CBD's. In such areas developers are willing to forego the added expense of transit improvements because of locational advantages. These zones may be "floated" if a development with significant traffic impact is proposed for an area adjacent or near existing transit zones (Refs 31 and 45). Strict mandatory zoning is practiced in the mid-town area of New York City.

Incentive Zoning. Incentive zoning involves relaxation of standard zoning requirements for developments that provide transit amenities. The most common incentives for transit provision are decreases in parking requirements and increases in allowable density (Refs 29, 41, and 43). Austin's largest commercial developer/landowner, Trammell Crow, favors zoning incentives as an encouragement to private transit provision (Ref 39).

Reductions in parking provision can range from allowing no parking at all, to degrees of parking reductions based on the scale of the transit improvement provided by the developer. Reductions in parking provision save the developer construction costs, but also have the environmental benefit of reducing impervious cover at the site level. Portland is one U.S. city which allows developments to provide no parking in order to encourage transit use (Ref 29). A developer needs a firm commitment of transit provision from the local transit authority in order to facilitate parking reductions.

Density bonuses are granted, in the form of increased floor-to-area ratios (FAR's), to developers who provide transit improvements (Ref 43). Density bonuses are economically attractive to developers. Marginal costs for adding "bonus" floor area to planned developments are very low (Ref 29).

Performance Zoning. Performance zoning is a technique to address the building induced transit impacts of projects (Ref 45). Impacts, generally identified in an Environmental Impact Statement (EIS), are mitigated through transit improvements which allow the developer to meet established performance standards for noise, air quality, and water quality, as well as traffic generation (Refs 29 and 45).

Conditional Development Approval

The use of conditional development approval dependent on transit improvements is a common local practice. All forms of development approval are under the jurisdiction of the local government. Transit provisions at the site level become a developer requirement to proceed to the project construction phase. Discretionary instruments used in this manner include: building permits, subdivision approvals, certificates of occupancy, site plan approvals, master plan approvals, special use permits, and conditional use permits (Ref 41).

Contracts

Contracts between developers and the transit authority/local government specify the criteria to be met for transit improvements. Contracts serve as a written record of conditions required to bring about transit provision and clearly state obligations for all involved parties but may not be legally binding(Ref 41).

ENFORCEMENT AND MONITORING OF DEVELOPER INVOLVEMENT

Transit authorities and local governments must ensure that transit commitments will be carried out by the developer. This is often a difficult process especially during periods of economic downturn. Some options available to the public sector entities include: revoking or withholding building permits, performance bonds, one-time fee, or land set-aside. The monitoring of transit commitments can be assumed by the local transit authority or the developer. Periodic site checks or reports can verify developer compliance (Ref 41).

ANALYSIS OF OPTIONS

Advantages and disadvantages exist for policies chosen for private sector contribution to local transit provision. The public sector and private sector have different vantage points when evaluating cooperative transit agreements, and will perceive benefits and risks differently. Described below are some positive and negative aspects of transit integration policies.

Financial Considerations

Financial benefits result from any policy option that solicits private sector funds. Scarce public resources can be conserved by both mandatory and flexible policy options. For example, some negotiated transportation agreements have netted upwards of $50 million private sector dollars in transportation improvements. Cost-sharing arrangements have the additional advantage of combining public and private funds to compete for federal funding of local transit improvements. Special benefit assessments and transit funds reimburse the public sector for transportation services rendered. Mandatory zoning for transit facilities also reduces costs to the local transit authority, developers construct local transportation improvements at their own expense.

Developer Considerations

While mandatory policies for transit provision conserve public sector dollars, these requirements may be viewed negatively by the local development community due to increased construction costs. But if inclusion of public transit improves the marketability of given projects, local developers will recoup their intial investment in transit. Transit integration over the lifetime of a development can have the long-term net effect of increased profits to developers and landowners.

