TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-80/8+205-11		

4. Title and Subtitle	5. Report Date
Factors Influencing The Utilization of Park-And-Ride Dallas/Garland Survey Results	July 1980
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Dennis L. Christiansen, Diane Bullard, Patricia L. Benfer, and Patricia Guseman	Research Report 205-11
9. Performing Organization Name and Address	10. Work Unit No.
Texas Transportation Institute The Texas A&M University System College Station, Texas 77843	11. Contract or Grant No.
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	Interim - September, 1973 July, 1980
Texas State Department of Highways and Public Transportation; Transportation Planning Division P. O. Box 5051 Austin, Texas 78763	14. Sponsoring Agency Code

15. Supplementary Notes

Research performed in cooperation with DOT, FHWA.
Research Study Title: Priority Use of Freeway Facilities

16. Abstract

This report presents the results of both park-and-ride user and non-user surveys performed in Dallas and Garland, Texas. In addition to obtaining socieoconomic and demographic information, the surveys were designed to: 1) identify the features of the existing park-and-ride service that are most important in generating ridership; and 2) identify what additional features could be added to the existing service and be most effective in increasing ridership. The findings should be of value in both planning and operating park-and-ride facilities.

17. Key Words	18. Distribution Statement
Park-and-Ride, Transit, Terminal Design, Mass Transportation, Bus Rapid Transit	No Restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

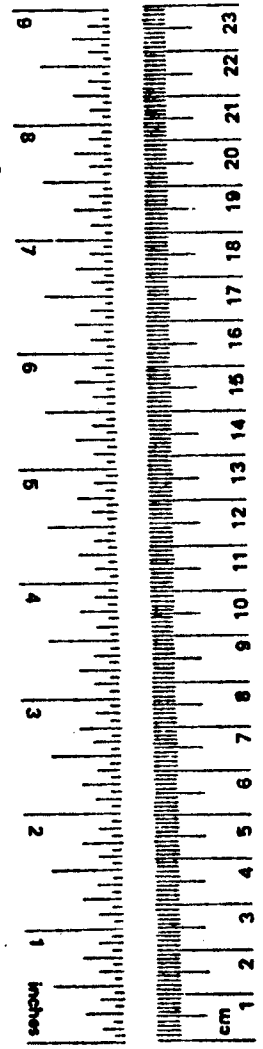
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	70	

Form DOT F 1700.7 (8-69)

METRIC CONVERSION FACTORS

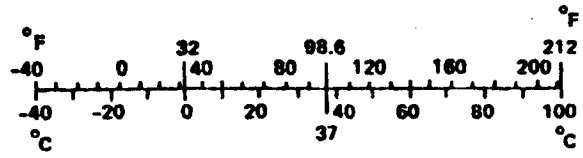
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



* 1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

FACTORS INFLUENCING THE UTILIZATION OF PARK-AND-RIDE

Dallas/Garland Survey Results

by

Dennis L. Christiansen
Study Supervisor

Diane Bullard
Research Associate

Patricia L. Benfer
Research Associate

and

Patricia Guseman
Assistant Research Sociologist

Edited by

A. V. Fitzgerald
Assistant Research Specialist

Research Report 205-11

Priority Use of Transportation Facilities
Research Study Number 2-10-74-205

Sponsored by

State Department of Highways and Public Transportation
in Cooperation with
U.S. Department of Transportation
Federal Highway Administration

Texas Transportation Institute
The Texas A&M University System
College Station, Texas

July 1980

ACKNOWLEDGEMENTS

To successfully undertake a project of this nature, the cooperation and assistance of a number of organizations and agencies are necessary. The Texas Transportation Institute was provided with this assistance, and the cooperation of the following organizations is gratefully acknowledged: Dallas Transit System; City of Dallas; City of Garland; North Central Texas Council of Governments; and State Department of Highways and Public Transportation, District 18.

ABSTRACT

This report presents the results of both park-and-ride user and non-user surveys performed in Dallas and Garland, Texas. In addition to obtaining socieoconomic and demographic information, the surveys were designed to: 1) identify the features of the existing park-and-ride service that are most important in generating ridership; and 2) identify what additional features could be added to the existing service and be most effective in increasing ridership. The findings should be of value in both planning and operating park-and-ride facilities.

Key Words: Park-and-Ride, Transit, Terminal Design, Mass Transportation, Bus Rapid Transit

SUMMARY

Park-and-ride is an effective means of aggregating transit patronage in Texas cities. Many new lots are being developed, and guidelines are needed for planning and operating those lots. Surveys, both of users and non-users, were performed in Dallas and Garland to develop those guidelines; a primary intent of those surveys was to: 1) identify those features of existing park-and-ride service that were most important to users in deciding to use the park-and-ride service; and 2) identify the additional features that would need to be added to the existing service to attract the greatest number of new users. Three park-and-ride lots were surveyed; priority treatment for buses is not available from those lots.

The existing park-and-ride operations are serving 8% to 21% of the total market. Of those not using the service, about half feel they need a car available during the day, while about a third have tried using park-and-ride and are no longer using that service.

Money savings are the prime reasons for using the service. The "typical" park-and-ride patron is paying a 15-minute time penalty per trip to save 60¢. High parking costs must exist to generate that type of dollar savings. Frequent and reliable bus service plus the availability of park-and-ride lots close to the home with good access are considered as being extremely important by the users.

The non-user group is much more time sensitive than is the user group. In order to generate additional ridership, the most effective improvement would appear to be provision of priority treatment designed to provide travel time savings for the park-and-ride patron.

IMPLEMENTATION STATEMENT

The thrust of this project has been to assist the State Department of Highways and Public Transportation in planning and implementing improvements for high-occupancy vehicles. Park-and-ride facilities are a major component of most of these improvements.

Numerous park-and-ride facilities are being constructed in the state, and the Department is participating in the planning and financing of many of those facilities. The information presented in the report should be of use in maximizing the cost-effectiveness of the park-and-ride improvements.

Disclaimer

The contents of this report reflect the views of the authors who are responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

TABLE OF CONTENTS

INTRODUCTION

Park-and-ride has proven to be a popular and effective means of aggregating transit demand from the low-density residential development that characterizes Texas cities. At least six Texas cities presently provide park-and-ride service.

