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16. Abstract

Through the research program with the Texas State Department of Highways and Public Transportation, the Texas Transportation Institute has been involved in extensive evaluations of park-and-ride facilities. The results of that research form the basis for this reference guide.

As park-and-ride facilities are being developed in Texas, the information presented in this guide assists transit officials, transportation planners, traffic engineers and other decision-makers involved in the planning, designing and implementation of these new facilities. Included in the guide is information on the following subject areas:

- A brief history of the development of park-and-ride in the U. S. and Texas;
- Characteristics of users and non-users of park-and-ride;
- Characteristics of the park-and-ride market area;
- Guidelines for locating and sizing park-and-ride lots;
- Park-and-ride demand estimation procedures;
- Important and unimportant features of park-and-ride; and

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GUIDELINES FOR PLANNING, DESIGNING AND OPERATING PARK-AND-RIDE LOTS IN TEXAS

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Research Report 205-22F
Priority Use of Transportation Facilities
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October 1983

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As part of Project 2-10-74-205, Texas Transportation Institute has been evaluating Texas park-and-ride facilities for more than 8 years. In years past, extensive on-board and home mail-out surveys were performed in the Dallas, Garland, Houston and Fort Worth areas. This year on-board transit user surveys were performed at park-and-ride lots in San Antonio and El Paso. In addition to the on-board survey data, information concerning current park-and-ride operations in Texas was also collected. In these data collection efforts, the Institute received considerable cooperation and assistance and would like to gratefully acknowledge the following individuals and agencies for their contributions to the study.

San Antonio

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Fort Worth

CITRAN: John Bartosiewicz

Austin

Austin Transit System: Tom Parker

ABSTRACT

Through the research program with the Texas State Department of Highways and Public Transportation, the Texas Transportation Institute has been involved in extensive evaluations of park-and-ride facilities. The results of that research form the basis for this reference guide.

As park-and-ride facilities are being developed in Texas, the information presented in this guide assists transit officials, transportation planners, traffic engineers and other decision-makers involved in the planning, designing and implementation of these new facilities. Included in the guide is information on the following subject areas:

- A brief history of the development of park-and-ride in the U.S. and Texas;
- Characteristics of users and non-users of park-and-ride;
- Characteristics of the park-and-ride market area;
- Guidelines for locating and sizing park-and-ride lots;
- Park-and-ride demand estimation procedures;
- Important and unimportant features of park-and-ride; and
- Design guidelines for park-and-ride facilities.

This guide is the last in a series of 22 reports prepared since Project 2-10-74-205, "Priority Use of Transportation Facilities," was initiated.

Key Words: Park-and-Ride, Park-and-Go, Kiss-and-Ride, User Surveys, Non-User Surveys, Transit Market Area, Transit Demand Estimation, Bus Loading Area, Long-Term Parking, Amenities, Mode Change Facilities, Bus Rapid Transit.

SUMMARY

The private automobile and public transportation are the 2 most commonly used means of urban transportation in the U.S. The park-and-ride concept represents an effective way of combining the automobile and transit by using each mode in the operating environment to which it is best suited. By using park-and-ride, commuters can drive to a conveniently located park-and-ride lot, park their vehicles or be dropped off and then transfer to a transit mode to complete their trips.

Development of Park-and-Ride

Park-and-ride made its first appearance in Texas in 1963 with the provision of a parking lot one mile outside of the Fort Worth CBD at the terminus of the subway operated by Leonard's Department Store. By the end of 1982, a total of 73 lots had been implemented in Texas: 15 in Houston, 7 in the Dallas/Garland area, 22 in the Fort Worth area, 15 in San Antonio, 5 in El Paso and 9 in Austin. Today, park-and-ride programs are a part of most major transit improvement plans. Typically, these park-and-ride programs include the provision of express bus service between park-and-ride lots located in suburban communities and a CBD or other major activity center. While not the total solution to urban congestion, parking, energy and pollution problems, park-and-ride can nevertheless make a contribution to reducing the severity of many of these problems.

This reference guide presents data and procedures that are useful to plan, design and operate new bus park-and-ride facilities in Texas.

Characteristics of Patrons and Non-Users of Park-and-Ride

In order to obtain information that will assist in the development of park-and-ride planning guidelines, surveys of both park-and-ride users and non-users were performed. The park-and-ride user surveys were undertaken in

Dallas/Garland, Houston, Fort Worth, San Antonio and El Paso, while the non-user surveys were performed in Dallas/Garland, Houston and Fort Worth. Selected personal and transportation characteristics of the users and non-users surveyed are presented in Tables S-1, S-2 and S-3, respectively.

Characteristics of the Park-and-Ride Market Area

The primary market area, or watershed, for park-and-ride service is the geographical area from which the users originate. The primary market area associated with park-and-ride is reasonably well defined, although variations in survey data suggest that market area is not the same for all park-and-ride lots as indicated in the following.

- Based on on-board survey results in the Dallas/Garland, Houston and Fort Worth areas, the "typical" market area might be defined as being parabolic in shape, with a vertex 0.5 to 1.0 mile downstream of the lot, an axis 7 miles in length following the major artery upstream of the lot, and a chord of 8 miles in length. Virtually all users of the park-and-ride service live within 7 miles of the lot they use.

- Surveys conducted by VIA Metropolitan Transit found that the "typical" market area in San Antonio has a noticeably different shape. At all lots except 2, approximately 85% to 95% of the park-and-ride users live within a circle having a diameter of 7.5 miles. A reluctance of users to backtrack (travel in a direction away from the final destination) causes the location of the park-and-ride lot within this circle to be slightly off-center.

- In Fort Worth, it was found the market area for one group of lots approximated the same parabolic dimensions as in Dallas/Garland and Houston. Analysis of the other group of lots, indicated that slightly more than 75% of the park-and-go patrons live within a circle that radiates 1.5 miles from the lot.

Guidelines for Locating Park-and-Ride Lots

The following guidelines should be considered in the process of selecting a park-and-ride lot location.

Table S-1: Summary of Personal Characteristics of Park-and-Ride Users

Characteristic	El Paso	San Antonio	Dallas/ Garland	Houston	Fort Worth	Non-Weighted Average
Age groups	(n=108)	(n=365)	(n=402)	(n=2289)	(n=107)	(n=328)
Less than 18	2%	3%	0%	0%	0%	1%
18 - 21	5	10	5	8	4	6
22 - 31	37	38	36	45	35	38
32 - 41	28	23	28	27	23	26
42 - 51	17	11	20	12	20	16
52 - 61	11	11	10	7	14	11
62 and over	0	4	1	1	4	2
Sex	(n=108)	(n=354)	(n=408)	(n=2348)	(n=111)	(n=3329)
Male	40%	45%	42%	42%	37%	41%
Female	60	55	58	58	63	59
Highest level of education	(n=109)	(n=362)	(n=371)	(n=2222)	(n=106)	(n=3170)
Less than high school	3%	5%	2%	1%	7%	4%
High school graduate	23	22	24	19	33	25
Some college	45	41	27	24	22	32
College graduate	25	23	33	42	10	27
More than college	4	9	14	14	18	12
Occupation	(n=108)	(n=343)	(n=396)	(n=2254)	(n=106)	(n=3207)
Unemployed	0.9%	0.0%	0.0%	0.1%	0.0%	0.2%
Homemaker	0.9	0.0	0.5	0.3	0.0	0.3
Student	8.4	14.6	2.5	1.4	0.0	5.4
Retired	0.9	0.3	1.0	0.1	0.9	0.7
Household worker	0.0	0.0	0.0	0.0	0.0	0.0
Laborer	2.8	0.0	.8	0.0	0.0	0.7
Operative	0.9	1.2	1.5	0.6	4.7	1.8
Service worker	2.8	8.5	1.3	0.4	5.6	3.7
Craftsman	0.9	2.0	1.5	1.0	9.4	2.9
Clerical	38.0	32.9	39.6	35.2	35.8	36.3
Sales	4.6	3.2	4.3	3.7	0.9	3.4
Managerial	13.0	17.8	18.7	17.1	14.1	16.2
Professional	25.9	19.5	28.3	40.1	28.3	28.4

Table S-2: Summary of Personal Characteristics of Non-Users of Park-and-Ride

Characteristic	Dallas/ Garland	Houston	Fort Worth	Non-Weighted Average
Age group	(n=198)	(n=751)	(n=290)	
Less Than 18	0%	1%	0%	0%
18 - 21	5	3	2	3
22 - 31	20	22	27	23
32 - 41	28	31	25	28
42 - 51	24	26	15	22
52 - 61	20	15	25	20
62 and over	3	2	6	4
Sex	(n=201)	(n=762)	(n=301)	
Male	70%	71%	68%	70%
Female	30	29	32	30
Highest level of education	(n=187)	(n=738)	(n=294)	
Less than high school	3%	4%	4%	4%
High school graduate	21	17	21	20
Some college	22	22	26	23
College graduate	36	33	26	32
More than college	18	24	23	21
Occupation	(n=194)	(n=781)	(n=296)	
Unemployed	0.0%	0.0%	1.0%	0.3
Homemaker	0.0	0.0	0.4	0.1
Student	4.1	3.7	2.7	3.5
Retired	0.0	0.0	0.0	0.0
Household worker	0.0	0.0	0.0	0.0
Laborer	0.5	0.1	1.0	0.5
Operative	2.1	0.9	3.1	2.1
Service worker	2.5	2.2	5.4	3.4
Craftsman	4.2	6.1	5.7	5.4
Clerical	15.4	11.5	10.5	12.5
Sales	12.4	10.2	6.4	9.7
Managerial	29.9	31.0	8.1	23.0
Professional	28.9	34.3	55.1	39.5

Table S-3: Overview of Selected Characteristics of Users and Non-users of Park-and-Ride in Dallas/Garland, Houston and Fort Worth

Characteristic	Dallas/Garland		Houston		Fort Worth	
	Users	Non-Users	Users	Non-Users	Users	Non-Users
Age group						
Less than 18	0%	0%	0%	1%	0%	0%
18 - 21	8	5	8	3	4	2
22 - 31	45	20	45	22	35	27
32 - 41	27	28	27	31	23	25
42 - 51	12	24	12	26	20	15
52 - 61	7	20	7	15	14	25
62 and over	1	3	1	2	4	6
Sex						
Male	42%	70%	42%	71%	37%	68%
Female	58	30	58	29	63	32
Highest level of education						
Less than high school	2%	3%	1%	4%	7%	4%
High school grad.	24	21	19	17	33	21
Some college	27	22	24	22	22	26
College graduate	33	36	42	33	10	26
More than college	14	18	14	24	18	23
Occupation						
Clerical	39.6%	15.4%	35.2%	11.5%	35.8%	10.5%
Managerial	18.7	29.9	17.1	31.0	14.1	8.1
Professional	28.3	28.9	40.1	34.3	28.3	55.1
All Other	13.4	25.8	7.6	23.2	21.8	26.3
Mode of travel to work or school[1]						
Drove alone	50%	69%	49%	70%	63%	83%
Carpool/vanpool	11	25	17	27	15	12
Local bus	11	4	8	2	8	3
Did not make trip	25	---	24	---	9	---
Other	3	2	2	1	5	2
Length of time at present address (years)						
50th percentile	1.7	5.5	1.4	4.2	2.9	5.0
85th percentile	7.5	16.0	6.7	10.0	16.7	16.1

[1]This is the previous mode of travel for park-and-ride users and the current mode of travel for non-users.

- Park-and-ride service will generate the greatest ridership in travel corridors that experience intense traffic congestion.
- The park-and-ride lot should be located in advance of the more intense traffic congestion.
- Lots should be located at least 4 to 5 miles from the activity center being served.
- Given appropriate development patterns, there appears to be no outer limit concerning how far a lot can be located from the activity center.
- The lot should be located in a geographic area having a high affinity to the activity center being served.
- As the total population in the park-and-ride market area increases and as the percentage of that population working in the activity center served by the park-and-ride operation increases, so will park-and-ride lot utilization.
- Lots should be developed with both good access and good accessibility.
- There should be no charge for parking at the park-and-ride facility.
- If the current number of park-and-ride spaces available are sufficient to handle "all" the demand from a given watershed, other lots in that same travel corridor should be located no closer than 4 to 5 miles.
- Park-and-ride service should not be expected to compete with local bus routes.

Park-and-Ride Demand Estimation Procedures

Using information that is generally available for urban areas in Texas, 3 different procedures can be used to estimate potential park-and-ride utilization.

- **Market Area Population** - The percentage of the total population living in the park-and-ride watershed that is represented by ridership at the park-and-ride lot, i.e., (ridership ÷ market area population) X 100.

Data indicate that relationships exist between ridership and market area population. The following guidelines appear to be applicable.

City	Ridership as a Percent of Market Area Population
Houston	0.7% to 2.0%
Dallas Area	0.4% to 1.3%
San Antonio	varies up to 1.2%
Austin	0.3% to 0.6%
Fort Worth	0.05% to 0.3%
El Paso	0.07% to 0.4%

Other data suggest that, at properly located lots in congested corridors with priority bus service, perhaps as much as 2.5% to 3% of the total market area population could be served by park-and-ride.

- **Modal Split** - The percentage of the person-trips that originate in the park-and-ride watershed, terminate in the activity center served by park-and-ride, and actually use the park-and-ride service.

  Existing park-and-ride lots in the Dallas area are typically serving 10% to 20% of demand (i.e., 10% to 20% of the persons living in the market area served by the park-and-ride lot and working in the activity center served by the park-and-ride buses). In Houston, this percentage is typically 15% to 30%. Data suggest that park-and-ride lots have the potential to serve 50% modal splits.

- **Regression Equations** - The data base is evaluated in all possible manners to develop equations that can be used to estimate park-and-ride patronage.

In evaluating a potential lot site, it is suggested that all 3 procedures (described in more detail in Chapter 6) be used to provide a range of estimates. That range can then be used as a basis for further planning and decision-making.

Guidelines for Sizing Park-and-Ride Lots

It is suggested that a new park-and-ride facility should contain at least 250 all-day parking spaces. If the new lot has only a single bus loading area, as is typically characteristic of the lots in Texas, the size of the lot should not exceed about 1,800 to 1,900 all-day parking spaces (Table S-4).

Table S-4: Summary of Constraints on Park-and-Ride Lot Size Per Bus Loading Area

Constraint	Number of All-Day Parking Spaces
Constraints on Maximum Size	
Walking Distance	1,000-1,900
Bus Headways (Service)	1,400
Suggested Guideline	**1,800-1,900**
Constraint on Minimum Size	
Bus Headways (Service)	250
Suggested Guideline	**250**

Important and Unimportant Features Of Park-and-Ride Service

Based on the park-and-ride user surveys conducted in El Paso, San Antonio, Dallas/Garland, Houston and Fort Worth, it appears that the following are the most important features to consider when planning a new park-and-ride service.

- Monetary savings;
- Reliable bus service;
- Direct bus service;
- A park-and-ride lot close to home; and
- Convenient access to the park-and-ride lot.

Data from the household surveys of non-users in Dallas/Garland, Houston and Fort Worth suggest that the provision of the following would further increase park-and-ride utilization.

- Bus travel times shorter than auto travel times; and
- Bus stops closer to final destinations.

Lesser important park-and-ride features (based on user survey responses) include new, modern buses and off-peak service. Some of these "unimportant" features are relatively expensive to provide. Non-user survey responses suggest that the provision of newspapers and magazines and lot visibility from the roadway are not likely to have much effect on increasing park-and-ride patronage.

Design Guidelines for Park-and-Ride Facilities

During the design phase of park-and-ride development, a number of different components should be addressed including:

- The coordination of traffic near the lot;
- The internal lot design; and
- The provision of various lot amenities.

Coordination of Traffic Near Park-and-Ride Facilities

In general, it appears that about 40% of daily directional traffic on the roadways leading to the park-and-ride facility occurs during the peak hour and that 30% of peak-hour traffic occurs in the peak 15 minutes. This traffic should not experience long delays or conflicts. Ways of accomplishing this objective include proper entrance/exit location, traffic control devices and placement of directional and informational signs. To minimize possible adverse effects on the surrounding traffic flow patterns, the following guidelines are suggested.

Access/Egress

- The most efficient access point to a park-and-ride lot will usually be from a collector or local street rather than from a major arterial or freeway ramp.

- Should it be necessary to provide access on an arterial route, entrances should be located so as to avoid queues from nearby intersections or freeway interchanges.

- If a choice readily exists, it may be desirable for the park-and-ride lot to be located on the right side for inbound traffic.

- Entrances and exits should be located as far from intersections as possible and preferably at midblock.

- When a park-and-ride lot is located on the left side of a 2-way arterial for inbound traffic, left-turn storage is desirable to accommodate inbound vehicles in the morning.

- Access to the lot by feeder systems (local transit, kiss-and-ride, bicycles, etc.) should be provided when the need is apparent.

- In planning the access points for a park-and-ride lot, separate entrance/exit roads for the transit vehicles are desirable.

- Table S-5 provides a summary of automobile access/egress requirements at park-and-ride lots. The actual number of entrance/exit locations required at the lot to accommodate the required number of lanes will depend on whether the access points are designed as 1-way entrance and exit drives or as common (2-directional) entrance and exit drives.

Table S-5: Auto Access/Egress Requirements for Varying Park-and-Ride Demands

Design Demand[1] (Vehicles/Day)	Minimum Number of Directional Lanes
Less than 750	1 in each direction
750 to 1,500	2 in each direction
1,500 to 2,250	3 in each direction

[1]Based on 40% of the total demand arriving during the peak hour and a capacity of 300 vehicles per hour per lane.

Traffic Signals

- The nature of the traffic generated by a park-and-ride lot is usually not sufficient to warrant a separate traffic signal for the lot.

Signing

- Directional and informational signs along major routes and on the streets leading to the park-and-ride facility should be provided to introduce the service to commuters and make the lot easier to access.

Internal Lot Design Guidelines

In many respects, the layout of a park-and-ride lot is similar to the layout of a regular parking lot. Park-and-ride lots are different, however, in that they must accommodate transfers between automobiles and buses; they must provide some short-term as well as long-term parking and they must be designed to handle most of their traffic in 2 short peak periods daily. In addition, certain amenities are often provided at park-and-ride lots which are not found at regular parking lots.

Bus Loading Area. The bus loading area represents the focal point of the park-and-ride facility. In most instances, the location of the bus loading area adjacent to the parking facility (rather than within the facility) is preferred. In general, for the types of park-and-ride operations that will exist in Texas, 2 to 3 bus loading spaces will be needed at each bus loading area.

Patron accumulation at the bus loading area in the morning is a critical value in shelter design. Park-and-ride lots which operate on relatively short (3 to 10 minute) headways during peak periods will tend to keep patron accumulation at the shelter/loading area to a minimum. Data at 2 Houston lots indicated that patron accumulation as a percentage of peak period ridership in the range of 4% to 9% might be used as design guidelines. In general, at least 4 square feet of shelter space should be provided per person.

Location of Different Parking Functions. Several different types of parking will typically be included in the lot. In terms of proximity to the bus loading area, handicapped parking, bicycles and motorcycles should be

immediately adjacent to the loading point; kiss-and-ride parking should be given the next priority; the park-and-ride all-day parking area will generally be the farthest removed from the bus-loading area.

Handicapped Parking

- Preferably, it should not be necessary for handicapped patrons to cross any internal circulation roadways or travel behind parked cars in order to reach the bus loading area.
- As a general guideline, approximately 0.5% to 1% of the total parking spaces should be devoted to handicapped parking.

Bicycles and Motorcycles

- If a site appears to have the potential for many bicyclists or motorcyclists, space can be provided near the bus loading area in which to park.

Kiss-and-Ride Parking

- An area that allows kiss-and-ride, taxi, paratransit, or other short-term parking only should be set aside and clearly marked as 20-minute parking.
- Average dwell time per vehicle in the evening is a critical design variable in determining the number of kiss-and-ride spaces to provide. A design dwell time in the range of 7.5 minutes appears appropriate.
- As a general guideline, it appears that 1% to 3% of the total parking spaces in a park-and-ride lot should be devoted to the kiss-and-ride operation.

Long-Term Parking

- By far, the most used access mode is the automobile that is driven to the park-and-ride lot and left all day.
- Park-and-ride all-day parking is generally designed to be right-angle parking with the aisles aligned normal to the bus loading area to facilitate pedestrian movement.

Pedestrian Flow Patterns

- The distance a patron has to walk from his/her car to the bus loading area should generally not exceed 650 feet.
- To assist in laying out a park-and-ride lot the coefficient of directness may be used where:

$$C = \text{coefficient of directness} = \frac{\text{designated walking path distance}}{\text{straight-line distance}}$$

- Pedestrian flow patterns should be designed so that this coefficient of directness does not exceed a value of 1.2; 1.4 should be considered a maximum value.

IMPLEMENTATION STATEMENT

Project 205 is oriented toward assisting the Department in the planning, implementation and evaluation of priority treatment projects. Park-and-ride facilities are an integral part of these improvements.

Numerous new park-and-ride lots continue to be built in the state, and the Department is frequently involved in planning and funding those improvements. The information presented in this reference guide should enhance the cost-effectiveness of future park-and-ride improvements.

DISCLAIMER

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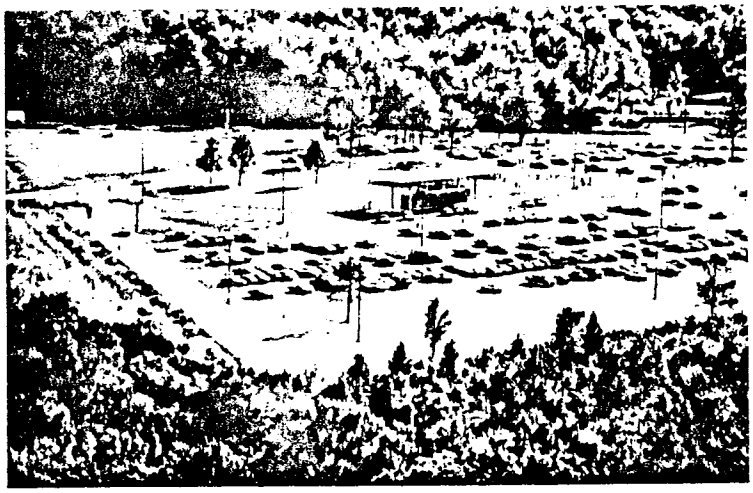
Chapter 1



Introduction

1 Introduction

During the last several decades, the intensity of development in the central business district (CBD) and other major activity centers in the larger cities of Texas has continued to increase. At the same time, relatively low land costs and the widespread use of the private automobile have caused low density residential development to occur farther from these centers of business activity. This pattern of development has resulted in increasingly larger numbers of commuters traveling increasingly longer distances to reach their place of work. Furthermore, this trend is expected to continue.

Along with the growth of the major activity centers and the outward movement of residential development has come the need for increasing the capacity of the transportation facilities which link these areas together. During the 1950's and the better part of the 1960's, the need for increased vehicular capacity along heavily traveled corridors was generally met by constructing new roadway facilities. By the 1970's, however, the construction of new facilities had been curtailed due to cost considerations, land availability and environmental and energy concerns. As a result, considerable effort is now being concentrated in the area of increasing the person movement capacity of the existing transportation systems.

The Park-and-Ride Concept

Public transportation represents an implementable, relatively low cost alternative means of increasing the person movement capacity of existing transportation systems without major new construction. However, the pattern of development which is characteristic of the major cities in Texas has made providing effective transit service between low density residential areas and high density activity centers difficult. Furthermore, transit service, while economical and effective in moving large numbers of persons between fixed

points, is neither economical nor efficient in providing the collection/distribution service at the low density end of the trip (i.e., within the residential areas) (1)*. The park-and-ride concept, however, has proven to be an effective way of combining the automobile and public transportation by using each mode in the geographic area to which it is best suited. Because the automobile is used for the initial collection part of the journey, park-and-ride is able to draw trips from a relatively large market area to a point where there is enough concentrated demand to support public transit. For this reason, park-and-ride is especially suited to low density areas which may not otherwise be able to support fixed-route transit service (2). Although the park-and-ride concept is applicable to both bus and rail transit, this report addresses its application to bus transit.

By using park-and-ride, patrons avoid high activity center parking costs and driving on congested streets. Community benefits are also realized, including a reduction in the number of vehicles using the highways and entering the activity center, a reduction in the demand for activity center parking and the possible revitalization of transit service (3). The use of transit on the line-haul portion of the trip also has positive effects on pollution and energy consumption.

Park-and-ride has an inherent flexibility in that existing parking areas, either unused or partially unused, can be utilized initially. Then, if a sufficient demand is generated, new lots can be built at a subsequent date. Bus service can usually be readily implemented. Or, if the demand proves to be insufficient, service can be terminated.

The type of service available at park-and-ride lots may vary. The buses may or may not provide direct express service from the park-and-ride lot to the activity centers. In many cases, the transit service utilizes freeway facilities for a portion of the line-haul trip; although in many instances, freeway facilities are not used. Also, although priority treatment is sometimes given to buses serving park-and-ride lots, this is not an essential or even typical feature of park-and-ride service.

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*Numbers in parentheses refer to references listed at the end of the report.

The need for park-and-ride is influenced by a number of factors, including traffic congestion, activity center parking costs, and trip purpose. Park-and-ride is most likely to operate successfully where congestion is a problem, activity center parking costs are high, existing fixed-route transit service is not readily available at the surburban trip end (but can be reached by auto), and where a major share of work trips are concentrated in one or more major activity centers. In such instances, commuters can drive to a park-and-ride lot, park their vehicles or be dropped off, and then transfer to a bus to complete their trips. The park-and-ride lot accumulates the transit demand, and the transit service can then serve the high volume, line-haul travel between fixed points. Furthermore, park-and-ride users do not completely forsake the comfort and convenience of using their automobiles. As long as the transit headways are kept short, patrons are still able to leave their homes when they choose and receive relatively direct transportation to their destinations.

To be successful, park-and-ride operations must offer advantages over comparable travel by automobile. Incentives must exist to attract Texans away from their single-occupant automobiles. Free or low-cost parking at the park-and-ride lots offers an important incentive in attracting potential users. Ideally, the 2-way transit fare plus the parking cost (if any) should be such that the transit user perceives some monetary savings from using transit.

Other advantages of park-and-ride to the user include the following:

- Not having to drive in heavy traffic congestion;
- Assurance of a parking space at the park-and-ride lot, whereas activity center parking might be scarce;
- Extra security protection for cars parked at the park-and-ride lot;
- Increased convenience by reducing walking distance and time required at the trip destination; and
- Possible time savings, especially where priority treatment for buses is available.

This alternative form of transportation service offers potential benefits both to the users and to the community. As a result, considerable additional development of park-and-ride facilities is being pursued throughout the state. This reference guide presents data and procedures for use in planning, designing and operating new bus park-and-ride facilities in Texas.

Reference Guide Content

During the past 8 years, the following major park-and-ride studies have been performed by the Texas Transportation Institute.

- Park-and-Ride Facilities: Preliminary Planning Guidelines. Research Report 205-2, 1975.
- Design Guidelines for Park-and-Ride Facilities. Research Report 205-3, 1979.
- Factors Influencing the Utilization of Park-and-Ride: Dallas/Garland Survey Results. Research Report 205-11, 1980.
- Houston Park-and-Ride Facilities - An Analysis of Survey Data. Research Report 205-15, 1981.
- Guidelines for Estimating Park-and-Ride Demand. Technical Report 1064-IF, 1981.
- Fort Worth Park-and-Go Facilities - An Evaluation of Survey Data. Research Report 205-19, 1982.

These 6 studies along with analyses of recent San Antonio and El Paso park-and-ride survey data form the basis of this reference guide. Research into various aspects of park-and-ride was supplemented with pertinent information from related research conducted in other areas of the United States.

This reference guide is designed for use by transit officials, transportation planners, traffic engineers and other decision-makers involved in the planning, designing or implementation of park-and-ride facilities in Texas. The guide is designed to allow the user to refer to the Table of Contents to identify those sections which are of specific interest. In addition to this introductory chapter, the guide is comprised of the following 8 chapters.

- **Chapter 2 - The Development of Park-and-Ride.** A brief history of the development of park-and-ride in the United States and Texas is outlined. In addition, alternative forms of park-and-ride, such as park-and-go and express bus service, are discussed. Finally, a summary of existing park-and-ride facilities and services in Texas is presented.

- **Chapter 3 - Characteristics of Patrons and Non-Users of Park-and-Ride.** This chapter begins by presenting a comparison of personal and transportation characteristics of park-and-ride users in Dallas, Garland, Houston, Fort Worth, San Antonio and El Paso. Next, characteristics of non-users in Dallas, Garland, Houston and Fort Worth are compared. Finally, a comparison between users and non-users of park-and-ride service is made.

- **Chapter 4 - Characteristics of the Park-and-Ride Market Area.** The typical size and shape of the primary area from which a park-and-ride lot draws its patronage is described. The percentage of users that reside within the primary market area is also presented.

- **Chapter 5 - Guidelines for Locating Park-and-Ride Lots.** Generalized guidelines for use in developing alternative sites for park-and-ride facilities are presented.

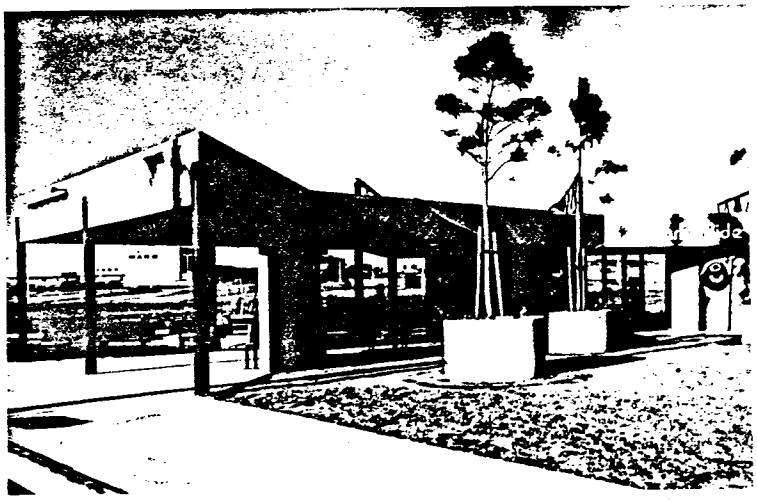
- **Chapter 6 - Park-and-Ride Demand Estimation Procedures.** Upon the selection of desired lot location(s), certain guidelines can be followed to determine the range of potential demand which can be expected at the park-and-ride lot. Three different demand estimation procedures (which would use information generally available for urban areas in Texas) are described.

- **Chapter 7 - Guidelines for Sizing Park-and-Ride Lots.** Given an average daily demand estimate, the size of the lot(s) that should be developed to accommodate that demand can be determined. Various factors which influence the number of parking spaces that should be provided are outlined, and generalized guidelines for sizing park-and-ride facilities are presented.

- **Chapter 8 - Important and Unimportant Features of Park-and-Ride Service.** Those features of the existing park-and-ride service which were most and least important to the users in their decision to use park-and-ride are identified. In addition, the relative importance of making various improvements to the existing service in order to attract new riders is identified.

- **Chapter 9 - Design Guidelines for Park-and-Ride Facilities.** Generalized guidelines for designing bus park-and-ride facilities are presented including vehicular access and egress and internal lot design (location of the bus loading area, location of different parking functions, pedestrian flow patterns, etc.).

Chapter 2



The Development of Park-and-Ride

2 The Development of Park-and-Ride

Like many transportation services which have been implemented in recent years, the park-and-ride concept is not new. In fact, bus park-and-ride facilities have been in existance in the United States for more than 40 years. For example, in the late 1930's, the City of Detroit opened 8 small park-and-ride lots at gasoline stations located at various points along existing transit lines. None of these lots were considered successful, however, and all were subsequently discontinued (1).

Perhaps the first major bus park-and-ride facility in the U.S. was the 1,000-space lot opened in the St. Louis suburb of Forest Park in 1953. Transit service linked this lot to the St. Louis CBD located about 5 miles away (1).

Two years later, the Port Authority of New York and New Jersey implemented a bus park-and-ride lot to serve Manhattan. Constructed at the west end of the Lincoln Tunnel in North Bergen, New Jersey, the lot offered 1,600 spaces and transit service was provided between New Jersey and Manhattan. The year 1955 also marked the beginning of park-and-ride service in the Washington, D.C. metropolitan area. An 900-car lot at the Carter Barron Amphitheater in northwest Washington, D.C. was used, and buses served the 22-minute trip between the lot and the downtown area (3).

By the middle 1960's, more than 36 cities in the United States had implemented some form of park-and-ride service, and that service was still operational in at least 28 of those cities (2). Numerous other cities followed in the 1970's and early 1980's.

Park-and-ride made its first appearance in Texas in 1963 with the provision of a parking lot one mile outside of the Fort Worth CBD at the terminus of the subway operated by Leonard's Department Store. By the end of 1982, 7 major Texas cities (Houston, Dallas, Garland, Fort Worth, San Antonio, El Paso and Austin) had implemented a total of 73 lots.

Many of the earlier park-and-ride facilities differed somewhat from those being considered today. Only minimal planning went into the initial facilities, and the emphasis was more on accommodating existing demand than on generating new demand. Today, however, park-and-ride programs are a part of most major transit improvement plans. While not the total solution to the congestion, parking, energy and pollution problems currently faced by many large urban areas, park-and-ride can nevertheless make a contribution to reducing the severity of these problems.

Types of Park-and-Ride Service

Bus park-and-ride services can generally be classified by the location and type of park-and-ride lot and by the type of transit service provided to the users.

Location of the Lot

Park-and-ride services may be designed to serve different segments of the journey. In this sense, there are primarily 3 types of park-and-ride: remote, local and peripheral.

Remote Park-and-Ride. Remote park-and-ride facilities provide a change of mode from a suburban or satellite community to a major activity center by intercepting the auto trip near its origin. Remote lots are located relatively far from the ultimate destination (4-30 miles), yet are usually near the residential concentration which constitutes the primary market area for the service. Most commuters arrive at these lots by automobile, although some walk or use other modes to the lot. Generally speaking, remote park-and-ride facilities offer a transit alternative for suburban areas which would not otherwise be able to support fixed-route transit service (4). The majority of park-and-ride lots in Texas are remote facilities.

Local Service Park-and-Ride. A local service park-and-ride facility is simply an additional stop designated along an existing local bus route. Demand for this service comes from residential neighborhoods located along

the transit route (4). This type of facility can be found in Fort Worth where approximately 22 local service "Park-and-Go" lots have been established.

Peripheral Park-and-Ride. Peripheral park-and-ride operations are similar to remote park-and-ride in that they provide transit service to a major activity center. However, these lots are characterized by the location at the edge of the particular activity center being served. Unlike the remote operations, the commuter completes most of the journey by car and switches to transit for the final segment of the trip (generally less than 1.5 miles in length). Shuttle or local service routes are then used to transport commuters into the activity center. Peripheral lots often function to expand activity center parking availability (2,4). The Reunion lot located adjacent to the Dallas CBD is an example of a peripheral park-and-ride operation in Texas as is the Fort Worth lot serving the Tandy Center (the lot originally built to serve Leonard's Department Store).

Type of Lot

Park-and-ride lots may be either single-use or joint-use facilities. A single-use lot is one, such as the North Shepherd lot in Houston, which has been specifically constructed to serve as exclusive parking for park-and-ride patrons. A joint-use lot serves more than one parking purpose. A joint-use lot utilizes the unused portion of an existing parking lot to serve as the parking area for the park-and-ride service. An example of this operation is the Windsor Park Mall facility in San Antonio. Sites commonly used in this shared-use lot arrangement include shopping centers, movie theatres, stadiums, and churches.

Type of Transit Service Available at Park-and-Ride Lots

In general, remote bus park-and-ride facilities are served by express transit service to one or more destinations (i.e., CBD, major industrial park, major medical center complex). The express bus service may operate in mixed traffic and/or on an exclusive busway or high occupancy vehicle (HOV) lane. Express bus service may be categorized as:

- **Full express** - point to point service;
- **Limited express** - non-stop service along a portion of a route only; or
- **Link express** - service with stops at a selected few major points on the route (5).

Local service (or park-and-go) facilities, are served by local transit routes, and provide patrons with transportation to any number of destinations along a specified route. Peripheral park-and-ride operations use shuttle buses or local service routes to transport patrons.

The general nature of remote, local service and peripheral park-and-ride operations is illustrated in Figure 1. It should be noted, however, that the distinction as to which category a particular lot belongs in is not always clear. Some facilities, such as the Wonderland lot in San Antonio, are served by both express and local bus service, thereby making the determination between "remote" and "local service" relatively subjective.

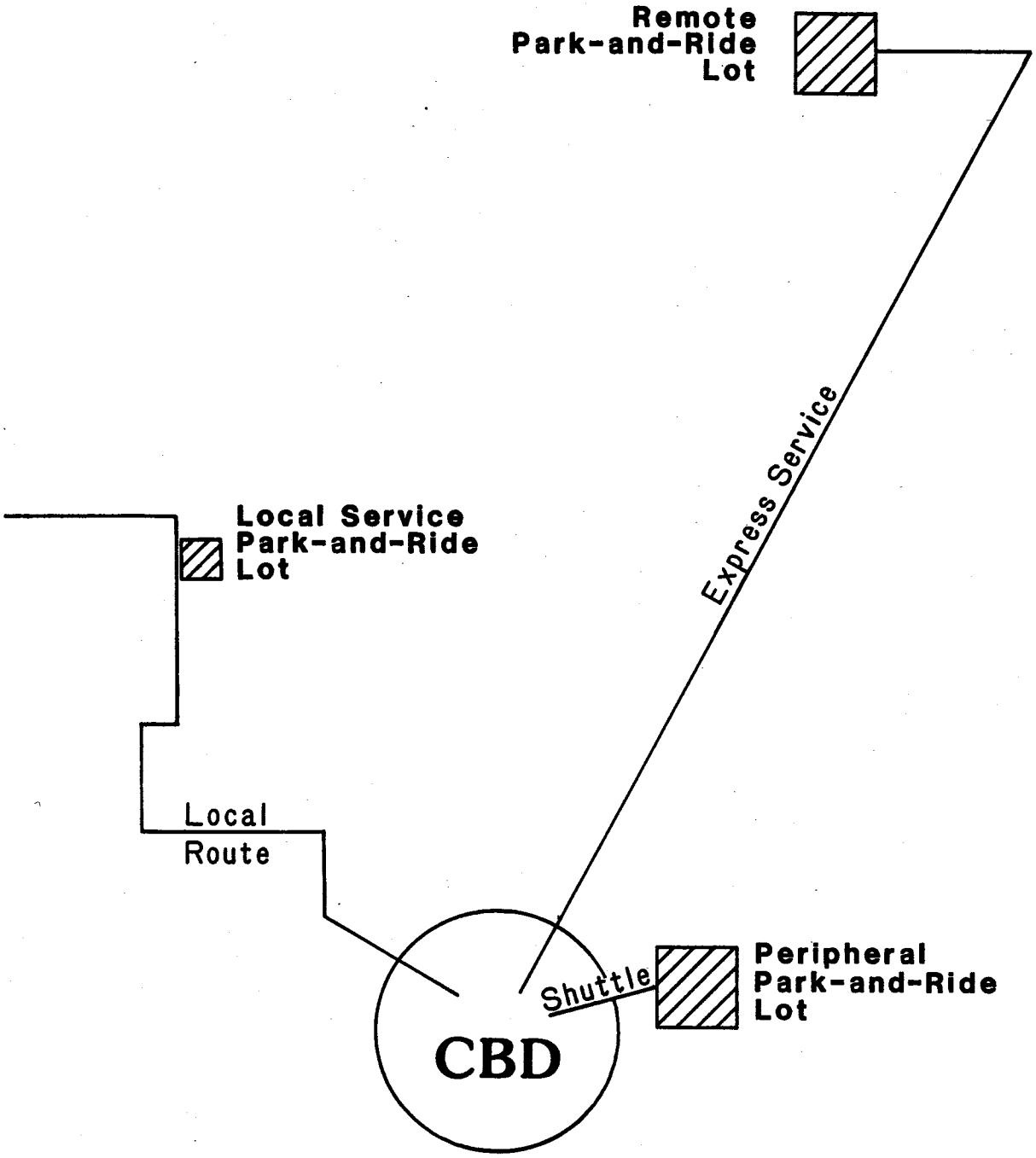
The guidelines developed in this report pertain primarily to remote lots with express service.

Benefits of Park-and-Ride

Many potential benefits are associated with the implementation of park-and-ride. Because park-and-ride facilities generally intercept trips made by auto and divert them to transit, a reduction in the number of vehicles used and the number of vehicle-miles traveled are realized. This, in turn, results in benefits to the area being served, such as:

- Decreased demand for activity center parking;
- Reduced energy consumption and air pollution emissions; and
- Reduced traffic congestion.

These benefits, which have become important considerations in the last decade, are discussed in more detail in the following sections.



Source: Reference 4.

Figure 1: Remote, Peripheral and Local Service Park-and-Ride Lots

Demand for Parking

Park-and-ride services are designed to divert parking from a destination where parking is scarce or expensive to an area where parking is more readily available or less expensive. However, the provision of a specified number of park-and-ride spaces will not reduce parking demand at the destination by the same amount since park-and-ride attracts transit users and carpoolers as well as auto drivers. While some park-and-ride patrons shorten their auto trips, other commuters who formerly made their entire trip by public transit or by riding as a passenger in a private vehicle will begin to drive to the park-and-ride lot. Thus, the number of parking spaces that are diverted is equal to the number of park-and-ride users who formerly made their entire trip by driving an auto (2); as shown subsequently in this report, this represents about half of Texas park-and-ride patrons. When large numbers of these former auto drivers switch to park-and-ride and leave their cars at lots located on less expensive land in outlying areas, the more valuable land in or near the activity center (which had previously been reserved for parking) can then be put to a more intensive use. For example, the park-and-ride lots serving the Contraflow Lane in Houston are reducing the demand for parking downtown by about 2,000 spaces. This reduces the need to provide the equivalent of approximately 10 to 20 acres of parking in downtown Houston.

Energy Consumption, Air Quality and Congestion

The implementation of park-and-ride service is an effective means of conserving energy as well as reducing air pollution and traffic congestion. These benefits are achieved by a reduction of vehicle-miles traveled (VMT) that result from the diversion of auto trips to transit trips. The extent to which each of the potential benefits is realized, however, depends on the type of park-and-ride lots and the level of usage they receive. Remote lots, which are located farther from their ultimate destinations, can yield the greatest benefits. Peripheral lots will not have as significant an effect, since the transit portion of the trip is small relative to the total trip length (4).