Legal and Equity Considerations

When comparing flexible versus mandatory policy options, legal and equity considerations come to light. Legal challenges can be brought against any local ordinance. One zoning ordinance which created a special benefit assessment district in downtown San Francisco was successfully challenged in the courts. Although flexible policies (requiring no ordinance for implementation) are removed from legal threat they may be less equitable than mandatory policies. "Ad hoc" arrangements for transit provision are negotiated on a case-by-case basis. Only those local developers with a keen interest in public transit may be encouraged to integrate transit amenities into their projects, while other developments may receive transit service without ever directly paying for it.

Planning Considerations

One clear advantage of mandatory policies over flexible policies is their impact on orderly land use planning. Provision of public transit facilitates planning for high density districts within a city. High density districts in turn provide increased ridership. Both the local government and the local transit authority benefit. Using flexible policies within an indifferent development community may result in no private sector contribution to local transit provision, and may also increase public sector uncertainty about future service routes, available finances, and placement of high density districts.

Many variations of both flexible and mandatory policies successfully provide transit in cities throughout the United States. Local circumstances often dictate which policy will work best.

CONCLUSION

Capital Metro has the ability to coordinate the integration of public transit into new and existing development, but the actual integration of public transit can only result from active participation and cooperation among Capital Metro, city government, developers, and the citizens of the Capital Metro service area.

The participation and cooperation of all segments of the community is dependent on having an informed community that is aware of the potential benefits of an efficient public transportation system at both the neighborhood and regional level. Informed citizens and developers can better support transit in areas where it is feasible, and recognize those areas where the provision of public transportation is not economically feasible or warranted.

The key to transit integration is the inclusion of transit related planning into the initial phase of any project design. The analysis of transit integration feasibility during the initial phases of project planning permits the most comprehensive evaluation of whether transit integration can benefit a specific project and the community. If it is determined that transit integration is feasible, then the site plan and building design can incorporate the necessary design and construction elements from the preliminary design phase, and avoid the expensive process of retrofitting a development.

This document attempts to aid the process of transit integration by providing the basic information that is required to evaluate the benefits and costs of transit integration from every perspective in the community. This is accomplished by presenting not only the benefits of transit, but also the impact of land uses and density upon transportation feasibility. While the transit handbook is comprehensive in the scope of areas it covers, it is not intended to replace specific site design planning.

Site specific design should be developed in cooperation with city regulations and Capital Metro guidelines, and should take into account the potential for changes in vehicle design and project expansion, and site specific constraints. The greater the number of transit integration projects along a given corridor, the more likely that Capital Metro can provide efficient and economic public transportation for the entire Capital Metro service area.

REFERENCES

1. Alameda Contra Costa Transit District, Guide for Including Public Transit in Land Use Planning. Oakland: Research and Planning Department Alameda Contra Costa Transit District, March 1983.

2. Alameda Contra Costa Transit District, Transit Facilities Standards Manual Oakland: Research and Planning Department Alameda Contra Costa Transit District, March 1983.

3. American Association of State and Highway Transportation Officials, A Guide for Design of Pavement Structures. Washington D.C. 1986.

4. American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets. Washington D.C., 1984.

5. Baker, E.B., Rebekah Baines Johnson Center. Austin, Texas. Interview, March 30, 1988.

6. Barba, Leon. Street and Bridge Division, City of Austin. Interview, April 1, 1988.

7. Bushell, Chris and Peter Stonham, eds., Janes Urban Transportation Systems. 2nd.Edition. London: Janes Publishing Co. Ltd., 1983.

8. Cervero, Robert, Suburban Gridlock. New Jersey Center for Urban Policy Research, Brunswick, New Jersey, 1986.

9. City of Austin, Texas, Transportation Criteria Manual. Austin, June1988.

10. City of Austin, Texas, Street Design Standards. Austin, 1986.

11. City of Austin, 1980 Census Reports. Department of Planning and Growth Management, Austin, 1986.

12. City of Seattle, Metro Transportation Facility Design Guidelines. Seattle: City of Metropolitan Seattle, April 1985.

13. Donnelly, Wayne. Jones Lang Wooton. Austin, Texas. Interview, April 14, 1988.

14. Greater Bridgeport Transit District, Joint Development and Fixed Route Bus Systems: Experience in Bridgeport Connecticut. Washington D.C.: Departmentof Transportation - Government Printing Office, January 1985.