Most previous park-and-ride studies have concentrated on identifying user characteristics. Extensive data describing user characteristics such as age, income, trip purpose, trip frequency, previous mode of travel, etc., have been collected for park-and-ride operations both in the United States and, more specifically, in Texas (Research Reports 205-2 and 205-3). Other efforts have been made to calibrate urban transportation planning models to provide estimates of park-and-ride demand (1,2)*; such models are difficult to use and do not necessarily provide accurate demand estimates. In addition, none of these models are oriented to using data that are generally available in Texas.

As a result, in regard to park-and-ride operations in Texas cities, the following two major areas of concern have not been fully addressed.

- Facility planning and operation. Given the fact that funding limitations exist, in laying out and operating a park-and-ride facility, what features of the layout and design are most important and which are least important?
- Demand estimation. Park-and-ride lots are rapidly being developed in Texas. A demand estimation approach that utilizes data that are routinely available in Texas is needed; the initial step in this procedure is to identify the variables that are most important to consider in demand estimation. A literature review (Research Report 205-2) has identified in excess of 40 variables that have been hypothesized as being "important" concerns in park-and-ride utilization.

---

*Denotes number of reference listed at end of report.

User and Non-User Surveys

This particular research effort was geared toward developing information that could be used to address the issues of concern previously identified. Two separate surveys, a park-and-ride user and a non-user survey, were performed. The survey instruments are included in Appendix A, and the statistical sampling analysis is included in Appendix B.

Although a number of issues were addressed in these surveys, they were designed primarily to identify the following.

- User Survey. What features of the existing park-and-ride service were most important to the user in making the decision to utilize park-and- ride?
- Non-User Survey. For those individuals that live in the area served by the park-and-ride lot and work in the area served by the bus operation, what additional features would need to be incorporated into the park-and-ride service to cause the non-users to choose to use park-and-ride?

The surveys were undertaken in Dallas and Garland, Texas (Figure 1). These locations were selected primarily because three relatively large park-and-ride lots serve the area and have been in operation for several years. A stable, relatively high level-of-service is provided.

User Survey

A detailed description of the user survey is included in Appendix B. The survey was performed at three lots, two in Garland and one in Dallas (Table 1). Bus service is provided from those lots to downtown Dallas. Approximately 30% of the buses serving those lots were surveyed and, for each bus surveyed, a 100% sample was taken. Approximately 420 survey instruments were completed.

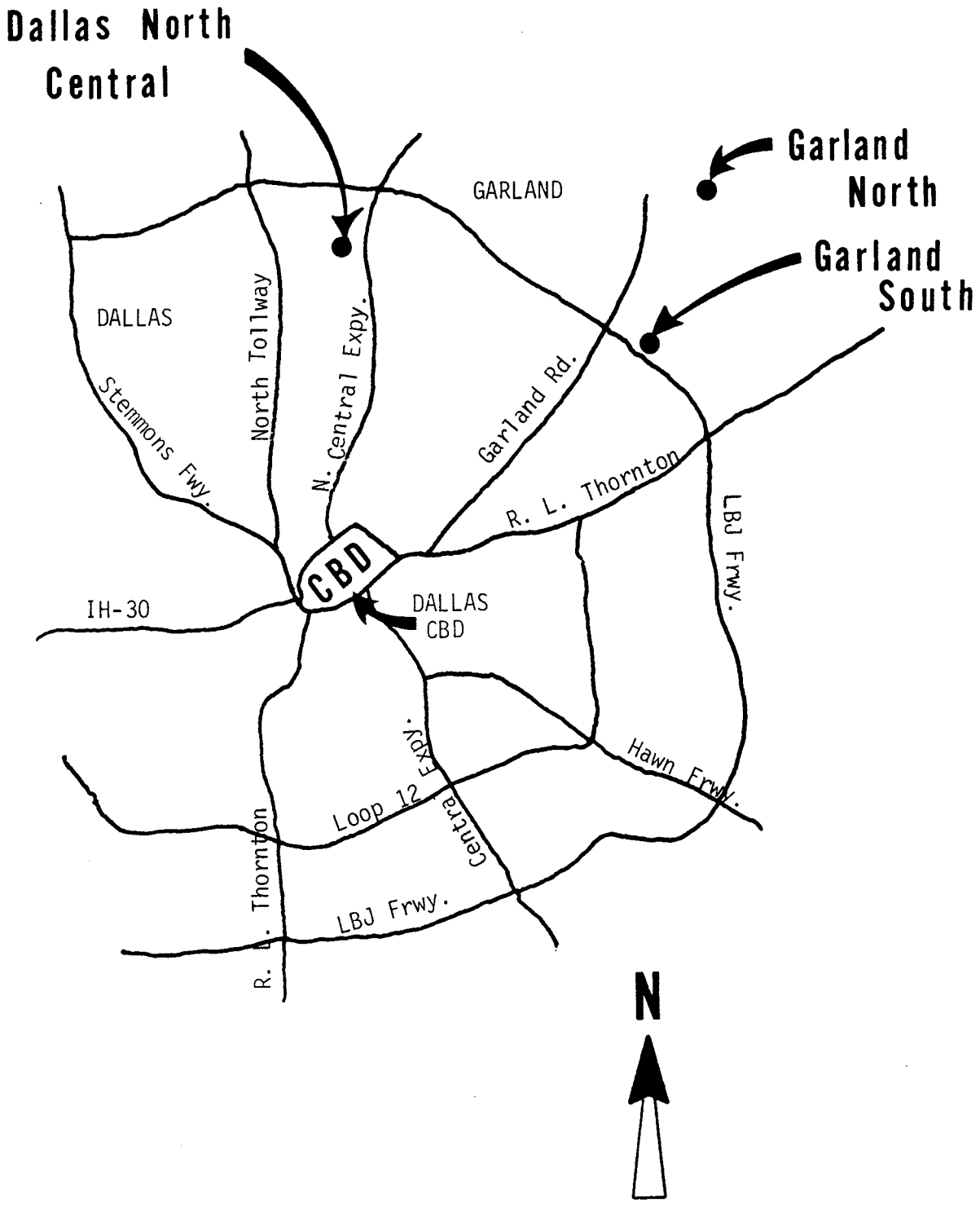


Figure 1: Location of Park-and-Ride Lots Surveyed

Table 1: Characteristics of the Park-and-Ride Lots Surveyed in the User Survey

Park-and-Ride Characteristic	Park-and-Ride Lot		
	Dallas North Central	Garland North	Garland South
Parking Spaces	356	312	315
Daily Patronage (Each Direction)	545	360	440
Headways, Peak Hour	10 min.	10 min.	7 min.
Daily Bus Trips To Dallas CBD	21	37	20
One-Way Fare[1]	$0.95	$1.00	$1.00
Avg. Schedule Speed	18 mph	22 mph	22 mph