Energy Use. By leaving their vehicles at specially designated lots and riding transit to the CBD or other major activity center, commuters will use less fuel for transportation. Often not considered in the evaluation of park-and-ride services as energy savers, however, is the fact that the development of the park-and-ride lots also involves an expenditure of energy. For example, fuel is consumed by the vehicles used in lot construction and materials hauling. Also, the materials themselves require energy from mining or manufacturing processes. The energy used in these types of activities is referred to as "indirect" energy or energy "implementation costs." The issue then becomes at what point will direct fuel savings (that which results from commuters switching to transit for the major portion of their trips) exceed the "indirect" energy expenditure involved in the development of the park-and-ride lot (6). Research (6) into the questions of "direct" and "indirect" energy use associated with both a "typical" park-and-ride operation in Texas and actual operations in the Dallas/Garland/Fort Worth area revealed that:

- The distance vehicles must travel to their destination appears to have considerable impact on energy savings and the indirect energy payback time. Because of the fuel saved by autos not traveling to the major activity center, lots located farther from the destination generally would result in more energy savings and would therefore take less time for construction energy payback.

- The fuel efficiency of buses has a minor impact on indirect energy payback time. This is probably a result of the relatively small proportion of direct energy use (about 12% of the total) attributed to bus use.

- Largely due to the relatively small impact of bus fuel use on total direct fuel consumption for the lot, the impact of bus load factor on energy savings was not as significant as had been thought.

- The impact of varying lot sizes, assuming a similar lot usage rate, was found to have only a slight effect on indirect energy payback time.

- All factors considered, indirect energy expenditures can be accounted for by direct energy savings in less than 3 years of lot operation in most cases examined.

- In some cases (peripheral lots), park-and-ride may increase energy use.

- Auto fuel efficiency rates would have to be very high, about 100 mpg, before the prototype lot becomes ineffective as an energy-saving measure.

In general, park-and-ride does offer significant fuel savings for those trips it is able to serve. However, the relative magnitude of park-and-ride fuel savings in relation to total transportation fuel consumption for the state (and nation) is minimal due to the low percentage of total trips that can realistically be accommodated by park-and-ride.

Air Pollution. In most cases, the reduction in VMT associated with park-and-ride will also result in an overall reduction in hydrocarbons and other air pollutants. Studies have shown, however, that a vehicle with a cold engine emits more pollution than a warmed-up one (2,7). Therefore, the emission of pollutants by an automobile is somewhat higher on a short trip than on a longer one. Thus, a park-and-ride lot which attracts a large number of short trips without diverting many long trips may fail to reduce overall pollution levels. In addition, the effects of pollution will vary from one area to another, depending on the amount of pollutants already present in the air. For example, a surburban park-and-ride facility which provides service to a CBD will probably be effective in improving the air quality of the CBD, but the pollution output will have increased in the vicinity of the park-and-ride lot. Furthermore, most of these auto trips to the lot will be short, resulting in a slightly higher emission rate. Even when such is the case, however, an overall reduction in air pollutants will usually occur.

Traffic Congestion. Park-and-ride service, by definition, will reduce the number of vehicles entering the activity center it serves. The number of vehicles which are diverted is equal to the number of park-and-ride users who formerly drove the entire trip to their destinations. The overall effect of park-and-ride in reducing traffic congestion is not always readily apparent, however, because those vehicles which have been diverted to park-and-ride lots are frequently replaced by other vehicles (latent demand). This is particularly evident in urban areas which are experiencing rapid rates of growth.

In addition, although park-and-ride will reduce traffic congestion at or near the destination it serves, it may increase congestion levels at or near the park-and-ride facility. The overall effect of park-and-ride on congestion is highly dependent on existing conditions in the areas affected by park-and-ride traffic.

Potential Effects of a Park-and-Ride Lot on Fuel Consumption, Air Quality and Congestion. As a means of demonstrating the impact on freeway energy consumption, air quality, and congestion, the FREQ simulation model was used. As an example, it was assumed that a 1,200 car park-and-ride lot was built on the Southwest Freeway (US 59) in Houston at a location 10 miles from downtown (in the vicinity of Gessner).

It was assumed that the lot was fully occupied, thereby serving approximately 1,400 persons. It was also assumed that, during the 3-hour peak period, the presence of that lot would remove 800 downtown destined autos (500 during the peak hour); 35 buses would depart from the lot during that period. The impact of this improvement on freeway operations is shown in Table 1.

Table 1: Impact of a Park-and-Ride Lot on Freeway Energy Consumption, Air Quality, and Congestion Per 3-Hour Peak Period

Freeway Evaluation Factor	Freeway Conditions	
	Without Park-and-Ride	With Park-and-Ride
Person-hours of travel	6,029	4,754 (-21%)
Average speed (mph)	43	53 (+23%)
Gasoline consumption (gallons)	11,037	10,630 (- 4%)
Pollutants emitted (kilograms)		
Hydrocarbons	536	475 (-11%)
CO	3,552	2,872 (-19%)
NO	746	759 (+ 2%)

Notes: Based on implementing a 1200-space, fully-utilized park-and-ride lot along a highly congested 6 and 8 lane freeway a distance of 10 miles from downtown. Based on FREQ computer simulation analysis.

When properly located, park-and-ride facilities are cost-effective approaches for improving transportation. An evaluation of a "typical" park-and-ride lot identified a benefit cost ratio in excess of 2.5.

The park-and-ride lot reduces fuel consumption by about 4%, with 10% to 20% reductions in HC and CO emissions. The impact on congestion is also noticeable, with overall freeway operation being improved by about one level-of-service.

Cost-Effectiveness of Park-and-Ride. The data from the FREQ model were used to develop an estimate of the benefit-cost ratio associated with the park-and-ride lot. In performing the analysis, the following assumptions were used.

- Initial lot cost including right-of-way = $4,500,000
- Daily cost for transit service = $5,000
- Annual operating/enforcement cost = $25,000
- Project life = 15 years with 10% discount rate
- Value of time = $6/passenger-hour
- Cost of fuel = $1.20 per gallon

The resulting benefit/cost ratio for this type of improvement is 2.53.

Existing Park-and-Ride Service in Texas

Park-and-Ride service was first implemented in Texas 20 years ago (1963) with the provision of a parking lot at the terminus of the Leonard's Department Store subway in Fort Worth. Since that time, park-and-ride has become an increasingly popular travel alternative; by the end of 1982, Houston, Dallas, Garland, Arlington, Irving, Euless, San Antonio, El Paso and Austin had followed Fort Worth's example. A brief description of the existing services in these urban areas is presented in the following pages.

Fort Worth

Fort Worth refers to its service as "Park-and-Go." This name was selected to distinguish the type of transit service (local, generally non-express) provided by CITRAN in Fort Worth, Arlington, Irving and Euless from

the express service provided by the Dallas Transit System (DTS) in Dallas and Garland. A total of 22 park-and-go facilities were in operation at the end of 1982. Characteristics of these lots and the transit service provided are presented in Tables 2 and 3, respectively. Figure 2 shows the location of the lots.

Parking Facility Characteristics. Fort Worth's park-and-go program has taken advantage of the non-capital intensiveness of this form of transit operation. Arrangements have been made with various local organizations and groups (churches, shopping centers, etc.) to utilize unused portions of their existing lots. These parking areas are provided to the city at no cost and public expenditure involved in placing them into service is minimal.

Transit Service. All of the park-and-go lots are located adjacent to existing local bus routes with the lots representing additional stops along the previously established routes.

Dallas/Garland

In November 1973, Dallas opened its initial park-and-ride facility on the North Central Expressway (US 75) to complement an Urban Corridor Demonstration Project (1). Today, the Dallas Transit System provides service to 5 park-and-ride facilities in the Dallas area and 2 in Garland. Characteristics of these lots and the transit service are outlined in Tables 4 and 5. The lot locations are illustrated in Figure 3.

Parking Facility Characteristics. At present, a total of 3,935 parking spaces, 19 kiss-and-ride spaces, and 11 handicapped parking spaces are provided at the 7 Dallas/Garland park-and-ride facilities. Approximately 57% of the total number of park-and-ride spaces are currently utilized on a typical day.

Transit Service. Characteristics of the transit service are shown in Table 5. Approximately 2,347 commuters currently utilize the 7 Dallas/Garland park-and-ride facilities on an average day.

Table 2: Characteristics of Fort Worth Park-and-Go Lots, 1982

Park-and-Go Lot	Lot Location	Lot Capacity				Lot Amenities							
		Parking Spaces	Kiss-and-Go Spaces	Handicapped Spaces	Spaces Used	Shelter	Security Personel	Security Lighting	Newsstand	Telephone	Vending Machines	Pavement Condition	Shared Lot
Springdale Baptist Church	3016 Selma	← None are specifically designated for Park-and-Go →			3	no	↑	↑	↑	no	↑	↑	↑
Northeast Mall	Loop 820 @ SH 183				25	no				no			
First United Meth. Church	Bedford Rd. @ Airport Fwy.				77	no				no			
First Baptist Chruch Euless	Hwy 157 @ Airport Fwy.				31	no				no			
Arlington Stadium	Randol Mill Rd.				135	no				no			
Six Flags	I-30 @ Turnpike Motor Lodge				129	no				yes			
Brentwood Chruch of Christ	6516 Brentwood Stair				90	no				no			
Ft. Worth Bible Church	Terbert @ Brentwood Stair				10	no				no			
Jefferson Unitarian Church	1950 Shady Lane				10	no				no			
Handley Meth. Church	2929 N. Forest Street				71	no				no			
Handley Baptist Church	6800 Church Street				2	no				no			
Herman E. Clark Stadium	TCJC Folwell Dr./Eastside				12	no	no	no	no	no	no	good	yes
K-mart	4812 South Fwy.				15	yes				no			
St. Mark's Meth. Church	6250 South Fwy.				10	no				no			
St. Luke's Pres. Church	1404 Sycamore School Rd.				1	no				no			
Edgepark Meth. Church	5616 Crowley Rd.				59	no				no			
K-Mart	Altamesa / McCart				22	no				no			
Altamesa Church of Christ	4600 Altamesa				6	no				no			
Tanglewood Village	3100 Hulen				71	no				no			
Sound Warehouse	7100 Camp Bowie Blvd.				6	yes				no			
Ridglea Baptist Church	6037 Calmont				51	yes				no			
Arlington Hts. Christ Church	4600 Camp Bowie Blvd.				5	no	↓	↓	↓	no	↓	↓	↓

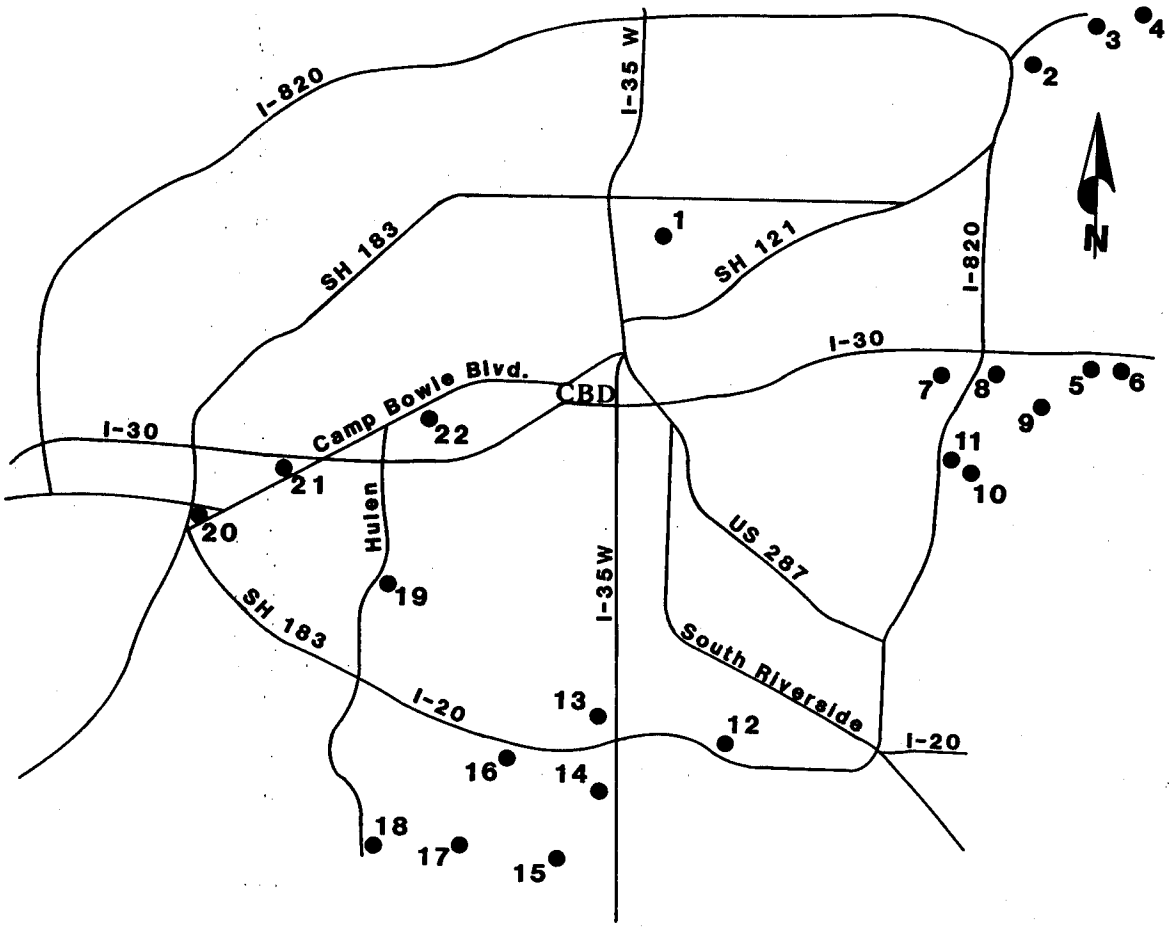
Source: Reference 8.

Table 3: Characteristics of Fort Worth Park-and-Go Service, 1982

Park-and-Go Lot	Transit Service				Distance To Activity Center[2] (miles)	Travel Time To Activity Center (minutes)	Number of A.M. Peak Buses	Number Of Riders[3]
	Fare[1] (one-way)	A.M. Peak Headways (minutes)	Service Midday	Express Service				
Springdale Baptist Church	$ .75	40	yes	no	5.0	20	2	3
Northeast Mall	$ .75	N/A[4]	N/A	N/A	N/A	N/A	N/A	25
First United Meth. Church	$ .75	N/A	N/A	N/A	N/A	N/A	N/A	77
First Baptist Church, Euless	$ .75	N/A	N/A	N/A	N/A	N/A	N/A	31
Arlington Stadium	$ .75	N/A	N/A	N/A	N/A	N/A	N/A	135
Six Flags	$ .75	N/A	N/A	N/A	N/A	N/A	N/A	129
Brentwood Church of Christ	$ .75	N/A	N/A	N/A	N/A	N/A	N/A	90
Ft. Worth Bible Church	$ .75	1 trip only	no	yes	8.1	25	1	10
Jefferson Unitarian Church	$ .75	30	no	no	9.6	40	2	10
Handley Meth. Church	$ .75	30	yes	1 trip only	8.0	44	3	1
Handley Baptist Church	$ .75	30	yes	1 trip only	7.5	28	3	2
Herman E. Clark Stadium	$ .75	45	yes	no	11.0	50	2	12
K-Mart (South Freeway)	$ .75	15	yes	no	5.8	30	6	15
St. Mark's Meth. Church	$ .75	1 trip only	no	yes	10.0	30	1	10
St. Luke's Pres. Church	$ .75	1 trip only	no	yes	11.5	40	1	1
Edgepark Meth. Chruch	$ .75	30	yes	no	7.5	37	3	59
K-Mart (Altamesa)	$1.25	1 trip only	no	yes	9.3	30	1	22
Altamesa Chruch of Christ	$ .75	15	yes	yes	11.5	45	2	6
Tanglewood Village	$ .75	15	yes	yes	6.6	25	2	1
Sound Warehouse	$ .75	25	no	1 trip only	7.4	31	2	6
Ridglea Baptist Church	$ .75	10	no	yes	5.4	15	4	51
Arlington Hts. Christ. Church	$ .75	15	yes	no	3.6	18	5	5

[1] $27.00 monthly pass is also available.
[2] "Activity Center" refers to Fort Worth CBD.
[3] Ridership recorded in 2-way person-trips per day.
[4] N/A = current information is not available.

Source: Reference 8.



LEGEND

1. Springdale Baptist Church
2. Northeast Mall
3. First United Methodist Church
4. First Baptist Church, Euless
5. Arlington Stadium
6. Six Flags
7. Brentwood Church of Christ
8. Ft. Worth Bible Church
9. Jefferson Unitarian Church
10. Handley Methodist Church
11. Handley Baptist Church
12. Herman E. Clark Stadium
13. K-Mart
14. St. Mark's Methodist Church
15. St. Luke's Presbyterian Church
16. Edgebrook Methodist Church
17. K-Mart
18. Altamesa Church of Christ
19. Tanglewood Village
20. Sound Warehouse
21. Ridglea Baptist Church
22. Arlington Heights Christian Church

Figure 2: Location of Park-and-Go Lots in the Fort Worth Area

Table 4: Characteristics of Dallas/Garland Park-and-Ride Lots, 1982

Park-and-Ride Lot	Lot Location	Lot Capacity				Lot Amenities							
		Parking Spaces	Kiss-and-Ride Spaces	Handicapped Spaces	Spaces Used	Shelter	Security Personnel	Security Lighting	Newsstand	Vending Machines	Telephone	Pavement Condition	Shared Lot
North Central	Coit Rd. @ Churchill Way	482	0	0	400	yes	no	yes	yes	no	yes	poor	yes
Pleasant Grove	Seaford @ Maddox	710	0	0	200	yes	no	no	no	no	no	good	yes
Redbird	Redbird Airport	302	0	4	220	yes	no	yes	yes	no	yes	good	yes
Garland North	Fifth @ Walnut	320	9	3	200	yes	yes	yes	yes	yes	yes	good	no
Garland South	NW Hwy @ Jackson Dr.	446	10	4	300	yes	no	yes	yes	no	yes	good	no
Las Colinas	SH 114 @ O'Connor Rd.	175	0	0	110	yes	yes	yes	yes	no	yes	good	no
Reunion[1]	Memorial Dr. @ Sports St.	1,500	0	0	820	yes	yes	yes	no	no	no	good	yes

[1] CBD peripheral lot with shuttle service.

Source: Reference 8.

Table 5: Chracteristics of Dallas/Garland Park-and-Ride Service, 1982

Park-and-Ride Lot	Transit Service				Distance To Activity Center[1] (miles)	Travel Time to Activity Center (minutes)	Number of A.M. Peak Buses	Number of Riders[2]
	Fare (one-way)	A.M. Peak Headways (minutes)	Midday Service	Express Service				
North Central	$1.20	5	yes	limited[3]	10.9	30	14	420
Pleasant Grove	$1.20	8	yes	limited[3]	10.0	30	11	220
Redbird	$1.50	20	no	yes	11.0	23	2	230
Garland North	$2.50	5	yes	limited[4]	20.7	50	14	215
Garland South	$2.50	5	yes	yes	15.3	35	14	330
Las Colinas	$2.20	20	no	yes	13.9	29	2	112
Reunion	$ .25[5]	6	yes	no	0.5	5-10	8	820

[1] "Activity Center" refers to the Dallas CBD.
[2] Ridership recorded in 2-way person-trips per day.
[3] Partial local stops/partial freeway express.
[4] All trips semi-express to Garland-South Lot then full express.
[5] Bus fare (round trip $ .50) included in $1.00 parking fee.

Source: Reference 8.

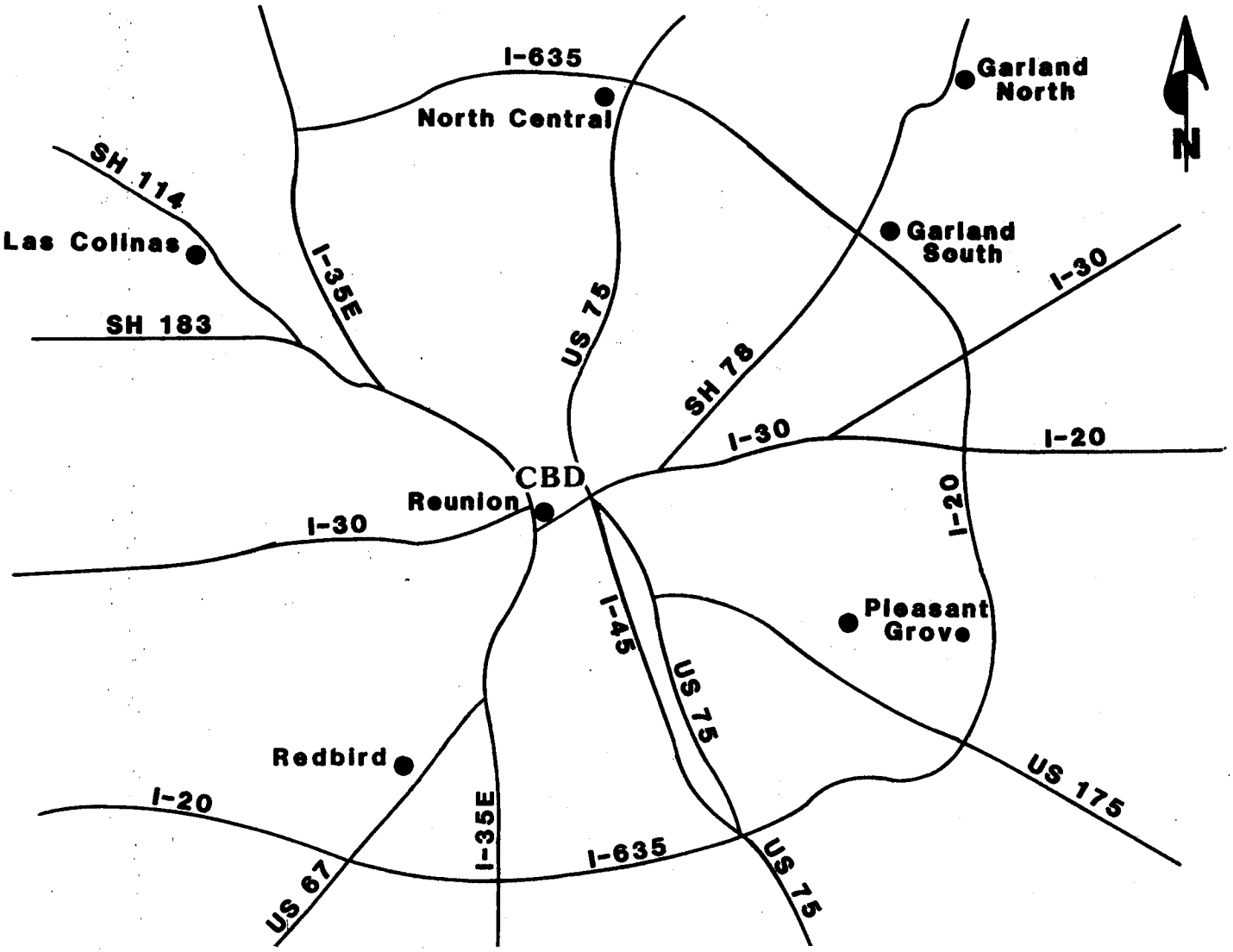


Figure 3: Location of Park-and-Ride Lots in the Dallas/Garland Area

Austin

The City of Austin initiated its park-and-ride service as part of a transportation energy conservation program. The initial service was offered from a theatre parking lot on the city's north side in March 1974. Two additional lots were opened 5 months later in south Austin (1). By the end of 1982, the Austin Transit System provided service to a total of 9 park-and-ride facilities. The Austin CBD/University of Texas area is the destination of 8 of these lots while the ninth offers express service to and from the Internal Revenue Service Center. Characteristics of the Austin park-and-ride facilities and service are presented in Tables 6 and 7. Specific lot locations are pictured in Figure 4.

Parking Facility Characteristics. Like Fort Worth, the City of Austin has made arrangements with various shopping centers, theatres, etc. to utilize the unused portion of existing parking facilities for park-and-ride patron parking. The number of spaces alloted to park-and-ride varies from 25 to 100 spaces.

Transit Service. All 9 of Austin's park-and-ride facilities offer express bus service to their destinations. The number of patrons utilizing any one of Austin's park-and-ride facilities varies from 6 to 69 on a typical day, with the total number of riders at all lots averaging 172.

San Antonio

The City of San Antonio implemented its first park-and-ride facilities in 1974. Two lots were opened that year, one located at Wonderland Shopping Center and another located at McCreless Shopping Center (1). A total of 15 park-and-ride facilities with service to the San Antonio CBD and the University of Texas at San Antonio (UTSA) is currently provided by VIA Metropolitan Transit Authority. Characteristics of these facilities and the service provided at them are noted in Tables 8 and 9, respectively, and various lot locations are presented in Figure 5.

Table 6: Characteristics of Austin Park-and-Ride Lots, 1982

Park-and-Ride Lot	Lot Location	Lot Capacity				Lot Amenities							
		Parking Spaces	Kiss-and-Ride Spaces	Handicapped Spaces	Spaces Used	Shelter	Security Personnel	Security Lighting	Newsstand	Vending Machines	Telephone	Pavement Condition	Shared Lot
North #1	Research @ Northgate	25	0	0	15	no	no	yes	yes	yes	yes	good	yes
North #2	Lamar @ Rundberg	25	0	0	15	no	no	yes	yes	yes	yes	good	yes
Northcape	Rundberg @ Middle Fiskville	50	0	0	10	no	no	yes	no	no	no	good	yes
US 183 North #1	Research @ Spicewood Springs	50	0	0	30	no	no	yes	yes	yes	yes	good	yes
US 183 North #2	Research @ Balcones Wood Dr.	40	0	0	30	no	no	yes	yes	yes	yes	good	yes
US 183 North #3	Far West @ Hart Lane	30	0	0	15	no	no	yes	no	no	no	good	yes
Fox Theatre	Airport @ Pampa	75	0	0	70	no	no	yes	no	no	no	good	yes
Southwest	US 290W @ Toney Burger Ctr.	100	0	0	10	no	no	yes	no	no	no	good	yes
South	S. First @ Wm. Cannon	40	0	0	18	no	no	yes	yes	yes	yes	good	yes

[1] Park-and-ride lots with "yes" marked have access to these amenities by way of the stores located on the parking site.

Source: Reference 8.

Table 7: Characteristics of Austin Park-and-Ride Service, 1982

Park-and-Ride Lot	Transit Service				Distance To Activity Center[2] (miles)	Travel Time To Activity Center[2] (minutes)	Number of A.M. Peak Buses	Number of Riders[2]
	Fare[1] (one-way)	Headways (minutes)	Midday Service	Express Service				
North #1	$ .90	1 trip only	no	yes	10.3	35	1	11
North #2	$ .90	1 trip only	no	yes	10.3	30	1	11
Northcape	$ .90	1 trip only	no	yes	10.8	22	1	4
US 183 North #1	$1.00	15	no	yes	16.0	40	3	64
US 183 North #2	$1.00	15	no	yes	16.0	30	3	64
US 183 North #3	$ .90	15	no	yes	16.0	25	3	64
Fox Theatre	$ .90	5	no	yes	IRS-9.0	IRS-20	2[4]	69
Southwest	$ .90	30	no	yes	6.0	30	2	6
South	$ .90	30	no	yes	9.5	27	2	18

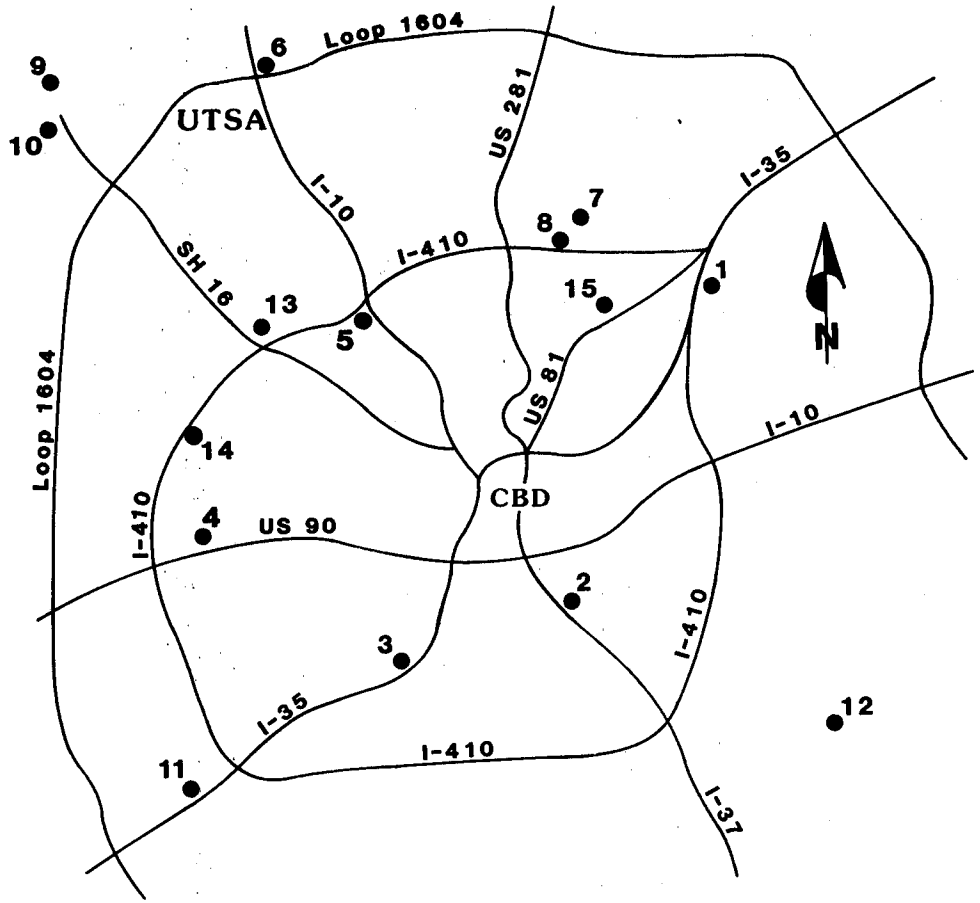
[1] Park-and-ride passes are also available. Fares are distance based. $30/mo. based on 4.90 fare and $34/mo. based on $1.00 fare.

[2] "Activity Center" refers to Austin CBD unless otherwise noted.

[3] Ridership recorded in 2-way person-trips per day.

[4] Add 1 extra bus during tax season.

Source: Reference 8.



LEGEND

1. Windsor Park Mall
2. McCreless
3. South Park Mall
4. Kel-Lac
5. Wonderland
6. University
7. Bitters/MacArthur Plaza
8. Broadway/K-Mart
9. Helotes (United Methodist Church)
10. Helotes (Our Lady of Guad. Church)
11. Von Ormy
12. Elmendorf
13. Ingram
14. Northside
15. Terrell Plaza

Figure 4: Location of Park-and-Ride Lots in the San Antonio Area

Table 8: Characteristics of San Antonio Park-and-Ride Lots, 1982

Park-and-Ride Lot	Lot Location	Lot Capacity				Lot Amenities							
		Parking Spaces	Kiss-and-Ride Spaces	Handicapped Spaces	Spaces Used	Shelter	Security Personnel	Security Lighting	Newsstand	Vending Machines	Telephone	Pavement Condition	Shared Lot
Windsor Park Mall	I-35 @ Walzem	170	0	1	123	yes	no	yes	no	no	yes	good	yes
McCreless	S. New Braunfels @ Ada	75	0	1	31	yes	no	yes	no	no	yes	good	yes
South Park Mall	S.W. Military @ Zarzamosa	70	0	1	24	yes	no	yes	no	no	yes	good	yes
Kel-Lac	Highway 90 @ Military Dr.	173	0	1	94	yes	no	yes	no	no	yes	good	no
Wonderland	Gill @ Wonderland	322	0	1	285	yes	no	yes	yes	no	yes	good	no
University	Loop 1604 @ I-10	152	0	0	26	no	no	yes	no	no	no	good	no
Bitters/MacArthur Plaza	Bitters @ Nacogdoches	66	0	1	24	yes	no	yes	no	no	no	good	yes
Broadway/K-Mart	Broadway @ Gulfmart	63	0	1	3	yes	no	yes	no	no	no	good	yes
Helotes[1]	United Meth. Church @ Hwy 6	32	0	0	0	no	no	no	no	no	no	good	yes
Helotes[2]	Guadalupe Church @13,715 Riggs	15	0	0	2	no	no	no	no	no	no	good	yes
Von Ormy	Tex Mart Truck Stop @ Frontage	15	0	0	0	no	no	no	no	no	no	good	yes
Elmendorf	St. Anthony Church @ Kilowatt	10	0	0	0	no	no	no	no	no	no	fair	yes
Ingram	Ingram @ Wurzbach	125	0	1	23	yes	no	yes	no	no	yes	good	yes
Northside	Northside Stadium @ Loop 410	50	0	1	1	no	no	yes	no	no	no	good	yes
Terrell Plaza	Bryn Mawr @ Chevy Chase	60	0	1	1	yes	no	yes	no	no	no	good	yes

[1]United Methodist Church
[2]Our Lady of Guadalupe Church

Source: Reference 8.

Table 9: Characteristics of San Antonio Park-and-Ride Service, 1982

Park-and-Ride Lots	Transit Service				Distance To Activity Center[1] (miles)	Travel Time To Activity Center[1] (minutes)	Number of A.M. Peak Buses	Number of Riders[2]
	Fare[1] (one-way)	A.M. Peak Headways (minutes)	Midday Service	Express Service				
Windsor Park Mall	$ .75	15.8	yes	yes	10.5	20	8	234
McCreless	$ .75	24.0	yes	yes	4.4	8	6	254
South Park Mall	$ .75	24.2	yes	yes	6.1	15	4	75
Kel-Lac	$ .75	15.0	yes	yes	9.6	18	8	647
Wonderland	$ .75	CBD-10.6 UTSA[3]-11.2	yes	yes	CBD-7.6 UTSA-N/A[4]	CBD-13 UTSA-17	CBD-14 UTSA-10	590
University	$1.00	15.8	yes	yes	16.0	28	9	31
Bitters/MacArthur Plaza	$ .75	21.0	yes	yes	10.6	38	5	36
Broadway/K-Mart	$ .75	21.1	yes	yes	8.6	31	5	3
Helotes (United Meth. Church)	$ .85	22.1	no	yes	14.9	46	3	N/A
Helotes (Our Lady of Guadalupe Church)	$ .85	22.1	no	yes	14.9	46	3	7
Von Ormy	$ .85	1 trip only	no	yes	15.4	36	1	8
Elmendorf	$ .50	1 trip only	no	no	N/A	39	1	N/A
Ingram	$ .40	19.2	yes	no	9.2	36	7	74
Northside	$ .40	19.2	no	no	11.0	47	4	2
Terrell Plaza	$ .40	44.1	yes	no	5.5	21	3	12

[1] "Activity Center" refers to the San Antonio CBD unless otherwise noted.
[2] Ridership recorded in 2-way person-trips per day.
[3] UTSA = University of Texas at San Antonio.
[4] N/A = Current information is not available.

Source: Reference 8.

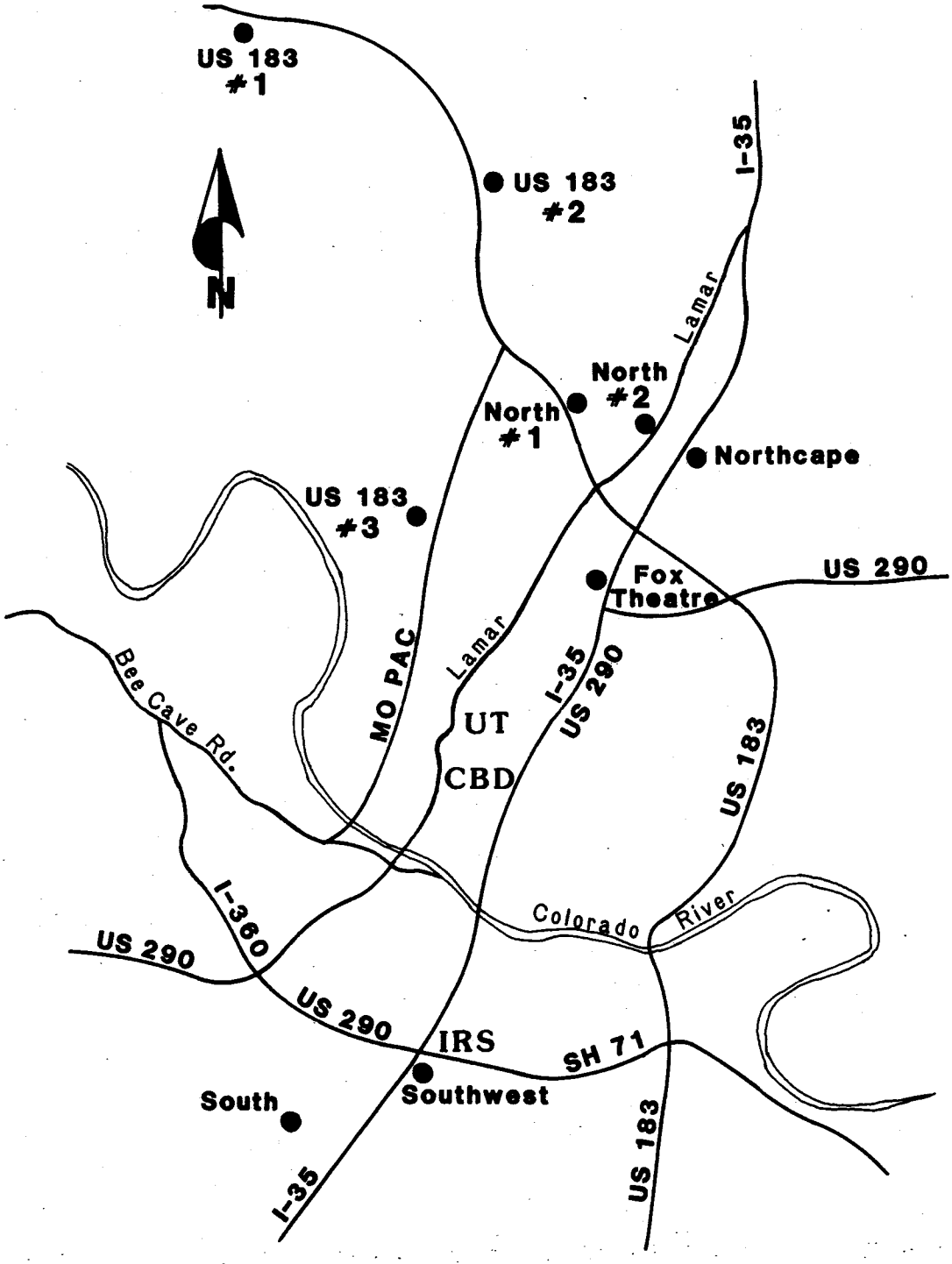


Figure 5: Location of Park-and-Ride Lots in the Austin Area

Parking Facility Characteristics. The majority of the park-and-ride lots in San Antonio may be classified as joint-use facilities. Three of the largest lots (Wonderland, University and Kel-Lac), however, were constructed for the exclusive use of park-and-ride patron parking. On an average day, approximately 637 (46%) of the 1,398 available spaces are occupied.

Transit Service. Ridership on San Antonio's park-and-ride routes varies greatly. The 2 most heavily utilized facilities, Kel-Lac and Wonderland, average 647 and 590 riders, respectively, on a typical day. Two other lots, McCreless and Windsor Park Mall, average 254 and 234 daily riders, respectively, while the remaining lots have somewhere between 2 and 75 daily patrons. Total daily park-and-ride patronage is almost 2,000 riders per day.

Houston

Park-and-ride service was initiated in the Houston metropolitan area in March 1977 with the opening of a lot in southeast Houston at a Sage Department Store. Three months later, 2 additional lots were opened in southwest Houston. Interest in park-and-ride flourished during the next few years and, by the end of 1982, Houston had the most extensive park-and-ride program in the state. Fifteen different lots with more than 10,700 spaces are currently operated by the Metropolitan Transit Authority of Harris County (METRO). Characteristics of Houston's park-and-ride lots and the service available at them are presented in Tables 10 and 11, respectively. Lot locations and the major activity centers serviced are illustrated in Figure 6.

Parking Facility Characteristics. Houston area park-and-ride facilities currently offer between 150 and 1,357 patron parking spaces with 5 of the 15 lots operating over capacity.

Transit Service. At present, METRO's park-and-ride service provides express service (either full, limited or link express) to and from 4 different major activity centers: the Houston CBD, the Texas Medical Center complex, the Greenway Plaza area and the Galleria/Post Oak area. No other park-and-ride program in the state services as many activity centers. In addition, Houston's program is also the only one in the state to offer priority treatment to selected lots. At present, buses traveling to and from 4 of the 15 lots are able to take advantage of the I-45 North Freeway Contra-

Table 10: Characteristics of Houston Park-and-Ride Lots, 1982

Park-and-Ride Lot	Lot Location	Lot Capacity				Lot Amenities							
		Parking Spaces	Kiss-and-Ride Spaces	Handicapped Spaces	Spaces Used	Shelter	Security Personnel	Security Lighting	Newsstand	Vending Machines	Telephone	Pavement Condition	Shared Lot
N. Shepherd	7821 N. Shepherd	693	72	0	920	yes	no	yes	N/A[1]	N/A	yes	N/A	no
Sage	4645 Beechnut	210	0	0	215	no	no	yes	N/A	N/A	no	N/A	yes
Meyerland	112 Meyerland	200	0	0	205	no	no	no	N/A	N/A	no	N/A	yes
Cy-Fair Stadium	Bobcat @ Cougar	400	0	0	250	no	no	no	N/A	N/A	no	N/A	yes
Clear Lake	16,511 Diana Lane	270	0	0	291	no	no	yes	N/A	N/A	no	N/A	yes
Missouri City	13,849 Fondren	761	18	2	315	yes	no	yes	N/A	N/A	yes	N/A	no
Addicks	14,230 Old Katy Rd.	1085	34	6	228	yes	no	yes	N/A	N/A	yes	N/A	no
Spring	17,444 Carlsway Rd.	1219	42	5	575	yes	no	yes	N/A	N/A	yes	N/A	no
Westwood	9900 S.W. Freeway	1182	31	0	500	yes	no	yes	N/A	N/A	yes	N/A	no
Sharpstown	7000 Bellaire	150	0	0	180	yes	no	no	N/A	N/A	no	N/A	yes
Alief	8901 Boone Rd.	1357	20	6	250	yes	no	yes	N/A	N/A	yes	N/A	no
Kingwood	3210 Lake Houston Pkwy.	739	43	10	545	yes	no	yes	N/A	N/A	yes	N/A	no
Gulf Freeway	9524 Edgebrook	973	27	6	535	yes	no	yes	N/A	N/A	yes	N/A	no
Kuykendahl	12,820 Kuykendahl	1268	22	10	1375	yes	no	yes	N/A	N/A	yes	N/A	no
Katy/Mason	Mason @ Merrymont	245	0	8	160	yes	no	no	N/A	N/A	no	N/A	yes

[1] N/A = Current information is not available.