15. Kilbride, Larry and Virgil Hedwell. Barton Creek Mall. Austin, Texas. Interview, April 13, 1988.

16. Kramp, E.W.. Hancock Center, Austin, Texas. Interview, March 30, 1988.

17. Lave, Charles A., ed., Urban Transit: The Private Challenge to Public Transportation. Cambridge: Ballinger Publishing Company, 1985.

18. Orange County Transit District, Consideration of Transit in Project Developmet. Orange County: Orange County Transit District, 1982.

19. Orange County Transit District, Design Guidelines for Bus Facilities. 2nd Edition. Orange County: Orange County Transit District, November 1987.

20. Pushkarev, Boris S., and Jeffrey N. Zupan, Urban Densities for Public Transportation. Springfield: National Technical Information Services, 1976.

21. Rajappan, B.M. and M.C. Walton, An Assessment of The Operantional Impact of Larger and Wider Combination Vehicles on the Geometry of Diamond Interchanges Center for Transportation Research, University of Texas at Austin, 1986.

22. Sacramento Regional Transit, Design Guidelines for Bus and Light Rail Facilities. Sacramento: Sacramento Regional Transit, October 1987.

23. Schneider, Michael J. and Rober C. Schaevitz. Private Investments in Public Transit. Presented at the Annual Meeting of the American Society of Civil Engineers, Anaheim, California, October 1987.

24. Southeastern Michigan Transportation Authority, Designing for Transit: A TransitDesign Criteria and Standards Manual. Detroit: Southeastern Michigan Transportation Authority, April 1982.

25. Texas State Department of Highways and Public Transportation, Highway Design Division Operations and Procedures Manual. Austin, 1986.

26. Texas State Department of Highways and Public Transportation, Texas Manual of Uniform Traffic Control Devices. Austin, 1980.

27. Texas State Department of Highways and Public Transportation, Vehicle Turning Characteristics for Use in Geometric Design. Highway Design Division: Austin 1987.

28. Transportation Research Board, National Cooperative Highway Research Program Report no. 155. "Bus Use of Highways Planning and Design Guidelines". Washington D.C.: Transportation Research Board National Research Council, 1975.

29. Transportation Research Board, National Cooperative Transit Research and Development Program Report no. 12. "Strategies to Implement Benefit-Sharing for Fixed-Transit Facilities". Washington D.C.: Transportation Research Board,1985.

30. Transportation Research Board, Transportation and Land Use on Major Activity Centers. Washington D.C.: Transportation Research Board, 1982.

31. Tri-County Metropolitan Transportation District of Oregon, Planning with Transit Land Use and Transportation Planning Coordination. Portland: Tri-County Metropolitan Transportation District of Oregon, 1979.

32. U.S. Department of Transporatation, Manual of Uniform Traffic Control Devices. Washington D.C.: Goverment Printing Office, 1978.

33. U.S. Department of Transportation, Streets for Pedestrians and Transit: Examples of Transit Malls in the U.S. Washirigton D.C.: Government Printing Office, 1972.

34. U.S. Department of Transportation, Transportation Planning Data for Urbanized Areas. Washington D.C.: Government Printing Office, 1987.

35. Transportation Research Board, Quick Response Urban Travel Estimation Techniques and Transferable Parameters-Users Guide. Washington D.C.: Transportation Research Board.

36. Texas Transportation Institute, Research Report 205-3 "Design Guidlines for Park-and-Ride Facilities". Texas A&M University, September 1978.