[1]Fares have increased since the survey was performed

Source: Dallas Transit System

Non-User Survey

A detailed description of the non-user survey is included in Appendix B. For each of the three lots described in Table 1, an estimate of the geographical area served by that lot was made using information from Research Reports 205-2 and 205-3. An address listing was obtained for those areas, and a random sample of addresses was selected. A total of approximately 2700 addresses was selected. An initial mail-out was performed, and two "follow-ups" were also performed to increase the sample size to a satisfactory level. After the initial mail-out and two follow-up mail-outs, approximately 1720 responses were obtained (Table 2).

The remainder of this report consists of three major sections. The following section presents selected general characteristics of both the user and non-user surveys. The second technical section identifies the factors that

Table 2: Summary of Non-User Surveys Mailed to Households in the Dallas and Garland Park-and-Ride Lot Market Areas

Park-and-Ride Lot Market Area	Total Surveys Mailed to Households	Total Surveys Returned	Households with at Least One Person Employed in Downtown Dallas[1]
Garland North and Garland South	1,810	1146 (63.3%)	132 (11.5%)
Dallas North Central	884	573 (64.8%)	118 (20.6%)
Total	2,694	1719 (63.8%)	250 (14.5%)

[1]The percentage value shown is the percent of the total household surveys returned that indicated that at least one household member was employed in downtown Dallas

appear to be most important in influencing modal choice. The final section presents the major study conclusions. Following the conclusion section, two Appendices are included that describe the survey procedures and techniques in more detail.

USERS AND NON-USERS, GENERAL CHARACTERISTICS

In addition to attempting to identify the aspects of park-and-ride service that were most important in generating ridership, the survey instruments used (Appendix A) obtained considerable additional information relating to park-and-ride service and the users of that service. A summary of some of the more pertinent data, as well as some of the possible implications associated with those data, are presented in this section.

Personal Characteristics

To obtain a profile of both users and non-users, questions were asked concerning age, sex, education, and occupation. Non-users, as referred to in this report, are eligible users (i.e., reside in an area served by a park-and-ride lot and work in the area served by the park-and-ride buses) who are not using the system. This information is summarized below.

Age

On both the user and non-user surveys, the question "What is your age?" was asked. The responses to this question are summarized in Figure 2.

In terms of age, there are major differences between users and non-users. It is apparent that the younger population is more receptive to park-and-ride service. The median age of users is approximately 34 years, while the median age of non-users is approximately 39 years.

Sex

Both surveys asked the question "What is your sex?" Table 3 summarizes the responses to that question.

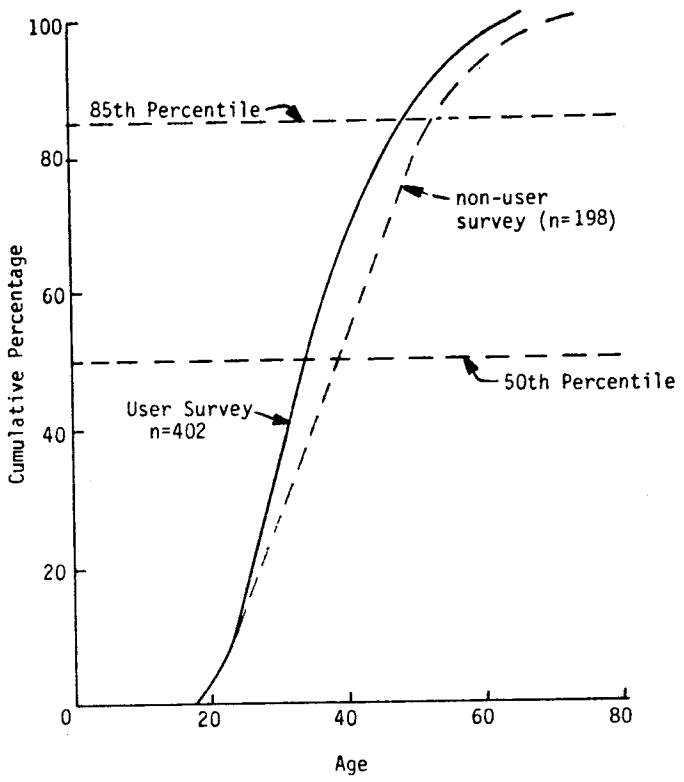


Figure 2: Cumulative Frequency Distribution, Age of Users and Non-Users

Table 3: Sex of Users and Non-Users, Percentage

Sex	Users (n=408)	Non-Users (n=201)
Male	42%	70%
Female	58%	30%

The data suggest that park-and-ride service is much more attractive to the female population, with 58% of the users being female. Of the non-users, only 30% are female. The predominant use of park-and-ride by women is in agreement with data collected in Dallas in 1974 (Research Report 205-2). While, based on the non-user survey, the overwhelming majority of the downtown work force would appear to be male, the large majority of park-and-ride patrons are female.

Education

Both surveys asked the question "What is the last year of school you completed?" Responses to that question are shown in Figure 3.