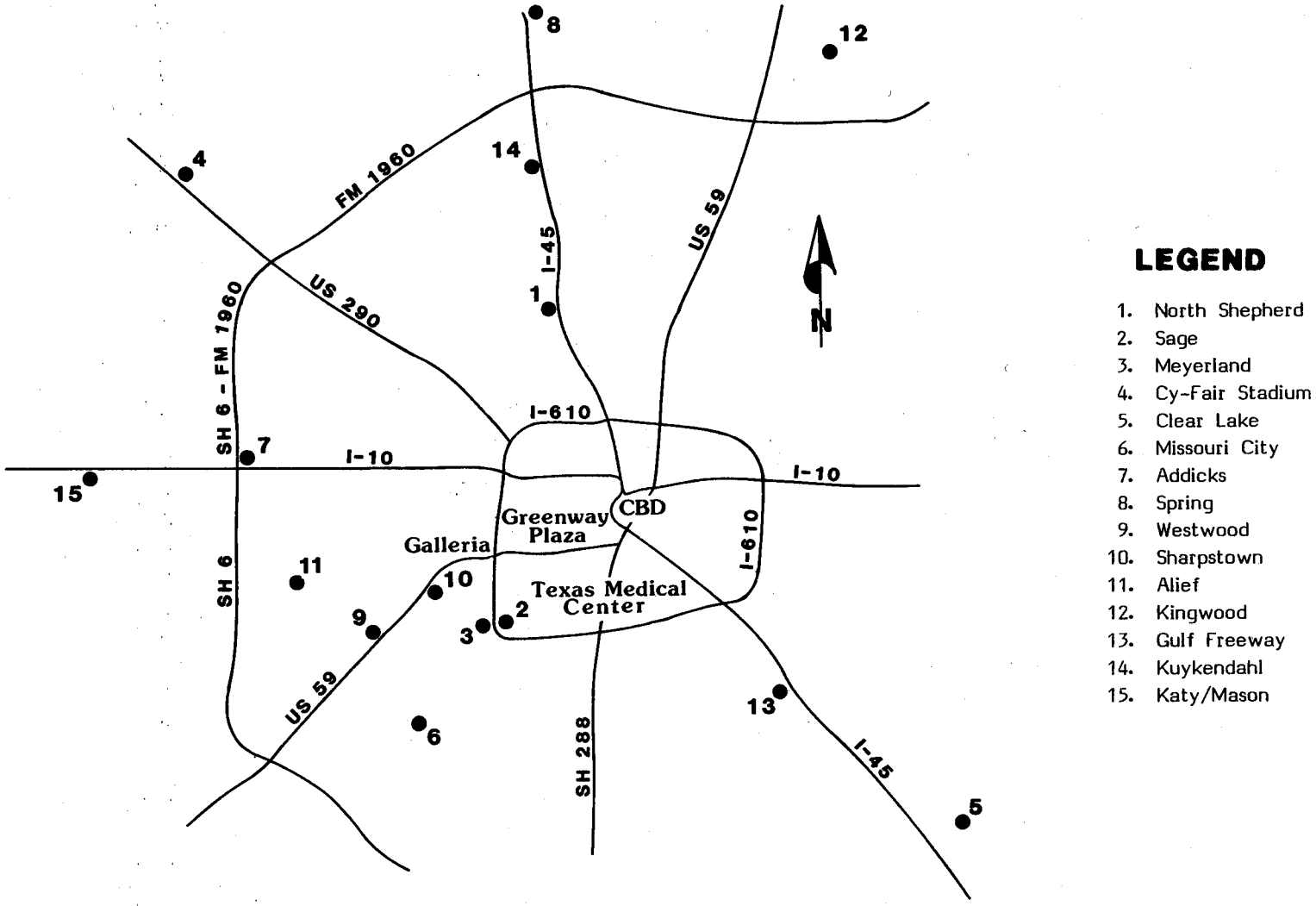
Source: Reference 9.

Table 11: Chracteristics of Houston Park-and-Ride Service, 1982

Park-and-Ride Lot	Transit Service				Distance To Activity Center[1] (miles)	Travel Time To Activity Center[1] (minutes)	Number of A.M. Peak Buses	Number of Riders[2]
	Fare[1] (one-way)	A.M. Peak Headways (minutes)	Midday Service	Express Service				
North Shepherd	Peak $ .90 Midday $ .50	4	yes-#44	yes	CBD-10.3 TMC[3]-10.2	CBD-12 TMC-29	CBD-33 TMC-4	1200
Sage	Peak $ .65 Midday $ .40	15	yes-#88	yes	10.0	25	9	290
Meyerland	Peak $ .65 Midday $ .50	15	yes-#88	yes	10.0	25	9	290
Cy-Fair Stadium	$1.40	16	no	1 other stop	26.0	40	N/A	350
Clear Lake	$1.40	15	no	limited	24.0	60	10	560
Missouri City	$1.15	25	no	yes	CBD-13.6 TMC-N/A[6]	CBD-40 TMC-20	CBD-13 TMC-13	355
Addicks	$1.40	15	no	yes	21.3	35	N/A	285
Spring	$1.65	7	yes	yes	21.0	43	N/A	645
Westwood	$1.15	10	yes	yes	13.5	26	15	650
Sharpstown	$ .90	30	no	yes	11.3	30	6	275
Alief	$1.15	10	no	yes	15.0	45	12	335
Kingwood	$1.65	8	no	yes	CBD-26.0 GP[4]-34.5 G/PO[5]-N/A	CBD-50 GP-59 G/PO-76	CBD-17 GP-3 G/PO-3	550
Gulf Freeway	$ .90	10	no	yes	13.0	25	16	710
Kuykendahl	$1.40	4	yes	yes	17.0	22	29	1650
Katy/Mason	$1.90	40	no	Link Express (2 other stops)	30.0	40	7	230

[1] "Activity Center" refers to Houston CBD unless otherwise noted.
[2] Ridership recorded in 2-way person-trip per day.
[3] TMC = Texas Medical Center.
[4] GP = Greenway Plaza
[5] G/PO = Galleria/Post Oak.
[6] N/A = Current information is not available.

Source: Reference 9.



LEGEND

1. North Shepherd
2. Sage
3. Meyerland
4. Cy-Fair Stadium
5. Clear Lake
6. Missouri City
7. Addicks
8. Spring
9. Westwood
10. Sharpstown
11. Alief
12. Kingwood
13. Gulf Freeway
14. Kuykendahl
15. Katy/Mason

Figure 6: Location of Park-and-Ride Lots in the Houston Area

flow Lane. Some buses servicing other Houston lots will also be able to utilize priority treatment facilities in the near future upon the completion of Houston's network of transitways along existing freeway corridors.

The number of persons taking advantage of Houston's park-and-ride service on a typical day varies from a low of 230 at the Katy/Mason lot to a high of 1,650 at the Kuykendahl lot. The total number of riders at all 15 lots average about 8,375 daily. This number represents about 57% of the 14,682 daily park-and-ride patrons in the state.

El Paso

The most recent city in Texas to implement a park-and-ride program is El Paso. In December 1978, a 76-space lot was opened at Montwood Square Shopping Center at the east end of town. At present, the Sun City Area Transit provides service to 5 park-and-ride facilities located in the city's east and northeast sections. Characteristics of these lots and the service provided to them are presented in Tables 12 and 13, respectively, and the location of the lots is illustrated in Figure 7.

Parking Facility Characteristics. Like the cities of Fort Worth and Austin, El Paso's park-and-ride program has made use of existing unused parking areas in local shopping centers for park-and-ride patron parking. A total of 374 spaces in 5 different shopping centers are currently reserved for park-and-riders.

Transit Service. The number of park-and-ride patrons utilizing the system on a typical day varies from 32 at the Pecan Grove lot to 816 at the combined Montwood and Vista Hills lots. Total daily ridership averages 1,114 persons.

Summary

A summary of the daily park-and-ride patronage, by lot, for all Texas cities is presented in Table 14.

Table 12: Characteristics of El Paso Park-and-Ride Lots, 1982

Park-and-Ride Lot	Lot Location	Lot Capacity				Lot Amenities							
		Parking Spaces	Kiss-and-Ride Spaces	Handicapped Spaces	Spaces Used	Shelter	Security Personnel	Security Lighting	Newsstand	Vending Machines	Telephone	Pavement Condition	Shared Lot
Montwood	Montwood @ Yarbrough	76	0	0	N/A[1]	no	no	yes	yes	no	no	good	yes
Vista Hills	Montwood @ Bobby Jones	73	0	0	N/A	no	no	yes	no	no	no	good	yes
Northgate	Diana @ Joe Herrera	100	0	0	N/A	no	no	yes	no	no	no	good	yes
Rusfair	Rushing @ Fairbanks	73	0	0	N/A	no	no	yes	no	no	no	good	yes
Pecan Grove	North Loop @ Zaragosa	52	0	0	N/A	no	no	yes	no	no	no	good	yes

[1] N/A = Current information is not available.

Source: Reference 8.

Table 13: Characteristics of El Paso Park-and-Ride Service, 1982

Park-and-Ride Lot	Transit Service				Distance To Activity Center (miles)	Travel Time to Activity Center (minutes)	Number A.M.Peak Buses	Number of Riders[1]
	Fare (one-way)	A.M. Peak Headways (minutes)	Midday Service	Express Service				
Montwood/Vista Hills	$1.00	15	no	yes	CBD-15.25 UTEP[2]-16.75	CBD-32.5 UTEP-45.0	CBD-4 UTEP-1	CBD-788 UTEP-28
Rushfair/Northgate	$1.00	30	no	yes	CBD-16.8 UTEP-18.3	CBD-40.0 UTEP-42.5	CBD-2 UTEP-1	CBD-260 UTEP-6
Pecan Grove	$1.00	1 trip only	no	yes	CBD-17.2 UTEP-18.7	CBD-32.5 UTEP-45.0	CBD-1 UTEP-1	CBD-29 UTEP-3

[1] Ridership recorded in 2-way person-trips per day.
[2] UTEP = University of Texas at El Paso.

Source: Reference 8.

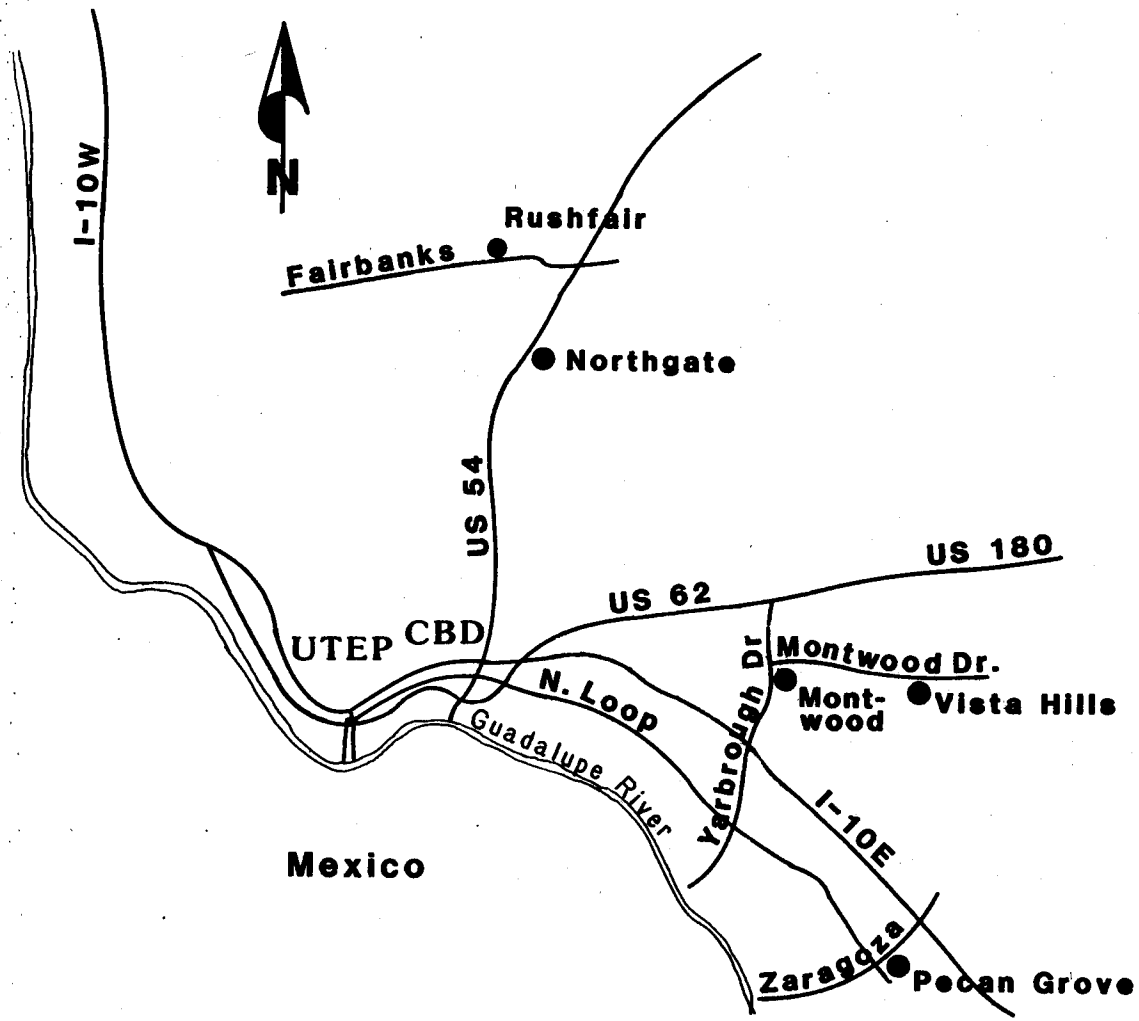


Figure 7: Location of Park-and-Ride Lots in the El Paso Area

Table 14: Summary of Daily Park-and-Ride Patronage in Texas

Lot Location	Daily Riders
Fort Worth	
Springdale Baptist Church	3
Northeast Mall	25
First United Methodist Church	77
First Baptist Church, Euless	31
Arlington Stadium	135
Six Flags	129
Brentwood Baptist Church	90
Ft. Worth Bible Church	10
Jefferson Unitarian Church	10
Handley Methodist Church	1
Handley Baptist Church	2
Herman E. Clark Stadium	12
K-Mart (South Fwy.)	15
St. Mark's Methodist Church	10
St. Luke's Presbyterian Church	1
Edgepark Methodist Church	59
K-Mart (Altamesa)	22
Altamesa Church of Christ	6
Tanglewood Village	1
Sound Warehouse	6
Ridglea Baptist Church	51
Arlington Hts. Christian Church	5
TOTAL	**701**
Dallas/Garland	
North Central	420
Pleasant Grove	220
Redbird	230
Garland North	215
Garland South	330
Las Colinas	112
Reunion	820
TOTAL	**2,347**
Austin	
North #1 and #2	11
Northcape	4
US 183 North #1, #2 and #3	64
Fox Theatre	69
Southwest	6
South	18
TOTAL	**172**
San Antonio	
Windsor Park Mall	234
McCreless	254
South Park Mall	75
Kel-Lac	647
Wonderland	590
University	31
Bitters/MacArthur Plaza	36
Broadway/K-Mart	3
Helotes (United Meth. Church)	N/A[1]
Helotes (Our Lady/Guad. Church)	7
Von Ormy	8
Elmendorf	N/A
Ingram	74
Northside	2
Terrell Plaza	12
TOTAL	**1,972**
Houston	
North Shepherd	1,200
Sage	290
Meyerland	290
Cy-Fair Stadium	350
Clear Lake	560
Missouri City	355
Addicks	285
Spring	645
Westwood	650
Sharpstown	275
Alief	335
Kingwood	550
Gulf Freeway	710
Kuykendahl	1,650
Katy/Mason	230
TOTAL	**8,375**
El Paso	
Montwood and Vista Hills	816
Rushfair and Northgate	266
Pecan Grove	32
TOTAL	**1,114**

[1]N/A = current information not available.

During a typical weekday, nearly 15,000 Texans make use of Park-and-Ride service.

Surveys of Park-and-Ride Users and Non-Users in Texas

In order to obtain information that will assist in the development of park-and-ride guidelines, park-and-ride user and non-user surveys were performed. Although the surveys addressed a number of different issues concerning park-and-ride, they primarily were designed to identify the following.

- **User Surveys.** What features of the existing park-and-ride service were most important to the user in making the decision to utilize park-and-ride? Also, what are the socioeconomic, demographic and travel characteristics of the park-and-ride patrons?

- **Non-User Surveys.** For those individuals that live within the area served by a park-and-ride lot and work in the major activity center served by the park-and-ride buses, what additional features would need to be incorporated into the park-and-ride service to cause non-users to choose to use park-and-ride? Also, what are the socioeconomic, demographic and travel characteristics of the non-users?

The park-and-ride user surveys were undertaken in Dallas/Garland, Houston, Fort Worth, San Antonio and El Paso, while the non-user surveys were performed in Dallas/Garland, Houston and Fort Worth.

User Surveys

On-board surveys were conducted at a total of 3 lots in the Dallas/Garland area, 12 lots in Houston, 5 in Fort Worth, 6 in San Antonio and 5 lots in El Paso (Table 15). Approximately 30% of the buses serving each of the lots was surveyed (except in El Paso where all 7 buses serving the 5 lots were included). For each bus surveyed, a 100% sample of riders was taken. A total of 420 questionnaires were completed in Dallas/Garland, 2,392 in Houston, 113 in Fort worth, 365 in San Antonio and 111 in El Paso. Copies of the questionnaires and a description of the survey procedures are presented in the Appendix.

Non-User Surveys

Park-and-ride related home mail-out surveys were directed to the market areas of 3 of the Dallas/Garland lots, 2 of the Fort Worth lots and 5 of the

Table 15: Park-and-Ride Lots Involved in On-Board Park-and-Ride User Surveys

City	Park-and-Ride Lots Surveyed
Dallas/Garland (surveyed 2/80)	Dallas North Central Garland North Garland South
Houston (Surveyed 12/80-1/81)	Kuykendahl North Shepherd Champions Kingwood Gulf Freeway Clear Lake Sharpstown Sage Meyerland Westwood Alief Katy/Mason
Fort Worth (Surveyed 1/82)	Jefferson Unitarian Church Herman E. Clark Stadium K-Mart (South Freeway) Edgepark Methodist Church Altamesa Church of Christ Montgomery Ward Ridglea Baptist Church Arlington Heights Christian Church
San Antonio (surveyed 10/82)	Wonderland University Windsor Park Mall McCreless Bitters/MacArthur Plaza Broadway/K-Mart
El Paso (surveyed 10/82)	Montwood Vista Hills Rushfair Northgate Pecan Grove

Houston lots. In addition, a home mail-out was performed for the entire Gulf Freeway Corridor in Houston; this mail-out was performed largely to assist with on-going planning for the Gulf Transitway.

The market area associated with each of the lots was identified, an address listing was obtained for each of those areas, and a random sample of addresses was selected. An initial mail-out and at least 1 "follow-up" mail-out were performed to increase the sample size of each area. A total of 2,694 surveys were mailed to households in the Dallas/Garland area, 4,826 to households in the Houston area and 1,200 to Fort Worth area residents. Copies of the household surveys and a more detailed description of the survey procedures are included in the Appendix. Table 16 presents a summary of the non-user survey distribution and response rate for each area.

Table 16: Summary of Non-User Surveys Mailed to Households in the Dallas/Garland, Houston and Fort Worth Areas

Target Mailing Area	Number of Surveys Mailed	Number of Surveys Returned	Return Rate (percent)
Dallas/Garland			
Dallas North Central Lot	884	573	65%
Garland North and Garland South Lots	1,810	1,146	63%
TOTAL	**2,694**	**1,719**	**64%**
Houston			
Gulf Freeway Corridor	838	376	45%
Edgebrook Lot	798	339	43%
Champions Lot	800	427	53%
Kuykendahl Lot	800	405	51%
North Shepherd Lot	790	307	39%
Westwood Lot	800	325	41%
TOTAL	**4,826**	**2,179**	**45%**
Fort Worth			
Area 1 *	800	278	35%
Area 2 **	400	136	34%
TOTAL	**1,200**	**414**	**35%**

*Area 1 includes Ridglea Baptist Church Lot and Arlington Heights Christian Church Lot.

**Area 2 includes Jefferson Unitarian Church Lot.

Source: References 10,11 and 12.

Documentation of Survey Results

Previous Reports. The results of the park-and-ride user and non-user surveys performed in the Dallas/Garland area are detailed in Research Report 205-11. Houston's user and non-user survey findings are presented in Research Report 205-15, and the results of the Fort Worth user and non-user surveys appear in Research Report 205-19. The findings from the recent San Antonio and El Paso user surveys have not appeared in previous reports.

Documentation of Survey Results in This Reference Guide. Selected personal and transportation characteristics of park-and-ride users and non-users in each city surveyed are highlighted in Chapter 3 of this guide. In addition, those features of the existing park-and-ride services which were discovered to be most (and least) important to users are outlined in Chapter 8. Those features which would have to be incorporated into the existing service to attract new riders are noted in Chapter 8 as well. The information presented in these chapters forms the basis of planning and design guidelines presented in subsequent chapters.

Chapter 3

Characteristics of Patrons and Non-Users of Park-and-Ride

3 Characteristics of Patrons and Non-Users of Park-and-Ride

In describing the socioeconomic, demographic and travel characteristics of park-and-ride users and non-users, this chapter is organized into 3 parts. The first part compares the various user characteristics in El Paso, San Antonio, Dallas/Garland, Houston and Fort Worth. The second part compares non-user characteristics in Dallas/Garland, Houston and Fort Worth. The third section compares user and non-user characteristics for Dallas/Garland, Houston and Fort Worth. Similar data for other U.S. Cities are also presented in this chapter.

User Characteristics: El Paso, San Antonio, Dallas/Garland, Houston and Fort Worth

The data collected from the on-board user surveys fall into 2 groupings. The first grouping describes the personal characteristics of park-and-ride patrons; the second grouping documents travel characteristics.

Personal Characteristics

To obtain a profile of park-and-ride patrons in each of the cities surveyed, questions were asked concerning age, sex, education and occupation. The responses to these questions are summarized in Table 17.

Age Groups. As indicated in Table 17, park-and-ride users are relatively young. In fact, between 62% and 80% of the park-and-ride patrons surveyed are less than 42 years old.

Sex. Park-and-ride patrons in all 5 study cities were found to be predominately female.

Table 17: Summary of Personal Characteristics of Park-and-Ride Users

Characteristic	El Paso	San Antonio	Dallas/ Garland	Houston	Fort Worth	Non-Weighted Average
Age groups	(n=108)	(n=365)	(n=402)	(n=2289)	(n=107)	(n=328)
Less than 18	2%	3%	0%	0%	0%	1%
18 - 21	5	10	5	8	4	6
22 - 31	37	38	36	45	35	38
32 - 41	28	23	28	27	23	26
42 - 51	17	11	20	12	20	16
52 - 61	11	11	10	7	14	11
62 and over	0	4	1	1	4	2
Sex	(n=108)	(n=354)	(n=408)	(n=2348)	(n=111)	(n=3329)
Male	40%	45%	42%	42%	37%	41%
Female	60	55	58	58	63	59
Highest level of education	(n=109)	(n=362)	(n=371)	(n=2222)	(n=106)	(n=3170)
Less than high school	3%	5%	2%	1%	7%	4%
High school graduate	23	22	24	19	33	25
Some college	45	41	27	24	22	32
College graduate	25	23	33	42	10	27
More than college	4	9	14	14	18	12
Occupation	(n=108)	(n=343)	(n=396)	(n=2254)	(n=106)	(n=3207)
Unemployed	0.9%	0.0%	0.0%	0.1%	0.0%	0.2%
Homemaker	0.9	0.0	0.5	0.3	0.0	0.3
Student	8.4	14.6	2.5	1.4	0.0	5.4
Retired	0.9	0.3	1.0	0.1	0.9	0.7
Household worker	0.0	0.0	0.0	0.0	0.0	0.0
Laborer	2.8	0.0	.8	0.0	0.0	0.7
Operative	0.9	1.2	1.5	0.6	4.7	1.8
Service worker	2.8	8.5	1.3	0.4	5.6	3.7
Craftsman	0.9	2.0	1.5	1.0	9.4	2.9
Clerical	38.0	32.9	39.6	35.2	35.8	36.3
Sales	4.6	3.2	4.3	3.7	0.9	3.4
Managerial	13.0	17.8	18.7	17.1	14.1	16.2
Professional	25.9	19.5	28.3	40.1	28.3	28.4

In comparison to traditional transit operations, park-and-ride serves a clientele that is younger, more educated and employed in white-collar positions. Park-and-ride patrons are not "captive" riders.

Education. Park-and-ride users are an educated group. For example, in El Paso, San Antonio and Dallas/Garland, at least 73% of the users have attended college, and at least 29% of those are college graduates. In Houston, 80% have attended college, and 56% of those have graduated.

Occupation. Data showing the occupations of park-and-ride patrons are also presented in Table 17. Again, data for all 5 cities show strong similarities. A high percentage of clerical workers appears in all 5 cities which is consistant with the high percentage of female park-and-ride users. Clerical, managerial and professional categories constitute approximately 70% of the total users in San Antonio, 77% in El Paso, 78% in Fort Worth, 87% in Dallas/Garland and more than 92% of the total in Houston. San Antonio and El Paso also have relatively significant percentages of park-and-ride users who are students (14.6% and 8.4%, respectively).

Transportation Characteristics

In the on-board user surveys, several questions were asked that relate to the travel patterns of park-and-ride users. These questions addressed items such as previous mode of travel, mode of arrival at the park-and-ride lot and how long park-and-ride has been used. Responses to the questions are summarized in the following paragraphs.

Previous Mode of Travel. As expected, the highest percentage of park-and-ride users in each city (between 49% and 63%) had driven alone to their destinations prior to using park-and-ride (Table 18).

Table 18: Previous Mode of Travel for Users of Park-and-Ride

Mode	El Paso (n=109)	San Antonio (n=361)	Dallas/ Garland (n=416)	Houston (n=2378)	Fort Worth (n=112)	Non-Weighted Average
Drove alone	61%	57%	50%	49%	63%	56%
Carpool/vanpool	28	20	11	17	15	18
Local bus	8	20	11	8	8	11
Didn't make trip	3	3	25	24	9	13
Other	0	0	3	2	5	2

Over half of the individuals using park-and-ride previously drove alone.

In general, these findings are not surprising. However, the percentage of users in Dallas/Garland, Houston and San Antonio that indicated that they did not previously make the trip is higher than expected. Although a latent demand would be expected to exist, it does not seem that a 20% to 25% of the total park-and-ride trips in these cities would be represented by latent demand. Part of the reason for the high response to "did not make trip" lies in the answer to the question pertaining to how long had the user lived at his/her present address. As shown in Table 19, in all cities except San Antonio, park-and-ride users who "did not make trip" have lived at their present address for a shorter period of time than park-and-ride users in general.

Table 19: Years at Present Address for Park-and-Ride Users

Years at Present Address	El Paso	San Antonio	Dallas/ Garland	Houston	Fort Worth	Non-Weighted Average
For all users	(n=106)	(n=356)	(n=412)	(n=2342)	(n=110)	
50th percentile	3.5	2.7	1.7	1.4	2.9	2.4
85th percentile	9.0	12.8	7.5	6.7	16.7	10.5
For users who previously "Didn't make trip"	(n=3)	(n=10)	(n=102)	(n=554)	(n=9)	
50th percentile	0.1	4.0	0.8	0.4	2.6	1.6
85th percentile	1.2	13.5	6.0	4.0	13.0	7.5

Apparently many individuals begin using park-and-ride as soon as they move to an area. Thus, they "did not previously make the trip."

It is possible, then, that many of the park-and-ride patrons began using the service immediately upon moving into the area and thus, they did not previously make the trip. The lot location may even have been a consideration in residential site location.

Mode of Arrival at Park-and-Ride Lot. In all the cities surveyed except El Paso, more than half of the park-and-ride users indicated that they drove themselves to the lot (Table 20). In El Paso, 40% reportedly drove to the

lot, while 31% were dropped off (kiss-and-ride) and an additional 21% had walked. The high percentage of users in El Paso (and even the 4% to 8% in San Antonio, Houston and Fort Worth) who walk to the lot suggest that, if a park-and-ride lot is located close to residential areas and is easy to walk to, a significant percentage of walk-in traffic can be generated. In Houston, the percent of users who walk to the lot ranges from 0% at the Kuykendahl lot to 22.9% at the Alief lots (Table 21).

Table 20: Mode of Arrival at Park-and-Ride Lots

Arrival Mode	El Paso (n=111)	San Antonio (n=365)	Dallas/ Garland (n=420)	Houston (n=2384)	Fort Worth (n=113)	Non-Weighted Average
Drove alone	40%	64%	66%	68%	57%	59%
Rode with other park-and-ride user	5	3	9	11	8	7%
Dropped off	31	19	20	15	26	22
Walked	21	4	0	5	8	8
Another bus	3	10	--	--	--	3
Other	--	--	5	1	1	1

Nearly 25% of the park-and-ride patrons use kiss-and-ride as their arrival mode to the lot.

Table 21: Percentage of Riders Walking to Park-and-Ride Lots, Houston

Park-and-Ride Lot	Percent of Users Walking to Lot
Sage (I-45S)	7.1%
Bellaire	7.0
West Loop/Sage & Meyerland	2.1
Westwood	14.4
Clear Lake	7.8
Alief	22.9
North Shepherd	0.7
Kuykendahl	0.0
Champions	1.3
Kingwood	4.5
Katy/Mason	2.2

Depending upon lot location and design, the volume of patronage walking to the lot can be significant.

Length of Time Using Park-and-Ride Service. The length of time park-and-ride users in each city have used the service is illustrated in Figure 8.

Trip Purpose and Frequency of Use. All survey data indicated that the overwhelming majority (as much as 100% in some surveys) of trips made by park-and-ride are work trips. Survey data further indicated that approximately 80% of the patrons use the service 5 days per week.

Parking/Driving Cost. User surveys in Houston and Fort Worth asked if the employer would pay all or part of the parking cost at the work location if the employee chose to drive to work rather than use park-and-ride. Surveys in El Paso and San Antonio asked if the employer would pay all or part of the cost of driving to work (gasoline, vehicle maintenance, parking, etc.). The responses to these questions are shown in Table 22. While employers may consider subsidizing parking or driving costs a necessary cost to attract employees to the work location, it also reduces potential monetary savings that could be realized by using park-and-ride. The alternative would be for the employers to offer similar dollar benefits to apply to transit fares.

Comparison of Selected Park-and-Ride User Characteristics for Texas and Other U.S. Cities

Numerous bus park-and-ride facilities have been implemented in other cities across the United States. Although detailed data describing park-and-ride user characteristics at most of these facilities have not been reported, a literature search revealed that a limited amount of information is available, and that which was found to be comparable to the type of data collected for Texas park-and-ride facilities is presented in the following pages.

Personal Characteristics

Age. Generally speaking park-and-ride users are relatively young with the majority in Miami, Virginia and Texas in their 20's, 30's or early 40's (Table 23). In Milwaukee, however, the age distribution between the "less than 24", "25 to 44" and "45 to 64" categories is fairly even. Very few users in any of the cities fall into the "62 (65 or 66) and over" category.

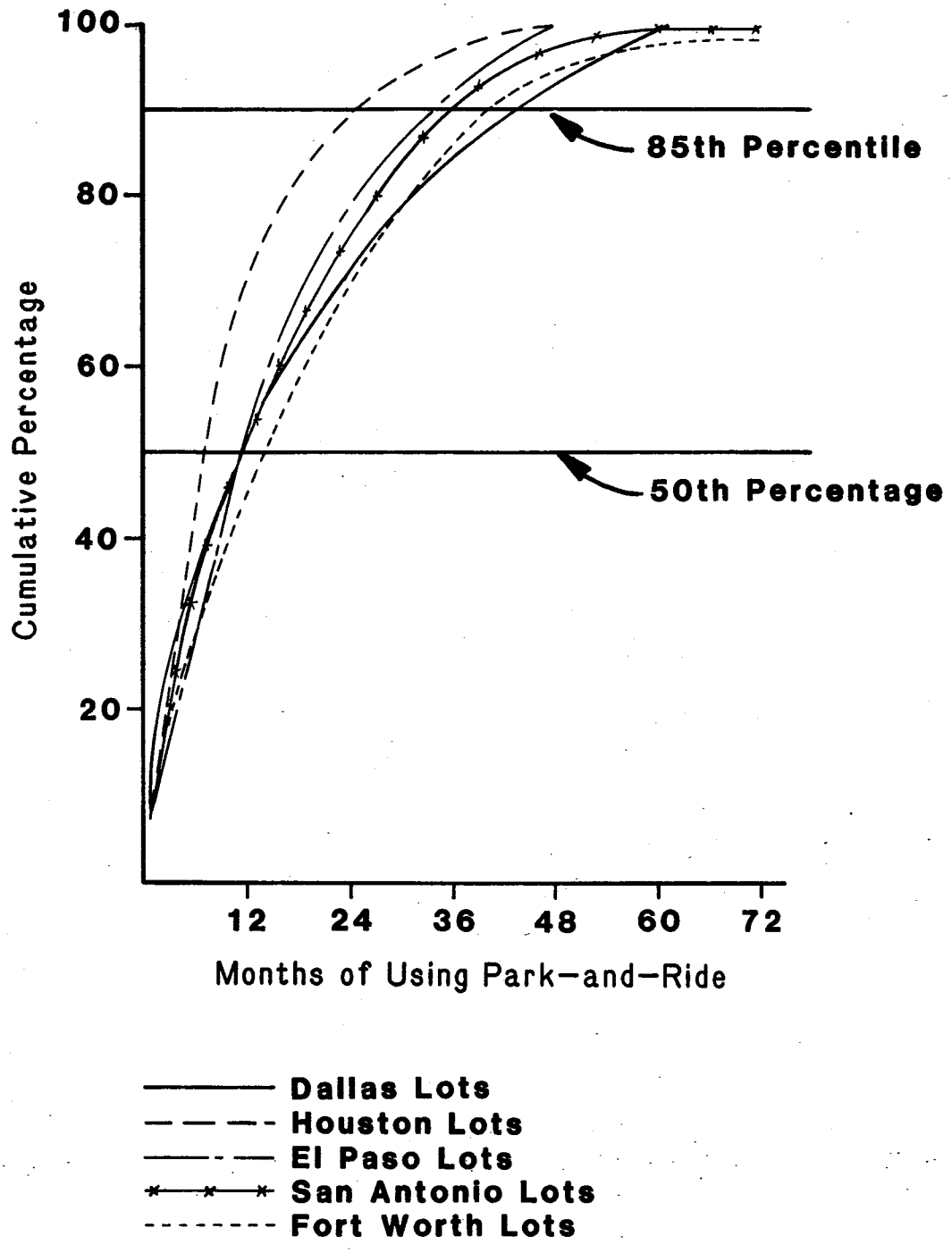


Figure 8: Length of Time Utilizing Park-and-Ride Service

Table 22: Employer Subsidization of Parking/Driving Costs if Employee Drives to Work Instead of Using Park-and-Ride

City and Lot	Employer's Share of Parking/ Driving Costs		
	All	Part	None
Houston, Total (n=2109)	8%	15%	77%
Sage (n=198)	10	8	82
Bellaire (n=149)	6	17	77
W. Loop /Sage&Meyerland (n=301)	4	16	80
Westwood (n=330)	10	13	77
Clear Lake (n=125)	6	20	74
Alief (n=121)	5	18	77
North Shepherd (n=284)	4	15	81
Kuykendahl (n=287)	12	18	70
Champions (n=139)	11	16	73
Kingwood (n=134)	14	16	70
Katy/Mason (n=41)	7	10	83
Fort Worth, total (n=110)	20%	5%	75%
Jefferson Unitarian Church (n=11)	36	0	64
Herman E. Clark Stadium (n=1)	0	0	100
K-Mart (n=6)	33	34	33
Edgepark Methodist Church (n=27)	30	0	70
Altamesa Church of Christ (n=4)	50	0	50
Montgomery Ward (n=9)	0	0	100
Ridglea Baptist Church (n=46)	6	7	87
Arlington Hts. Christ. Church (n=6)	50	0	50
El Paso, total (n=105)	0%	5%	95%
Montwood (n=57)	0	7	93
Vista Hills (n=18)	0	6	94
Rushfair (n=8)	0	0	100
Northgate (n=19)	0	0	100
Pecan Grove (n=3)	0	0	100
San Antonio, total (n=348)	1%	18%	81%
University (n=21)	0	14	86
Wonderland (n=177)	1	20	79
McCreless (n=40)	5	10	85
Windsor Park Mall (n=84)	0	17	83
Bitters (n=23)	0	17	83
Broadway (n=3)	0	33	67

Table 23: Age of Park-and-Ride Users in Texas and Other U.S. Cities

Park-and-Ride Location	Age Group			
	Less than 22	22 to 41	42 to 61	62 and over
El Paso, TX	7%	65%	28%	0%
San Antonio, TX	13	61	22	4
Dallas/Garland, TX	5	64	30	1
Houston, TX	8	72	19	1
Fort Worth, TX	4	58	34	4
	Less than 21	21 to 39	40 to 65	66 and over
Shirley Highway, VA	4	60	36	0%
	Less than 20	20 to 44	45 to 64	65 and over
Miami, FL	3	60	36	1%
	Less than 24	25 to 44	45 to 64	65 and over
Milwaukee, WI				
Mayfair Route	35	32	27	2%
Bayshore Route	31	33	28	3%

Sex. In 9 of the 12 park-and-ride locations listed in Table 24, between 55% and 70% of the park-and-ride patrons are female. However, between 60% and 62% of the users at Dade County, Atlanta and Shirley Highway facilities are male.

Occupation. Occupations of park-and-ride users in Miami and New Brunswick show strong similarities to those of the Texas cities surveyed (Table 25). In fact, between 69% and 95% of the park-and-ride users in the 7 cities listed have occupations which can be classified as clerical, professional, managerial, or office.

Table 24: Sex of Park-and-Ride Users in Texas and Other U.S. Cities

Park-and-Ride Location	Sex	
	Male	Female
El Paso, TX	40%	60%
San Antonio, TX	45	55
Dallas/Garland, TX	42	58
Houston, TX	42	58
Fort Worth, TX	37	63
Miami, FL	30	70
Dade County, FL	60	40
Milwaukee, WI	44	56
Shirley Highway, VA	62	38
Atlanta, GA	60	40
Philadelphia, PA	40	60
Non-Weighted Average	46	54

Source: References 2, 13, 14, and 15.

Table 25: Occupations of Park-and-Ride Users in Texas and Other U.S. Cities

Park-and-Ride Location	Occupation				
	Professional	Managerial	Clerical	Student	All Others
El Paso, TX	26%	13%	38%	8%	15%
San Antonio, TX	20	18	33	15	14
Dallas/Garland, TX	28	19	40	3	10
Houston, TX	40	17	35	1	7
Fort Worth, TX	28	14	36	0	22
	Professional	Skilled	Clerical	Student	All Others
Miami, FL	31%	11%	53%	2%	3%
	Retail	Manufacturing	Office	Student	All Others
New Brunswick, NJ	10%	8%	69%	3%	10%

Sources: References 14 and 16.

A significant percentage of park-and-ride patrons are employed in either professional or managerial positions.

Previous Mode of Travel. Before using the park-and-ride service, a sizable percentage of users in 8 out of the 10 locations listed in Table 26 drove alone. In Milwaukee and Washington, D.C., however, only about 15% had driven alone prior to using park-and-ride with 38% in Milwaukee and 23% in Washington, D.C., having used local transit and an additional 18% in each city having carpooled.

Table 26: Previous Mode of Park-and-Ride Users in Texas and Other U.S. Cities

Mode	El Paso TX	San Antonio TX	Dallas/ Garland TX	Houston TX	Fort Worth TX	Miami FL	Dade County FL	Mil-Waukee WI	Wash Wash. D.C.	San Pedro CA
Drove Alone	62%	57%	50%	49%	63%	46%	65%	25%	25%	63%
Carpool/ Vanpool	20	10	11	17	15	14	12	18	18	23
Local Bus	7	10	11	8	8	16	17	38	23	
Didn't make trip	8	20	25	24	9	24	0	0	0	14
Other	3	3	3	2	5	0	6	19	34	

Source: References 2, 14, 15, 17.

Mode of Arrival at Park-and-Ride Lots. Data for all 14 of the park-and-ride locations in Table 27 show that between 40% and 70% of the patrons drive alone to the park-and-ride lots. Other popular modes to lots (which include riding with another user of park-and-ride or being dropped off at lot) also involve the use of a private vehicle. However, a significant percentage of users in Dade County (36%), El Paso (21%) and Milwaukee (12%) walk to the park-and-ride facilities.

Table 27: Mode of Arrival to Park-and-Ride Lot for Texas and Other U.S. Cities

City	Drove Alone	Rode with Other Park-and-Ride User	Dropped Off	Walked	Local Bus	Other
El Paso, TX	40%	5%	31%	21%	3%	--
San Antonio, TX	64	3	19	4	10	--
Dallas/Garland, TX	66	9	20	0	--	5%
Houston, TX	68	11	15	5	--	1
Fort Worth, TX	57	8	26	8	--	1
Miami, FL	53	--	23	--	12	12
Dade County, FL	45	16	*	36	2	1
Milwaukee, WI	46	33	*	12	9	--
Washington, DC	76	9	9	3	3	--
Hartford, CT	66	30	*	4	--	--
Pittsburgh, PA	53	20	*	8	6	2
Los Angeles, CA	74	8	9	4	4	1
Seattle, WA	76	9	9	3	3	--
Shirley Highway, VA	70	10	4	--	--	16

*Percentages for "Dropped Off" are included in percentages for "Rode with Other Park-and-Ride User"

Source: References 2, 13, 14, 15 and 18.

Non-User Characteristics: Dallas/Garland, Houston and Fort Worth

In general, respondents to the home mail-out household surveys performed in Dallas/Garland and Houston were defined as non-users of park-and-ride service if they: 1) reside in the area served by a park-and-ride lot, 2) work in an activity center served by park-and-ride service; and 3) were not current park-and-ride users. Characteristics of the non-users in the Dallas/Garland and Houston areas are documented in Research Report 205-11 and 205-15, respectively.

In Fort Worth, non-users of park-and-go were defined somewhat differently since Fort Worth park-and-go lots are developed not only to serve transit patrons but also to serve carpoolers (Rideshare program). Therefore, non-users have the option of pooling to areas outside the bus service area which makes the "area served by park-and-go" difficult to delineate. Considering the dual purpose of park-and-go, non-users were defined in terms of

occupation, age and current use of park-and-go service. Those survey respondents who were retired, over 70 years of age and/or current users of park-and-go were deleted from the data base. Characteristics of the non-users of park-and-go in Fort Worth are presented in Research Report 205-17.

Data collected from the home mail-out surveys included both personal and transportation characteristics of the non-users of park-and-ride.

Personal Characteristics

Questions concerning age, sex, education, occupation and years at present address of non-users were posed in the mail-out household surveys. The responses to these questions are summarized in Table 28.

Age Group. As indicated in Table 28, the majority of non park-and-ride users in all 3 of the study cities are less than 42 years old.

Sex. Data on the sex of the non-users who responded to the household surveys are also presented in Table 28. Between 68% and 71% of the non user respondents employed at the major activity centers are male.

Education. Employees in major urban centers tend to be well-educated. In fact, at least 75% of the non-users surveyed in each study area have at least some college education.