37. Pushkarev, Boris S. and Jeffrey N. Zupan, Public Transportation and Land Use Policy. Bloomingington: Indiana University Press, 1977.

38. Texas Transportation Institute, Report 339-7 "Procedures for Estimating Park-and-Ride Demand in Large Texas Cities". Texas A&M University, February 1987.

39. Livermore, Bob. Trammell Crow Company. Austin, Texas. Interview, Spring 1988.

40. Zapalac, George. Office of Land Development Services, City of Austin. Interview, Spring 1988.

41. U.S. Department of Transportation, New Directions in Urban Transportation. Washington D.C.: Government Printing Office, November 1985.

42. Bloomfield, Donald. New York Metropolitan Transit Agency. Interview, Spring 1988.

43. Callies and Frelich, Cases and Materials in Land Use. West Publishing Company, St. Paul, Minnesota, 1986.

44. AustinPlan Incentive Committee, "Draft Incentive Report". Unpublished, Austin, February 1988.

45. Johnson, Gregory, Private Development Station Improvements. Urban and Mass Transit Agency Symposium, New Orleans, March 1988.

46. Institute of Traffic Engineers, Trip Generation, Vol. 3. Institute of Traffic Engineers, Washington D. C., 1983.

47. Urban Land Institute, "Joint Development: Making the Real Estate-Transit Connection: Executive Summary". Urban Land Institute, Washington D.C., 1979.

48. Jenkins, Tom. Parsons, Brinkerhoff, Quaid, and Douglas, Interview, Spring, 1988.

NOTE: This reference list contains several references that are mentioned only in the supplementary document "Transit Facility Design Guide".

APPENDIX

EXAMPLES OF EXISTING TRANSIT INTEGRATED DEVELOPMENTS

APPENDIX:
EXAMPLES OF EXISTING TRANSIT INTEGRATED DEVELOPMENTS

Rebekah Baines Johnson Center

The R. B. Johnson Center is a housing complex of 250 apartments for senior citizens and is located at 21 Waller Street in Austin. Integrated bus service has been provided since it opened in 1972. Generally, the bus enters the parking lot and stops adjacent to the building to board passengers. Residents are able to take care of their shopping and downtown activities on a regular basis. The greater mobility provided helps them feel more independent by their not having to rely on family, friends or more expensive means of transportation such as taxi service. The residents are able to board the vehicle quickly without worrying about oncoming cars. It is the opinion of the center's administrator that Capital Metro serves the needs of the residents well (Ref 5).

The integrated facilities at the RBJ center are far from elaborate. At most they consist of properly designed curb returns and circulation streets. The minimal effort involved in providing convenient pick-up illustrates how little effort and how inexpensive successful transit integration can be. It should be noted however that if the parking lot and on sight circulation roads had not been properly designed, the service would not be able to operate.

Hancock Center

Hancock Center is a shopping center, with a large grocery store, three department stores, and several small shops, located near the intersection of IH 35 and Airport Blvd. in Austin, Texas. Capital Metro service to the center works well and is believed to increases retail trade. The property manager has observed that after the bus stops, the number of shoppers significantly increases. Many employees also utilize the transit service in commuting to and from work. The integrated transit facility at Hancock Center is incorporated into the main building. The bus is allowed to pull up and park next to a covered awning of the building. Passengers, waiting comfortably under the shelter, can board the bus with minimal effort.

Anderson Mill Shopping Center

The Anderson Mill Shopping Center is located at the intersection of US 183 and Lake Creek Parkway in northwest Austin. Capital Metro has operated a Park-and-Ride service there for approximately two years. The assistant property manager's opinion of the service is that it provides a community service and promotes goodwill toward the shopping center. The service helps sales: even though the anchor store has left, the center is "still alive." The Park-and-Ride service operates as a shared lot type facility. The transit service utilizes the unused portion of the center's lot for daily commuters. Problems of increased costs for parking lot maintenance , and litter collection have been experience by the center (Ref 13). These problems can be avoided at other locations by using proper pavement designs and by providing waste receptacles. Developers should consult the pavement design standards provided in this manual, and the provision of trash receptacles.