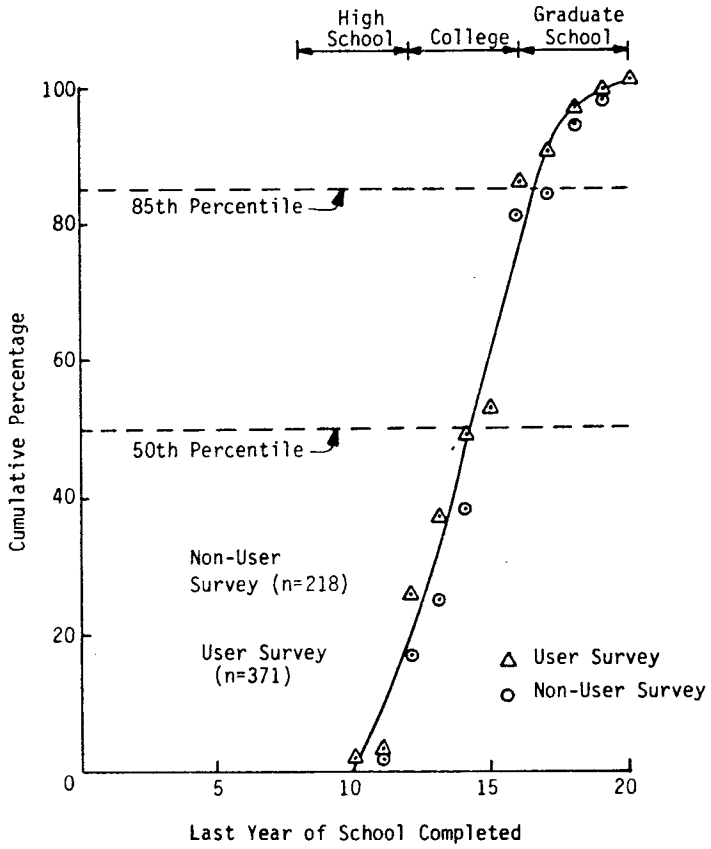


Figure 3: Cumulative Frequency Distribution, Education of Users and Non-Users

It is evident that downtown employees are an educated group; over 75% have some college education and over 18% have attended graduate school. There are only minor differences between the education of the users and the non-users.

Occupation

In both surveys, the question "What is your occupation, in as specific terms as possible? (Also, please specify if retired, unemployed, student, or housewife)" was asked. The responses to these questions were grouped into 13 categories; the results are summarized in Table 4.

Table 4: Occupation of Users and Non-Users, Percentage

Occupation	Users (n=396)	Non-Users (n=194)
	Percent	Percent
Unemployed	0.0	0.0
Housewife	0.5	0.0
Student	2.5	4.1
Retired	1.0	0.0
Private Household Workers	0.0	0.0
Laborers	0.8	0.5
Operatives	1.5	2.1
Service Workers	1.3	2.5
Craftsmen	1.5	4.2
Clerical	39.6	15.4
Sales	4.3	12.4
Managerial	18.7	29.9
Professional	28.3	28.9

Of the users, the highest percentage is clerical which also explains the high utilization of park-and-ride by females. The combination of clerical, managerial and professional accounts for 86.6% of total users. While professional and managerial also predominate the non-user survey results, a much lower clerical percentage occurs.

Transportation Characteristics

To better understand past and present travel patterns, a series of questions was asked. These questions addressed previous mode of travel (users)

and mode of travel (non-users), mode of arrival at the park-and-ride lot, how long park-and-ride service has been used, and general satisfaction with fare and service levels.

Mode of Travel

On the user survey, "Before you began using the park-and-ride service, how did you normally make this trip?" was asked. The non-users were asked "How do you normally get to work downtown?" The responses to these questions are summarized in Table 5.

Table 5: Mode of Travel to Downtown (previous mode for Users, present mode for Non-Users), Percentage

Mode	Users (n=416)	Non-Users (n=207)
Drove Self	50%	69%
Carpool/Vanpool	11%	25%
Regular Route Bus	11%	4%
Did Not Make Trip	25%	-
Other	3%	2
Total	100%	100%

In general, the user results are not surprising and substantiate other data published in Research Report 205-2. However, the high percentage of users responding that they did not previously make the trip is, perhaps, higher than expected; although a latent demand would be expected to exist, the latent demand would not be expected to represent 25% of the trips served by the park-and-ride operation.

The non-user surveys results are not unexpected. The percentages noted from that survey are not out of line with other count data that have been tabulated in the state.

Part of the explanation for the high user response to the "did not previously make the trip" option would appear to lie in the answer to the question "How long have you lived at your present address?" The results to that question, shown in Figure 4, suggest that half the users have lived at their present address for less than 2 years. An interpretation of this could be that a number of users began using park-and-ride immediately upon locating at their current address; this might be further interpreted to suggest that, at least for a portion of the population, availability of a good transit service is a factor in residential location decisions. Major differences exist between users and non-users regarding years of residing at the present address. Of the non-users, over 50% have lived at the present address for more than 5 years.