Occupation. Occupation data summarized in Table 28 show that approximately 74% of the non-users employed at a major activity center in Dallas/Garland, Houston and Fort Worth have occupations classified as clerical, managerial or professional. These findings are consistent with the educational data.

Years at Present Address. Non-users of park-and-ride services surveyed were also asked how long they had lived at their present address. While the answers were similar, non-users in the Dallas/Garland and Fort Worth areas have lived at their current address somewhat longer than those in the Houston area (Table 29).

Table 28: Summary of Personal Characteristics of Non-User of Park-and-Ride

Characteristic	Dallas/ Garland	Houston	Fort Worth	Non-Weighted Average
Age group	(n=198)	(n=751)	(n=290)	
Less Than 18	0%	1%	0%	0%
18 - 21	5	3	2	3
22 - 31	20	22	27	23
32 - 41	28	31	25	28
42 - 51	24	26	15	22
52 - 61	20	15	25	20
62 and over	3	2	6	4
Sex	(n=201)	(n=762)	(n=301)	
Male	70%	71%	68%	70%
Female	30	29	32	30
Highest level of education	(n=187)	(n=738)	(n=294)	
Less than high school	3%	4%	4%	4%
High school graduate	21	17	21	20
Some college	22	22	26	23
College graduate	36	33	26	32
More than college	18	24	23	21
Occupation	(n=194)	(n=781)	(n=296)	
Unemployed	0.0%	0.0%	1.0%	0.3
Homemaker	0.0	0.0	0.4	0.1
Student	4.1	3.7	2.7	3.5
Retired	0.0	0.0	0.0	0.0
Household worker	0.0	0.0	0.0	0.0
Laborer	0.5	0.1	1.0	0.5
Operative	2.1	0.9	3.1	2.1
Service worker	2.5	2.2	5.4	3.4
Craftsman	4.2	6.1	5.7	5.4
Clerical	15.4	11.5	10.5	12.5
Sales	12.4	10.2	6.4	9.7
Managerial	29.9	31.0	8.1	23.0
Professional	28.9	34.3	55.1	39.5

Table 29: Length of Time at Present Address for Non-Users of Park-and-Ride

Years at Present Address	Dallas/Garland (n=201)	Houston (n=697)	Fort Worth (n=297)
50th percentile	5.5	4.2	5.0
85th percentile	16.0	10.0	16.1

Transportation Characteristics

In addition to questions pertaining to the personal characteristics of non-users, a series of questions was also included in the household surveys to identify past and present travel patterns of non-users. These questions addressed mode of travel to work (or school), use of local bus service, use and knowledge of park-and-ride serivce and perceived need for an automobile during the day. The responses received from the home mail-out questionnaire pertaining to travel characteristics are highlighted in the following paragraphs.

Mode of Travel. When asked how they normally travel to work or school, the majority of respondents in all 3 study areas reported that they drive alone (Table 30).

Table 30: Mode of Travel to Work or School for Non-Users of Park-and-Ride

Mode	Dallas/Garland (n=207)	Houston (n=711)	Fort Worth (n=297)
Drive alone	69%	70%	83%
Carpool/vanpool	25	27	12
Local bus	4	2	3
Other	2	1	2

Use of Local Bus Service. Respondents to the home mail-out were also asked how frequently they used local bus service. The responses to this

question, as summarized in Table 31, show that very few use local bus service on a regular basis. In fact, at least 88% of those surveyed in each city reported that they seldom, if ever, ride a local bus.

Table 31: Use of Local Bus Service by Non-Users of Park-and-Ride

Frequency of Use	Dallas/Garland (n=119)	Houston (n=774)	Fort Worth (n=300)
Every day	13%	11%	5%
About once a week	6	1	4
Seldom	81	10	17
Never	*	78	74

*"Never" was not listed as an option on the Dallas/Garland home mail-out survey questionnaire.

Knowledge of Park-and-ride Service. In addition to being asked about their use of local bus service, the home mail-out survey respondents were also asked several questions concerning their use and knowledge of the park-and-ride service in their area. The responses to these questions are presented in Table 32.

Table 32: Non-Users Use and Knowledge of Park-and-Ride

Question	Dallas/Garland	Houston	Fort Worth
Have you ever used park-and-ride?	(n=207)	(n=783)	(n=301)
Yes	35%	25%	10%
No	65	75	90
Do you know enough about the park-and-ride service to confidently begin using it?	(n=200)	(n=792)	(n=297)
Yes	42%	41%	26%
No	48	50	61
Not sure	10	9	13
Do you know the location of the park-and-ride lot nearest your home?	(n=203)	(n=792)	(n=300)
Yes	80%	87%	54%
No	17	5	39
Not sure	3	8	7

From their responses, it appears that most non-users are not familiar with the CITRAN Park-and-Go service. Ninety percent have not used park-and-go, 61% felt that they did not have sufficient knowledge of the service to confidently begin using it, and 39% did not even know the location of the nearest park-and-go lot. Respondents in Dallas/Garland and Houston, on the other hand, appear to be more knowledgeable about the service provided, with 35% of the respondents in Dallas/Garland and 25% of the respondents in Houston having tried the service.

Perceived Need for an Auto. Household surveys in all 3 study cities asked if the respondent needed an automobile available during the day. Generally, those individuals perceiving a need for a vehicle during the day are not potential park-and-ride patrons. Responses to the question are presented in Table 33.

Table 33: Perceived Need for an Automobile During the Workday for Non-Users of Park-and-Ride

City and Market Area	Perceived Need for an Automobile			
	Everyday	1 day/week	Seldom	Never
Dallas/Garland, total (n=118)	48%	*	*	52%
Garland North & South (n=57)	38	*	*	62
Dallas N. Central (n=61)	58	*	*	42
Houston, total (n=700)	51%	18%	23%	8%
North Shepherd (n=79)	60	6	23	11
Kuykendahl (n=152)	59	16	20	5
Champions (n=158)	48	17	27	8
Westwood (n=130)	49	24	19	8
Edgebrook (n=92)	47	25	22	6
Gulf Freeway Corridor (n=87)	46	19	24	11
Fort Worth, total (n=295)	71%	12%	15%	2%
Area 1** (n=183)	67	13	16	4
Area 2*** (n=112)	78	9	13	0

*The Dallas/Garland survey questionnaire provided only "yes" and "no" as possible answers to the question of needing an automobile during the day.

**Area 1 included both the Ridglea Baptist Church lot and the Arlington Heights Christian Church lot.

***Area 2 included the Jefferson Unitarian Church lot.

About half of the non-users of park-and-ride perceive a need for their personal auto during the day.

Parking Cost. The household survey in Houston also asked if the employer paid all, part or none of the employee's parking cost at the work location. Approximately 55% of the respondents indicated that their employees paid at least part of the cost of parking (Table 34). This group of non-users would not realize as great a monetary savings from switching to park-and-ride as those who do not have any of their parking costs subsidized.

Table 34: Employer's Subsidization of Non-Users' Parking Cost

City and Market Area	All	Part	None
Houston, total (n=792)	42%	13%	45%
North Shepherd	36	20	44
Kuykendahl	42	13	45
Champions	40	17	43
Westwood	46	10	44
Edgebrook	47	9	44

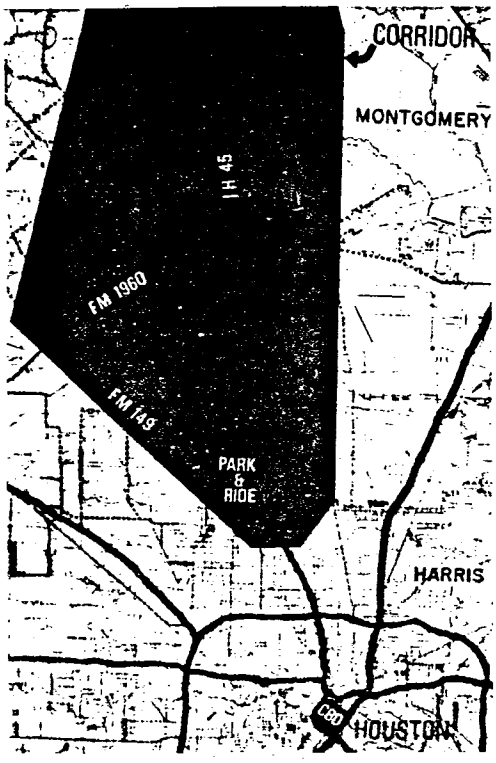
Comparison of User and Non-User Characteristics in Dallas/Garland, Houston, and Fort Worth

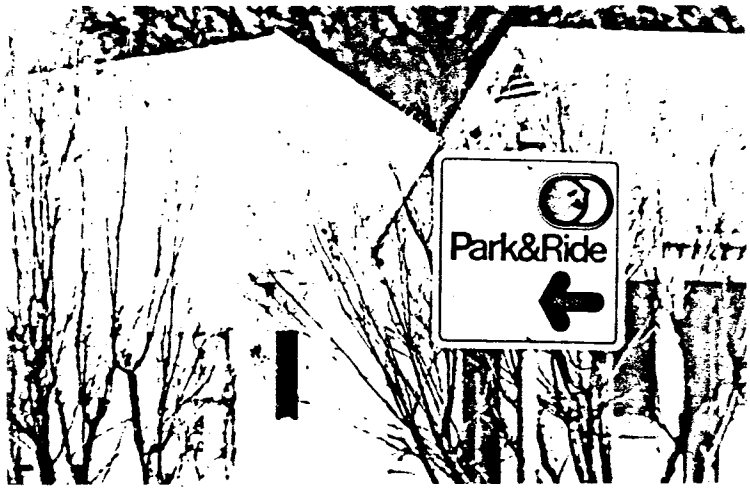
Characteristics of both users and non-users of park-and-ride for Dallas/Garland, Houston and Fort Worth have been presented previously. Table 35 summarizes selected characteristics of these 2 groups. As this table indicates, non-users of park-and-ride tend to be older and have resided longer at their current address. Also, the vast majority of non-users employed in major activity centers served by park-and-ride are male, whereas the majority of park-and-ride users are female. Both users and non-users are highly educated; clerical occupations are more prevalent among users. Finally, a larger percentage of non-users typically drive alone to work or school, rather than carpool/vanpool as a significant percentage of users had done prior to utilizing park-and-ride service.

Table 35: Overview of Selected Characteristics of Users and Non-users of Park-and-Ride in Dallas/Garland, Houston and Fort Worth

Characteristic	Dallas/Garland		Houston		Fort Worth	
	Users	Non-Users	Users	Non-Users	Users	Non-Users
Age group						
Less than 18	0%	0%	0%	1%	0%	0%
18 - 21	8	5	8	3	4	2
22 - 31	45	20	45	22	35	27
32 - 41	27	28	27	31	23	25
42 - 51	12	24	12	26	20	15
52 - 61	7	20	7	15	14	25
62 and over	1	3	1	2	4	6
Sex						
Male	42%	70%	42%	71%	37%	68%
Female	58	30	58	29	63	32
Highest level of education						
Less than high school	2%	3%	1%	4%	7%	4%
High school grad.	24	21	19	17	33	21
Some college	27	22	24	22	22	26
College graduate	33	36	42	33	10	26
More than college	14	18	14	24	18	23
Occupation						
Clerical	39.6%	15.4%	35.2%	11.5%	35.8%	10.5%
Managerial	18.7	29.9	17.1	31.0	14.1	8.1
Professional	28.3	28.9	40.1	34.3	28.3	55.1
All Other	13.4	25.8	7.6	23.2	21.8	26.3
Mode of travel to work or school[1]						
Drove alone	50%	69%	49%	70%	63%	83%
Carpool/vanpool	11	25	17	27	15	12
Local bus	11	4	8	2	8	3
Did not make trip	25	---	24	---	9	---
Other	3	2	2	1	5	2
Length of time at present address (years)						
50th percentile	1.7	5.5	1.4	4.2	2.9	5.0
85th percentile	7.5	16.0	6.7	10.0	16.7	16.1

[1]This is the previous mode of travel for park-and-ride users and the current mode of travel for non-users.





Chapter 4

Characteristics of the Park-and-Ride Market Area

4 Characteristics of the Park-and-Ride Market Area

The primary market area, or watershed, for park-and-ride service is the geographical area from which the users originate. The size of the park-and-ride watershed depends upon the type of the facility: remote, local or peripheral. Surveys have indicated that the watershed areas for peripheral lots extend across urban areas without any recognizable pattern, whereas, remote and local service facilities have relatively localized watershed areas. This difference is due to the basic nature of each type of facility. Peripheral lots are essentially parking lots on the edge of a major activity center and, as such, are used by people whose final destination is near the lot. Remote and local service lots that are near the "origin" end of the trip, on the other hand, are used by people who live close to the lot and whose destination is near the bus route's terminus (4).

Park-and-ride experience in Texas has indicated that the primary market area associated with a local service or remote park-and-ride facility is reasonably well defined, although variations in survey data suggest that the market area is not the same for all park-and-ride lots. Factors such as the location of adjacent park-and-ride facilities, accessibility (a function of the street system in the area) and the type of bus service offered appear to influence the market area. Based on on-board survey results in the Dallas/Garland, Houston and Fort Worth areas, the "typical" market area might be defined as being parabolic in shape, with a vertex 0.5 to 1.0 mile downstream of the lot, an axis 7 miles in length following the major artery upstream of the lot, and a chord of 8 miles in length (Figure 9) (11, 12). Survey data (12) further revealed that, in Houston, virtually all users of the park-and-ride service reside within 7 miles of the lot they use, (Table 36, Figures 10, 11 and 12).

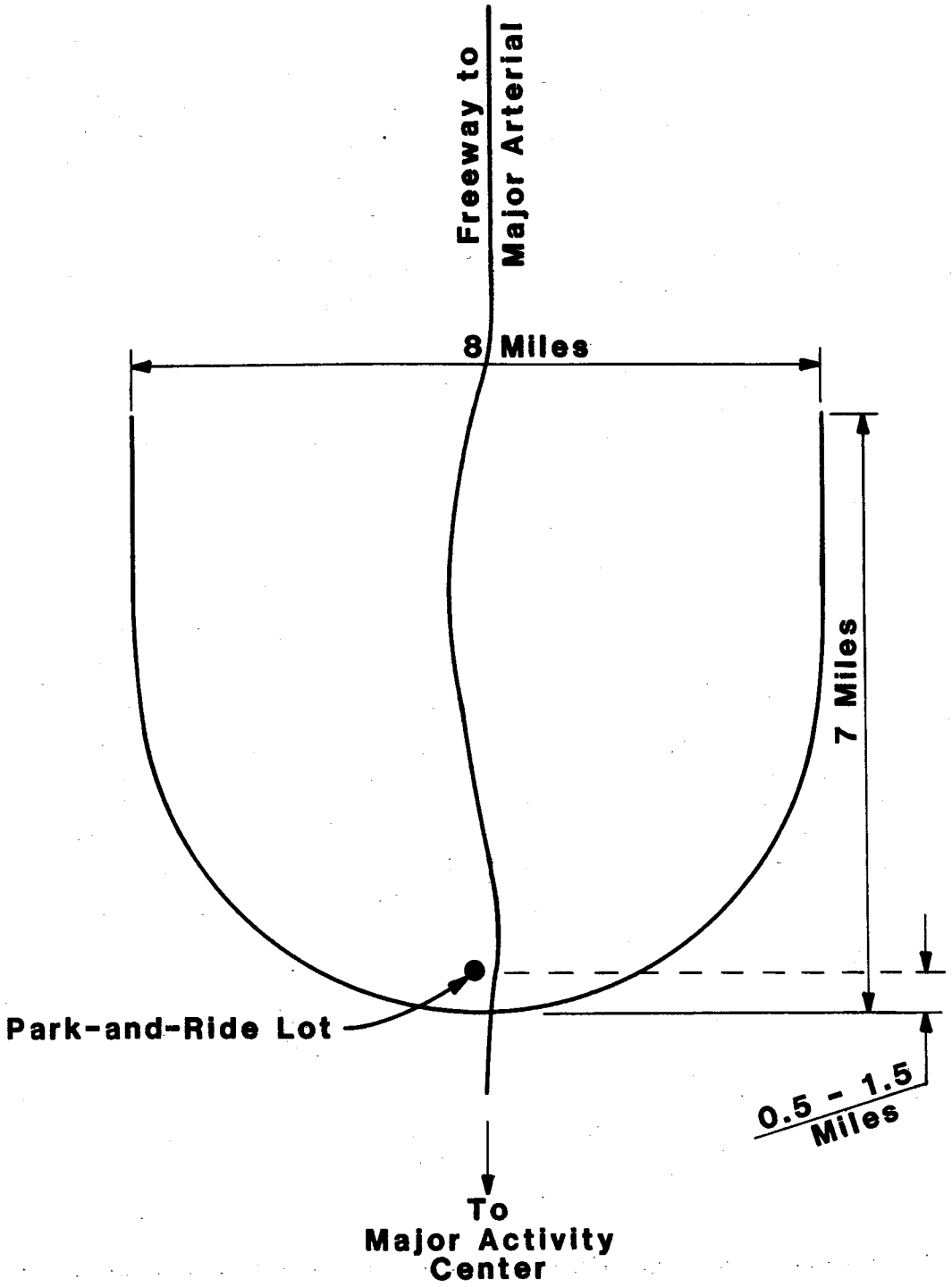
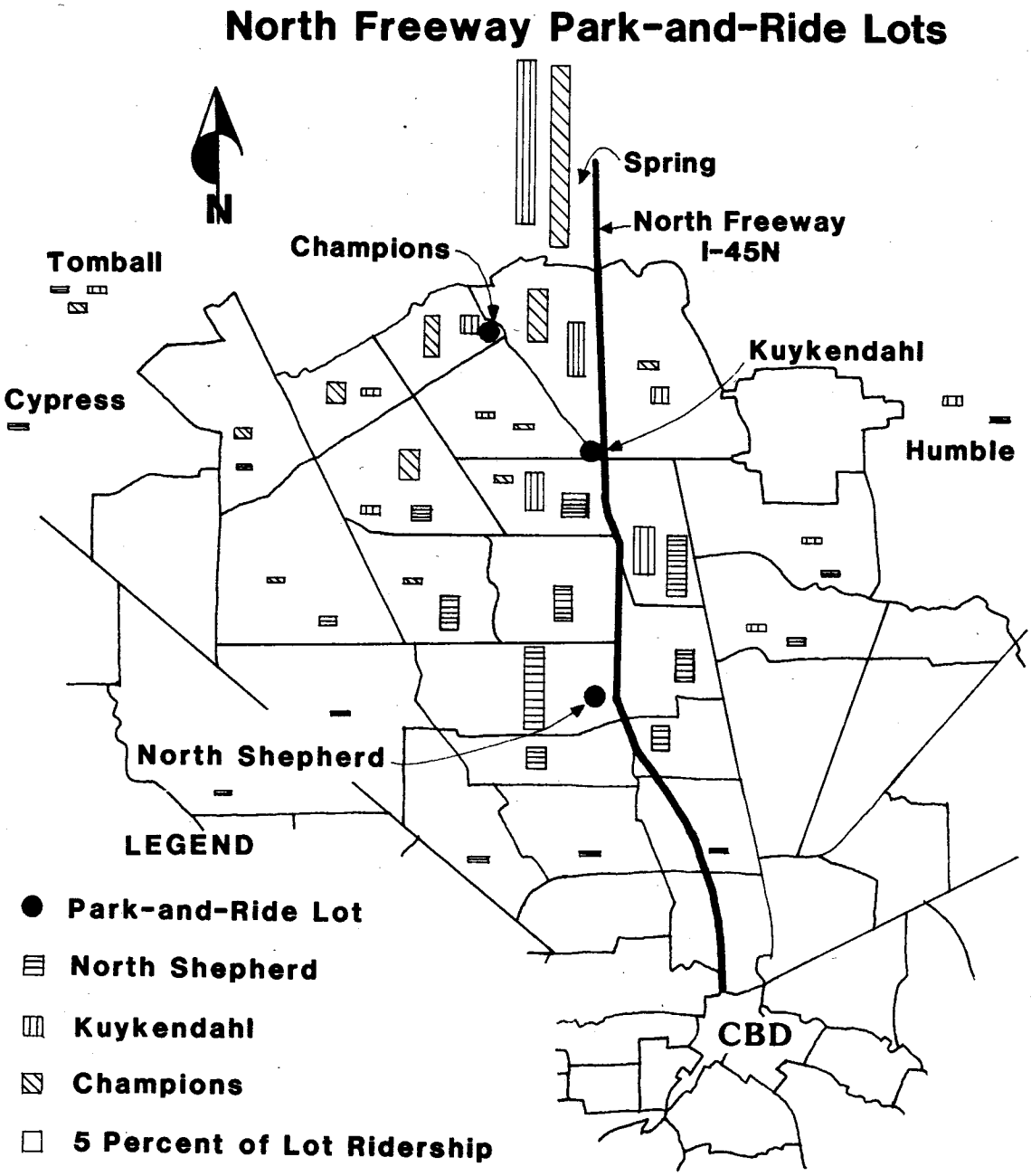


Figure 9: General Shape of "Typical" Park-and-Ride Market Area for Dallas, Garland and Houston Lots



Park-and-Ride Lot	Percent Within		
	5 Mi.	7 Mi.	10 Mi.
North Shepherd	86	92	96
Kuykendahl	47	92	94
Champions	89	93	96

Figure 10: Park-and-Ride Lot Market Characteristics - North Freeway Corridor, Houston

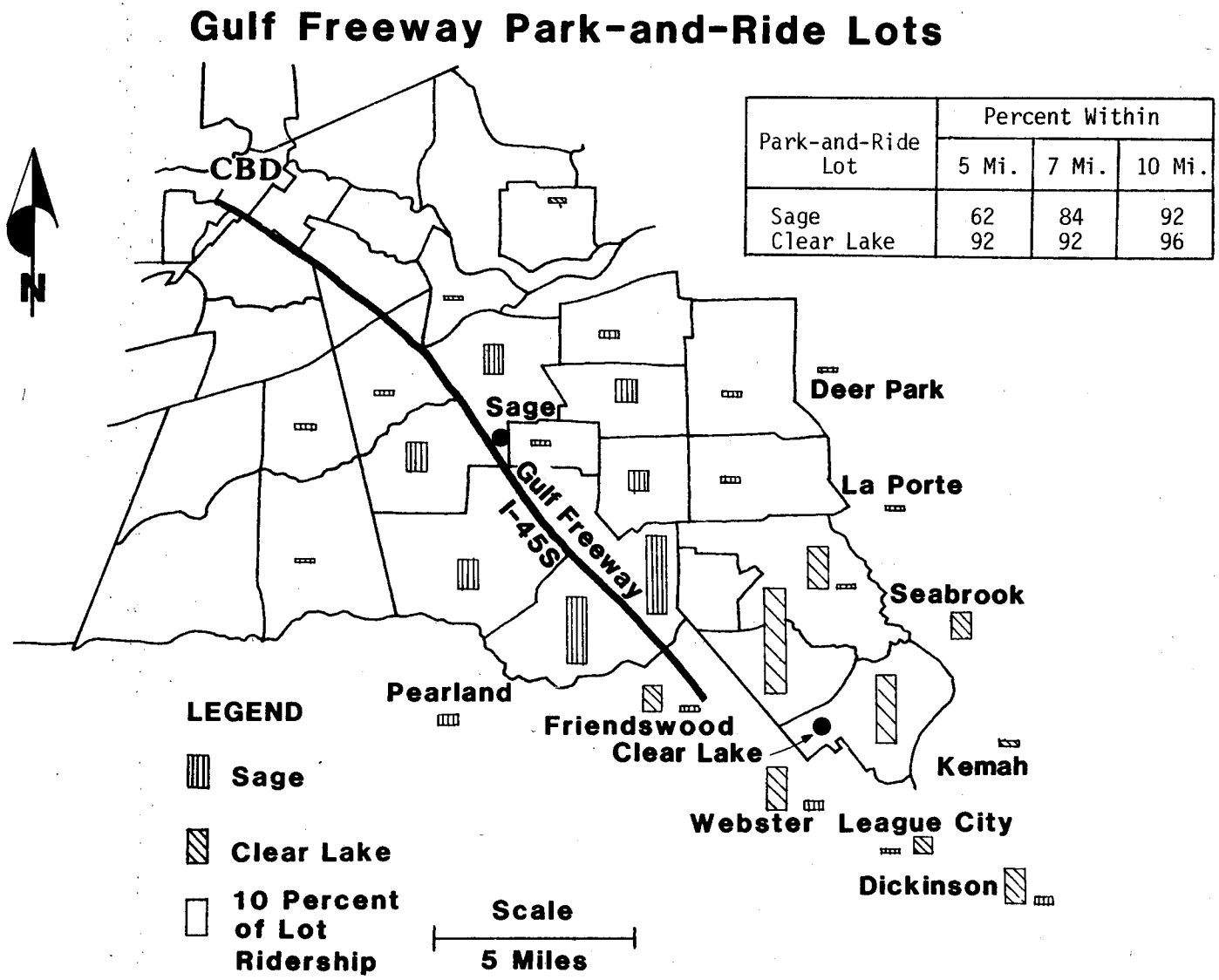


Figure 11: Park-and-Ride Lot Market Characteristics - Gulf Freeway Corridor, Houston

Southwest Freeway Park-and-Ride Lots

Park-and-Ride Lot	Percent Within		
	5 Mi.	7 Mi.	10 Mi.
Bellaire	95	97	98
Westwood	63	100	100
West Loop	80	99	100
Alief	88	94	100

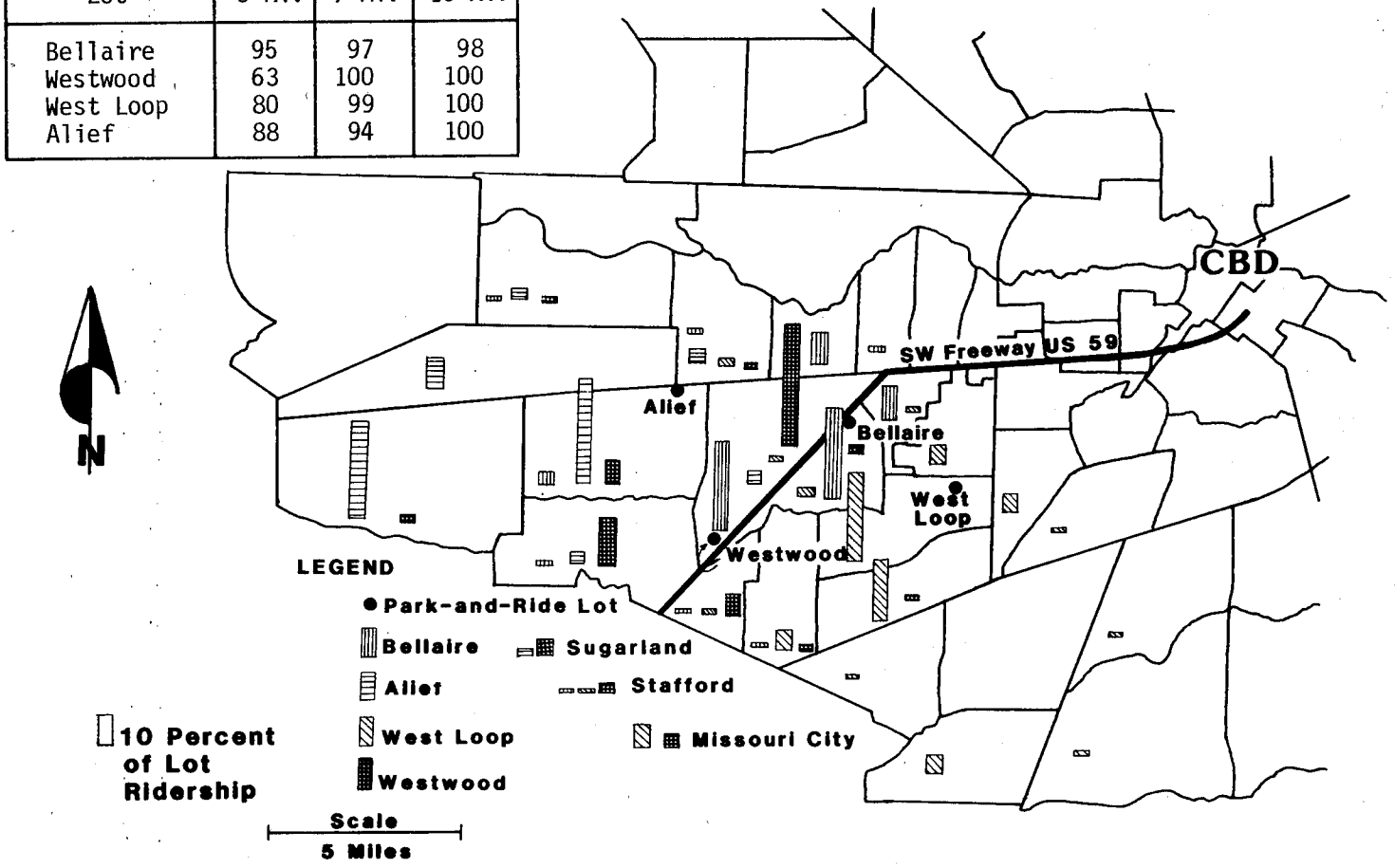


Figure 12: Park-and-Ride Lot Market Characteristics - Southwest Freeway Corridor, Houston

Table 36: Distance Houston Park-and-Ride Patrons Live From the Lot They Use

Park-and-Ride Lot	Percent Living Within		
	5 Miles	7 Miles	10 Miles
Clear Lake City	80	99	100
Gulf/Sage	47	92	94
Westwood	86	92	96
Champions	95	97	98
North Shepherd	88	94	100
Kuykendahl	63	100	100
Kingwood	86	89	89
Beechnut/West Loop	62	84	92
Alief	89	93	96
Sharpstown/Bellaire	92	92	96
Katy/Mason	26	98	100
Non-Weighted Average	74	94	96

Virtually all park-and-ride patrons live within 7 miles of the lot they use.

Surveys conducted by VIA Metropolitan Transit found that the "typical" market area in San Antonio has a noticeably different shape. At all lots except Kel-Lac and Wonderland, approximately 85% to 95% of the park-and-ride users live within a circle having a diameter of 7.5 miles (8). A reluctance of users to backtrack (travel in a direction away from the final destination) causes the location of the park-and-ride lot within this circle to be slightly off-center (Figure 13). The market area around the Kel-Lac lot is shaped like a comet with the larger end located around the lot and the tail extending in a southeasterly direction. The Wonderland lot, which serves both the CBD and the University of Texas at San Antonio (located in opposite directions from the lot), draws its patronage from the entire metropolitan area.

In Fort Worth, it was found that the market area for one group of lots approximated the same parabolic dimensions as in Dallas/Garland and Houston. Analysis of the other group of lots, however, indicated that slightly more than 75% of the park-and-go patrons live within a circle that has a radius of 1.5 miles. Given the local or non-express transit service provided to typical park-and-go lots, a much smaller market area seems to be more representative of the watershed for the park-and-go transit users (12).

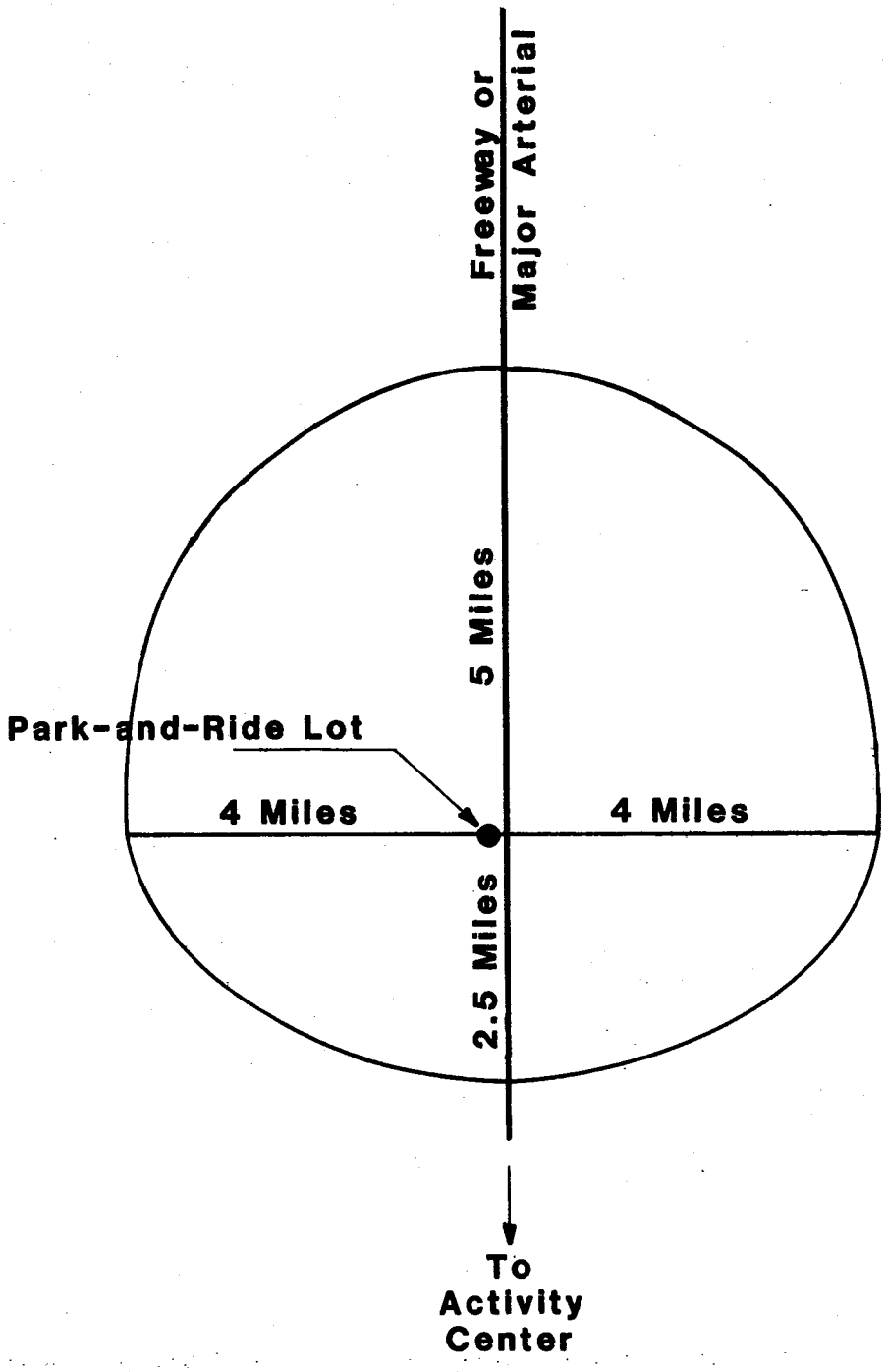
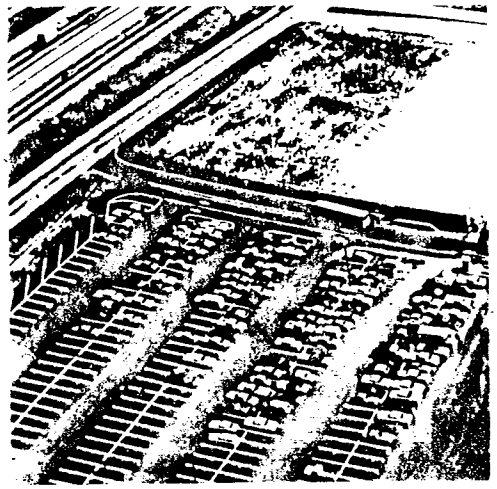


Figure 13: General Shape of "Typical" Park-and-Ride Market Area for San Antonio Lots

Chapter 5



Guidelines for Locating Park-and-Ride Lots

5 Guidelines for Locating Park-and-Ride Lots

During the preliminary design phase, certain flexibility may exist regarding the approach to use in implementing park-and-ride service. In this chapter, several factors that influence the location in which a park-and-ride facility will be provided are discussed. Guidelines for identifying desirable park-and-ride lot locations are presented. In addition, the issue of whether to develop a new park-and-ride facility or whether to locate the park-and-ride service in an existing parking location is addressed. Finally, consideration is given to the advantages and disadvantages of developing one large park-and-ride facility as opposed to several smaller facilities.

General Factors Influencing Park-and-Ride Lot Location

In some highly developed urban areas, little choice may be available concerning the selection of potential parking lot locations. In effect, land availability and/or cost may greatly restrict alternative lot locations. Nevertheless, the following guidelines should be considered in locating potential park-and-ride facilities (19, 21). If several of these guidelines are not adhered to, utilization of the lot may be less than expected.

- **Park-and-ride service will generate the greatest ridership in travel corridors that experience intense levels of traffic congestion.** The congestion index which was developed in Research Report 205-7 provides relative measures of congestion on Texas freeways and was found to be an important variable in predicting park-and-ride utilization. The more successful lots in Texas appear to be located in corridors with congestion indices in excess of 1.0 to 1.5 (refer to CI in Table 5, Research Report 205-7); as a general guide, this range of congestion index is experienced as average daily traffic per lane approaches about 20,000. Figure 14 shows the relationship between congestion and park-and-ride utilization in Texas.

- **The park-and-ride lot should be located in advance of the more intense traffic congestion.** Potential park-and-ride patrons should have the opportunity to select the park-and-ride alternative prior to encountering the more heavily congested peak-period traffic.

- **Lots should be located at least 4 to 5 miles from the activity center served.** The most successful lots in Texas are those which are located at least 4 to 5 miles from their destination. Most park-and-ride patrons drive less than 5 miles to get to the lot. Since the typical work trip in Texas is about 8 miles in length, it appears that if a lot is developed closer than 4 miles to the activity center served, the auto trip will constitute more than half of the total trip. This may cause the potential user to forego the mode change opportunity. In major urban areas it appears that park-and-ride lots should not be located much closer to downtown than the freeway loop (generally 4 to 7 miles).

- **Given appropriate development patterns, there appears to be no outer limit concerning how far a lot can be located from the activity center.** Successful lots in Texas are located as far as 30 miles from the destination.

- **The lot should be located in a geographic area having a high affinity to the activity center being served by the park-and-ride operation.** Since relatively few patrons backtrack to use a park-and-ride lot, the lot should be located so that the area immediately upstream of the park-and-ride facility generates sufficient travel demand to the activity center being served. For example, in the market areas of the park-and-ride lots serving the North Freeway Contraflow Lane, as many as 25% of the households have at least one individual who works in downtown Houston.

- **As the total population in the park-and-ride market area or watershed increases and as the percentage of that population working in the activity center served by the park-and-ride operation increases, so will park-and-ride utilization.** As a result, the magnitude of development at the activity center will be an important determinant of potential park-and-ride utilization.

- **Lots should be developed with both good access and good accessibility.** Both accessibility (a measure of the ease with which potential users can get to the general area of the park-and-ride lot) and the access (a measure of how easily users can get into and out of the specific lot site) associated with a park-and-ride facility can influence utilization.

- **Generally speaking, there should be no charge for parking at the park-and-ride facility.** Although data are not sufficient to conclusively state that parking should always be free, it appears that a parking charge may adversely affect ridership.

- **If the current number of park-and-ride spaces available are sufficient to handle "all" the demand from a given watershed, other lots in that same travel corridor should be located no closer together than 4 to 5 miles.**

- **Park-and-ride service should not be expected to compete with local bus routes.** "Competitive" local transit routes, especially when a fare differential exists between the local and the park-and-ride service, can siphon off potential park-and-ride utilization.

If flexibility exists in the selection of a specific lot site, the following factors should also be considered in determining the preferred lot location (19).

- **To minimize development costs, the site should be flat and well drained.** Compatibility with adjacent land uses also needs to be considered.

- **Space should be available for expansion of the lot.** Initial demand may be underestimated, and demand should increase over time.

- **Preferably, a park-and-ride lot will be located on the right side of the roadway to conveniently intercept inbound traffic.** However, numerous successful lots have been developed that were not located in this manner.

Shared Use Versus New Park-and-Ride Facilities

Two general approaches can be used in implementing park-and-ride service. One alternative is to construct new facilities specifically designed to serve as exclusive park-and-ride terminals. The second alternative is to utilize the unused portion of an existing parking lot to serve as the parking area for the park-and-ride service. Sites commonly used in this shared-use lot arrangement include shopping centers, movie theatres, churches and various sporting facilities.

As listed below, both of these alternative approaches have certain advantages and disadvantages (19).

Shared Lots, Advantages

- **The parking facility is already available and, therefore, the lead time to implementation of park-and-ride service is reduced.** Provision of entirely new facilities can greatly increase lead time.
- **The parking area and access roadways already exist.** As a result, less capital is required to implement the park-and-ride service.
- **Due to the lower capital requirements, shared lots can be used as a means of testing demand.** If demand proves inadequate, the service can be quickly terminated. If the demand is substantial, the desirability of serving that demand with more capital intensive facilities can then be considered. Although the location, amenities, and transit service at a shared-use lot may not be optimal, opening a lot at the location may still generate a significant park-and-ride patronage.
- **The shopping opportunities available at some shared-lot locations may encourage ridership.**

Shared Lots, Disadvantages

- **The park-and-ride operation must be worked into the existing lot layout.** This may create difficulty in developing desirable access and circulation patterns.
- **Space may not be available for expansion.** Expansion area will be needed if initial demand estimates are low, or if demand increases over time. If the demand at the shared-lot location is greater than anticipated, problems may be created when the excess parking demand begins parking in areas not designated as park-and-ride lot areas.
- **It may be difficult to obtain assurance that a certain number of parking spaces will be available on a daily basis.** Many facilities that have unused parking area during most of the year require the use of that parking area during peak times of the year. In essence, the transit operator lacks total control over the facility.
- **Many of the amenities provided will be temporary in nature.** The temporary appearance of the facility may discourage some potential ridership.

- **During peak periods, especially the evening peak, congestion within the lot and at the access points may be intensified due to traffic generated by the shared use.** For example, evening shopping traffic may conflict with evening park-and-ride traffic.

Single Versus Multiple Lots

Given an estimated demand for park-and-ride service, a question arises as to whether that demand can better be served by providing one large lot or two or more smaller lots. Some of the advantages and disadvantages of these approaches are listed below (19). It appears that, as long as the maximum lot size constraints developed subsequently are not exceeded, the advantages of providing one large facility generally exceed the disadvantages of the large lot.

Multiple Lots, Advantages

- **Provision of multiple lots results in a larger geographical area being included in the total park-and-ride market area.** The result should be some increase in total park-and-ride utilization.
- **If the maximum parking lot size constraints (1,800-1,900 parking spaces/ bus-loading area) developed in a subsequent chapter of this guide are exceeded, multiple lots may provide a means of accommodating the demand.**
- **If either land availability and cost or available surface street capacity pose problems in providing one large lot, it may be more economical to provide multiple smaller lots rather than incur massive land and/or street improvement costs to build a single large facility.**
- **Smaller lots will reduce both congestion and walking distances within the lot.**
- **A smaller percentage of the total trip distance will be made by auto.**

Multiple Lots, Disadvantages

- **The construction and maintenance costs of one large facility will be less (assuming similar land costs and facilities) than those of multiple smaller lots.** This will generally be true as

long as the demand at the one large lot does not necessitate large-scale improvements to the adjacent street system. In general, transit operators prefer to operate their service to a single lot location.