Barton Creek Mall

Barton Creek Mall is one of the largest shopping malls in Texas, and is located at Loop 360 and MoPac in Austin, Texas. Capital Metro has provided transit to one of the four main mall entrances for several years. Many employees ride the bus to work. Approximately one percent of the mall's annual shoppers, or several thousand customers per year, arrive by bus. The management at the mall feels that it is important to have the mall accessible to all who wishes to shop there. A person should not be deterred from shopping there simply due to a lack of automobile access.

The integrated facility simply consists of a bus stop adjacent to a main mall entrance. Also included in the mall's comprehensive plan is a bus lay over station. The layover station is located on the perimeter road of the mall, out of the way of heavy traffic and congestion. The layover station is far from elaborate. It consists of a bus stop strategically place near a widened section of roadway. The layover station allows busses to adjust their schedules so as to facilitate system wide scheduling. The layover station also allows the bus driver a few moments out of traffic to take a break (Ref 15).

ANNOTATED BIBLIOGRAPHY

Alameda Contra Costa Transit District, Guide for Including Public Transit in Land Use Planning. Oakland: Research and Planning Department Alameda Contra Costa Transit District, March 1983.

A guideline on the inclusion of "public transportation perspective" in development. The purpose of the booklet is to indicate the benefits derived from including public transit in the planning process. It considers the effect on transit that population densities, traffic generators, parking policies, transit orientation, transit corridors, and transit funding methods have.

Alameda Contra Costa Transit District, Transit Facilities Standards Manual Oakland: Research and Planning Department Alameda Contra Costa Transit District, March 1983.

The purpose of the standards manual is to develop uniform policies and standards for the design, construction, and operation of various transit related improvements. The document aims to encourage the inclusion of transit related facilities with other street improvement projects. The report includes information on design vehicles, geometric design standards, operational standards, structural standards, and guidelines on planning and site selection.

American Association of State and Highway Transportation Officials, A Guide for Design of Pavement Structures. Washington D.C. 1986.

This guide presents design factors, procedures and rehabilitation techniques for flexible (asphalt concrete) and rigid (portland cement concrete) pavements. The guide is used by many state highway agencies, including the Texas State Department of Highways and Public Transportation, in their pavement design procedures.

American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets. Washington D.C., 1984.

The "Green Book" discusses the design policies for streets and highways. The primary sections are: highway functions, design controls and criteria, elements of design, cross section elements, local roads and streets, collector roads and streets, rural and urban arterials, freeways, at grade intersections and grade separations, and interchanges.

AustinPlan Incentive Committee, "Draft Incentive Report". Unpublished, Austin, February 1988.

Describes examples of incentives to the private sector in exchange for the provision of specific public benefits. The emphasis is on incentives used in local land development.

Bushell, Chris and Peter Stonham, eds., Janes Urban Transportation Systems, 2nd.Edition. London: Janes Publishing Co. Ltd., 1983.

A catalog of public transit vehicles, transit systems, maintenance systems, equipment and consultants of the world. Includes manufacturer's addresses and some specifications.

Callies and Frelich, Cases and Materials in Land Use. West Publishing Company, St. Paul, Minnesota, 1986.

Covers classic zoning cases with summaries and comments. Includes a section on the legality of public/private partnerships and tax laws affecting joint development.

Cervero, Robert, Suburban Gridlock. New Jersey Center for Urban Policy Research, Brunswick, New Jersey, 1986.

Examines steps taken by municipalities to enlist the support of private interests in both reducing employee trip making and financing area wide improvements. The study is national in scope with detailed case studies and in depth insights into suburban traffic problems.

City of Austin, Texas, Policy on Geometric Roadway Design. Austin, 1987.