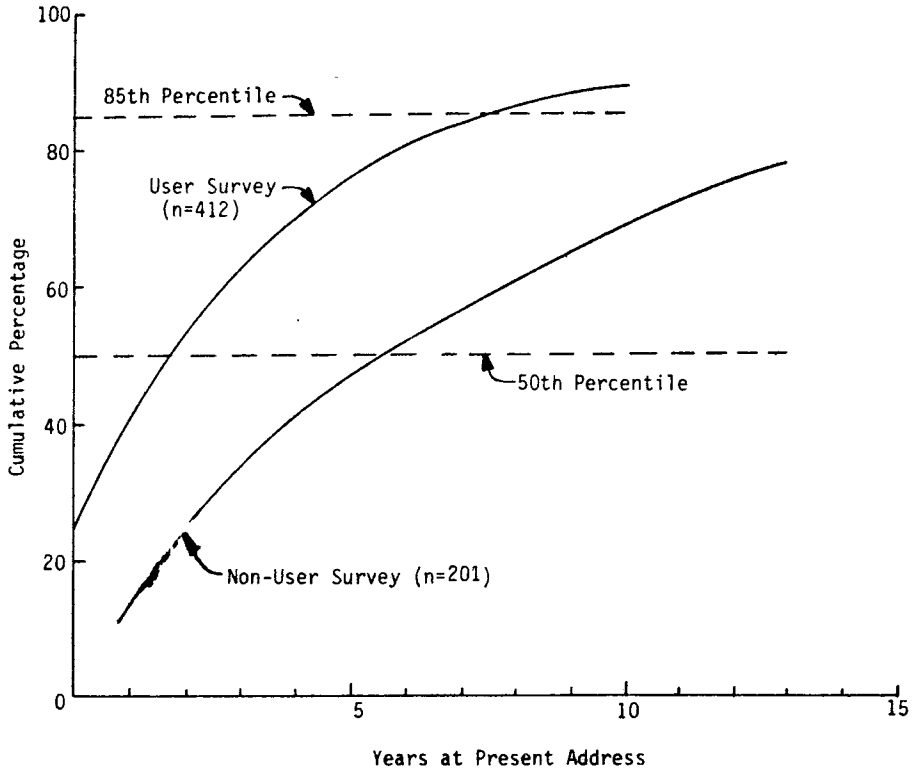


Figure 4: Cumulative Frequency Distribution, Length of Time at Present Address for Park-and-Ride Users and Non-Users

Mode of Arrival at Park-and-Ride Lot

On the user survey, "How did you arrive at the park-and-ride lot this morning?" was asked. Responses are shown in Table 6.

Table 6: Mode of Arrival at the Park-and-Ride Lot, n=420

Arrival Mode	Percentage
Drove Alone	66%
Rode With Someone Who Also Uses Park-and-Ride	9%
Dropped Off By Someone	20%
Motorcycle	0%
Bicycle	1%
Other	4%
Total	100%

This table also confirms data reported in previous studies. The kiss-and-ride percentage is in agreement with that reported in Research Report 205-3. The average number of patrons per arriving vehicle, approximately 1.1, also agrees with values used in the development of design guidelines presented in Research Report 205-3.

Length of Using Park-and-Ride Service

On the user survey, the question "How long have you used the park-and-ride service?" was posed. The responses to that question are displayed in Figure 5. The Dallas lot has been in operation (although not at the same location) since early 1974, while the Garland lots opened in late 1975.

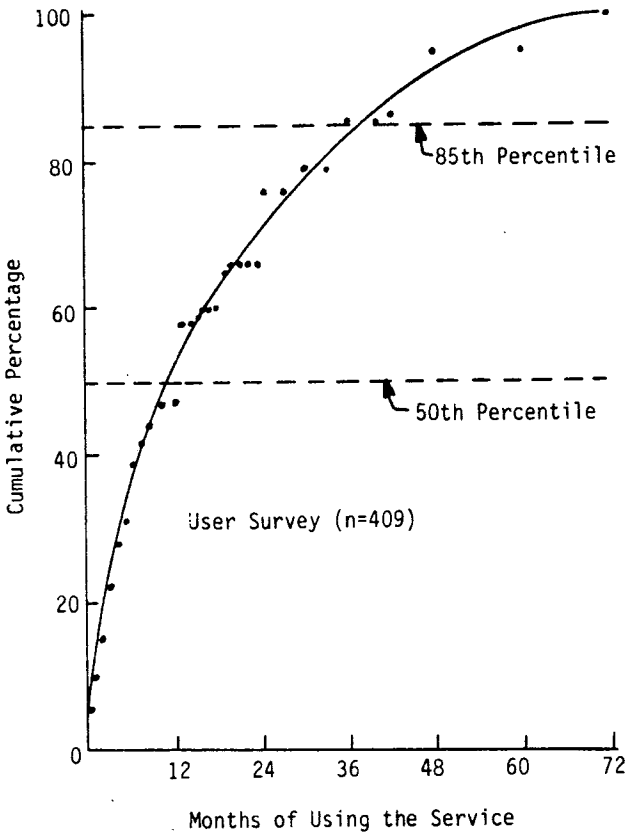


Figure 5: Cumulative Frequency Distribution, Length of Use of The Park-and-Ride Service

Overview, Personal and Transportation Characteristics

In terms of some characteristics, such as education, users and non-users of park-and-ride service are highly similar. In terms of other factors, such as sex and years of residing at the respondent's present address, marked differences occur. The overall responses of both users and non-users are summarized in Table 7.

Table 7: Overview of Selected Personal and Transportation Characteristics, Users and Non-Users

Characteristic	Users	Non-Users
Age (years)		
50th Percentile	34	39
85th Percentile	48	55
Sex		
Male	42%	70%
Female	58%	30%
Years of Education		
50th Percentile	14	15
85th Percentile	17	17
Occupation		
Clerical	40%	15%
Managerial	19%	30%
Professional	28%	29%
Mode of Travel To Downtown[1]		
Drove Self	50%	69%
Carpool/Vanpool	11%	25%
Regular Route Bus	11%	4%
Did Not Make Trip	25%	-
Other	3%	2
Length of Time at Present Address (years)		
50th Percentile	1.75	5.5
85th Percentile	7.5	16.0

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

FACTORS INFLUENCING MODAL SPLIT

This section is divided into three major parts. The first identifies the actual modal split occurring at the study lots. The second presents some general attitudes, both user and non-user, concerning the use of park-and-ride. The third part documents the specific park-and-ride service elements that are most important to users and are perceived to be most important by non-users.

Existing Modal Split

The home mail-out survey provides the best indication of modal split for park-and-ride facilities in Texas. This information is summarized in Table 8.

Table 8: Percentage of Eligible Users Riding Park-and-Ride, Dallas North Central and Garland Lots

Park & Ride Lot	Total Household Surveys Mailed	Total Household Surveys Returned[1]	Households with at Least One Member Employed in Downtown Dallas[2]	Households with at Least One Member Using Park-and-Ride To Downtown Dallas[3,4]
Garland North and Garland South	1,810	1,146 (63.3%)	132 (11.5%)	28 (21.2%)
Dallas North Central	884	573 (64.8%)	118 (20.6%)	9 (7.7%)
Total	2,694	1,719 (63.8%)	250 (14.5%)	37 (14.8%)

[1]Percentage value is the return rate for the entire survey.
[2]Percentage value is the percent of returned surveys that indicated at least one household member working in downtown Dallas.
[3]Percentage value is the percentage of households with a member employed in the Dallas CBD that are already using park-and-ride service.
[4]Caution must be used in comparing the modal split values for the Garland and Dallas lots. Since the general market areas were known from previous surveys, a very high proportion of mail-out surveys for Garland were sent within 3 miles of the lot (Appendix B). For North Central, the primary mailing area extended a much greater distance from the lot.