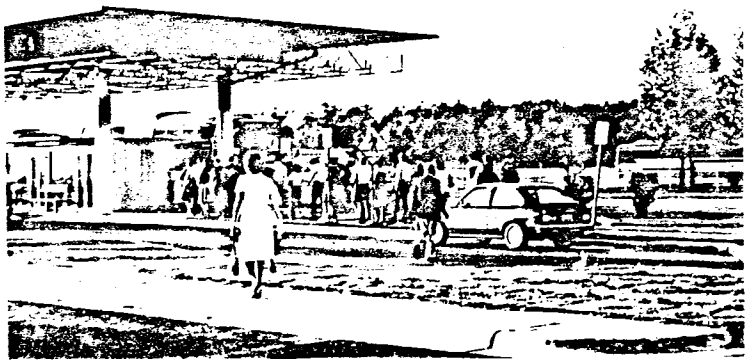
- **If express bus service is provided, longer headways will exist in the multiple-lot situation (assuming comparable bus load factors).** That is, each small lot will not have the same level of bus service that would be provided at one large lot.

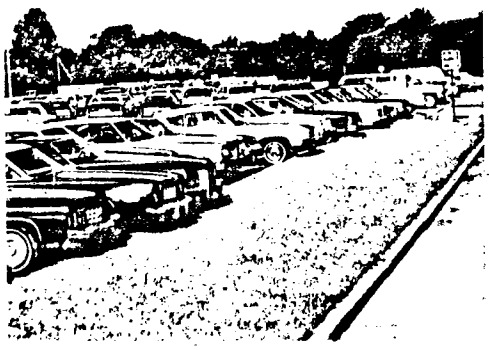
- **Bus breakdowns may pose a greater problem in the multiple lot situation, where the breakdown might cause headways to increase from the scheduled 15 or 20 minutes to 30 or 40 minutes.** The latter represents unacceptably long headways. Conversely, at the large lot, a bus breakdown would typically result in bus headways in the range of 10 to 15 minutes.

- **Provision of certain amenities (security, information, shelters, vending machines, etc.) may be more easily justified at one large facility than at several smaller facilities.**

- **Although multiple lots may provide an adequate number of total spaces, a probability exists that one of the smaller lots may become filled while others have substantial unused capacity.** Drivers would then be expected to travel to more than one location to find an available space.

Chapter 6





Park-and-Ride Demand Estimation Procedures

6 Park-and-Ride Demand Estimation Procedures

Park-and-ride lots draw their demand from a rather well-defined watershed or market area. This watershed is generally parabolic in shape with a vertex 0.5 to 1.0 mile downstream of the lot, an axis of 5 to 7 miles following the major artery upstream of the lot, and with a chord of 6 to 8 miles (Figure 9). When market areas of multiple lots overlap, this geographic area must be adjusted accordingly. Experience has also shown that the number of park-and-ride patrons per parked auto in the lot varies from 0.0 to 6.3 (Table 37). For planning purposes, however, 1.4 persons per parked vehicle is generally used (21).

Demand Constraints by Service and Facilities

The fact that many of the park-and-ride lots in Texas are filled to capacity and that buses have numerous standees suggests that, in many instances, facilities and services are constraining the demand; if more parking spaces and more buses were available, a greater park-and-ride ridership might be served. These lots have demonstrated that a substantial demand exists for high-level transit service in those cities which experience heavy traffic congestion. The actual magnitude of that demand remains unquantified in many corridors, because sufficient services have not been provided to serve that demand. The estimation guidelines developed in Technical Report 1064-IF and highlighted in this chapter are based on existing experiences at park-and-ride lots in Texas. Therefore, these guidelines may provide conservative estimates of actual demand in heavily congested corridors. Where plans are made to attempt to serve all demand, utilization of the guidelines will involve extrapolation beyond the range of the data base used to develop the guidelines.

Table 37: Park-and-Ride Patrons Per Parked Vehicle

Location	Patrons Per Parked Vehicle	Location	Patrons Per Parked Vehicle
Houston, TX		Fort Worth, TX	
Sage	1.7	Jefferson Unitarian Church	1.5
Bellaire	1.4	Herman E. Clark Stadium	2.0
W. Loop Sage/Meyerland	1.4	K-Mart	3.0
Westwood	1.5	Edgepark Meth. Church	1.7
Clear Lake	1.5	Alta Mesa Church of Christ	0.0
Alief	1.5	Montgomery Ward	1.3
North Shepherd	1.4	Ridglea Baptist Church	1.7
Kuykendahl	1.3	Arlington Hts. Christ. Church	2.0
Champions	1.3	Average	1.6
Kingwood	1.5		
Katy/Mason	1.4		
Average	1.4	El Paso, TX	
Dallas, TX		Vista Hills	6.3
		Montwood	2.3
Garland North	1.7	Rushfair	3.0
Garland South	1.2	Northgate	1.5
Dallas N. Central	1.5	Pecan Grove	0.0
Pleasant Grove	1.5	Average	2.6
Oak Cliff	1.4		
Average	1.5	Seattle, WA	1.5
San Antonio, TX		Hartford, CT	1.7
University	1.7	Richmond, VA	1.6
Wonderland	1.4		
McCreless	2.9	Average, All Cities	1.7
Windsor Park Mall	1.4		
Bitters	1.6	Average, Texas Cities	1.8
Broadway	3.0		
Average	2.0		

Source: TTI Surveys and Reference 22.

For the larger Park-and-Ride lots, there are about 1.4 riders per parked vehicle.

Demand Estimation Guidelines

Using information that is generally available for urban areas in Texas, 3 different procedures can be used to estimate potential park-and-ride utilization. In evaluating a potential lot site, it is suggested that all 3 procedures be used to provide a range of estimates. That range can then be used as a basis for further planning and decision-making. The 3 alternative approaches, as defined below, assume that the park-and-ride facility has been located according to the guidelines set forth in Chapter 5.

- **Market Area Population** - The percentage of the total population living in the park-and-ride watershed that is represented by ridership at the park-and-ride lot, i.e., (ridership ÷ market area population) X 100.
- **Modal Split** - The percentage of the person-trips that originate in the park-and-ride watershed, terminate in the activity center served by park-and-ride, and actually use the park-and-ride service.
- **Regression Equations** - The data base is evaluated in all possible manners to develop equations that can be used to estimate park-and-ride patronage.

Market Area Population

Analysis of data indicates that the population in the park-and-ride lot watershed or market area can be used to obtain a "ballpark" estimate of potential park-and-ride lot utilization. (Note: Data used in this analysis are described in Technical Report 1064-IF).

The percentage of market area population that is represented by ridership varies between Texas cities and between corridors within cities. In general, however, the guidelines (Table 38) appear to be applicable.

Variation between cities and between corridors within cities can be at least partially explained by certain characteristics of the urban area that would be expected to influence park-and-ride utilization. Some of these data are shown in Table 39.

Table 38: Ridership as a Percentage of Population in the Park-and-Ride Market Area

City and Park-and-Ride Lot	Ridership as a % of Market Area Population	"Guideline" for City
Austin		
North Park-and-Ride	0.6	
US 183 North[1]	0.3	0.3 to 0.6
Dallas Area		
Garland South	0.8	
Garland North	1.3	
North Central	0.4[2]	0.4 to 1.3
Las Colinas	0.8	
Redbird	0.7	
Pleasant Grove	0.4	
El Paso		
Montwood[3]	0.4	
Northgate[4]	0.07	0.07 to 0.4
Fort Worth		
Meadowbrook	0.05	
College Avenue	0.3	0.05 to 0.3
Houston[5]		
Champions	0.9	
Kuykendahl	2.1	
N. Shepherd	1.0	
Edgebrook	0.8	0.7 to 2.0
Clear Lake	0.8	(constrained due
Beechnut (both lots)[6]	0.9	to size of lots
Sharpstown	0.3[7]	currently available)
Alief	0.9	
Westwood	1.1	
Katy/Mason	0.7	
Kingwood	1.4	
Lots serving contraflow lane		2.5 to 3.0
San Antonio		
Windsor Park	0.5	
McCreless	0.2[8]	varies up to 1.2
South Park	0.1	
Lackland	1.1	
Wonderland	1.2	
Nacogdoches[9]	0.2	

[1]Includes 3 lots served by the same bus--US 183 North #1, #2 and #3.
[2]Ridership is lower than would be expected due to paid parking, competing local bus service, poor lot access/accessibility and lot not located upstream of congestion.
[3]Includes 2 lots served by the same bus--Montwood and Vista Hills.
[4]Includes 2 lots served by the same bus--Northgate and Rushfair.
[5]Ridership at most of the Houston lots is constrained by parking spaces available.
[6]Includes 2 lots served by the same bus--Meyerland and Sage.
[7]Low percentage due to small lot size.
[8]Lot located in an uncongested corridor and relatively close to activity center.
[9]Includes 2 lots served by the same bus-Broadway and Bitters.

Table 39: Ridership as Related to Market Area Compared to Other Indicators of Park-and-Ride Potential, by City

City	Ridership as a % of Market Area Population	"Representative" Congestion Index[1]	Average Monthly Pkg. Cost	Activity Center Employment
Houston	0.7 to 2.0[2]	2.0 to 3.0	$85	158,000
Dallas Area	0.4 to 1.3	1.0 to 2.0	75	126,000
San Antonio	varies up to 1.2	0.5 to 1.5	35	38,000
Austin	0.3 to 0.6	0.5 to 1.0	55	17,000
Fort Worth	0.05 to 0.3	0.5 to 1.5	57	45,000
El Paso	0.07 to 0.4	0.5 to 1.0	40	19,000

[1]A "representative" value for the urban area as selected from Research Report 205-7. In actuality, considerable variation also occurs between corridors within a given urban area.

[2]In general, the Houston percentages are constrained by parking spaces available.

Source: References 8 and 21.

As congestion increases so does utilization of Park-and-Ride.

Table 39 suggests that park-and-ride becomes a more attractive alternative as congestion and the intensity of activity center development increase. Surveys have shown that saving money is, perhaps, the primary reason people choose park-and-ride. As congestion increases, so does auto operating cost and parking cost. Figure 14 shows the relationship between percentage of market area population riding the park-and-ride service to congestion index for all the lots studied. Considerable scatter occurs when less than 1% of the market area is represented by ridership; these data are typically associated with very small (less than 20 riders) park-and-ride facilities.

Using only market area population as a variable assumes that all market areas have a similar affinity for the activity centers being served. Total market area population is a more readily available variable than is the percentage of that market area population that works in the activity center (analysis of this percentage is discussed subsequently in this chapter). If there is reason to suspect that different corridors have significantly different affinities to the activity center, census or travel data can be used to make adjustments to the market area population.

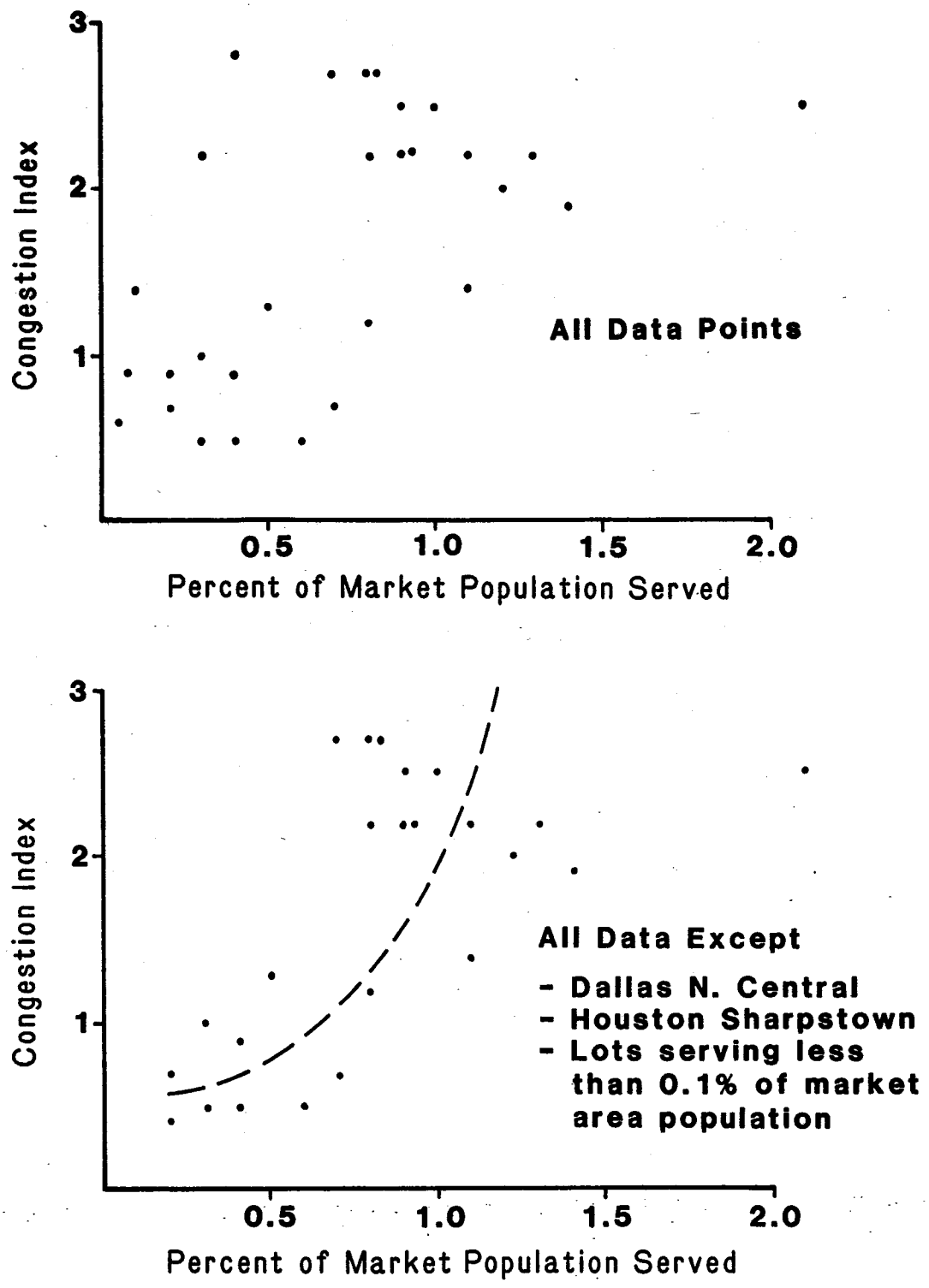


Figure 14: Relationship Between Congestion Index and Percent of Market Area Population Served for Texas Park-and-Ride Facilities

The effect of priority treatment on park-and-ride lot utilization is somewhat difficult to accurately assess due to the limited amount of data available. However, data for Houston (the only city in Texas with priority treatment currently available) suggests that, at properly located lots in congested corridors with priority bus service, perhaps as much as 2.5% to 3% of the total market area population could be served by park-and-ride. That percentage has continued to increase over the past several years since the Contraflow Lane opened.

Modal Split

The market area analysis described previously assumes that all market areas have an equal affinity to the activity centers being served by park-and-ride. While that approach is simple to apply and uses the most readily available data, it does not account for the fact that different parts of a corridor or an urban area can have different attraction rates to the activity centers being served.

Using the modal split procedure, however, requires the identification of that component of the market area population that works in the activity centers served by park-and-ride. Since this information is not always readily available, the attractiveness of this approach is somewhat diminished. Table 40 summarizes the available modal split data for Texas park-and-ride lots.

The modal split data show a wide spread. Some agreement with the congestion correlation appears to exist; modal splits tend to be relatively high in the more congested corridors.

The following guidelines--recognizing constraints imposed by lot sizes or lots not located in accordance with the lot location guidelines--might be used for park-and-ride analysis.

- **Dallas area lots - 10% to 20% modal split**
- **Houston area lots - 15% to 30% modal split, with some modal splits in the range of 50%.**

Those modal splits in the range of 50% suggest that if a lot is properly located and if a sufficient number of parking spaces are available, the result will be a significantly higher than "normal" modal split. That value might then be useful in identifying the "upper end" of potential lot size. Since surveys indicate that about half the persons perceive the need to have an auto available during the day, the 50% modal split value may mean that, in effect, all the eligible demand is being served.

Table 40: Estimated Modal Split For Selected Texas Park-and-Ride Lots

City and Lot	Modal Split[1]	Procedure to Estimate Modal Split[2]
Dallas/Garland Area		
Dallas North Central	7% to 8%	TTI Surveys (Research Report 205-11) and Census Analysis
Pleasant Grove	8	Census Analysis
Oak Cliff	4	Census Analysis
Garland North & South	21	TTI Surveys (Research Report 205-11)
Houston		
Clear Lake City	52	Census Analysis
Gulf Edgebrook	24	Census Analysis
Westwood	10	TTI Surveys (Research Report 205-15)
Champions	23	TTI Surveys (Research Report 205-15)
N. Shepherd	27	TTI Surveys (Research Report 205-15)
Kuykendahl	22	TTI Surveys (Research Report 205-15)
Kingwood	29	Census Analysis
Beechnut (2 lots)	13	Census Analysis
Alief	28	Census Analysis
Sharpstown	4	Census Analysis
Katy/Mason	50	Census Analysis

[1]Modal split is defined as the percent of the market area population working in the activity center served by park-and-ride that uses the park-an-ride service.

[2]In using census data, the percent of the population working in the CBD was obtained from 1970. Due to the massive growth in many of the areas being considered, applying the 1970 percentage to the 1980 market area results in potential error.

Source: Reference 21.

Modal splits in the range of 25% are commonly experienced at Park-and-Ride lots in Texas.

As was the case with the market area analysis, data are not sufficient to determine the effect of priority treatment on park-and-ride utilization. While the Houston data do suggest that the priority treatment lots are serving a greater modal share than the non-priority lots (Table 41), this could be true because relatively more parking spaces are presently provided at the priority-treatment lot locations. It appears that bus modal splits at least in the range of 25% are associated with priority treatment lots (Table 42). While it cannot conclusively be demonstrated, it appears that the provision of priority treatment increases modal split by at least 50%.

Table 41: Possible Impacts of Priority Treatment on Park-and-Ride Utilization Based on Market Area Analysis, Houston Lots

Houston Park-and-Ride Lots	% of Market Area Population Using Park-and-Ride	Available Parking Spaces per Market Area Population	Park-and-Ride Patrons Per Available Parking Space
3 lots with Priority Treatment	1.17%	0.012	0.97
8 lots without Priority Treatment	0.75%	0.007	1.02

Source: Reference 21.

Table 42: Possible Impacts of Priority Treatment on Park-and-Ride Utilization Based on Modal Split Analysis, Houston Lots

Houston Park-and-Ride Lots	Modal Split[1]	Available Parking Spaces per Market Area Population	Park-and-Ride Patrons Per Available Parking Space
3 lots with Priority Treatment	24%	0.012	0.97
8 lots without Priority Treatment	15%	0.007	1.02

[1]Modal split values shown are weighted averages for the lots shown in Table 41.

Source: Reference 21.

Limited available data suggest that provision of priority treatment may increase modal split by 60%.

Regression Analysis

Multiple regression is a common approach to demand estimation. The results of these analyses can be relatively easy to utilize, and the widely available Statistical Analysis System (SAS) Computer package simplifies the use of this analytical tool.

The data for 35 park-and-ride lots in Texas (all that were in service at the time of the study) were combined and analyzed in all possible manners to develop equations that can be used to predict park-and-ride patronage (Table 43). Since data are included from several lots in smaller urban areas with limited utilization, those lots tend to underestimate utilization at the larger lots in congested urban areas. Several of these equations are discussed in Technical Report 1064-IF. The following represent some of the more applicable equations.

1. **Ridership = -160 + 204 (CI) + 0.0034 (MAPOP)** $R^2 = 0.57$

where:

CI = congestion index for line-haul roadway (Refer to Table 44)
(described in more detail in Research Report 205-7 and Technical Report 1064)

MAPOP = total population in the park-and-ride lot market area

In most instances this equation predicts ridership at existing lots within 50% of actual ridership.

2. A. **Ridership = -86 + 0.8 (MIN) + 0.002 (MAPOP)** $R^2 = 0.93$
Note: Applies to lots with CI $\geq$ 1.3

   B. **Ridership = 61 + 0.1 (MIN) + 0.001 (MAPOP)**
Note: Applies to lots with CI between 0.9 and 1.2

   C. **Ridership = 7 + 0.43 (MIN)** $R^2 = 0.81$
Note: Applies to lots with CI $\leq$ 0.9

where:

MIN = a control based on service provided. It equals the minimum of the following 2 variables: 1) auto parking spaces x 1.5 persons/auto or 2) peak-period bus seats. The equation thus recognizes that at many existing lots demand is controlled by facilities provided.

MAPOP = total population in the park-and-ride lot market area

Table 43: Individual Congestion Indices (ICI)

City and Facility	AADT/Lane	# of Lanes	Delay in Minutes	ICI
Austin				
US 183 N	7,925	6	1.5	0.5
Mo Pac	6,466	6	1.0	0.4
I-35 N	7,188	8	1.5	0.5
I-35 S	18,367	6	2.0	1.1
Dallas				
Stemmons (I-35 E North)	13,210	10	5.0	1.2
N. Central (US 75 N)	20,517	6	18.0	2.8
Thornton East (I-30 E)	13,400	8	15.0	2.2
Thornton South (I-35 E South)	12,800	8	1.0	0.7
LBJ or North Side (I-635)	20,363	8	2.0	1.2
US 175	6,550	6	2.0	0.5
US 67	7,500	6	2.0	0.6
El Paso				
I-10 E	11,780	10	3.0	0.9
US 54	8,817	6	1.0	0.5
I-10 W	12,775	4	1.0	0.7
Fort Worth				
West (I-30 W)	22,675	4	8.0	1.9
South (I-35 W South)	13,900	6	3.0	1.0
East (I-30 E)	8,888	8	2.0	0.6
Houston				
Southwest (US 59 S)	21,633	9	11.0	2.2
Katy (I-10 W)	24,457	7	15.0	2.7
North (I-45 N)	19,000	8	15.0	2.5
Eastex (US 59 N)	15,225	8	11.0	1.9
East (I-10 E)	14,863	8	5.0	1.2
Gulf (I-45 S)	24,443	7	15.0	2.7
West Loop (I-610)	25,363	8	8.0	2.1
San Antonio				
S. Pan Am (I-35 S)	20,425	4	4.0	1.4
I-10 W	21,450	4	9.0	2.0
N. Pan Am (I-35 N)	20,110	4	3.0	1.3
US 281 N	10,062	8	2.0	0.7
I-37 S	8,725	8	0.0	0.4
US 90 W	8,775	8	0.0	0.4

Source: Reference 21.

Guidelines For The Selection of MIN. While the equations using the variable MIN do a good job of "predicting" ridership at existing lots, their

use in estimating demand at new lots requires estimating the value of MIN. Since MIN can vary considerably between lots in a given urban area, the best approach might be to locate an existing lot that is similar to the proposed lot in terms of congestion index, distance to the activity center, and market area population. Using this approach, the value of MIN for the existing lot (Table 44) can be used in the appropriate regression equation to estimate ridership at the new lot.

In the absence of a comparable existing lot that can be used to determine the MIN value, one of two approaches might be used. The values in Table 45 can be applied. These values were obtained for each urban area by averaging the numbers shown in Table 44. Again, it should be noted that, due to the large variation in MIN values for a given urban area, use of the "typical" value increases the error estimate.

Table 45: "Typical" MIN Values For Urban Areas in Texas

Urban Area	"Typical" MIN Value[1]
Houston	600
Dallas	425
San Antonio	250
Austin, El Paso, and Fort Worth	125 to 175

[1]Obtained by averaging the values in Table 44.

Source: Reference 21.

The MIN variable can be used in some instances to assist in estimating Park-and-Ride demand.

Alternatively, since MIN is somewhat related to variables such as market area population, distance to activity center, and congestion index, those values for the proposed new lot can be used to estimate a value of MIN (Figure 15).

The equations using the MIN variable accept the fact that current park-and-ride patronage is often controlled by either facilities (i.e., parking

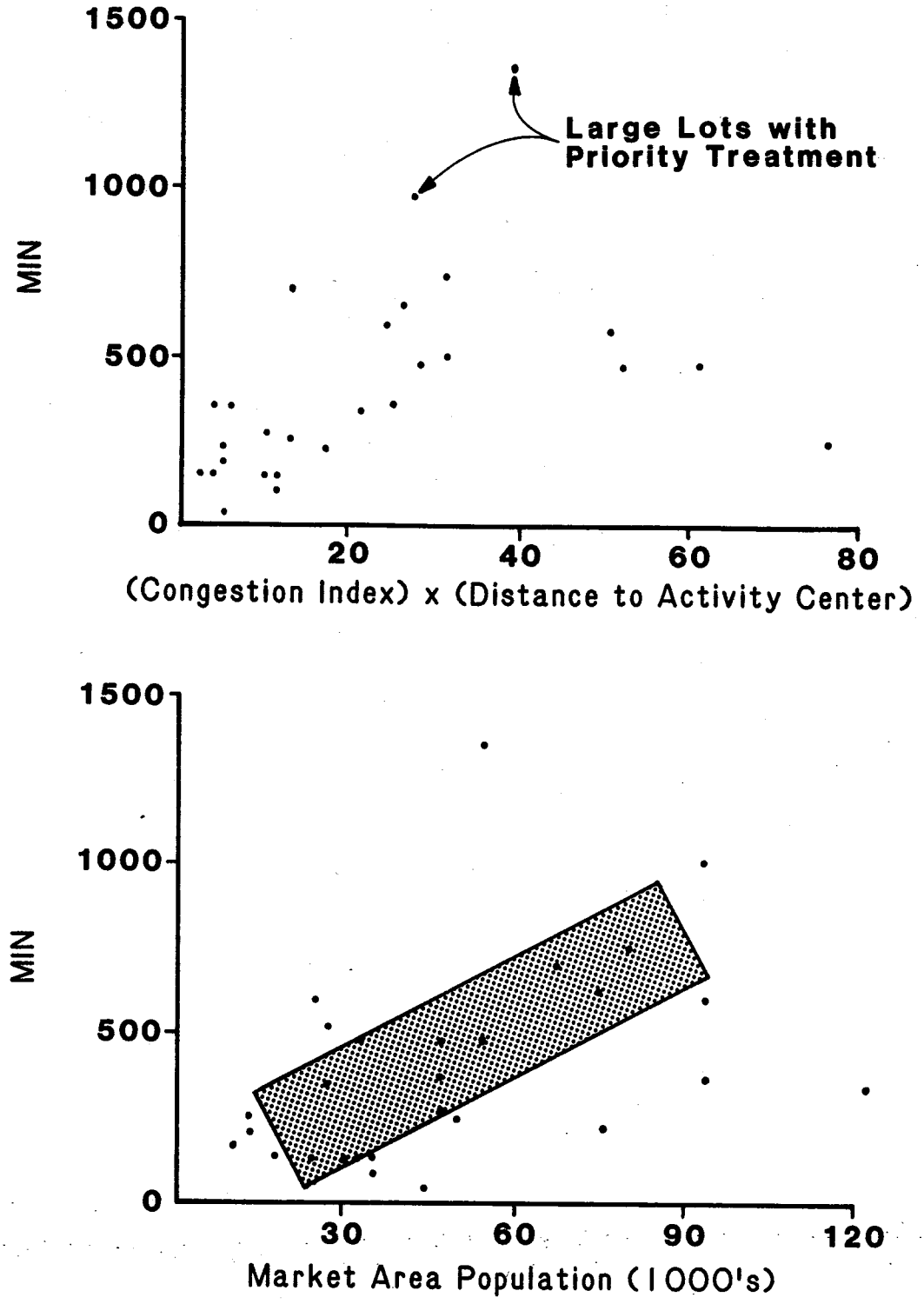


Figure 15: Relationship Between the Variable MIN and Selected Descriptors of Park-and-Ride Lots

Table 44: Estimated Values of the Variable MIN at Selected Texas Park-and-Ride Lots

Lot	# of Peak Buses X Seats =	Parking Spaces X 1.5*	MIN
Austin			
North Park and Ride	3 x 45 = 135	260 X 1.5 = 390	135
US 183 North[1]	2 X 43 = 86	239 X 1.5 = 359	86
US 183 Express	1 X 43 = 43	146 X 1.5 = 219	43
Dallas Area			
Garland South[2]	20 X 50 = 1000	440 X 1.5 = 660	660
Garland North[2]	13 X 50 = 650	320 X 1.5 = 480	480
North Central	11 X 50 = 550	1300 X 1.5 = 1950	550
Las Colinas	3 X 50 = 150	150 X 1.5 = 225	150
Red Bird	7 X 50 = 350	315 X 1.5 = 473	350
Pleasant Grove	7 X 50 = 350	624 X 1.5 = 936	350
El Paso			
Montwood[3]	4 X 47 = 188	75 X 1.5 = 113	113
Northgate Express[4]	4 X 47 = 188	209 X 1.5 = 314	188
Fort Worth			
Meadowbrook	2 X 48 = 96	25 X 1.5 = 38	38
College Avenue	6 X 48 = 288	185 X 1.5 = 278	278
Houston			
Kingwood	12 X 47 = 564	950 X 1.5 = 1425	564
Champions	10 X 47 = 470	349 X 1.5 = 524	470
Kuykendahl	29 X 47 = 1363	1300 X 1.5 = 1950	1363
North Shepherd	21 X 47 = 987	750 X 1.5 = 1125	987
Gulf Sage	10 X 47 = 470	230 X 1.5 = 345	345
Clear Lake	10 X 47 = 470	325 X 1.5 = 488	470
Beechnut Express[5]	12 X 52 = 624	487 X 1.5 = 731	624
Sharpstown	7 X 47 = 329	200 X 1.5 = 300	300
Alief	12 X 47 = 564	300 X 1.5 = 450	450
Westwood	16 X 47 = 752	600 X 1.5 = 900	752
Katy	5 X 47 = 235	170 X 1.5 = 255	235
San Antonio			
Windsor	6 X 47 = 282	167 X 1.5 = 251	251
McCreless	5 X 47 = 235	117 X 1.2 = 140	140
South Park	3 X 47 = 141	64 X 1.2 = 77	77
Lackland	5 X 47 = 235	136 X 1.5 = 204	204
Wonderland	13 X 52[7] = 676	474 X 1.5 = 711	676
Nacgdoches[6]	5 X 47 = 235	123 X 1.2[8] = 148	148

*1.5 - assumed maximum average auto occupancy.
[1]Includes 3 lots served by the same bus- US 183 North, Covenant and NW Hill.
[2]Since the buses from Garland North also stop at Garland South, parking spaces are used to establish the MIN values for Garland.
[3]Includes 2 lots served by the same bus - Montwood and Vista Hills.
[4]Includes 2 lots served by the same bus - Northgate and Rushfair.
[5]Includes 2 lots served by the same bus - Meyerland and Sage.
[6]Includes 2 lots served by the same bus - Bitters and Broadway.
[7]Bus capacity was inflated to account for numerous standees.
[8]Auto occupancy lower than state average.

Source: Reference 21.

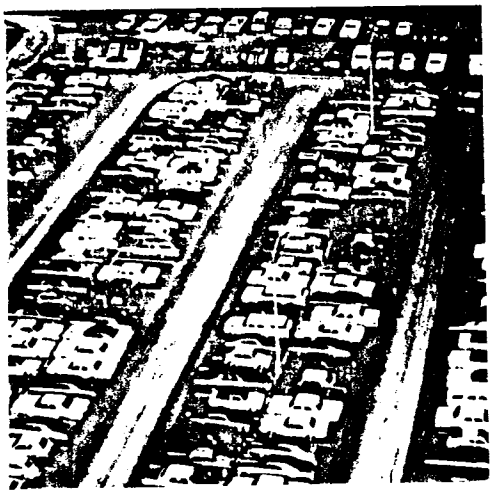
spaces available) or service (i.e., number of buses provided to the lot). These equations, in most instances, predict ridership at existing lots within 25% of actual ridership. Further discussion of the MIN variable for demand estimation is included in Technical Report 1064-IF.

Conclusions

It should be noted that once the ratio of parking spaces to market area population exceeds that characteristic of existing Texas lots, use of any of the demand estimation procedures will require extrapolation of the data base.

In conclusion, this chapter has presented several alternative techniques for estimating the potential utilization of park-and-ride service in Texas cities. Each technique has certain limitations, and all assume that the proposed lot is situated in accordance with the lot location guidelines presented in this manual. In planning for new park-and-ride facilities, it is recommended that all 3 of the demand estimation techniques outlined be applied in order to obtain a range of estimates of potential lot utilization. That range, along with knowledge of the local area, can be used to estimate the size of the new park-and-ride facility.

Chapter 7



Guidelines for Sizing Park-and-Ride Lots

7 Guidelines for Sizing Park-and-Ride Lots

After selecting the desired lot location(s) and determining the range of potential demand for the park-and-ride service, the next step is to estimate the size of the lot(s) that should be developed to adequately serve the anticipated demand. Because the size and design of the lot are influenced by the demand, consideration must be given to whether daily fluctuations in demand should be expected. In addition, those factors that determine both the maximum and minimum number of parking spaces to be provided at a new park-and-ride lot must be examined. These factors are addressed in this chapter of the guide.

Daily Demand Fluctuations

The planning process will have developed an average daily demand estimation. Due to the nature of park-and-ride services, little daily fluctuation in this demand should be expected. Persons using the park-and-ride mode are routinely doing so for trips to and from work and, as would be expected, these trips are made on a regular basis (usually 5 round trips per person per week). Thus, if a park-and-ride facility is designed to accommodate a demand approximately 10% greater than the estimated average demand, the probability of actual demand exceeding capacity on any given day will be small (19).

Constraints on Parking Lot Size

Certain design and operational features of the park-and-ride service place constraints on both the maximum and minimum lot size. Some of the more pertinent factors that influence parking lot size are presented in the following pages.

Maximum Lot Size

The maximum desired lot size of a park-and-ride facility can be constrained by walking distance, bus headways and other factors.

Walking Distance Constraint. Ideally, the maximum walking distance from the location in which the car is parked to the bus loading area should not exceed 400 feet (19). This maximum may not always be practical, however. More realistic maximum walking distances fall into the range of 600 to 1,000 feet (5, 19). Experience at Texas lots has shown that, when patrons must walk distances greater than 650 feet, many will park in restricted areas of the lot or on adjacent roadways in order to shorten the distance they must walk to board the bus. Therefore, excessively long walking distances may require moving the bus loading area to a more centralized location. Thus, for each bus loading area provided at a park-and-ride facility, walking distance will place a constraint on lot size. Table 46 lists 2 examples of how walking distance can affect the total lot size, assuming that the walking distance will not exceed 650 feet (an observed distance that functions satisfactorily at several Houston lots).

Table 46: Constraint of Walking Distance on Maximum Park-and-Ride Lot Size Per Bus Loading Area

Type of Lot Layout	Maximum Number of Auto Parking Spaces[1]
Loading area in the center of a square lot	1,900
Loading area on the periphery of a square lot	1,000

[1]Based on all parking spaces within 650 feet of the bus loading area and 450 sq.ft. per parking space.

Source: Reference 19.

Bus Headway or Service Constraint. The frequency of service, or bus headways, provided at each loading location places a constraint on the amount of demand that can be accommodated at the park-and-ride facility. Although bus headways in the range of 5 to 10 minutes are most desirable from an

operational point of view, headways of as little as 3 minutes have been successfully attained at certain lots in Texas. These headways are maintained during peak hours at several Houston lots.

Based on this constraint, parking lot size per bus loading area should not exceed about 1,800 parking spaces.* However, it is feasible to provide more than one bus loading area, possibly with the different loading areas serving different destination points, in order to increase the parking demand that can be accommodated at a specific lot.

Other Constraints. In addition to walking distance and bus service constraints, other factors can further constrain the maximum park-and-ride lot size. For example, inadequate capacity on surrounding roadways or at adjacent intersections may severely restrict the volume of traffic that can enter or leave a lot during a given period of time. Without good access, substantial traffic delays may develop which will adversely affect park-and-ride patronage and operation. Land availability and/or cost may also constrain the land area that can feasibly be obtained for the development of a park-and-ride lot. Observations at existing lots suggest that the impact of those park-and-ride lots on adjacent intersections may frequently be the controlling factor in how large a lot can be.

Minimum Lot Size

Bus headways, which influence the maximum size of a park-and-ride lot, also influence the minimum lot size. A minimal level of bus service is considered essential to justify the existance of a major park-and-ride facility. While peak-period headways in the range of 5 to 10 minutes are most desirable, certain operations in Texas have successfully generated significant demands with headways in excess of 10 minutes.

Based on the park-and-ride experience in Texas, it appears that headways at park-and-ride lots should not exceed 15 to 20 minutes. If 20 minutes is

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*Twenty buses during the peak hour at 50 persons per bus yields 1,000 persons. Assume this to be 40% of the total demand (12). The total demand would be approximately 2,500. At 1.4 persons per vehicle (19, 21), this results in the need for roughly 1,800 spaces.

considered to represent the longest acceptable headway, the park-and-ride facility should have at least 250 parking spaces to justify its existance.*

This minimum lot size standard assumes that the new park-and-ride facility is being provided with the intent of developing a major transit demand. Certainly, smaller park-and-ride lots with buses operating on longer headways have functioned well, especially when served by non-express service. However, unless a daily demand of approximately 250 vehicles can be guaranteed, the lot will be of sufficient size to justify minimal acceptable service of 20-minute headways.

Summary of Guidelines for Sizing Park-and-Ride Lots

Based on the information presented previously, it is suggested that a new park-and-ride facility should contain at least 250 all-day parking spaces. If the new lot has only a single bus loading area, as is typically characteristic of the lots in Texas, the size of the lot should not exceed about 1,800 to 1,900 all-day parking spaces (Table 47). Should the anticipated demand for

Table 47: Summary of Constraints on Park-and-Ride Lot Size Per Bus Loading Area

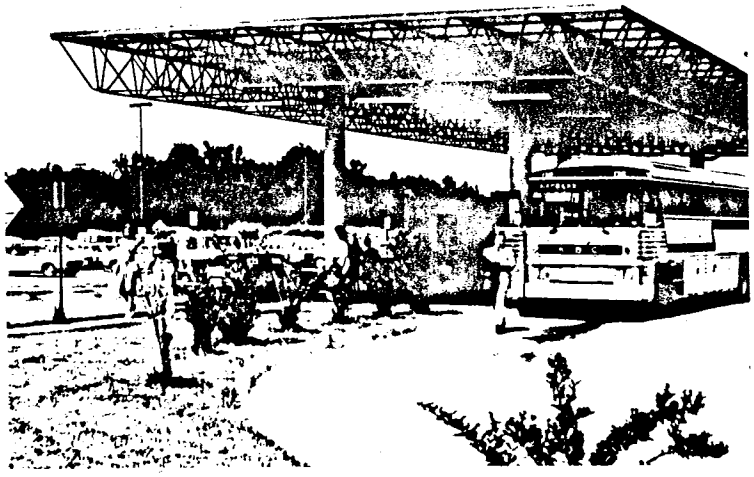
Constraint	Number of All-Day Parking Spaces	
Constraints on maximum size		
Walking distance	1,000-1,900	
Bus headways (service)	1,800	
Suggested Guideline		**1,800-1,900**
Constraint on minimum size		
Bus headways (service)	250	
Suggested Guideline		**250**

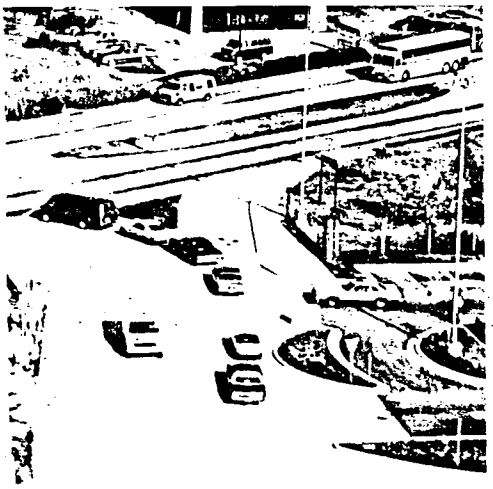
"Successful" Park-and-Ride lots might be as small as 250 spaces or as large as 1,900 spaces.

*Three buses during the peak hour at 50 persons per bus yields 150 persons. Assuming this to 40% of total demand (12), the total demand would be approximately 375 persons. At 1.4 persons per vehicle (19, 21), this results in the need for approximately 250 parking spaces.

park-and-ride service establish the need for more than 1,900 parking spaces, consideration should be given to providing more than one bus loading area or designing the lot layout such that bus loading area conflicts, excessively long walking distances and access problems are minimized.

Chapter 8





Important and Unimportant Features of Park-and-Ride

8 Important and Unimportant Features of Park-and-Ride

Assuming that a new park-and-ride facility is being provided with the intent of developing a major transit demand, attention should be focused on what features of the lot layout and service need to be provided in order to attract the desired ridership. In addition to identifying the characteristics of park-and-ride users and non-users, the on-board and household surveys described in Chapter 3 also attempted to identify those aspects of park-and-ride that were most (and least) important in maintaining existing or generating new ridership. This information is summarized in the following pages.

User Survey

Time/Money Savings

Patrons in El Paso, San Antonio, Dallas/Garland, Houston and Fort Worth were asked whether they saved time and/or money by using the park-and-ride service. Follow-up questions asked the amount of time and/or money saved or lost.

Time Savings. As would be expected, the Contraflow Lane in Houston allows a time savings not usually associated with the lots in the other study areas (Table 48). For those lots without special priority treatment, the majority of the respondents in all the study cities except El Paso paid a time penalty by using park-and-ride. The extent of time savings or losses experienced as a result of using park-and-ride are influenced by bus headways and how close the final destination is to the bus stop compared to where the employee would normally park his or her vehicle.

Money Savings. Responses to the question concerning possible money savings realized as a result of using park-and-ride and the perceived amount saved or lost are presented in Table 49. It is apparent that dollar savings are a major reason for using park-and-ride in all cities surveyed.

Table 48: Time Saved or Lost by Using Park-and-Ride

Time Saved or Lost	El Paso	San Antonio	Dallas/ Garland	Houston		Fort Worth	Non-Weighted Average
				CFL[2] Lots	CFL Lots		
Save time using park-and-ride	(n=102)	(n=344)	(n=380)	(n=783)	(n=1454)	(n=107)	(n=3170)
Yes	53%	40%	26%	74%	40%	33%	41%
No	34	55	69	19	53	62	52
Same	13	4	5	7	6	5	7
Not Sure	0	1	0	-	1	0	0
Minutes saved using park-and-ride (per 1-way trip)	(n=49)	(n=132)	(n=84)	(n=579)	(n=581)	(n=34)	(n=1341)
50th percentile	12	11	13	19	14	10	12
85th percentile	22	26	20	30	25	20	23
Minutes lost using park-and-ride (per 1-way trip)	(n=33)	(n=177)	(n=241)	(n=149)	(n=2743)	(n=54)	(n=1332)
50th percentile	14	14	15	13	14	13	14
85th percentile	26	28	29	19	28	20	26

[1]CFL = Contraflow Lane

Most persons using park-and-ride pay a travel time penalty to do so. That "penalty" averages 14 minutes per 1-way trip.