Sets forth specific design criteria for each type of street category and highways, and also presents alternative design criteria for developments located in watershed districts. Also discusses the design criteria for intersection design. Other areas for which design criteria are presented are: medians, turn lanes, driveways, pavement markings, signing, bikeways, and sidewalks.

City of Austin, Texas, Street Design Standards. Austin, 1986.

Collection of short reports, memos, and letters that provide general and technical data required for transit facilities in Austin. The information includes a section with the definitions of transit related terms, the classification of streets, and street design criteria by classification. Also includes sections on turning radii, swept paths, and the bus dimensions of the current Capital Metro inventory.

City of Austin, 1980 Census Reports. Department of Planning and Growth Management, Austin, 1986.

1980 demographic census data presented both by individual census tracts, and and for the City of Austin as a unit.

City of Seattle, Metro Transportation Facility Design Guidelines. Seattle: City of Metropolitan Seattle, April 1985.

A short manual discussing policies, guidelines, and basic design criteria for five basic areas: vehicle specifications and needs, transfer and destination points, high occupancy vehicle facilities, bus stops, and passenger information facilities. Included in the manual are turning templates for the critical design vehicle used in Seattle (a 60 foot articulated bus); figures of transit passenger shelters and information signs, and plan views of three types of bus stop areas: near side, far side, and mid block bus stops. Includes an extensive bibliography.

Greater Bridgeport Transit District, Joint Development and Fixed Route Bus Systems: Experience in Bridgeport Connecticut. Washington D.C.: Department of Transportation - Government Printing Office, January 1985.

Department of Transportation report number DOT-I-81-4. A case study of the experience of Bridgeport, Connecticut in its efforts to stimulate community and economic development in cooperation with fixed-route bus service. The report specifically looks at integrating commercial centers with the bus service and discusses innovative transit financing approaches as well as links between development and transit.

Institute of Traffic Engineers, Trip Generation, Vol. 3, Institute of Traffic Engineers, Washington, D.C. 1983.

The standard reference for estimating the number of vehicle trips generated from development. Based upon extensive national surveys and statistical analysis.

Johnson, Gregory, Private Development Station Improvements. Urban Mass Transportation Agency, Symposium, New Orleans, March 1988.

Describes New York Metropolitan Transit Authority's zoning ordinances which mandate private transit provisions for mid-town manhattan. Discusses Zoning with and without incentives.

Lave, Charles A., ed., Urban Transit: The Private Challenge to Public Transportation. Cambridge: Ballinger Publishing Company, 1985.

A look at privatization of public transportation services and operations. Explores options that can help transit do more with what is available and increase competition to provide alternative choices in service to attract more riders.

Orange County Transit District, Consideration of Transit in Project Development. Orange County: Orange County Transit District, 1982.

Brief history of Orange County transit system. Discusses benefits to everyone involved. Lists special considerations for including transit with development.

Orange County Transit District, Design Guidelines for Bus Facilities, 2nd Edition. Orange County: Orange County Transit District, November 1987.

This document was prepared for the purpose of providing uniform guidelines and design considerations for the design and placement of bus facilities and amenities in Orange County, California. The following six areas were considered in the preparation of this document: 1) basic bus operations, 2) current engineering practices in Orange County, 3) standards used by other transit operators, 4) amenities necessary for attracting and maintaining ridership, 5) possible benefits to participating developers, and 6) improvement compatibility with existing road uses.

Typical designs are provided for the following facilities and amenities: 1) pedestrian accessways, 2) bus turnouts, 3) bus stops, 4) bus shelters, 5) bus benches, 6) bus stop signs, 7) park-and-ride facilities, and 8) transit centers. Current bus fleet dimensions are provided along with bus turning radii and recommended road grades.

Pushkarev, Boris S. and Jeffrey N. Zupan, Public Transportation and Land Use Policy. Bloomingington: Indiana University Press, 1977.

A thorough overview of public transportation systems and how these systems are impacted by land use. Information provided includes the demand for transit services, the role of density, operating and capital costs, operating conditions, and the matching of supply and demand densities. The book also defines eight modes of public transportation, and dedicates a major portion of the book to rail transit.