The modal split values, particularly for the Garland lots, are surprisingly high; over 21% of the trips to downtown Dallas that originate in the market area of the Garland park-and-ride lots are being served by that park-and-ride service without provision of any priority treatment measures. Without considerable additional evaluation, the modal split differences between Dallas North Central and the Garland lots are difficult to accurately explain. However, the following differences do exist which make it seem reasonable that Garland would have a higher modal split.

- Garland has two lots which offer a better areawide coverage.
- Access to the Garland lots is much superior to the current access to the Dallas North Central lot.
- The Garland lots are located a greater distance from downtown Dallas, and those lots also have midday bus service.
- The survey procedure influences the results. A higher percentage of total home mail-outs in the Garland area were sent within 3 miles of the lot (refer to Appendix B).

More detailed evaluation of this information will be pursued as part of future project work. However, the data indicate that, with no provision of priority treatment, park-and-ride operations can serve 8% to 21% of the trips to the downtown that originate within the market area of the park-and-ride operation.

General Attitudes

Both surveys asked certain questions designed to identify attitudes concerning the existing service as well as transit improvements in general. The responses to those questions provide certain insights regarding the public's perception of mass transportation services.

Satisfaction with Existing Service, Attitudes Regarding Fare

Questions were asked concerning satisfaction with the service provided (user survey) and attitudes pertaining to the fare levels (user and non-user surveys). These responses are shown in Table 9. The results indicate that, for those using the park-and-ride service, a high-level of satisfaction with the service exists. However, this is not too surprising since, if one were highly unsatisfied with the service, that individual would probably not be using park-and-ride. Nevertheless, modal splits in excess of 21% are being attained in Garland, representing a substantial number of satisfied users.

Table 9: Satisfaction With Service Provided and Fares, User and Non-User Surveys, Percentage

Service/Fare Choices	User Survey	Non-User Survey
Satisfaction With Overall Park-and-Ride Service	(n=410)	
Very Satisfactory	15%	-
Satisfactory	46	-
Neutral	10	-
Unsatisfactory	21	-
Very Unsatisfactory	8	-
Total	100%	-
Which Fare/Service Option Would You Prefer	(n=407)	(n=168)
A Lower Fare With Less Frequent Service	8%	17%
The Same Fare as Now With the Same Service	76	41
A Higher Fare With More Frequent Service	16	42
Total	100%	100%

Present fare/service relationships appear to be attractive to users. A strong preference for more frequent service, accompanied by higher fares, was expressed by the non-user group.

Thus, park-and-ride operations can serve large volumes of users and serve those users in a manner generally satisfactory to the user.

Non-User Survey

A series of attitudinal and extent of general knowledge questions were posed in the non-user survey; these were designed primarily to identify non-user attitudes toward mass transportation in general as well as the possible willingness of those individuals to choose to ride transit (Table 10). Most of the responses were neutral or positive (i.e., an average response of approximately 3.0 or higher). However, to some extent the fact that non-users are not expressing negative attitudes concerning transit might be viewed as encouraging to transit operators and planners.

Table 10: General Attitudes of Non-Users Concerning Mass Transportation and Personal Use of Mass Transportation (n=197)

Statement Relating to Transportation	Rating[1]
I'll always dislike the idea of riding buses no matter how much the service is improved	2.57
Traveling by bus is so much more relaxing than driving	3.40
More tax money should be spent on improving mass transit for the North Central Expressway	3.93
Bus riding will be more attractive as auto congestion and gasoline and parking costs increase	4.33

[1]The statements were rated on a scale of 1 to 5, a 1 meaning strongly disagree and a 5 meaning strongly agree.

There have been several recent indicators in the state that the citizenry of the major urban areas is interested in the development of viable transit systems. The information in Table 10 does not dispute that conclusion.

From a marketing standpoint, it is desirable to ascertain whether the non-users know enough about the service provided to use it if they choose to do so. Three questions addressed that issue (Table 11).

Table 11: Knowledge of Non-Users Concerning the Available Park-and-Ride Service, Percentage

Question	Response		
	Yes	No	Not sure
Have you ever used a park-and-ride service? (n=207)	35%	65%	-
Do you know enough about the park-and-ride service currently being provided along the North Central Expressway to confidently begin using it tomorrow? (n=200)	42	48	10
Do you know the location of the park-and-ride lot nearest your home? (n=203)	80	17	3

The responses suggest that non-users do not have a high level of knowledge concerning the service available. If efforts are to be made to gain additional ridership from the non-user group, some marketing efforts might be appropriate. Less than 45% of non-users feel they know enough about the park-and-ride service to begin to confidently use that service. However, the fact that 35% of the non-users have at some time used park-and-ride suggests that a significant portion of that group was not satisfied with the service offered by park-and-ride.

Important Park-and-Ride Service Features

A primary intent of this research effort was to: 1) identify those features of the existing service that were most important to users in deciding to use the park-and-ride service; and 2) identify the additional features that would need to be added to the existing service to attract the greatest number of existing non-users to become park-and-ride patrons. This section of the report documents that phase of the research study.

User Survey

Questions were posed in two separate areas. The first area considered whether users saved time and/or money by using park-and-ride. The second area identified the features of the present park-and-ride service that were perceived to be the most important by the users.

Time/Money Savings

Park-and-ride users were asked two questions: "Do you save time using the park-and-ride service rather than driving?" and "Do you save money using the park-and-ride service rather than driving?" Follow-up questions inquired as to the extent of time/money savings. These data are plotted in Figures 6 and 7. Over 70% of the repondents (n=325) said they lost time by using park-and-ride, while over 90% of the respondents (n=290) claimed to save money by using park- and-ride.