Table 49: Money Saved or Lost by Using Park-and-Ride

Money Saved or Lost	El Paso	San Antonio	Dallas/ Garland	Houston	Fort Worth	Non-Weighted Average
Save money using park-and-ride	(n=103)	(n=348)	(n=388)	(n=2247)	(n=110)	(n=3196)
Yes	84%	95%	86%	91%	87%	89%
No	7%	4	9	5	6	6
Same	8%	1	5	3	7	5
Not sure	1%	0	0	1	0	0
Dollars saved using park-and-ride (per month)	(n=70)	(n=284)	(n=261)	(n=1698)	(n=85)	(n=2398)
50th percentile	27	28	26	39	28	29
85th percentile	49	50	50	75	57	56
Dollars lost using park-and-ride (per month)	(n=4)	(n=3)	(n=29)	(n=84)	(n=6)	(n=126)
50th percentile	3	--	10	15	5	7
85th percentile	8	12	20	26	22	18

Virtually all users of Park-and-Ride perceive that they save money by using the service.

Satisfaction with Service

Users of park-and-ride were also asked to rate the general satisfaction with the service provided. Patrons in all 5 study cities are satisfied with the service (Table 50). This is a logical expectation since, if they were greatly dissatisfied with the service, they probably would not be using park-and-ride.

Table 50: Satisfaction with Park-and-Ride Service

Level of Satisfaction	El Paso (n=108)	San Antonio (n=356)	Dallas/ Garland (n=410)	Houston (n=2352)	Fort Worth (n=111)	Non-Weighted Average (n=3337)
Very satisfactory	23%	52%	15%	---	50%	28%
Satisfactory	61	43	46	78	42	54
Neutral	13	3	10	18	6	10
Unsatisfactory	2	1	21	4	1	6
Very unsatisfactory	1	1	8	---	1	2

Important/Unimportant Features

Park-and-ride patrons in all 5 study cities were asked which features of the service were most important to them in deciding to utilize park-and-ride. A list of features was provided, and each feature was rated on a scale of 1 (not important) to 5 (very important).

Responses to this question are shown in Table 51. Although some differences exist between the cities surveyed, it is apparent that, in general, patrons enjoy reliable, direct bus service to their destinations. They also desire a park-and-ride lot located close to home and convenient access to that lot. The rising cost of gasoline and vehicle maintenance was another factor which was rated highly.

Non-User Survey

Because current park-and-ride service has not attracted the non-user group, one of the major intents of the household surveys was to identify those features that could be added to the service that would be most successful in generating new ridership. A list of alternative improvements was provided to the non-users, and these individuals were asked to rate the improvement based on the likelihood of their using park-and-ride if the improvement was implemented. Each improvement was rated on a 1 to 5 basis, a 1 meaning very unlikely and a 5 meaning very likely. Those potential improvements addressed in the surveys are summarized in Table 52.

While the alternative improvements listed were not identical in the Dallas/Garland, Houston and Fort Worth surveys, some similarities do exist with respect to the relative importance of various improvements. For example, a time savings by using park-and-ride and bus stops closer to their final destination both rated highly in all 3 study cities. In Fort Worth, non-stop service (currently not available from many park-and-go lots) was also rated highly, and maintaining a comfortable temperature inside the buses was of major concern to respondents from Houston (the surveys were conducted during a period in which bus air conditioning problems were receiving considerable publicity). The least important concerns expressed by respondents

Table 51: Relative Importance of Various Park-and-Ride Features to Users of the Service

Feature	Rating[1]						
	El Paso	San Antonio	Dallas/ Garland	Houston	Fort Worth	Non-Weighted Average	Significance Level[2]
Reliable bus schedule	4.70	4.48	4.49	4.63	4.43	4.55	
Direct bus service	4.66	4.46	4.32	4.42	4.62	4.50	
A park-and-ride lot close to home	4.60	4.35	4.35	4.46	4.47	4.45	
Convenient access to the park-and-ride lot	4.49	4.44	4.35	4.42	4.31	4.40	
Rising cost of gas and vehicle maintenance	4.32	4.36	4.36	4.41	4.52	4.39	
Frequent bus service	4.09	4.36	4.52	4.55	3.93	4.29	
Avoiding the stress of driving	4.24	4.04	4.06	4.24	4.17	4.15	
Rising cost of parking at destingation	3.50	3.98	4.27	3.95	3.33	3.81	
Off-peak bus service	3.09	3.82	3.43	3.48	2.97	3.54	
Riding in a new, modern bus	3.37	3.46	2.84	3.51	3.03	3.24	
Bus travel time relative to auto travel time	3.06	3.15	2.89	3.44	2.94	3.10	

[1]Each feature was rated on a scale of 1 (not important) to 5 (very important).

[2]To access statistically significant differences in responses, a Duncan's multiple range test for variable rank was performed.

Table 52: Relative Importance of Various Improvements to Park-and-Ride Service in Generating Additional Ridership

Potential Improvement	Rating[1]			
	Dallas/ Garland	Houston	Fort Worth	Non-Weighted Average
If the bus trip took less time than an automobile	4.00	3.10	3.16	2.10
If the buses stopped closer to your place of work or school	3.83	3.03	2.93	3.26
If the bus trip was non-stop to your destination	----	----	3.22	3.22
If bus fares were lower	3.48	----	2.87	3.18
If there was always a seat available	3.67	3.01	2.79	3.16
If the cost of gasoline were to increase	3.45	----	2.87	3.16
If a comfortable temperature was always maintained inside the buses	3.49	3.11	2.81	3.14
If there was better security at the lot	3.59	2.73	2.88	3.07
If you didn't have to wait more than 5 minutes for a bus	3.47	2.90	2.71	3.03
If there were bus shelters and/or benches at the park-and-ride stops	3.27	----	2.84	2.96
If the bus arrived and departed at the scheduled time	3.35	2.84	2.62	2.94
If auto access to and from the lot was more convenient	3.28	2.75	2.63	2.89
If there were telephones at the bus waiting areas	2.99	----	2.69	2.84
If the buses were new and more modern	2.97	----	2.64	2.81
If the buses were safer to ride on than they are now	2.84	----	2.48	2.66
If newspapers/magazines were provided on board the bus	2.61	----	2.37	2.49
If you had a better understanding of how the service operates	2.65	----	2.33	2.49
If the trip did not require sitting next to strangers	2.44	----	2.38	2.41
If the park-and-ride lot was more visible from the roadway	2.00	----	2.50	2.25

[1]All improvements were rated on a scale of 1 to 5; the higher the rating, the more likely the improvement will generate additional ridership.

were a better understanding of the service, the provision of newspapers and magazines, seating arrangements on the bus and lot visibility from the roadway.

Summary of Important/Unimportant Features of Park-and-Ride Service

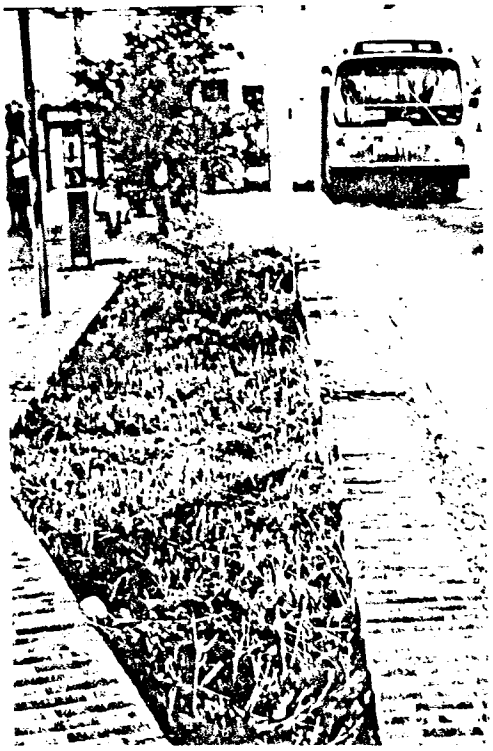
Based on the park-and-ride user surveys conducted in El Paso, San Antonio, Dallas/Garland, Houston and Fort Worth, it appears that the following are the most important features to consider when planning a new park-and-ride service.

- Monetary savings;
- Reliable bus service;
- Direct bus service;
- A park-and-ride lot close to home; and
- Convenient access to the park-and-ride lot.

Data from the household surveys of non-users in Dallas/Garland, Houston and Fort Worth suggest that the provision of the following may further increase park-and-ride utilization:

- Bus travel times shorter than auto travel times; and
- Bus stops closer to final destinations.

Other lesser important park-and-ride features (based on user survey responses) include new, modern buses and off-peak service. Some of these "unimportant features" are relatively expensive to provide. Non-user survey responses suggest that the provision of newspapers and magazines and lot visibility from the roadway are not likely to have much effect on increasing park-and-ride patronage.



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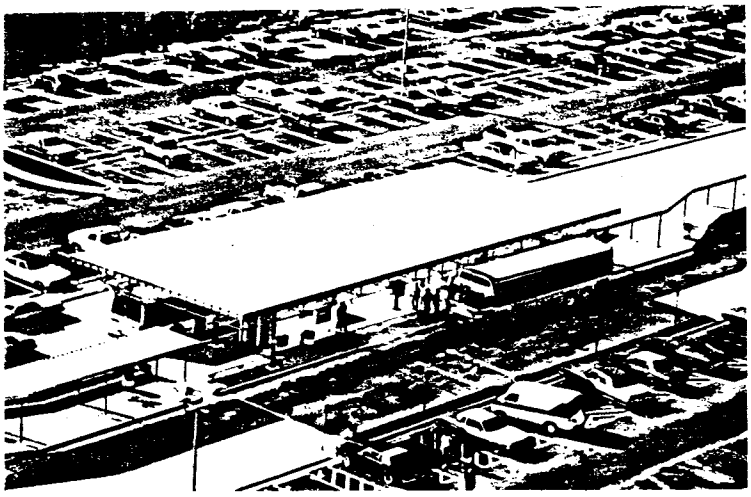
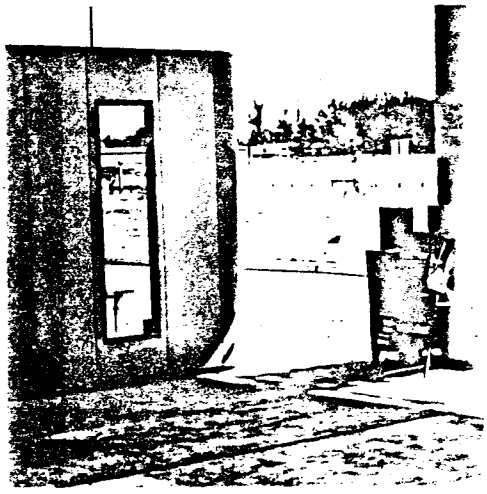




Design Guidelines for Park-and-Ride Facilities

9 Design Guidelines for Park-and-Ride Facilities

This chapter addresses the physical design and layout of the park-and-ride lot. This phase of the park-and-ride development should be carried out under the direction of the appropriate design and traffic engineers and in cooperation with other local agencies including the transit operating authority. Specific lot design features should be in compliance with applicable design standards, specifications and operating policies, or local requirements and zoning regulations that may apply (5).

During the design phase, a number of components should be addressed, including:

- The geometric design of access points and internal circulation;
- Traffic control devices;
- Lighting;
- Shelters;
- Landscaping; and
- Other amenities.

The guidelines outlined in this chapter represent the desirable requirements for each factor. Primary concerns during the design stages should include:

- Safe and efficient traffic flow for all modes (transit, automobiles, pedestrians, etc.) both on and adjacent to the site;
- An adequate number of usable parking spaces;
- Facilities for the park-and-ride patron which are comfortable and attractive; and
- Facilities that can accommodate elderly and handicapped patrons (5,18).

Coordination of Traffic Near Park-and-Ride Facilities

As stated previously, traffic on the roadways leading from the major routes to the park-and-ride facility should not experience long delays or conflicts. These reduce the perceived convenience of the service. Ways of accomplishing this objective include proper entrance and exit locations, traffic control devices, and placement of directional and informational signs (18).

Access/Egress Points

A major consideration in the location of a park-and-ride facility is the access to, and egress from, the lot. Vehicle arrival and exit patterns at 2 park-and-ride facilities are shown in Figures 16 and 17. Peaking data are summarized in Table 53. As a general guideline, it appears that 40% of daily directional traffic occurs in the peak hour, and that 30% of peak hour traffic occurs in the peak 15 minutes.

Table 53: Peaking Characteristics at Two Houston Park-and-Ride Lots

Traffic Data	Park-and-Ride Lot	
	North Shepherd	Kuykendahl
Arriving Traffic (vehicles)		
Daily volume	1,296	1,577
Peak hour volume	502 (7:15-8:15)	677 (6:45-7:45)
Peak 15 minutes	140 (8:00-8:15)	201 (7:15-7:30)
Peak hour/daily	40%	43%
Peak 15 minutes/peak hour	29%	30%
Existing Traffic (vehicles)		
Daily volume	1,284	1,563
Peak hour volume	577 (4:45-5:45)	643 (5:00-6:00)
Peak 15 minutes	194 (5:15-5:30)	186 (5:45-6:00)
Peak hour/daily	45%	41%
Peak 15 minutes/peak hour	34%	29%

Approximately 40% of the total daily traffic arrives at the lot during the peak hour.

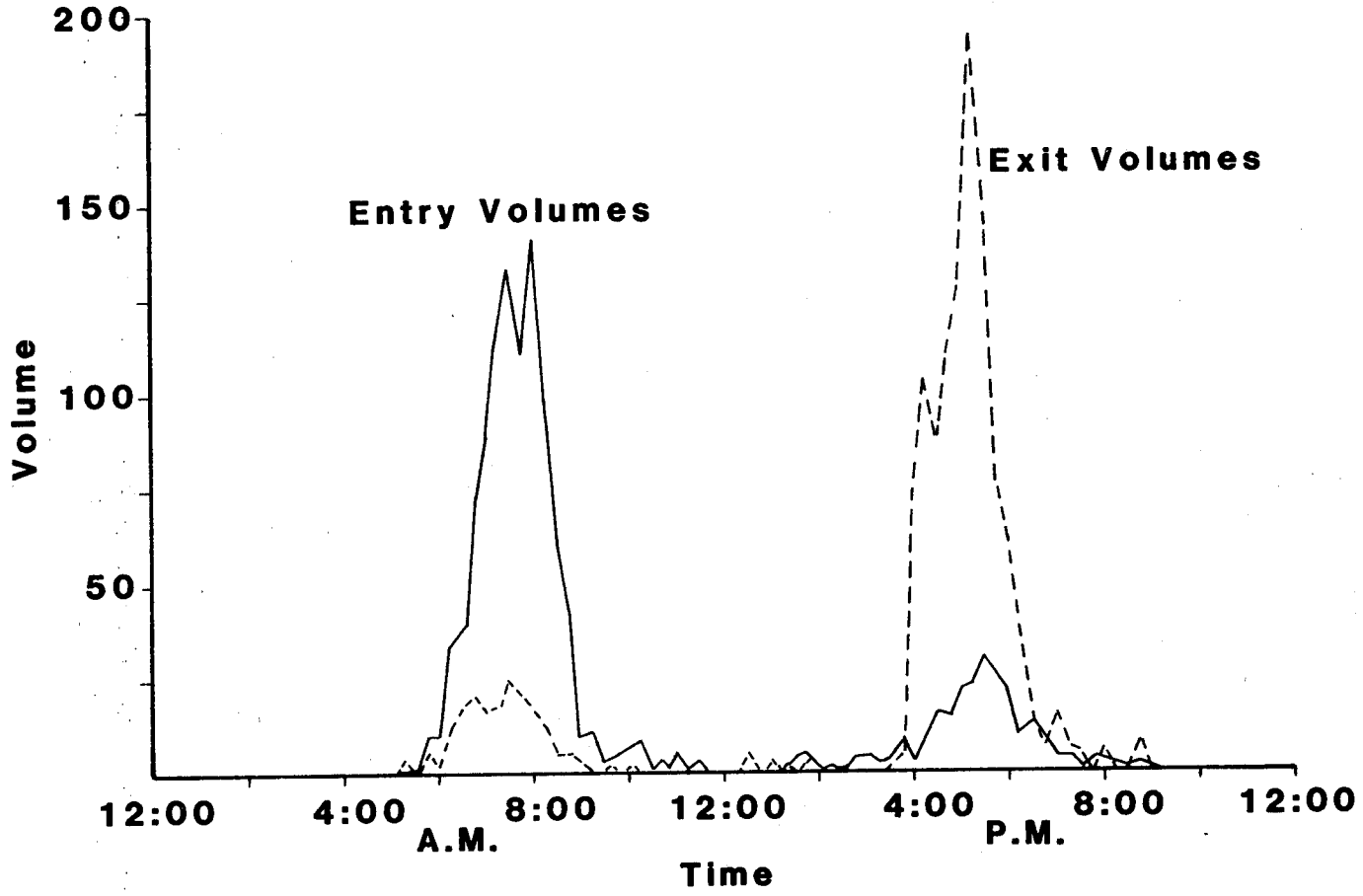


Figure 16: Vehicle Arrival and Departure Patterns - North Shepherd Lot, Houston

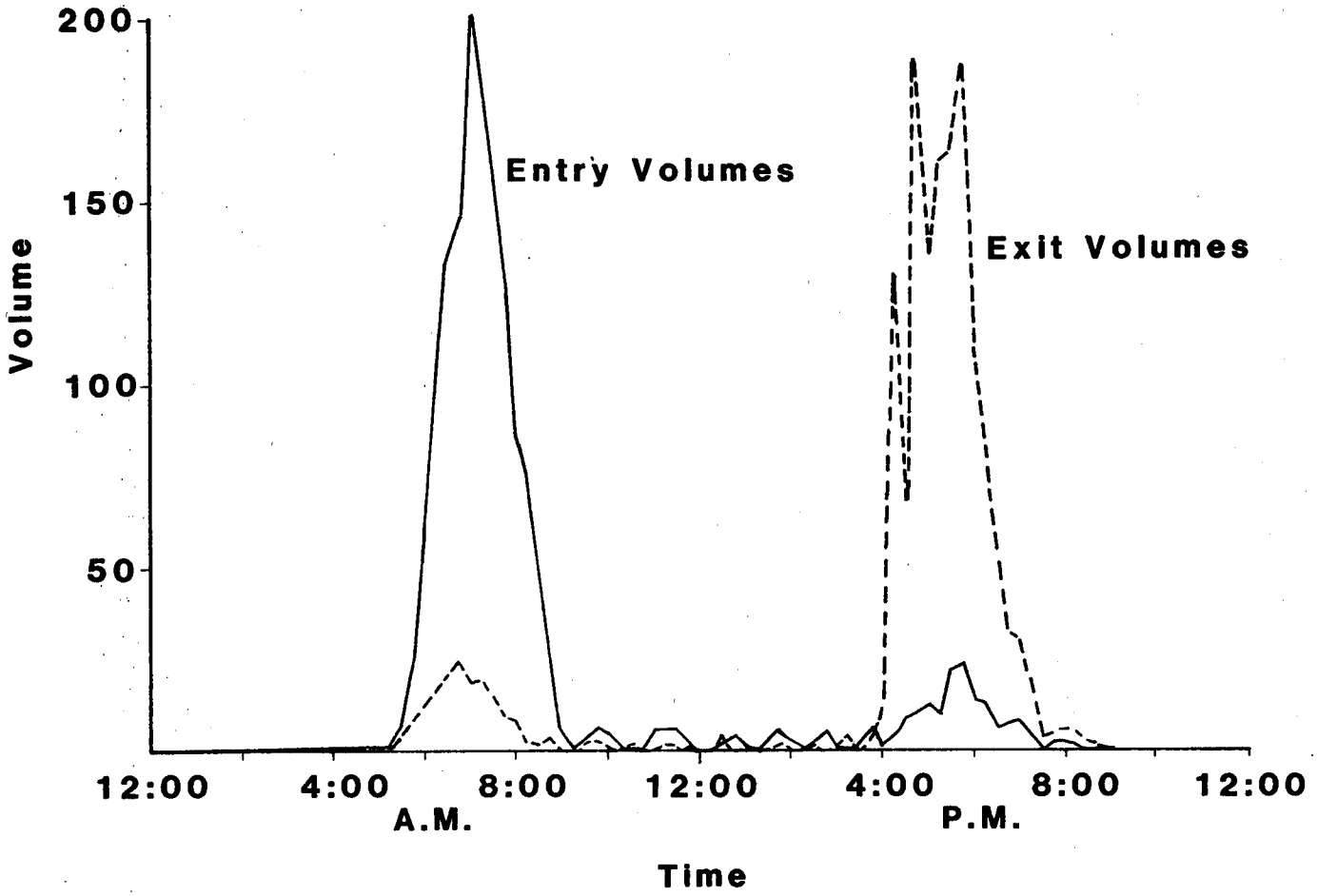


Figure 17: Vehicle Arrival and Departure Patterns - Kuykendahl Lot, Houston

To minimize possible adverse effects on the surrounding traffic flow patterns, the following guidelines are suggested (5,18).

- The most efficient access point to a park-and-ride lot will usually be from a collector or local street rather than from a major arterial or freeway ramp. In fact, when it is possible for 2 or more streets to access a park-and-ride site, it is generally more beneficial for the entrance/exits to be located on the streets with the least traffic. It is also desirable for the park-and-ride lot to access more than one street.

- Should it be necessary to provide access on an arterial route, entrances should be located so as to avoid queues from nearby intersections or freeway interchanges.

- If a choice readily exists, it may be desirable for the park-and-ride lot to be located on the right side for inbound traffic. It is possible that maximizing the accessibility for the inbound trips will be more effective in generating ridership than would improving the flow for exiting traffic in the evening. However, lots located on either side of a roadway have proven equally effective in generating demand.

- Entrances and exits should be located as far from intersections as possible and preferably at midblock. This reduces the conflicts between the major flow of traffic and park-and-ride users. In addition, the location of entrances and exits should be located with regard to adjacent intersections so that signal control of the access points could be installed at a later date, if necessary and justified.

- When a park-and-ride lot is located on the left side of a two-way arterial for inbound traffic, left turn storage will be desirable to accommodate inbound automobiles in the morning.

- Park-and-ride lots located along one-way arterials require special consideration; it is recommended that they be located between the 2 streets comprising a one-way pair, and access would be available from both streets.

- Planning, design and development criteria for park-and-ride access by feeder systems such as local transit, paratransit, kiss-and-ride, bikeways and pedestrian ways, should be determined and provided when the need is apparent.

- In planning the access points for a park-and-ride lot, separate entrance/exit roads for the transit vehicles are desirable.

Vehicular Access/Egress Capacity

Ideally, a park-and-ride lot should have at least 2 access/egress points (5, 19). Although in terms of theoretical capacity, a single access/egress point (one lane in each direction) may be sufficient, possible vehicular queueing both inside and on the periphery of the lot makes 2 access/egress points preferable.

To estimate access/egress design capacity, a value of approximately 300 vehicles per hour per lane is suggested (5, 19). Using this figure, which assumes that parking fees are not being collected at the entry to the lot, Table 54 provides a summary of automobile access/egress requirements at park-and-ride lots.

Table 54: Auto Access/Egress Requirements for Varying Park-and-Ride Demands

Design Demand[1] (Vehicles/Day)	Minimum Number of Directional Lanes
Less than 750	1 in each direction
750 to 1,500	2 in each direction
1,500 to 2,250	3 in each direction

[1]Based on 40% of the total demand arriving during the peak hour and a capacity of 300 vehicles per hour per lane.

Multiple access roadways to the lot are desirable.

The lot size constraints developed in Chapter 7 suggest that park-and-ride daily demand should not exceed approximately 1,800-1,900 vehicles per bus loading area. Such lots can be adequately served by 3 lanes for ingress and 3 for egress. The actual number of entrance/exit locations required at the lot to accommodate this number of lanes (6 total) will depend on whether the access points are designed as one-way entrance and exit drives or as common (2-directional) entrance and exit drives. If possible, entrances should be designed such that a vehicle approaching the site from any direction could miss one entrance and find a second one available without circuitous routing. The number of vehicular entrances along any one street should be spaced at least 350 feet apart. Access to the lot from 2 different

roadways is desirable. Finally, the capacity of the intersections in the vicinity of the lot must also be evaluated to determine the types of improvements, if any, that will be required as a result of the park-and-ride lot (5, 19).

Signing

Directional and informational signs along the major routes and on the streets leading to the park-and-ride facility should be provided to introduce the park-and-ride service to commuters. Proper "lead-in" trailblazer sign placement on high volume roads should intercept potential users on their normal paths and guide them to the park-and-ride facility. For example, surveys in El Paso and San Antonio revealed that significant percentages of the users (60% and 40%, respectively) did not normally drive past the park-and-ride lot prior to using the service (Table 55).

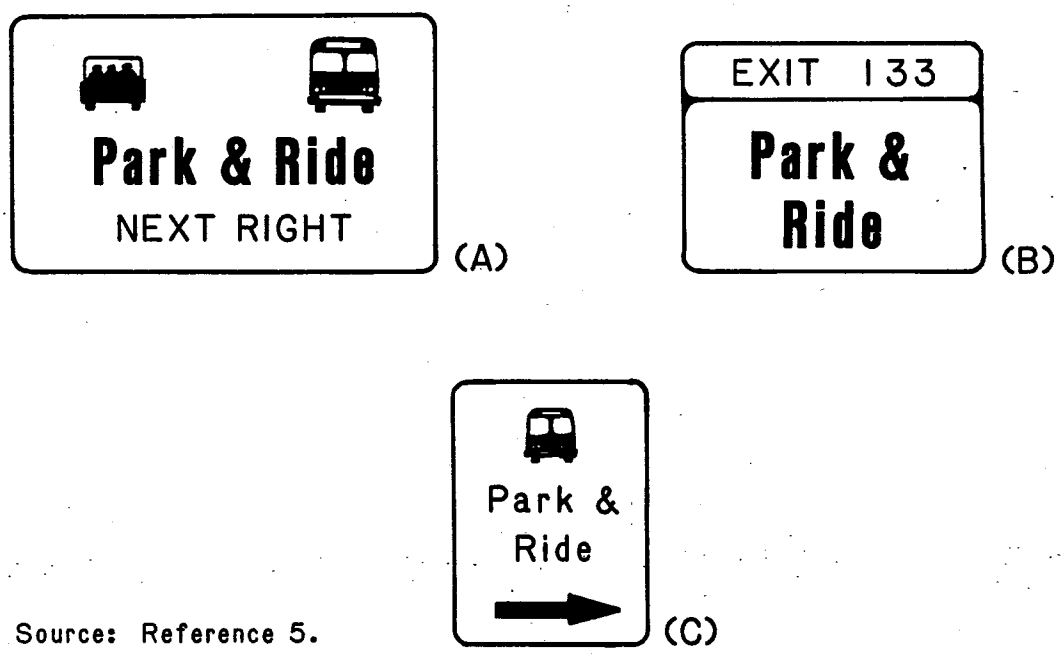
Table 55: Percentage of Patrons Who Drove Past Park-and-Ride Lot Prior to Using Service

City and Lot	Drive Past Lot	
	Yes	No
El Paso (n=92)	40%	60%
Vista Hills (n=14)	50	50
Montwood (n=51)	45	55
Rushfair (n=8)	38	62
Northgate (n=17)	24	76
Pecan Grove (n=2)	0	100
San Antonio (n=293)	57%	43%
University (n=20)	75	25
Wonderland (n=148)	68	32
McCreless (n=36)	33	67
Windsor Park Mall (n=70)	44	56
Bitters/MacArthur Plaza (n=17)	35	65
Broadway (n=2)	100	0

About half of the persons using park-and-ride service drove past the lot location prior to using park-and-ride.

Therefore, if a park-and-ride facility is designed and located to attract commuters destined from a residential area to a major activity center, the primary "lead-in" signing should be placed on major arterials between the residential area and the park-and-ride facility. In addition, other informational signs should be placed at the park-and-ride site to indicate lot entrances and exits and the desired traffic flow patterns (5, 18, 23).

Park-and-ride "lead-in" signs should be designed in accordance with current MUTCD as well as state and local criteria and policies. Messages should be brief and should utilize standard guidance methods to direct traffic to the facility, as illustrated in Figures 18-A and 18-B. In these instances where commuters must be directed from a major highway to a lot not visible from the highway, trailblazer assemblies incorporating the park-and-ride legend or logo along with directional arrows should be employed (Figure 18-C) (5).



Source: Reference 5.

Figure 18: Park-and-Ride Sign Examples

Recommended standards for park-and-ride signs are (5, 18, 23):

- Rectangular in shape;
- Reflectorized with white legend and border on green background;
- Mounted according to general specification for erection of signs;
- Contain the word message, Park-and-Ride;
- Contain directional information (arrow or word message); and
- (Optional) Contain local transit logo (standard color and shape; vertical dimension 18 inches or less).

Traffic Signals

The nature of the traffic generated by a park-and-ride lot (i.e., relatively low traffic volumes with definite peaking characteristics) is usually not sufficient to warrant a separate traffic signal for the lot. However, traffic signals may, on occasion, be justified at the exit of a park-and-ride lot onto a major arterial to provide safe and efficient use of the facility. Signalization should only be considered after a thorough study of the traffic situation in the surrounding area and should be warranted or justified in the manner prescribed in the National Manual on Uniform Traffic Control Devices (MUTCD), (18, 23).

Internal Lot Design Guidelines

In many respects, the layout of a park-and-ride lot is similar to the layout of a regular parking lot. Guidelines (24, 25) concerning regular parking lot design are readily available. Park-and-ride lots are different, however, in that they must accommodate transfers between automobiles and buses, they must provide some short-term as well as long-term parking and they must be designed to handle most of their traffic in two short peak periods daily. In addition, certain amenities are often provided at park-and-ride lots which are not usually found at regular parking lots. A discussion of those features which are unique to the design of a park-and-ride facility is presented in this section. In providing these park-and-ride

components, the need to develop safe, convenient circulation patterns for all modes should be recognized as being of primary importance.

Bus Loading Area

Location. The bus loading/unloading area represents the focal point of the park-and-ride facility. All parking areas are oriented toward this location and, as a consequence, an initial step in the design process involves establishing the location of the loading area. Two general alternatives exist; the loading area can be located on the periphery of the lot or within the lot.

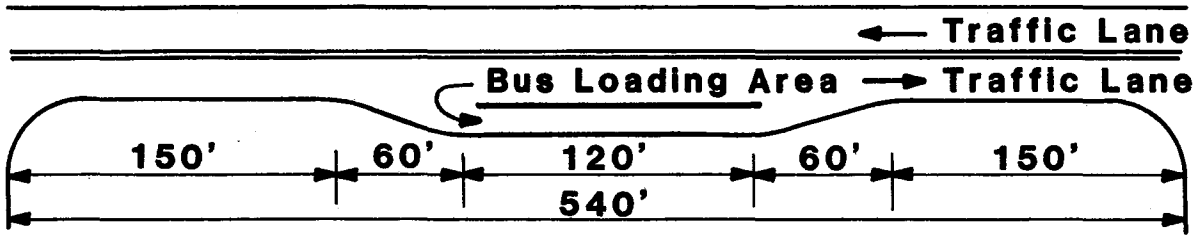
For the reasons listed below, the loading location adjacent to the parking area may be preferred. However, well designed park-and-ride lots can also function satisfactorily with bus-loading area located within the lot.

- The land requirements for the loading/unloading area are minimized.
- The conflict between autos and buses exiting and entering the lot may be eliminated.
- The time required for a loaded bus to enter the line-haul thoroughfare is generally reduced.

Locating the loading area adjacent to the lot does pose certain problems. The average walking distance from the parking spaces to the loading area is increased. Pedestrian flows along the sidewalk adjacent to the lot may be interrupted. Also, sufficient curb length must be available; nearly 550 feet of curb space is needed to provide a bus-loading area with space for 2 parked buses (19). Figure 19 illustrates a configuration that could be used in developing a busloading area adjacent to the park-and-ride parking lot.

If the bus loading area is located within the lot, several factors should be recognized. The closer the loading area is located to the center of the lot, the shorter the average walking distance will become. Observations at Houston lots suggest that 650' should be the maximum walking distance patrons must walk to reach the bus loading area. Bus circulation within the lot should be minimized both to conserve space and to reduce bus travel

time to the line-haul facility. At least one source (24) suggests that, after park-and-ride demand exceeds 500 all-day spaces, it is desirable to provide separate bus access roads to the loading/unloading area; that conclusion is supported by observations at lots in Houston where this is a common practice.



NOTE: The 150 foot dimension is intended to avoid interference with driveways or intersections.

Figure 19: Typical Geometrics Associated with a Bus-Loading Area Adjacent to the Park-and-Ride Lot

Bus Loading Space Capacity. Space needs to be provided within or adjacent to the park-and-ride lot for buses to park while loading and unloading passengers. If both the loading and unloading of passengers occur at the same location, the morning peak will determine capacity requirements, since the loading of passengers generally requires more time than the unloading of passengers (19). This will be true unless the loading passengers have already paid their fare, in which case the loading and unloading of passengers require similar periods of time.

Queueing theory (26) was used to estimate the number of bus loading spaces required; in order to assure that streets and circulation roadways are not blocked, it is suggested that a sufficient number of loading spaces be provided so that a 90 percent certainty exists that demand will not exceed space supply during the peak hour. It is further suggested that one additional loading space be provided for possible use by broken-down buses, service, or emergency vehicles. The resulting design guidelines are summarized in Table 56.

Table 56: Number of Bus Loading Spaces Required[1] to Accommodate Varying Levels of Transit Service

Average Headway During Peak 15 Minutes	Service Time[2]			
	60 Seconds	120 Seconds[3]	180 Seconds	300 Seconds
5 minutes	2	3	3	4
10 minutes	2	2	3	3
20 minutes	2	2	2	2

[1]Sufficient loading space is provided so that one space is available for use by a broken-down vehicle, and there is 90 percent certainty that the demand will not exceed the remaining capacity.

[2]The bus loading time or the required bus waiting time, whichever is longer.

[3]In the absence of other data, 120 seconds represents a reasonable time to load a 50-passenger bus.

Source: Reference 19.

In general, for the types of park-and-ride operations that will exist in Texas, 2 to 3 bus loading spaces will be needed at each bus loading area. It is particularly critical that sufficient bus loading space be provided at those locations where buses load at turnouts located adjacent to streets; inadequate space at those locations will cause the waiting bus to block a moving traffic lane.

Location of Different Parking Functions

Several different types of parking--handicapped, kiss-and-ride and park-and-ride--will typically be included in the parking area. In addition,

special parking for bicycles and motorcycles may also be provided. Desirably, the design should minimize the transfer time from these parking areas to the bus loading area. In terms of proximity to the bus shelter, handicapped parking, bicycles and motorcycles should be immediately adjacent to the loading area; kiss-and-ride parking should be given the next priority in terms of proximity; the park-and-ride all-day parking area will generally be the farthest removed from the bus loading area.

Handicapped Parking. Preferably, it should not be necessary for handicapped patrons to cross any internal-circulation roadways in traveling from their parking location to the bus loading area. In addition, handicapped patrons should never be forced to travel behind parked cars (5).

In determining the number of handicapped spaces to be provided at a park-and-ride lot, the guidelines in Table 57 have been suggested (5).

Table 57: Guidelines for Determining Handicapped Parking Space Requirements

Total Parking Spaces	Minimum Number of Handicapped Spaces
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1000	2%
over 1000	20 plus 1 for 100 over 1000

Source: Reference 5.

Contrary to these AASHTO guidelines, observations at Texas lots suggest that only 0.5% to 1% of the spaces need to be designated as handicapped spaces.

Recent studies at 2 park-and-ride lots in Houston, however, indicate that while handicapped spaces are being utilized, they generally are not utilized by handicapped persons. Table 58 summarizes these data.

Table 58: Usage of Designated Handicapped Parking Spaces, Houston

Park-and-Ride Lot and Date	Parking Spaces	Handicapped Spaces	Handicapped Spaces Used	Handicapped Spaces Used by Non-Handicapped Persons
North Shepherd				
7/27/81	765	10[1]	9	8
7/28/81	765	10[1]	6	5
Kuykendahl				
7/29/81	1,290	9	1	0
7/30/81	1,290	9	2	1

[1]One space occupied by a trash receptacle.

Source: Reference 12.

Where designated handicapped spaces are available, very few are actually used by handicapped persons.

Based on the Houston data, it appears that a more realistic guideline might be to devote approximately 0.5% to 1% of the total parking spaces to handicapped parking.

In the design of handicapped spaces, individual stalls should be 17 feet long by 8 feet wide, with an additional 5 feet between stalls for access. Appropriate signing or pavement markings should indicate the restricted use of these spaces for handicapped persons. Curbs to and from the bus loading area should be depressed for wheelchairs (as dictated by local standards) and wheelchair ramps should be provided were necessary to facilitate the movement of handicapped patrons (5).

Bicycles and Motorcycles. An area for bicycles with racks or lockers should be designated near the bus loading area but not so close as to create hazards or inconveniences for pedestrians. At the present time, a negligible percentage of patrons in Texas ride bicycles to park-and-ride sites. However, if the specific site appears to have the potential for many bicyclists (adjacent residential areas or connecting bikeways), space could be provided. Motorcycles may also be given space near the bus loading area in which to park.

In designing bicycle storage facilities, the lot layout normally consists of stalls 2 feet by 6 feet at 90 degrees to aisles of a minimum width of 5 feet. For motorcycles, the stall should be increased to 3 feet by 6 feet (5).

Kiss-and-Ride Parking. An area that allows kiss-and-ride, taxi, paratransit, or other short-term parking only should be set aside and clearly marked. This area should be near the bus loading area and convenient to use so that kiss-and-ride parking will take place in the designated spaces rather than creating conflicts with the other access modes. The kiss-and-ride parking process requires only curb space in the morning to drop off passengers, but in the afternoon the auto driver usually arrives before the bus passenger and must wait. This creates the need for a kiss-and-ride parking area that is easy to drive into and out of. Kiss-and-ride parking areas need to be signed (preferably as 20-minute parking), marked and enforced to assure their use as short-duration parking areas only. In designing the layout for the park-and-ride lot, the following guidelines for determining the number of parking spaces to provide for kiss-and-ride demand (5, 12, 19).

Initially, it is necessary to estimate the percentage of total park-and-ride patronage that will take advantage of the kiss-and-ride mode. This percentage can vary from lot to lot, as was observed for the North Shepherd and Kuykendahl lots in Houston (Table 59). If data are not available for the specific lot being designed, in Texas it appears that approximately 22% of the total patronage will use the kiss-and-ride arrival mode (Table 60).

Table 59: Kiss-and-Ride Patrons as a Percent of Total Patrons, 6:30 a.m. to 8:30 a.m.

Patronage Data[1]	Houston Park-and-Ride Lot	
	North Shepherd	Kuykendahl
Total boarding patrons	925	1,228
Kiss-and-ride patrons	170	179
Kiss-and-ride as a % of total patrons	18%	15%

[1]Data shown represent a two-day average value.

Source: Reference 12.

Table 60: Kiss-and-Ride Patrons as a Percent of Total Park-and-Ride Patronage

City	Kiss-and-Ride Patrons as a % of Total Park-and-Ride Patronage[1]
Houston	15
Dallas/Garland	20
Fort Worth	26
El Paso	31
San Antonio	19
Non-Weighted Average	22

[1]Based on the findings of the on-board surveys described previously in Chapter 3.

For planning purposes, approximately 20% to 25% of total patronage arrives at the lot using kiss-and-ride.

Estimates of total daily park-and-ride vehicular demand will have been developed during the initial stages of the park-and-ride planning process. Multiplying that value by an average vehicular occupancy of 1.4 yields daily patronage. Approximately 40% of that demand can be expected to occur during the peak hour (12). Thus, of the total daily patronage, approximately 9% (22% of daily patronage x 40% of daily patronage arriving during the peak hour) is represented by peak-hour kiss-and-ride patrons. Typical kiss-and-ride occupancy is approximately 1.1 patrons per vehicle (Table 61); peak-hour kiss-and-ride patrons divided by 1.1 yields peak-hour kiss-and-ride vehicles.

Table 61: Park-and-Ride Patrons Per Arriving Kiss-and-Ride Vehicle, Houston

Occupancy Data[1]	Park-and-Ride Lot	
	North Shepherd	Kuykendahl
One Patron	87%	92%
Two Patrons	12%	7%
Three or More Patrons	1%	1%
Average Patrons/Kiss-and-Ride Vehicle	1.15	1.10

[1]Data shown represent a two-day average value.

Source: Reference 12.

There are about 1.1 park-and-ride patrons per arriving kiss-and-ride vehicle.

Thus, the following equation can be used to estimate peak-hour kiss-and-ride vehicular demand[1] (19).

$$q = 0.11\ k$$

where: q = peak-hour kiss-and-ride vehicular demand
k = total daily park-and-ride vehicular demand

Of the two kiss-and-ride operations--dropping passengers off in the morning and picking passengers up in the evening--the evening operation determines capacity requirements since it consumes more time than the morning drop-off operation. The expected afternoon waiting time is a function of bus headways. It is interesting to note that shorter headways can result in longer waiting times. With longer headways kiss-and-ride users can estimate the precise bus they will use and prearrange specific pick-up times. With shorter headways, users are less sure of the precise bus they will use and, therefore, also less sure of the precise arrival time. At two existing park-and-ride operations, the typical waiting time of a vehicle picking up a kiss-and-ride patron ranged from 5.3 to 7.4 minutes (Table 62). Kiss-and-ride arrival patterns and vehicle accumulation by 5-minute increments for both of the study lots are shown in Figures 20 and 21. Distribution of dwell times is shown in Figures 22 and 23.

Table 62: Average Dwell Time Per Kiss-and-Ride Vehicle, p.m. Peak Period

Lot and Data	Total Kiss-and-Ride Vehicles	Average Dwell Time (minimum)
North Shepherd		
7/27/81	134	7.4
7/28/81	135	5.3
Kuykendahl		
7/29/81	146	7.2
7/30/81	137	7.3

Source: Reference 12.

The average dwell time for kiss-and-ride vehicles at the lot is about 7.5 miles.

[1] k x 1.4 = total daily patronage x 0.22 = daily kiss-and-ride patronage x 0.40 = peak-hour kiss-and-ride patronage ÷ 1.1 = peak-hour kiss-and-ride vehicles.