Pushkarev, Boris S., and Jeffrey N. Zupan, Urban Densities for Public Transportation. Springfield: National Technical Information Services, 1976.

Examines the suitability of different urban densities to eight modes of public transit including dial-a-bus, local bus and express bus, and the effects of densities on user habits. Operating and capital costs are examined. Residential development density is explored in terms of public transit service along with other forms of density and development.

Rajappan, B.M. and C.M. Walton, An Assessment of The Operational Impact of Larger and Wider Combination Vehicles on the Geometry of Diamond Interchanges Center for Transportation Research, University of Texas at Austin, 1986.

Assesses the impact that Long Combination Vehicles would have on the geometric design of interchanges, with a special emphasis on diamond interchanges. Proposes general pavement width requirements necessary for diamond interchanges to accommodate the turning maneuvers of Long Combination Vehicles.

Sacramento Regional Transit, Design Guidelines for Bus and Light Rail Facilities. Sacramento: Sacramento Regional Transit, October 1987.

An extensive design handbook, detailing the steps necessary for successful transit-development integration. The report addresses many key areas of the integration process. It begins by studying overall project design, incorporating ideas of access, location , and density and how these characteristics effect transit circulation. The report also outlines design criteria for bus stops, turnouts,shelters, benches, berths, layover areas, and turnarounds. The report gives geometric requirements for bus turning radii, maximum grades, and exclusive bus lanes. Also included in the report is information on traffic signals, park-and-ride facilities, transit centers, and light rail. In conclusion, the report describes design guidelines for bicycle storage facilities and information signs. Included in the appendix are a glossary of transit terms, a chart of design vehicle specifications, and a list of references.

Schneider, Michael J. and Rober C. Schaevitz. Private Investments in Public Transit. Presented at the Annual Meeting of the American Society of Civil Engineers, Anaheim, California, October 1987.

This paper describes and analyzes the emerging roles of private sector contributions to transit finance and management. Nine projects are described. Project areas are Tampa, Los Angeles, Denver, Houston, New York, Boston, Atlantic City, the Dulles Corridor, and the Hudson Waterfront in New Jersey.

Southeastern Michigan Transportation Authority, Designing for Transit: A Transit Design Criteria and Standards Manual. Detroit: Southeastern Michigan Transportation Authority, April 1982.

This manual is designed for a broad audience. Part 1 addresses the ordinary citizen., while Part 2 is for the technical expert. Major sections include: "Transit and the Community", and "Technical Design Standards, and Criteria". Included is a glossary of terms and a transit checklist. Attractive manual with well designed illustrations and numerous photographs.

Texas State Department of Highways and Public Transportation, Highway Design Division Operations and Procedures Manual. Austin, 1986.

This manual provides guidelines and standards for preparation of right-of-way and construction of highways and associated facilities.

Texas State Department of Highways and Public Transportation, Texas Manual of Uniform Traffic Control Devices. Austin, 1980.

Adopted from the National Manual of Uniform Traffic Control Devices and expanded to include the specific requirement of the State of Texas. All traffic control devices placed by the state and local authorities are required to conform to the manual and its specifications.

Texas State Department of Highways and Public Transportation, Vehicle Turning Characteristics for Use in Geometric Design. Highway Design Division: Austin 1987.

This document discusses the Texas Truck Offtracking Model (TXTOM) a model that simulates the offtracking characteristics of a vehicle or vehicle combinations making a turn. The document includes templates to various scales of the offtracking characteristics of the AASHTO design vehicles.

Texas Transportation Institute, Report 339-7 "Procedures for Estimating Park-and-Ride Demand in Large Texas Cities". Texas A&M University, February 1987.

This manual provides guidelines for estimating the ridership demands that can be generated by the location of Park-and-Ride lots. The key to location is the existence of potential transit riders upstream of the projected Park-and-Ride location.