These data indicate that, for current users, money savings are a very important reason for using park-and-ride, and that those individuals will accept a time penalty in order to gain a financial savings. Median values shown in Figures 6 and 7 suggest that a "typical" park-and-ride patron spends 15 additional minutes to make a one-way trip in order to save $25 per month (or about $0.60 per one-way trip).

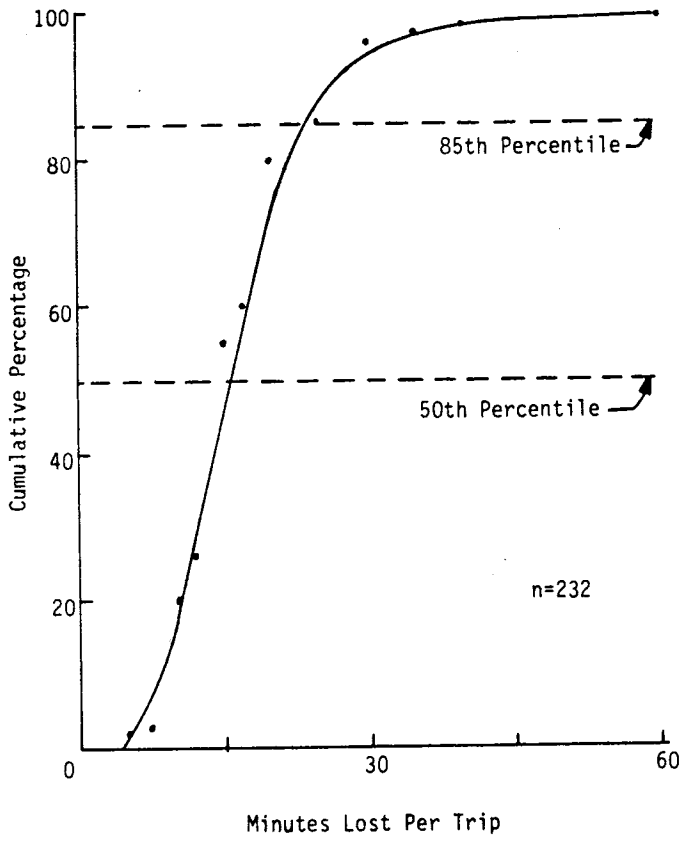
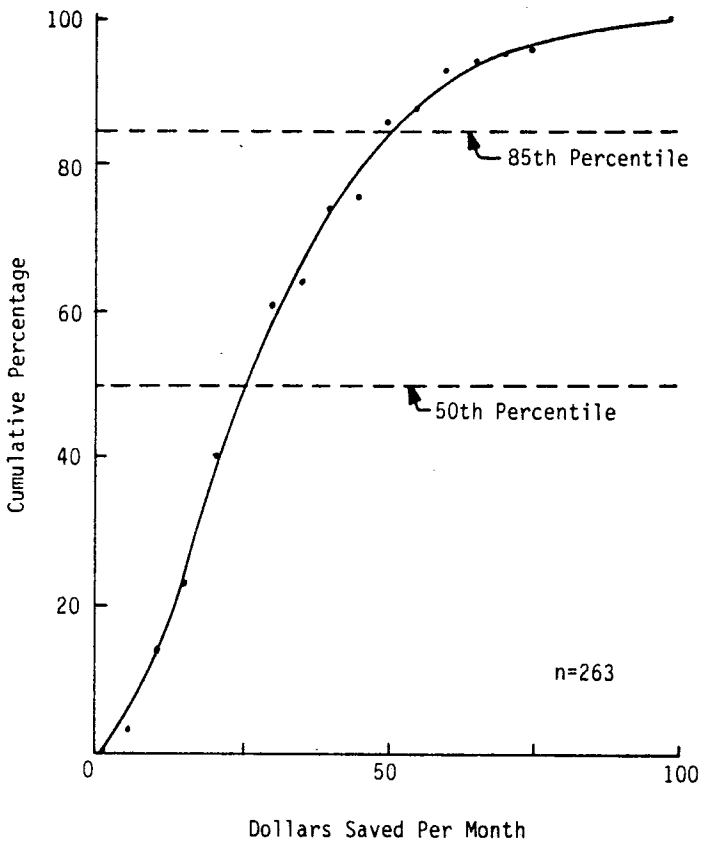


Figure 6: Cumulative Frequency Distribution, Time Lost Per One-Way Trip Using Park-and-Ride

This indicates several things. A high downtown parking cost must exist in order to generate the needed money savings; of course, the presence of a high CBD parking cost has implications concerning the intensity of downtown development, city size, and traffic congestion. It might also be expected that employer subsidies of downtown parking costs are a significant deterrent to utilization of park-and-ride, especially if corresponding subsidies of transit fares are not offered by the employer. In any event, travel time is not the important concern to current users of the park-and-ride service.



Note: Dollars saved per month divided by 44 yields approximate savings per one-way trip.

Figure 7: Cumulative Frequency Distribution, Dollars Saved Per Month by Using Park-and-Ride

Important/Unimportant Features of Park-and-Ride

Little is known concerning cost-effective approaches to laying out and operating park-and-ride service. Recognizing that funding is limited and that not all features can be incorporated into all park-and-ride operations, this study attempted to identify those features of the existing service that were most important to the users in their decision to use the park-and-ride service. In essence, an attempt was made to document those features of park-and-ride that should be emphasized in the planning and operation and, similarly,

identify those features that can be de-emphasized in park-and-ride planning and operation.

The survey included the following statement. "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." Following that statement, 19 park-and-ride features were listed; the user rated each feature on a scale of 1 (not important) to 5 (very important). These survey results are summarized in Table 12.