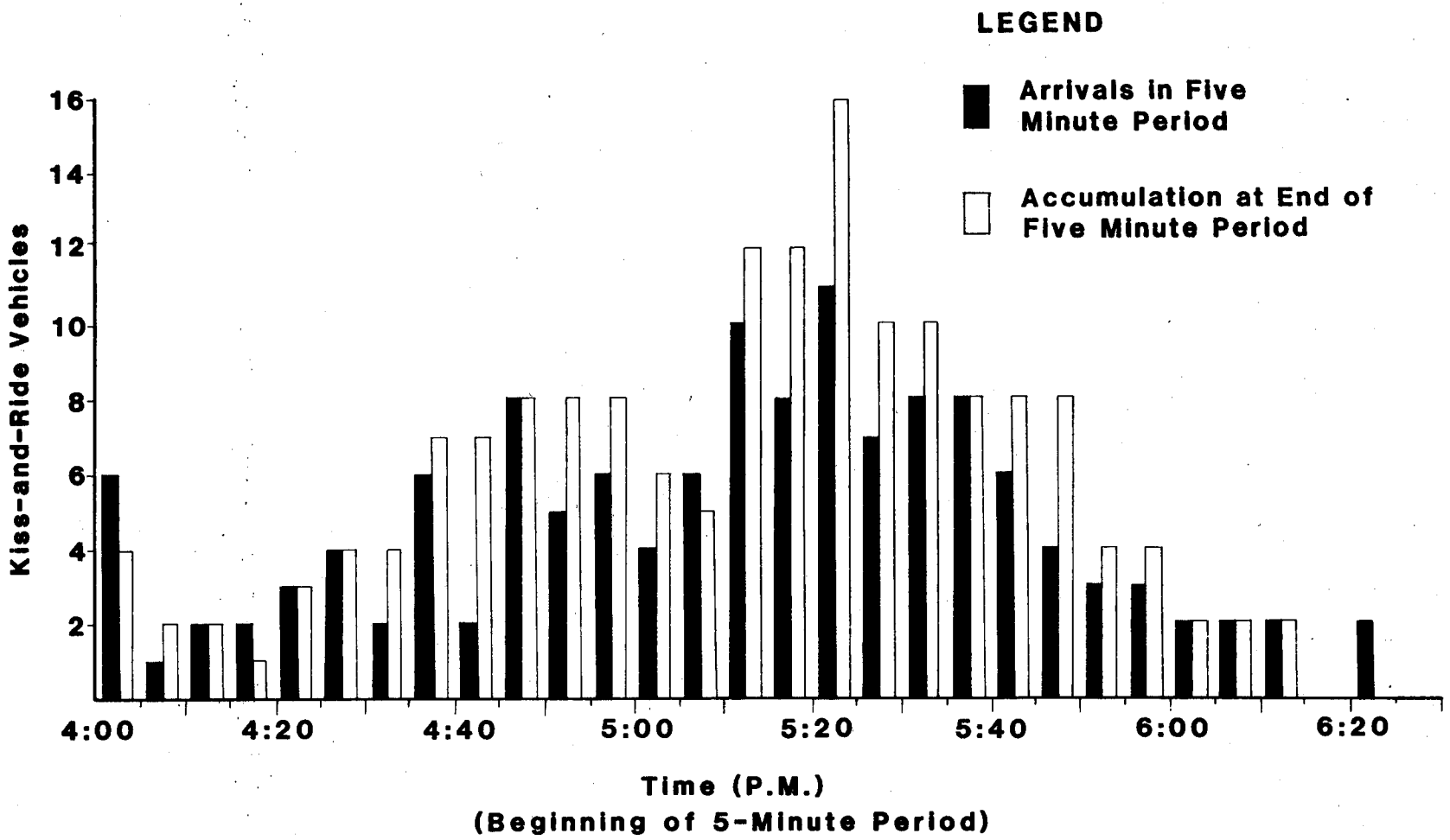


Figure 20: Kiss-and-Ride Vehicle Arrival and Departure Patterns - North Shepherd Lot, Houston

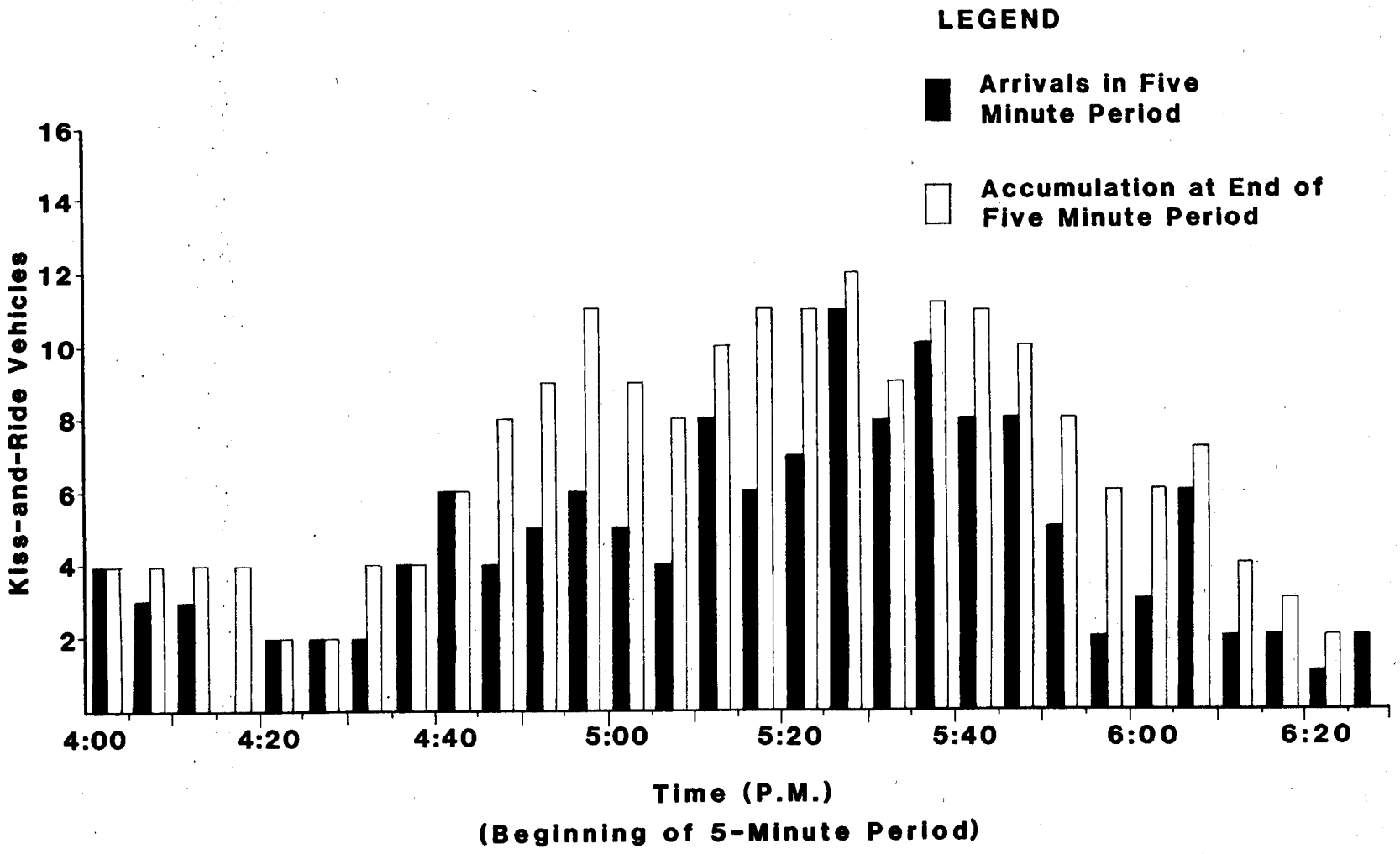


Figure 21: Kiss-and-Ride Vehicle Arrival and Departure Patterns - Kuykendahl Lot, Houston

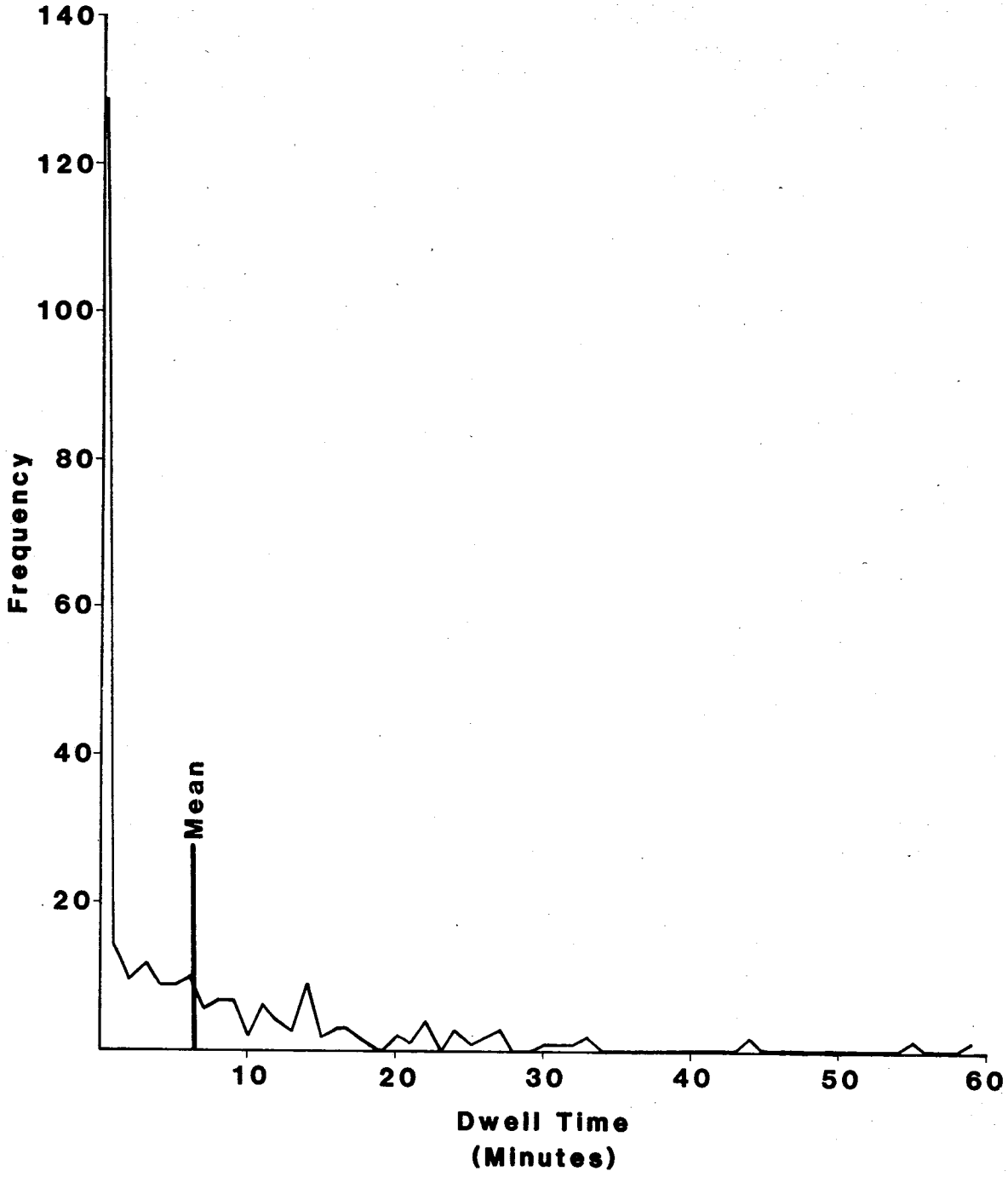


Figure 22: Distribution of Kiss-and-Ride Dwell Times - North Shepherd Lot, Houston

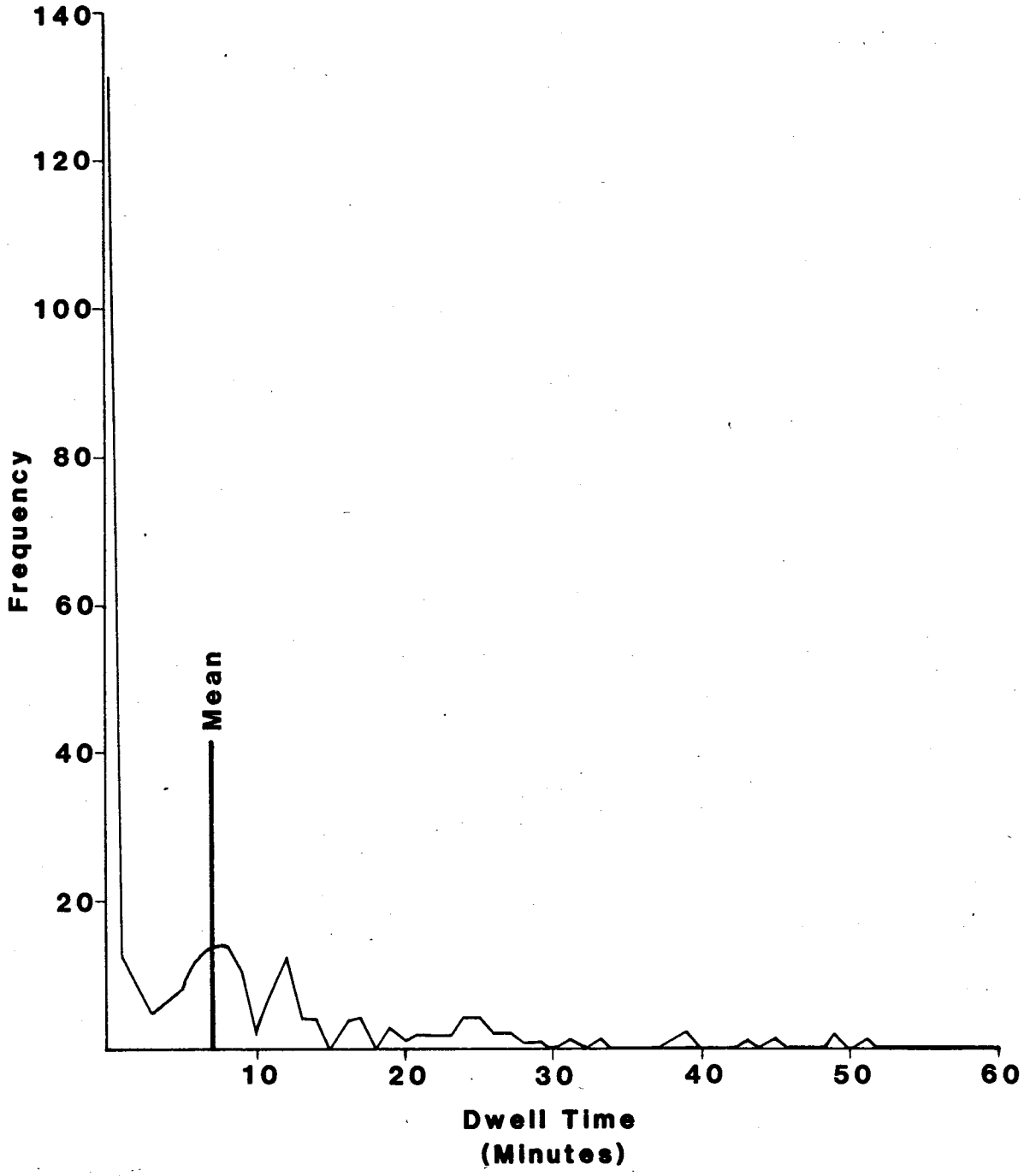


Figure 23: Distribution of Kiss-and-Ride Dwell Times - Kuykendahl Lot, Houston

Given the peak-hour demand and the average waiting time, multiple channel queueing theory (26) is used to determine the number of parking spaces that need to be reserved for use by kiss-and-ride vehicles. Figures 24 and 25 summarize the results of this analysis, assuming average waiting periods per kiss-and-ride vehicle of both 5 minutes and 10 minutes. These design values are based on the peak 15 minutes within the peak hour; it is assumed that 30% of the peak hour traffic occurs during the peak 15 minutes. These relationships depict the number of kiss-and-ride spaces that need to be provided to assure that, with varying levels of confidence, demand will not exceed capacity during the peak 15 minutes of the peak hour. Figure 24 (which assumes a 10-minute kiss-and-ride vehicle dwell time) might be viewed as representing a desirable design level; Figure 25 represents a minimum design level. Data in Houston suggest that a design dwell time in the range of 7.5 minutes seems appropriate.

Example Problem

Given: Total auto parking demand requires provision of 500 all-day parking spaces.

Therefore: Peak-hour kiss-and-ride vehicular demand will be 55 vehicles (500 x 0.11).

- Assuming a 10-minute average wait per vehicle (Figure 19), it will be necessary to provide 14 kiss-and-ride spaces in order to be 90 percent certain that capacity will not be exceeded during the peak 15 minutes.

As a general guideline, it appears that 1% to 3% of the total parking spaces in a park-and-ride lot should be devoted to the kiss-and-ride operation.

Long-Term Parking. By far, the most used access mode is the automobile that is driven to the park-and-ride lot and left all day. The parking for these long-term users should be close to the bus loading area, yet should not interfere with higher priority access modes (18).

Park-and-ride all-day parking is generally designed to be right-angle parking; this provides a simple, orderly configuration and also requires less land area per space. The parking aisles are typically aligned normal to the

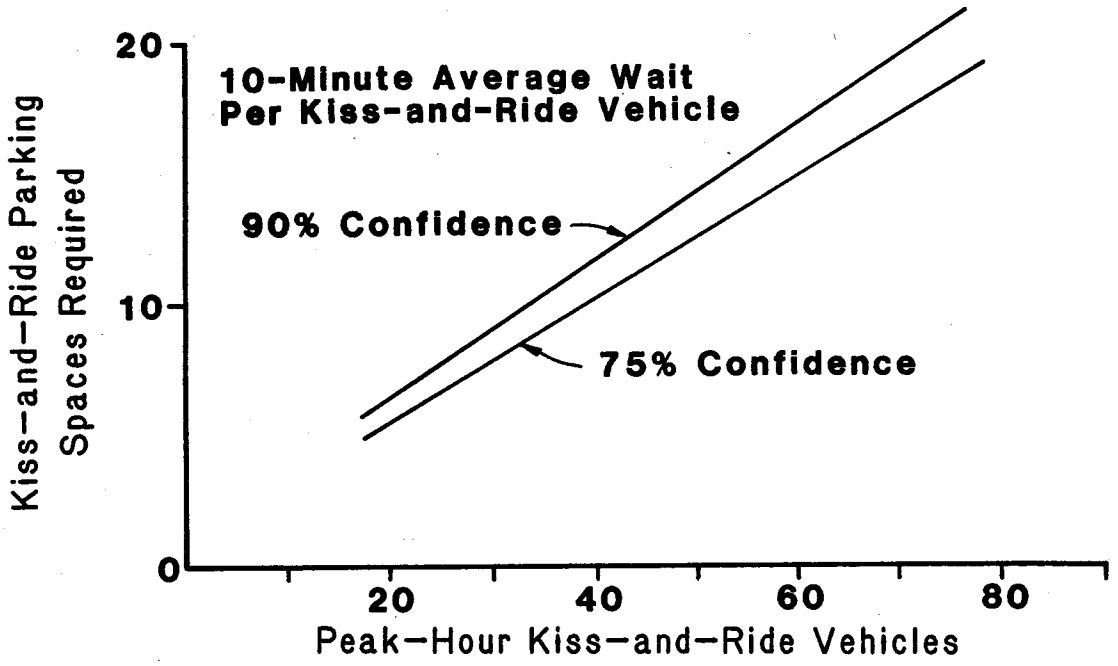


Figure 24: Peak 15-Minute Kiss-and-Ride Parking Space Requirements Assuming an Average 10-Minute Wait Per Vehicle

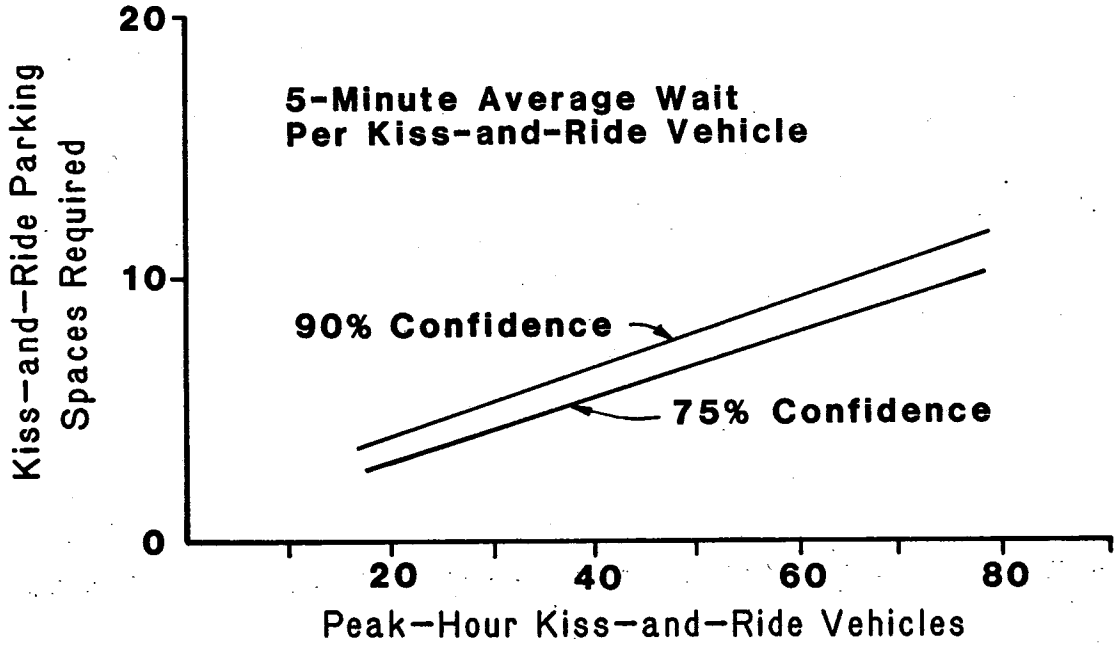


Figure 25: Peak 15-Minute Kiss-and-Ride Parking Space Requirements Assuming an Average 5-Minute Wait Per Vehicle

NOTE: A 7.5 minute wait per vehicle represents a good design value.

bus loading area to facilitate convenient pedestrian movement. Standard dimensions for parking stalls are recommended in Table 63.

Table 63: Typical Parking Dimensions

Type of Auto	Stall Width	Stall Length	Aisle Width
Standard	8.5' - 9.5'	18' - 20'	24' - 26'
Compact	7.5' - 8.5'	15' - 17'	10' - 22'

Source: Reference 5.

In recent years, due to energy conservation and cost considerations, the trend in automobile designs has been toward shorter, narrower, lighter weight and more economical vehicles. In fact, observations at 2 Houston lots revealed that between 23% and 37% of the total vehicles in the park-and-ride lots were compacts and sub-compacts (Table 64).

Table 64: Parking Space Utilization and Vehicle Type

Parking Data[1]	Park-and-Ride Lot	
	North Shepherd	Kuykendahl
Number of Spaces	765	1,296
Parked Vehicles	786	1,176
% of Spaces Used	103%	91%
Compacts and Subcompacts as a % of Total Vehicles	23%	37%

[1]Data shown represent a two-day average value.

Increasing use of small cars makes the reduction of design standards for park-and-ride lots more attractive.

While it is necessary for the greatest portion of the park-and-ride lot aisles and stalls to be dimensioned and marked to accommodate standard sized automobiles, specific areas within the lot designated for "small cars only" layed out at a smaller scale might be considered, recognizing that operational and enforcement problems may result. It is further suggested that these spaces be placed in a prime location to encourage their use, because if they are not convenient, small car drivers will park in the more convenient,

standard sized car spaces. Finally, because the vast number of larger cars now in use will gradually decrease, the parking lot layout should allow for future revisions to stall sizes, aisle widths and module dimensions (5).

A representative example layout of a park-and-ride facility is illustrated in Figure 26. Other examples of park-and-ride lot layouts may be found in the Guide for the Design of High Occupancy Vehicle and Public Transfer Facilities(5).

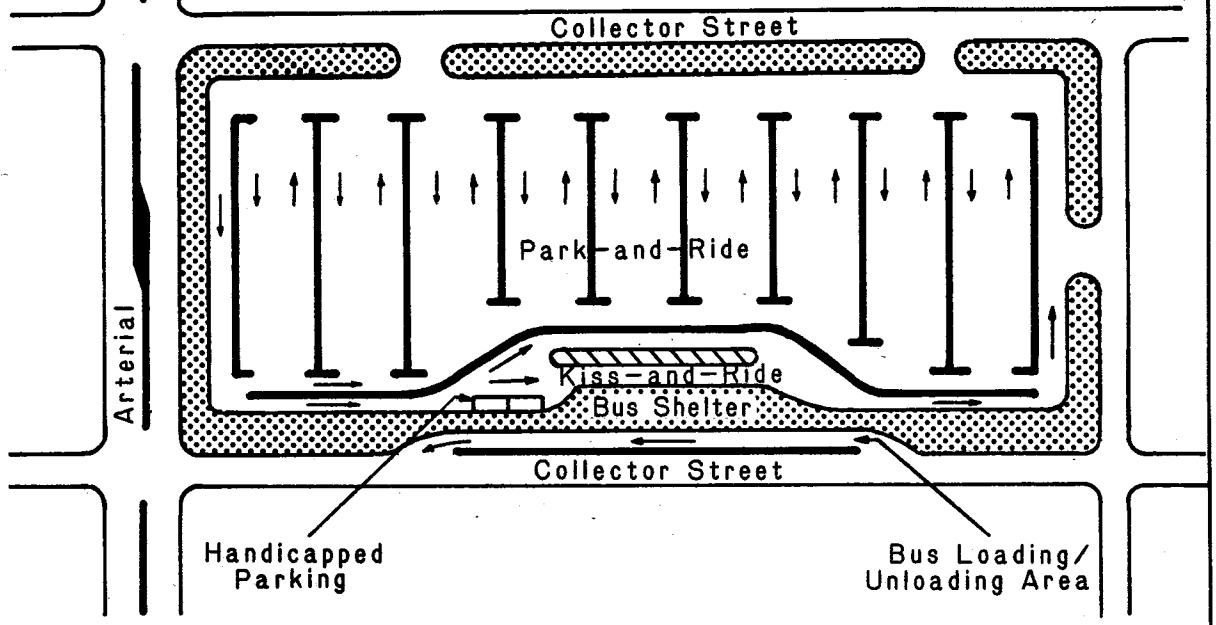


Figure 26: A Representative Layout for a Park-and-Ride Facility

Pedestrian Flow Pattern

As noted previously, the distance a patron has to walk from his/her car to the bus loading area should, desirably, not exceed 400 feet. A distance

of 650 feet was the observed maximum in Houston. A walking distance of 1,000 feet should be viewed as an absolute maximum.

The parking area should be laid out to facilitate safe and convenient pedestrian movement to and from the bus loading area. Pedestrians will tend to follow the most direct route from the vehicle to the loading area.

To assist in laying out a park-and-ride lot, coefficient of directness (5, 19) may be utilized. This coefficient is determined from the following formula.

$$C = \text{coefficient of directness} = \frac{\text{designated walking path distance}}{\text{straight-line distance}}$$

It is suggested that pedestrian flow patterns be designed so that this coefficient of directness does not exceed a value of 1.2; 1.4 should be considered a maximum value.

Amenities

Various amenities for the patrons can be included in the park-and-ride site design to make the service more desirable and promote its general acceptance. These amenities might include lighting, bus shelters, public telephones, landscaping, security personnel, trash receptacles, newspaper stands, vending machines, information displays and public restrooms. Whether some or all of these amenities should be provided at a park-and-ride facility will depend on local conditions and the capital and operating cost constraints. Tables 2, 4, 6, 8, 10, and 12 in Chapter 2 list the types of amenities currently provided at park-and-ride lots in Texas. The advantages of providing various passenger amenities in terms of the comfort and safety of the park-and-ride patrons are briefly discussed in the following pages. It should be noted however, that the provision of amenities may pose maintenance, vandalism and security problems. Furthermore, park-and-ride users in Texas have indicated that "bare bones" service is all that is needed. Therefore, it may be desirable to minimize the provision of amenities such as public restrooms.

Bus Shelters

Bus shelters placed adjacent to the bus loading areas are an amenity commonly provided at new park-and-ride lots to offer users protection from adverse weather conditions. The types of shelters provided can vary from small, semi-enclosed shelters with benches to large, fully enclosed, air conditioned buildings with public restrooms, vending machines, etc. The type of shelter that should be provided will depend on the local climate, the number of park-and-riders to be served, the average wait time and financial constraints. Surveys in 3 Texas cities revealed that shelters were not perceived as being important (Table 52, Chapter 8).

In those instances where the provision of shelters is desirable, at least 4 square feet of shelter area should be provided per person (19); this should be viewed as a minimum value in that other sources suggest that as much as 8 to 13 square feet should be provided per person (5, 19). These space guidelines are for the waiting area only. Space devoted to vending machines, fare collection, restrooms, etc., must be in addition to the required waiting area.

Assuming that the shelter area will provide 8 square feet of covered structure per estimated occupant, the recommended occupant load determination is as follows (5):

Number of Auto Drivers	=	1.00 X
Number of Auto Passengers	=	0.35 X
Number of People Who Walk to Facility	=	0.15 X
Number of Kiss-and-Ride Patrons	=	0.20 X
Number of Bicycle and Motorbike Patrons	=	0.30 X
Total Number of Patrons	=	2.00 X

X = Number of parking spaces

This is only a guideline and individual sites will need community input and research to determine their actual occupant load distribution.

Example Problem

Assume 40 percent arrive in the morning peak hour -- .40 (2.0X) = .8X. Assume the average waiting time is 10 minutes or 1/6 hours; therefore, the occupancy at any one time is 1/6 (.8X) = .13X. Using 8 square feet per

occupant, the required shelter becomes 8 (.13X) = 1.1 X or 1.1 square feet/stall. Therefore, a proposed park and ride structure size would be figured as follows: 765 parking stalls X 1.1 square feet per stall = 842 square feet. At 8 square feet per person, an 842 square foot shelter would accommodate a maximum of 105 patrons. This figure is slightly higher than the maximum accumulation of 83 patrons, observed at the 765-space North Shepherd in Houston (Table 65, Figure 27).

Table 65: Accumulation of Patrons at the Shelter for 2 Houston Lots

Patronage and Accumulation[1]	Houston Park-and-Ride Lot[2]	
	North Shepherd	Kuykendahl
Peak Period Ridership (6:30-8:30)	925	1,228
Peak Hour Ridership	625	856
Maximum Accumulation at Shelter	83	54
Accumulation as a % of:		
Peak-Period Ridership	9%	4%
Peak Hour Ridership	13%	6%

[1]Data shown represent a two-day average.

[2]Frequent bus service is provided at both lots, but frequency at Kuykendahl is greater from 6:00 to 8:00 a.m., 35 buses depart Kuykendahl and 24 depart North Shepherd.

For design purposes, about 15% of peak-hour ridership represents maximum person accumulation at the shelter.

Lighting

Adequate lighting at a park-and-ride facility is important from a safety standpoint and serves as a deterrent to vandalism in both the parking areas and the shelters (5). Lighting is particularly important during the winter months when the days are shorter and commuters may have to use the facility in the dark. The full lighting system should provide the proper illumination levels (as described in References 5 and 18) to all areas of the park-and-ride lot, yet not infringe upon the adjacent community.

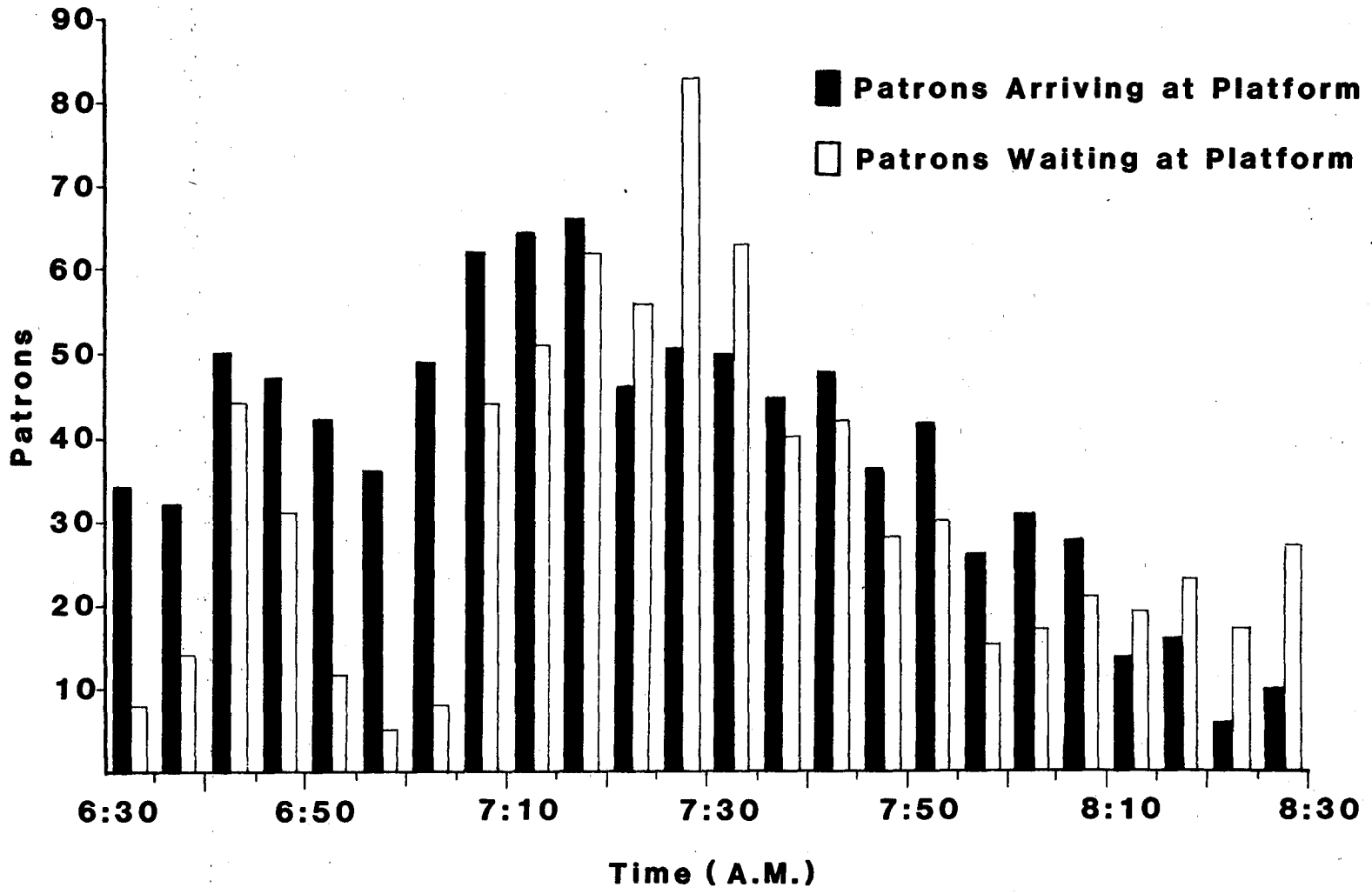


Figure 27: Patron Arrival and Accumulation at the North Shepherd Park-and-Ride Lot Shelter, Houston

Security Personnel

Security personnel, either stationed at the lot on a full-time basis or assigned to patrol the park-and-ride facility on a random basis is another important feature to provide to ensure passenger safety and guard against vandalism. Experience in Texas has shown that lots with no security may be susceptible to vandalism and that provision of random security checks can greatly reduce acts of vandalism.

Public Telephones

Public telephones located at the park-and-ride site enable commuters to arrange for private auto, taxi or paratransit pick-up service. Public telephones also enable a commuter with automobile trouble to phone for help. This is an important consideration.

Trash Receptacles, Newsstands, Vending Machines

The provision of trash receptacles at a park-and-ride site is a rather inexpensive measure which can reduce the amount of maintenance required (provided the receptacles are located at convenient locations and are used).

Newsstands and vending machines are additional features sometimes provided to park-and-ride patrons. While these may be desirable from a passenger comfort standpoint, the provision of these particular amenities may also contribute to the litter problem both at the lot and on-board the transit vehicles.

Information Systems

Systems which display information (transit schedules, route maps, etc.) pertaining to the park-and-ride services as well as other services provided by the local transit operation can be helpful to commuters.

Landscaping

Landscaping of park-and-ride facilities improves aesthetics. It should consist of plantings that will be compatible with the operation of the facility. In general, the types of plantings and their placement should not interfere with:

- Adequate lighting for the area thus resulting in a potential safety hazard to the patrons;
- The proper placement of traffic control devices; or
- The ability of pedestrians, including the handicapped, to use the facility.

In addition, care should be taken to use plants compatible with local climatic conditions along with the ability to withstand extreme sun (or shade), wind, pollution, poor water condition and marginal soils. Also, they should be decorative, long lasting, susceptible to few diseases, require little maintenance and be readily available at a reasonable cost. Trees provide shade and visual interest, reduce glare and are less costly to maintain than shrubs and ground cover. Landscaping should be designed in such manner that hiding places for vandals will be minimized (5, 23).

While landscaping is desirable from an aesthetic point of view, in extremely hot areas such as Houston and El Paso, maintenance can be extensive. Furthermore, survey findings show that this feature is not an important factor in generating ridership.

Joint-Use Park-and-Ride Facilities

An existing parking lot at a shopping center, drive-in theater, sports stadium or other large activity center that is also used for park-and-ride patron parking is a joint-use facility. Although many joint-use facilities are temporary or interim lots in nature, the following factors must be considered before such lots are used by a park-and-ride operation (18).

Adequate Size

A parking lot must be selected that is large enough for the usage it is expected to receive and for its possible expansion. The size of lot that is required will depend on the type of bus service to be provided at the lot. For example, an express bus from a remote lot (10-20 miles from the destination) would attract more riders and would, therefore, need to use a large shopping center or sports arena, while lots that are served by a local route

and are nearer the destination (4-10 miles) usually generate fewer patrons and can utilize churches or neighborhood shopping centers.

Delineation

The part of the lot designated for park-and-ride use should be well marked to prevent interference with other traffic in the lot and make it easier for the commuter to use. There should be bus logo, directional and informational signs as well as painted parking stalls and crosswalks. The bus loading area should also be clearly designated for improved safety for pedestrians and mobility for buses.

Design

Another problem with joint-use parking lots is that they are not designed for transit vehicles. Alterations may be required at the entrances and exits of the lot to accommodate the wider turning radii, greater axle loads and allowable grades for these vehicles. As with the exclusive park-and-ride lot, the loading area and roadways that will be used by the buses should be constructed with heavy load carrying pavement. A way to avoid altering the lot might be to provide a loading zone for buses directly off the street. This would allow the lot to be used by park-and-ride automobiles without requiring buses to enter the lot.

Amenities

The need for amenities at a joint-use lot is not as great as for the more permanent facilities. The additional expenditures are usually not warranted as the facility is either an interim lot or it serves too few people. Generally, the amenities for the joint-use lot should include a bus shelter with benches, an information board that indicates the schedules, trash receptacles and newspaper vending machines. There is less need for additional security measures since the park-and-ride operation would most likely share a lot that is lighted and has some form of security already available.

Other Considerations

There has been a reluctance by some owners of joint-use facilities to allow the use of their lots due to the liability problems involved. CITRAN in Fort Worth, Texas, has been using a "Hold Harmless Agreement." Basically, this agreement states that CITRAN wishes to use a certain parking lot, the land owner wishes to be protected from any claims and CITRAN will not consider the land owner responsible if property damage or injuries result from their using the facility.

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23. Creagor, G.S., Zelachowski, C.P. and Burns, E.N. Park-and-Ride Design Guidelines. Prepared for the Urban Mass Transportation Administration, Washington, D.C., January 1979.

24. Highway Research Board. Parking Principals. 1971.

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APPENDIX

Most of that data presented in Chapters 3 and 8 of this reference guide were obtained through either on-board (user) surveys performed in Dallas/Garland, Houston, Fort Worth, San Antonio and El Paso or home mail-out (non-user) surveys conducted in Dallas/Garland, Houston and Fort Worth. Survey instruments were used for both the on-board and home mail-out surveys. While there were slight differences in survey forms between different lots and different cities, the survey instruments used were all generally similar. Representative user and non-user surveys are included at the end of this appendix. Specific lot locations for the on-board surveys and target market areas for the home mail-out surveys are illustrated in Figures A-1 through A-9 respectively. The sample selection procedures utilized for these survey efforts are discussed in Research Report 205-11.

On-Board Survey

The on-board surveys were conducted on 30% of the buses departing each park-and-ride lot during the morning peak (except in El Paso where all 7 morning buses were surveyed). On those buses surveyed, each rider was given a questionnaire and asked to return the completed form to the survey taker before leaving the bus. (Note: In Fort Worth, CITRAN bus drivers distributed and collected the survey questionnaires). In all study cities, except Fort Worth, between 94% and 100% of the riders chose to participate by answering the questionnaire. In Fort Worth, approximately 77% of the park-and-go users participated. The number of surveys completed, by lot, is presented in Table A-1.

Table A-1: Completed On-Board Surveys Completed by Park-and-Ride Lot

Park-and-Ride Lot	Surveys Completed
Dallas/Garland	
Garland-North	141
Garland-South	77
Dallas N. Central	205
Total	**423**
San Antonio	
University	21
Wonderland	185
Mc Creless	44
Windsor Park Mall	87
Bitters/Mac Arthur Plaza	25
Waco/Broadway	3
Total	**365**
El Paso	
Vista Hills	19
Montwood Square	60
Rushfair	9
Northgate	20
Pecan Grove	3
Total	**111**

Park-and-Ride Lot	Surveys Completed
Houston	
Gulf Sage	226
Bellaire	158
West Loop (2 lots)	331
Westwood	383
Clear Lake City	141
Alief	141
North Shepherd	302
Champions	158
Kingwood	155
Katy/Mason	45
Total	**2,388**
Fort Worth	
Jefferson Unit. Church	12
Herman E. Clark Stadium	2
K-mart	6
Edgepark Meth. Church	27
Altamesa Church of Christ	4
Montgomery Ward	9
Ridgelea Baptist Church	47
Arlington Hts. Christ. Church	6
Total	**113**

Home Mail-Out Survey

The target survey areas as well as the number of household surveys mailed and returned from each survey area are discussed in Chapter 2 of this reference guide.

The target survey areas were identified using the results from the on-board park-and-ride user surveys. These market areas were related to the trade zones shown in Cole's Directory, and approximately 800 addresses were selected at random from each market area. The addresses formed the basis for the home mail-outs. An initial mail-out plus at least one "follow-up" mail-out was undertaken for each target area surveyed.