Texas Transportation Institute, Research Report 205-3 "Design Guidelines for Park-and-Ride Facilities". Texas A&M University, September 1978.

This report presents guidelines for designing bus Park-and-Ride facilities. Specifically, guidelines are developed for: 1)locating Park-and Ride lots; 2) determining the desired size of a Park-and-Ride lot; 3) evaluating the capacity of selected design components of the lot; and 4) establishing the physical layout of the parking area.

Transportation Research Board, National Cooperative Highway Research Program Report no. 155, "Bus Use of Highways Planning and Design Guidelines". Washington D.C.: Transportation Research Board National Research Council, 1975.

Guidelines for planning and designing preferential bus facilities in relation to freeways, arterials and terminals. Contains general guidelines on the design characteristics for each type of treatment discussed.

Transportation Research Board, National Cooperative Transit Research and Development Program Report no. 12, "Strategies to Implement Benefit-Sharing for Fixed-Transit Facilities". Washington D.C.: Transportation Research Board, 1985.

Summarizes important findings from seven case studies involving benefit-sharing practices among transit agencies. Identifies benefit-sharing opportunities, costs and benefits; transit agency experiences with benefit sharing strategies; and analysis techniques for use on different types of benefit-sharing strategies. Recommendations for implementing benefit-sharing techniques are also reviewed.

Transportation Research Board, Quick Response Urban Travel Estimation Techniques and Transferable Parameters-Users Guide. Washington D.C.: Transportation Research Board.

Provides guidelines and methods to quickly conduct travel demand forecasts for urbanized areas. Contains information regarding the estimation of trip generation, mode split, and distribution.

Transportation Research Board, Transportation and Land Use on Major Activity Centers. Washington D.C.: Transportation Research Board, 1982.

Discusses shaping a suburban activity center through transit and pedestrian incentives, land use changes in suburban clusters and corridors, defining regional employment centers and impacts of CBD fare-free transit on retail sales.

Tri-County Metropolitan Transportation District of Oregon, Planning with Transit Land Use and Transportation Planning Coordination. Portland: Tri-County Metropolitan Transportation District of Oregon, 1979.

An extensive manual covering many pertinent subjects with regards to transit integration into the development arena. The report is divided into seven sections including topics on Tri-Met organization and planning techniques, transit policy, transit science, regulations regarding development and transit in the Tri- County area, ride sharing advantages, and transit facility design and maintenance. The report also includes a worksheet used to determine wither a particular project is compatible with transit.

Urban Land Institute, "Joint Development: Making the Real Estate-Transit Connection: Executive Summary". Washington, D.C., Urban Land Institute, 1979.

Explores alternatives and benefits of joint development linked to public transportation. Types of arrangements and how they are made are discussed along with how transit planning can help joint development projects work. Looks at how communities can use transit to guide development.

U.S. Department of Transportation, Manual of Uniform Traffic Control Devices. Washington D.C.: Government Printing Office, 1978.

Extensively covers all traffic control devices including all signs, markings, and devices. Includes all technical specifications, placement considerations, and warrants.

U.S. Department of Transportation, New Directions in Urban Transportation. Washington D.C.: Government Printing Office, November 1985.

Contract number TX-06-0036, under direction of Rice Center. Details the numerous relationships which have emerged between the public and private sectors to provide transit facilities. Looks at why these relationships came about and who the participants are.

U.S. Department of Transportation, Streets for Pedestrians and Transit: Examples of Transit Malls in the U.S. Washington D.C.: Government Printing Office, 1972.

A study focusing on transit malls that incorporate regular bus routes into their design. The study includes an overview of development, existing transportation facilities, and the existing political and economic climate of the community.

U.S. Department of Transportation, Transportation Planning Data for Urbanized Areas. Washington D.C.: Government Printing Office, 1987.

Provides transportation information for major urbanized cities in the United States based upon data collected from the 1980 Census.