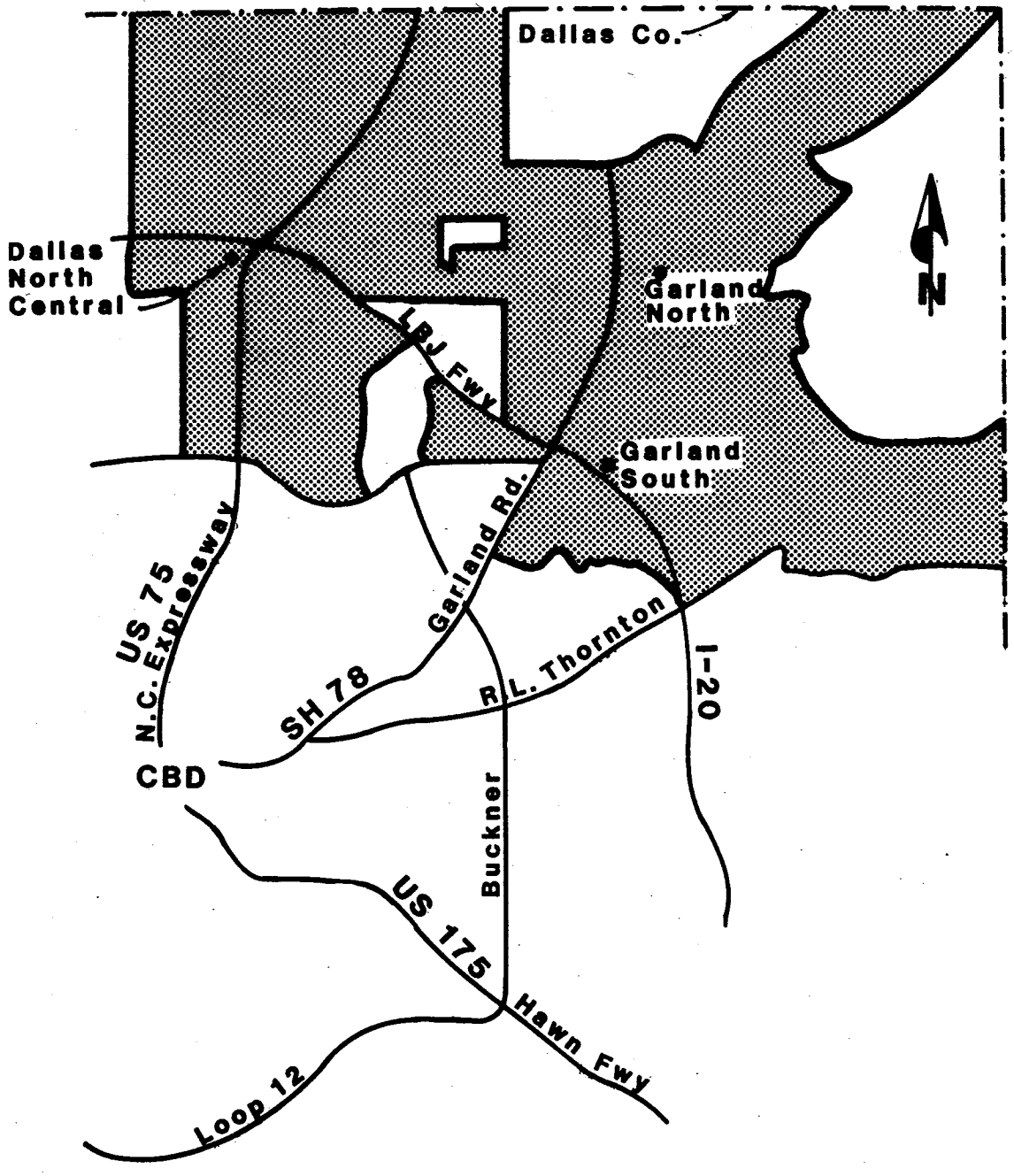

Figure A-1: Park-and-Ride Lot Locations for the Dallas/Garland On-Board Survey and Market Area for the Home Mail-Out Survey

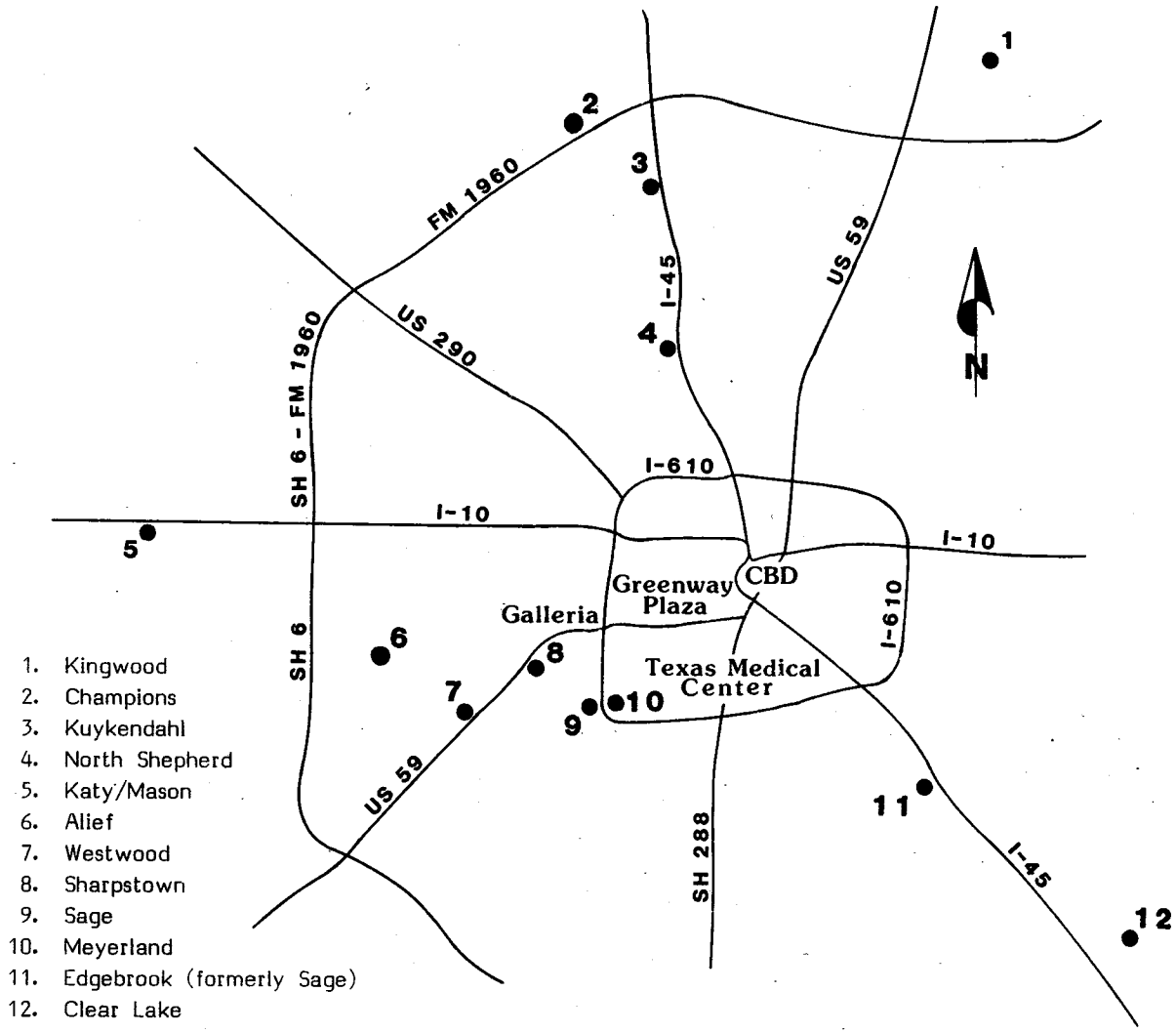

Figure A-2: Park-and-Ride Lot Locations for the Houston On-Board Survey

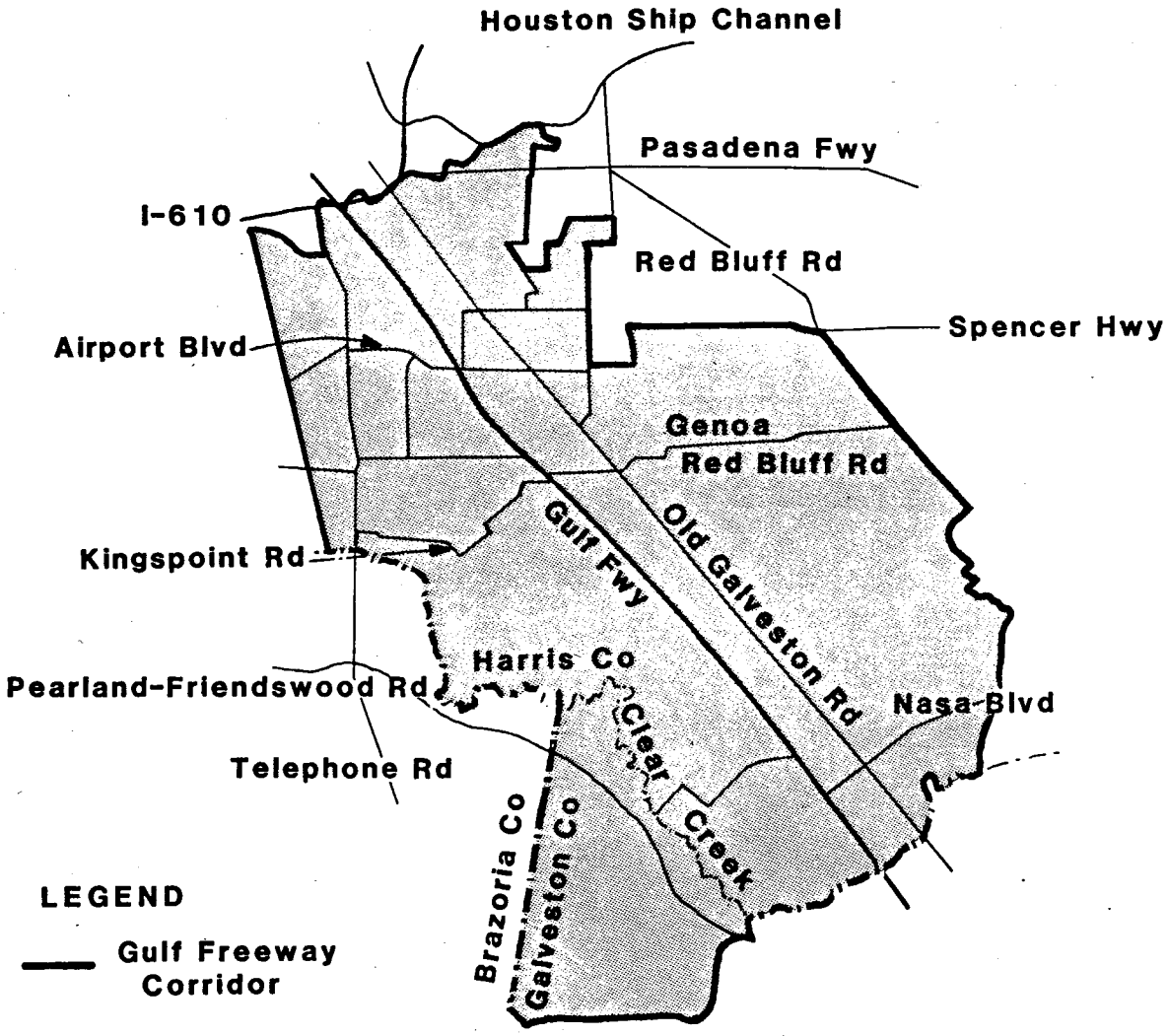

Figure A-3: Gulf Corridor Market Area for the Houston Home Mail-Out Survey

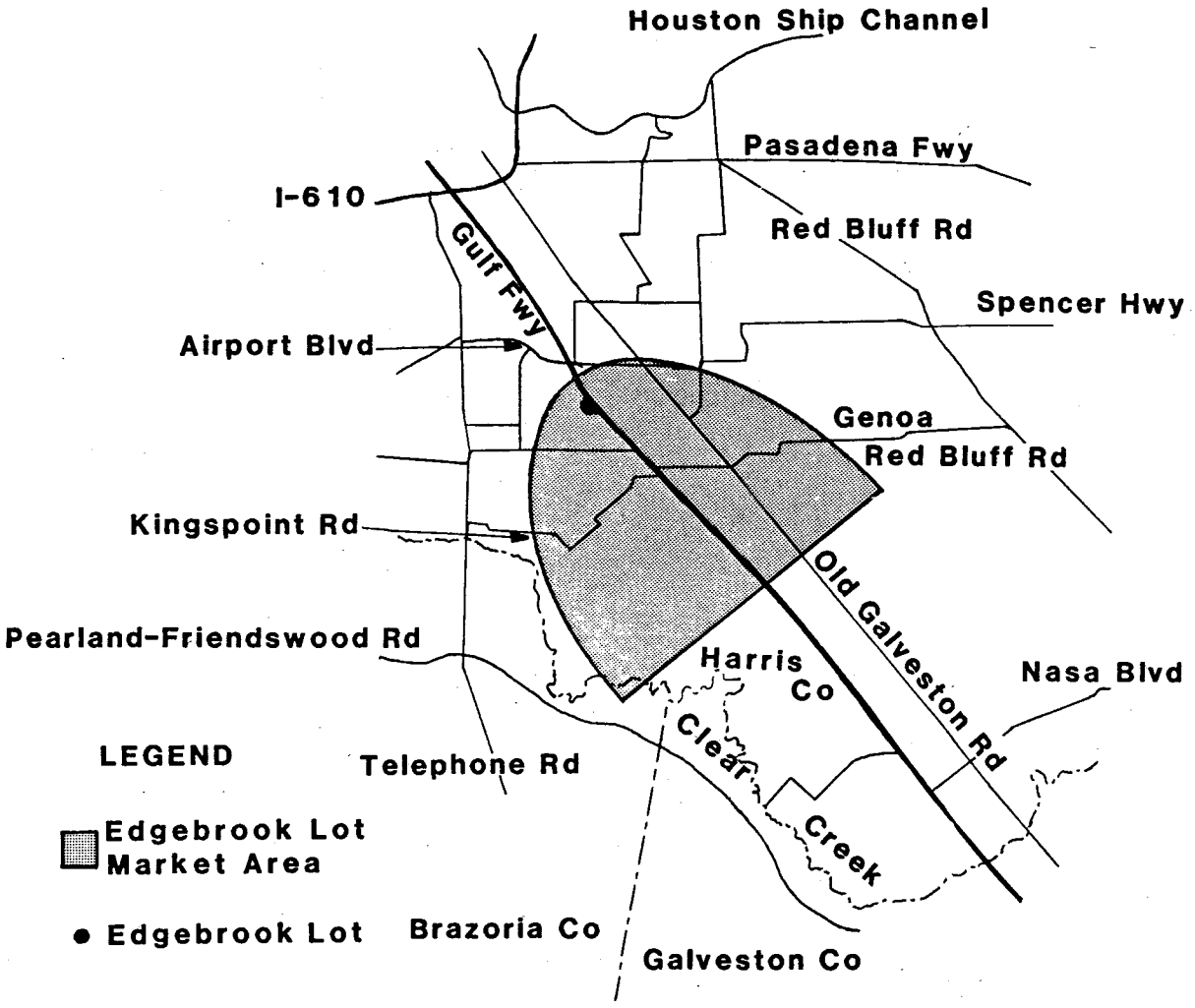

Figure A-4: Edgebrook Park-and-Ride Lot Market Area for Houston Home Mail-Out Survey

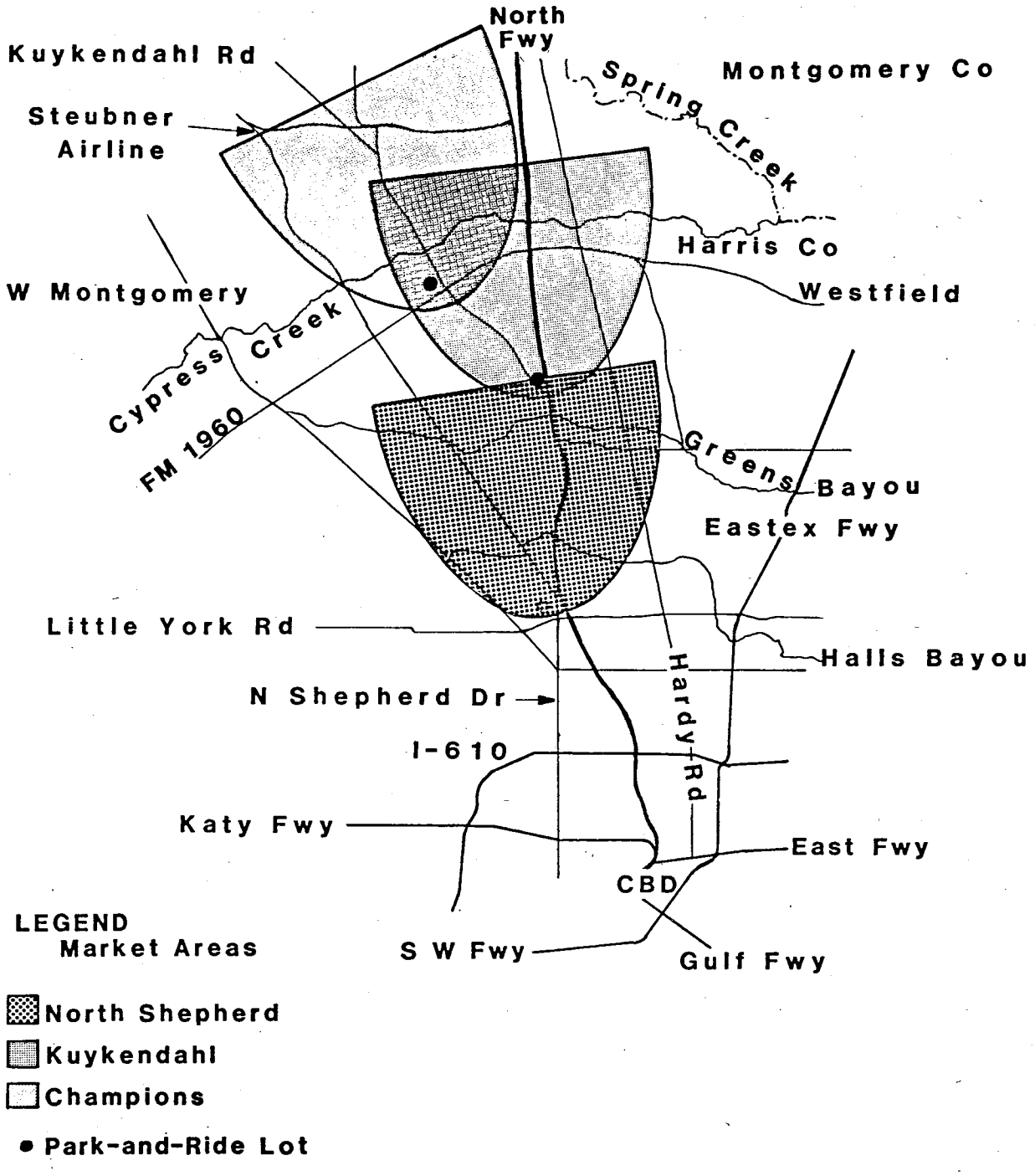

Figure A-5: North Freeway Park-and-Ride Lot Market Area for the Houston Home Mail-Out Survey

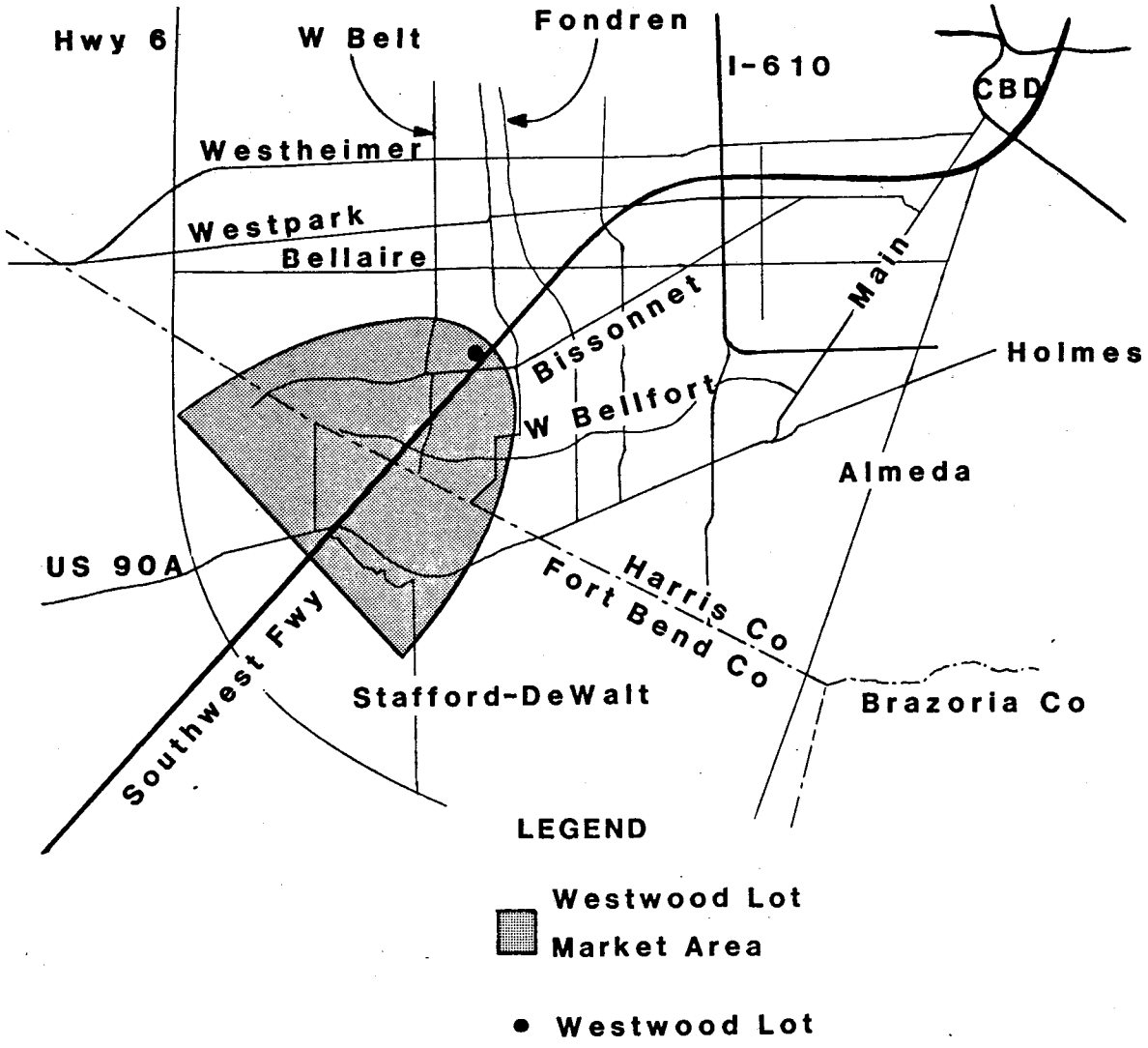

Figure A-6: Westwood Park-and-Ride Lot Market Area for the Houston Home Mail-Out Survey

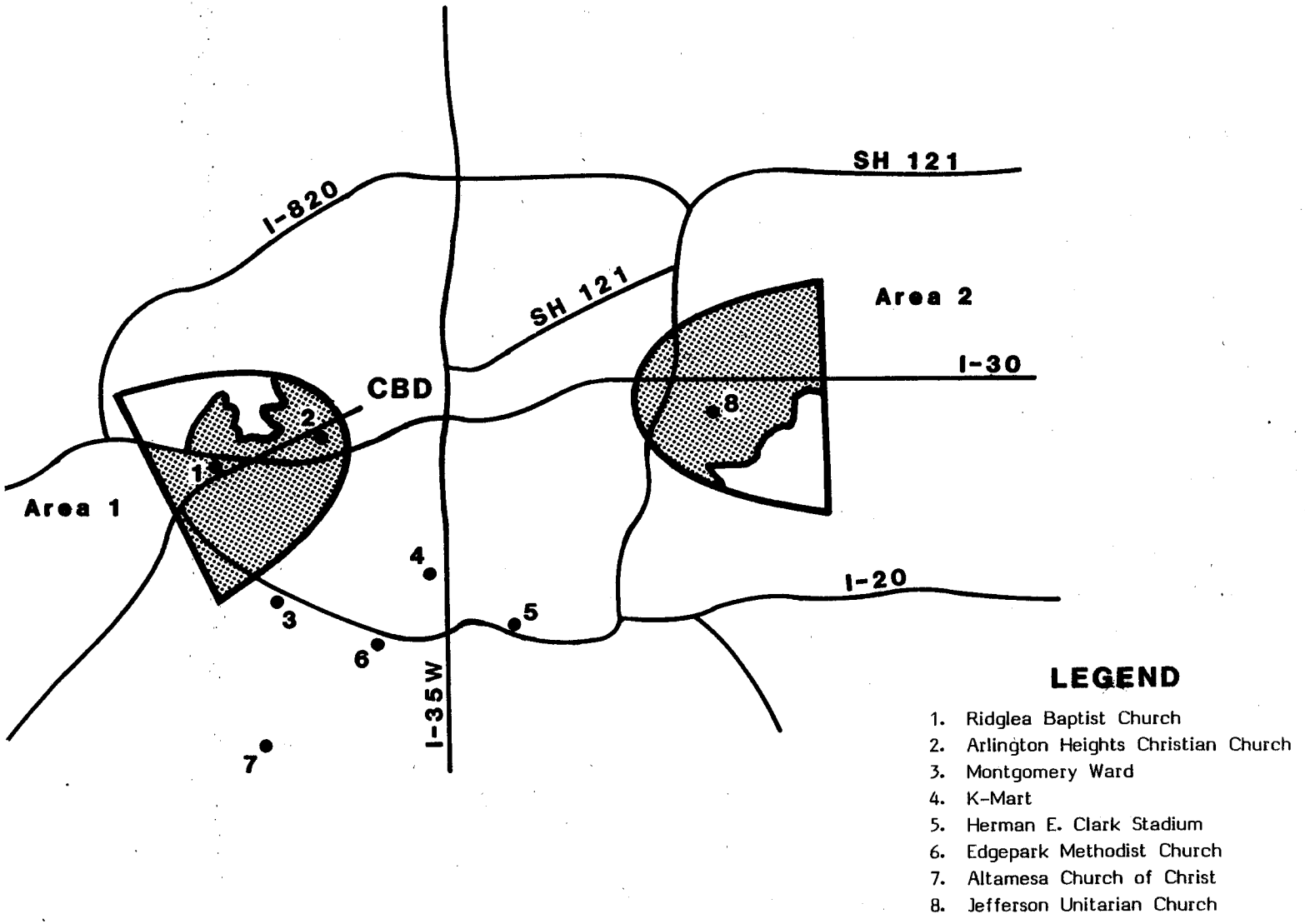

Figure A-7: Park-and-Ride Lot Locations for the Fort Worth On-Board Survey and Market Areas for the Home Mail-Out Survey

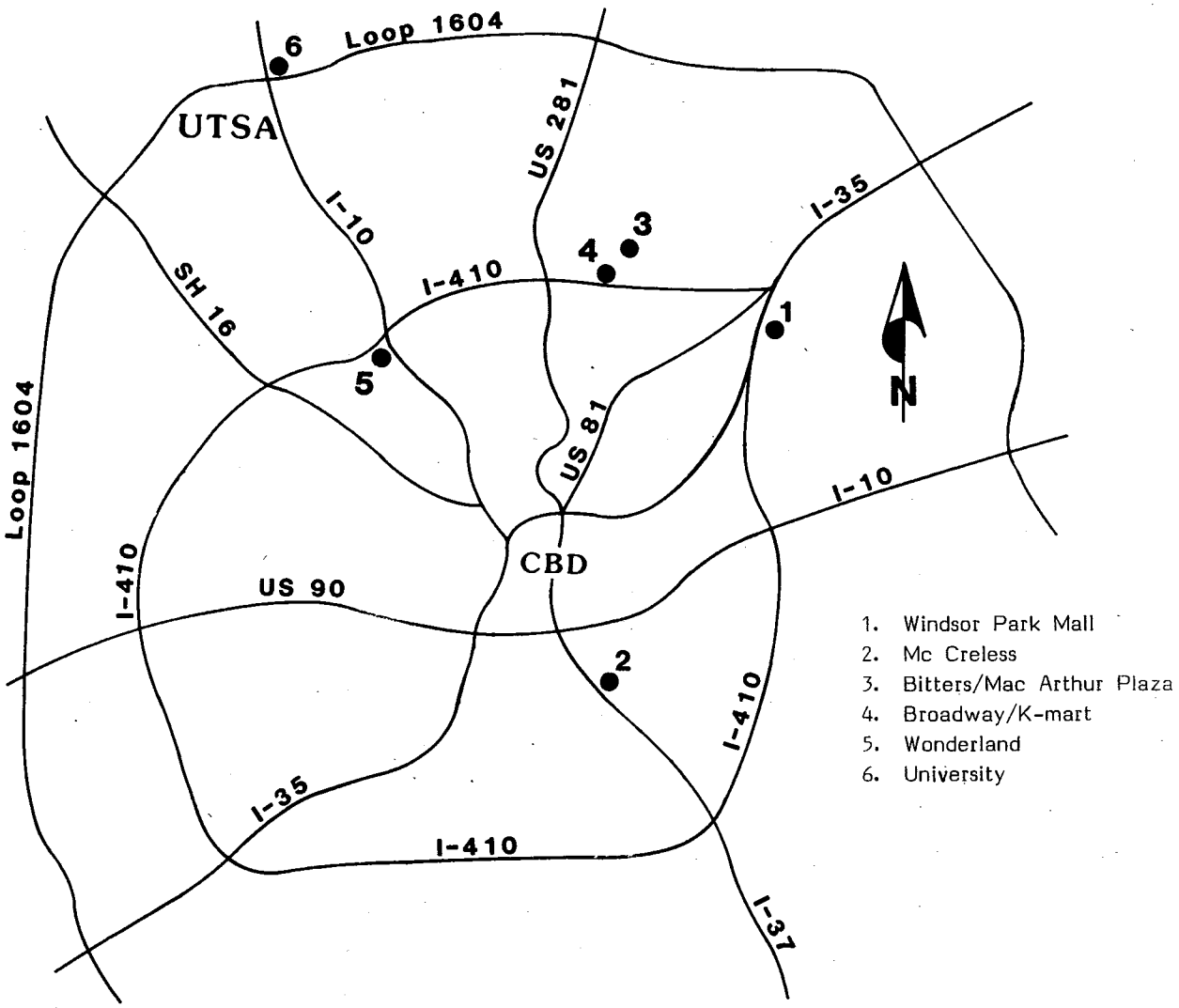

Figure A-8: Park-and-Ride Lot Locations for the San Antonio On-Board Survey

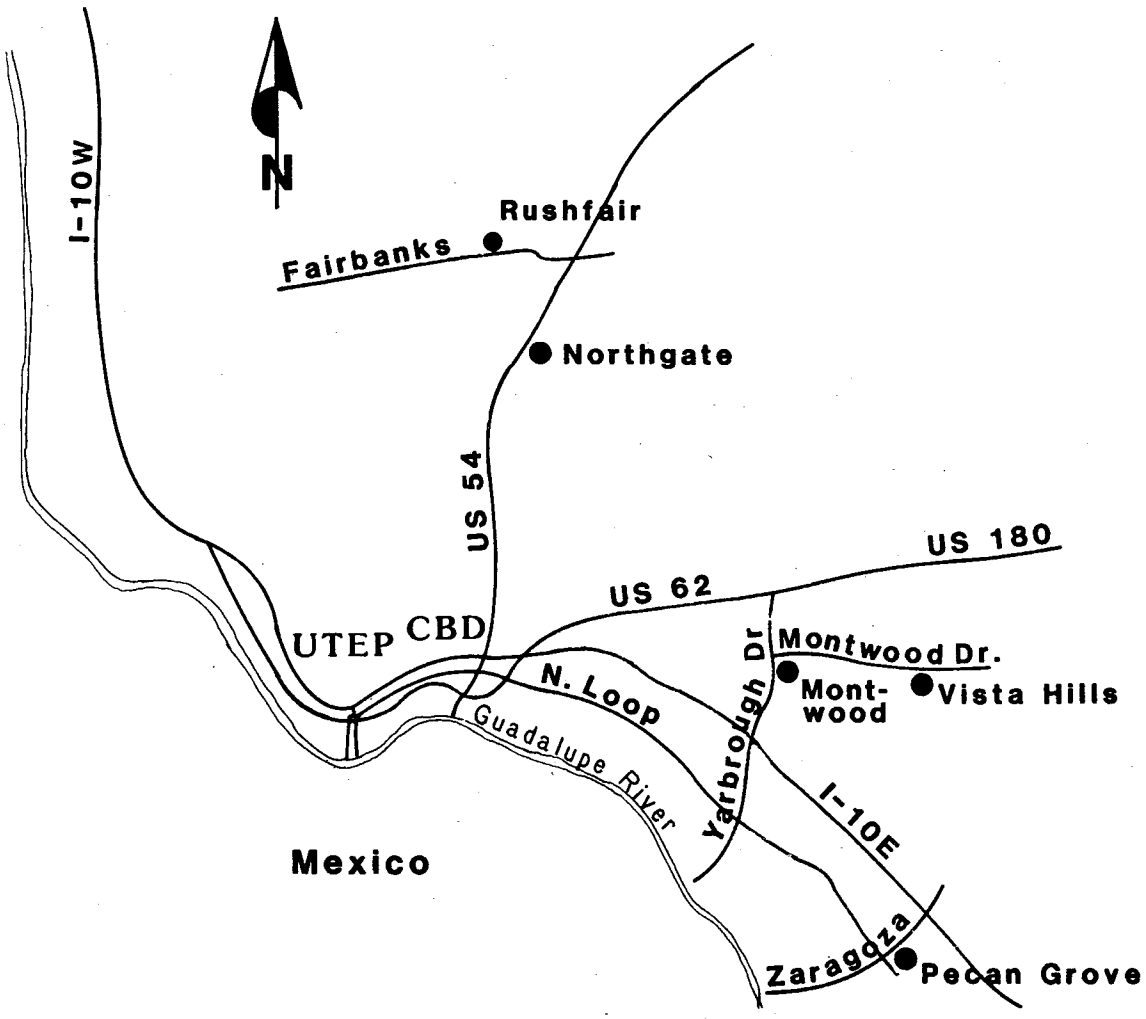

Figure A-9: Park-and-Ride Lot Locations for the El Paso On-Board Survey

Park-and-Ride User Survey

Undertaken by the Texas Transportation Institute, The Texas A&M University System in cooperation with the Texas State Department of Highways and Public Transportation, VIA Metropolitan Transit and the U.S. Department of Transportation, Federal Highway Administration

1. **How did you arrive at the Park-and-Ride lot for this trip?**

   _____Another bus, which bus?_____ _____Dropped off by someone

   _____Drove an automobile _____Walked

   _____Rode with someone who also uses Park-and-Ride

2. **Where did you begin this trip? (Please give the nearest street intersection, exact address or name of building you started from.)**

   _____

3. **Where will you end this trip? (Please give the nearest street intersection, exact address or name of building of your final destination.)**

   _____

4. **Will you need to transfer (catch another bus) to complete your trip?**

   _____Yes, which bus?_____ _____No

5. **Why are you primarily making this trip?**

   _____Work _____Shopping _____School

   _____Business _____Other

6. **In which of the following age groups do you belong?**

   _____Less than 18 _____22-31 _____42-51 _____62 or older

   _____18-21 _____32-41 _____52-61

7. **What is your sex?** _____Male _____Female

8. **What is the last level of school that you completed?**

   _____Less than high school _____Some college _____More than college

   _____High school graduate _____College graduate

9. **Before you began using the Park-and-Ride service, how did you normally make this trip?**

   _____Drove alone _____Vanpool _____Did not make trip

   _____Carpool _____VIA local bus _____Other

10. **If you drove your own auto prior to using Park-and-Ride, did you drive past the Park-and-Ride lot?** _____Yes _____No

11. **How long have you been using the Park-and-Ride service?**_____months

12. **How many days per week do you travel from this Park-and-Ride lot to your final destination?**_____days per week

13. **If you drove to work instead of using Park-and-Ride, would your employer pay all or part of your driving cost?**

    _____Yes (all) _____Yes (part) _____No

14. **Do you save time using the Park-and-Ride service rather than driving?**

_____Yes / If "yes," about how much do you save one-way? _____minutes

_____No / If "no," about how much do you lose one-way? _____minutes

15. **Do you save money using the Park-and-Ride service rather than driving?**

_____Yes / If "yes," about how much do you save? $_____per month

_____No / If "no," about how much do you lose? $_____per month

16. **A number of different factors can be important in causing people to use the Park-and-Ride service. Please answer by circling the number which best explains how important the following features are to you in your decision to use Park-and-Ride.**

IN YOUR DECISION TO USE PARK-AND-RIDE, HOW IMPORTANT IS . . .	Not Important		Neutral		Very Important
The rising cost of gasoline and automobile maintenance	1	2	3	4	5
The rising cost of parking at your destination	1	2	3	4	5
Avoiding the stress of driving to and from work or school	1	2	3	4	5
The bus travel time relative to auto travel time	1	2	3	4	5
A reliable bus schedule	1	2	3	4	5
Having direct bus service during peak periods	1	2	3	4	5
Frequent bus service during peak periods	1	2	3	4	5
Bus service being available throughout the day	1	2	3	4	5
Riding in a new, modern bus	1	2	3	4	5
Having a Park-and-Ride lot close to your home	1	2	3	4	5
Convenient access to the Park-and-Ride lot	1	2	3	4	5

17. **How would you rate your overall satisfaction with the Park-and-Ride service?**

_____Very Satisfactory _____Neutral _____Unsatisfactory

_____Satisfactory _____Very Unsatisfactory

18. **How long have you lived at your present address?** _____years

19. **What is your current occupation, in as specific terms as possible? (Also, specify if retired, unemployed, student or homemaker.)** _____

20. **Which of the following best approximates your total annual family income?**

_____Under $10,000 _____$15,000-$24,999 _____$35,000 or more

_____$10,000-$14,999 _____$25,000-$34,999

21. **Comments and suggestions:** _____

THANK YOU FOR YOUR COOPERATION

COMMISSION
A. SAM WALDROP, CHAIRMAN
DEWITT C. GREER
RAY A. BARNHART

STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION
AUSTIN, TEXAS 78763

ENGINEER-DIRECTOR
M. G. GOODE

IN REPLY REFER TO
FILE NO.

PUBLIC TRANSPORTATION SURVEY

Dear Resident:

A limited number of households in your area are being asked to participate in a study undertaken by the Texas Transportation Institute, Texas A&M University System. The purpose of this survey is to obtain information about your household's transportation needs.

Since we have included only a small number of households in this survey, your participation is essential to insure the success of the project. Please complete the requested information and return it in the enclosed envelope at your earliest convenience.

We are grateful for your participation in the survey.

Sincerely,

Phillip L. Wilson
State Planning Engineer, Transportation

PLW:jem
Enclosure

COMMISSION
A. SAM WALDROP, CHAIRMAN
ROBERT H. DEDMAN
JOHN R. BUTLER, JR.

STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION
AUSTIN, TEXAS 78763

ENGINEER-DIRECTOR
MARK G. GOODE

IN REPLY REFER TO
FILE NO.

PUBLIC TRANSPORTATION SURVEY

Dear Resident:

During the last few weeks a number of households in your area were asked to participate in a survey being conducted by The Texas Transportation Institute, Texas A&M University System. The purpose of this survey is to obtain information about your household's transportation needs.

Since we have included only a small number of households in this survey, your participation is essential to insure the success of the project. Please complete the requested information as best you can and return it to us in the postage-paid envelope at your earliest convenience.

We are grateful for your participation in the survey.

Sincerely,

Phillip L. Wilson
State Planning Engineer, Transportation

PLW:jem
Enclosure

Park & Go Household Survey

Undertaken by the Texas Transportation Institute, The Texas A&M University System in cooperation with the Texas State Department of Highways and Public Transportation and the U.S. Department of Transportation, Federal Highway Administration

This questionnaire is designed to be easy to complete and should take no more than 5-10 minutes of your time. All answers will remain confidential. Please answer the following questions and return this form at your earliest convenience in the postage-paid envelope.

1. What is the location of your work or college? Zip _____

2. How many <u>others</u> in your household work or attend college? _____

   2a. At which location(s) do they work or attend college?

   _____, Zip_____; _____, Zip_____; _____, Zip _____

3. How do you travel to your work or college location? ____Drive Alone ____Carpool

   ____Vanpool ____CITRAN Park & Go Bus ____CITRAN Local Bus ____Other

4. Do you know what bus route serves your area? ____Yes ____No

   If yes, about how far do you live from the nearest bus stop? _____Blocks

5. How often do you ride a CITRAN bus?

   ____Almost Every Day ____About Once a Week ____Seldom ____Never

6. Have you ever used a Park & Go Lot? ____Yes ____No

   Do you know what CITRAN Park & Go service is? ____Yes ____No ____Not Sure

7. Do you know the location of the Park & Go lot nearest your home?

   ____Yes ____No ____Not Sure

8. Do you know enough about the CITRAN Park & Go service to "confidently" start using it tomorrow?

   ____Yes ____No ____Not Sure

9. How often do you need to have <u>your</u> car available during the day?

   ____Almost Every Day ____About Once a Week ____Seldom ____Never

10. How many years have you lived at your present address? _____

    10a. If less than 2 years, in what city and state did you <u>previously</u> live?

    City:_____ State:_____

11. What is your current occupation, in as specific terms as possible. (Also, please specify if retired, unemployed, student, or homemaker.)

    _____

12. How many years of school have you completed? _____years 13. Age _____

14. Sex? ____Male ____Female

15. The following is a list of considerations which may affect a person's use of the CITRAN Park & Go service. Please answer by circling the number which best explains how likely you would be to use Park & Go for each of the following conditions.

HOW LIKELY WOULD YOU BE TO USE PARK & GO	Very Unlikely		No Difference		Very Likely
If you had a better understanding of how the service is operated	1	2	3	4	5
If the buses arrived and departed at the scheduled time	1	2	3	4	5
If you didn't have to wait more than 5 minutes for a bus	1	2	3	4	5
If the buses were safer to ride on than they are now	1	2	3	4	5
If the buses stopped closer to your place of work or school	1	2	3	4	5
If traffic congestion on the streets and freeways became worse	1	2	3	4	5
If the cost of gasoline were to increase	1	2	3	4	5
If the bus trip took less time than an automobile trip	1	2	3	4	5
If the bus fares were lower	1	2	3	4	5
If the buses were newer and more modern	1	2	3	4	5
If the trip did not require sitting next to strangers	1	2	3	4	5
If there was always a seat available	1	2	3	4	5
If a comfortable temperature was always maintained inside the buses	1	2	3	4	5
If newspapers/magazines were provided on board the bus	1	2	3	4	5
If the Park & Go lot was more visible from the roadway	1	2	3	4	5
If auto access to and from the Park & Go lot was more convenient	1	2	3	4	5
If there was better security at the Park & Go lot	1	2	3	4	5
If there were telephones at the bus waiting areas	1	2	3	4	5
If there were bus shelters and/or benches at the Park & Go stops	1	2	3	4	5
If the bus trip was non-stop to your destination	1	2	3	4	5

16. Below are several statements relating to transportation facilities and personal travel; you will probably agree with some of the statements and disagree with others. Please answer by circling the number which best represents your feeling about each of the statements.

	Strongly Disagree		Neutral		Strongly Agree
I'll always dislike the idea of riding buses no matter how much the service is improved	1	2	3	4	5
Traveling by bus is so much more relaxing than driving	1	2	3	4	5
More tax money should be spent on improving mass transit in the Fort Worth area	1	2	3	4	5
Bus riding will be more attractive as auto congestion and gasoline and parking costs increase	1	2	3	4	5

THANK YOU FOR YOUR COOPERATION!