Table 12: Relative Importance of Various Park-and-Ride Features to Users of the Park-and-Ride Service (n is between 400 and 416)

Feature	Overall Rating[1]	Significance Level[2]
Riding in a safe bus	4.66	Most Significant
Frequent bus service during peak periods	4.52	
A reliable bus schedule	4.49	
The rising cost of gasoline and automobile maintenance	4.36	
Having a park-and-ride lot close to your home	4.35	
Convenient access to the park-and-ride lot	4.35	
Having non-stop bus service to your destination downtown	4.32	Intermediate Significance
Always having a seat on the bus	4.30	
Not having to drive in traffic congestion	4.30	
The rising cost of downtown parking	4.27	
Security at the park-and-ride lot	4.24	
A bus stop close to your place of work	4.18	
Avoiding the stress associated with driving to and from work	4.06	
Having a terminal to wait in at the park-and-ride lot	3.84	Least Significant
Being able to park close to the bus loading point	3.80	
Bus service being available during off-peak periods	3.43	
A bench/shelter at each bus stop downtown	2.91	
The bus travel time relative to auto travel time	2.89	
Riding in a new, modern bus	2.85	

[1]Each feature was rated on a scale of 1 (not important) to 5 (very important).
[2]To assess statistically significant differences in the responses, a Duncan's multiple range test for variable rank was performed to identify significantly different means. The responses fell into the three general significance levels shown in the table.

Table 12 should provide some guidance in developing more cost-effective park-and-ride facilities. It is of interest to note that 5 of the 6 most significant features are controlled by the transit planner and operator. An open ended question, "How could park-and-ride be best improved for you?," lent confirmation to the information shown in Table 12. Of all the responses to that question, frequent and reliable peak period bus service was listed four times more often than any other response.

Thus, to best serve the present users, frequent and reliable bus service should be emphasized. The responses also suggest that, if the choice exists, provision of several 400-car lots may be superior to provision of a single 1200-car lot (refer to Research Report 205-3 for other considerations involved in sizing park-and-ride lots) since lot location relative to home is an important concern.

It is also of interest to note some of the features perceived as being least important by the users. Several of those features -- such as off-peak period bus service, operation of new buses, and provision of downtown bus shelters -- are expensive to provide and have often been thought to be important. The Dallas and Garland survey data suggest that it might be more cost-effective to spend available dollars on other aspects of the park-and-ride service.

Non-User Survey

Data presented previously show that existing park-and-ride service is accommodating between 8% and 21% of the trips to the downtown; thus, non-users represent the overwhelming majority of the total market. However, those individuals who need to have their autos available to them during the work day are not primary candidates for using park-and-ride service. The data obtained in this survey indicate that approximarely 48% of the non-users at least feel

that they need a car available during the day (Table 13). As a result, the responses to the non-user survey are presented in the following three groupings: total sample; workday auto availability not required, and; workday auto availability required.

Table 13: Need for an Auto for Work Purposes During the Workday

Park & Ride Lot	Total Household Surveys Returned[1]	Households With at Least One Member Employed in Downtown Dallas[2]	Households With at Least One Member Using Park-and-Ride to Downtown Dallas[3]	Persons Who Work in Downtown Dallas and Need Car During Day[4]
Garland North and Garland South	1,146 (63.3%)	132 (11.5%)	28 (21.2%)	39 (37.5%)
Dallas North Central	573 (64.8%)	118 (20.6%)	9 (7.7%)	63 (57.7%)
Total	1,719 (63.8%)	250 (14.5%)	37 (14.8%)	102 (47.8%)

[1]Percentage value is the return rate for the entire survey.
[2]Percentage value is the percent of returned surveys that indicated at least one household member working in downtown Dallas.
[3]Percentage value is the percent of households with a member employed in the Dallas CBD that are already using park-and-ride service.
[4]The percentage shown is the percent of persons who work in Dallas and do not use park-and-ride who need their car during the day.

If the park-and-ride service is already accommodating 21% of demand (value for Garland lots), of the 79% non-users, half of those need an auto during the day which makes them relatively poor candidates to be attracted to park-and-ride service; thus, approximately 37% of the total downtown work

force (50% of the non-users) appears to represent the best potential market for park-and-ride.

Important/Unimportant Features of Park-and-Ride

Current park-and-ride service has not attracted the non-user group. The question exists as to what additional features could be added to the current park-and-ride service to cause non-users to choose to become users of the service. This was a major issue addressed in the non-user survey.

The following statement was made on the non-user survey: "The following is a list of possible improvements which could be made to the existing park-and-ride service. Please answer by circling the number which best explains how likely you would be to use park-and-ride if the following improvements were made." A list of 29 possible improvements was provided; each improvement was rated on a scale of 1 (very unlikely) to 5 (very likely). The results are summarized in Table 14.

Of the most significant responses shown in Table 14, the issue of paying to park at the lot is not relevant to most Texas park-and-ride operations since such a fee is not currently assessed. The data suggest that a "free-parking" policy should be pursued. Gasoline price and availability, while not controlled by the transit operator and planner, will no doubt continue to make transit a more attractive alternative and, perhaps, make transit fares less of an issue.

The responses suggest that provision of priority treatment is an action that the planner/operator can undertake which will, perhaps, attract the greatest number of non-users to the park-and-ride system; two of the top seven responses would be addressed by such an action. Priority measures are designed to reduce bus travel time, and it is apparent that the non-user group places a higher value on time than does the user group.

Table 14: Relative Importance of Various Improvements to Park-and-Ride Service In Generating Additional Ridership

Potential Improvement	Rating			
	Non-Users Not Needing Auto[1]	Total Non-User Sample[2]	Non-Users Needing Auto[3]	Significance Level[4]
If you did not have to pay a fee to park your car at the lot	4.19	3.53	3.10	Most Significant
If the bus trip took less time than an automoblie trip	4.00	3.68	3.29	
If the bus fare were lower	3.98	3.48	2.92	
If gasoline availability were to decrease	3.87	3.66	3.40	
If the buses stopped closer to your place of work downtown	3.83	3.45	3.03	
If the cost of gasoline were to increase	3.81	3.45	3.01	
If there were special highway treatment for buses to reduce travel time	3.80	3.48	3.07	
If the park-and-ride bus service was operated all day long	3.69	3.37	3.00	
If there was always a seat available	3.67	3.29	2.90	Intermediate Significance
If there was better security at the park-and-ride lot	3.59	3.27	2.89	
If there were bus shelters at the park-and-ride stop downtown	3.56	3.27	2.93	
If there were change making machines available for fare payment	3.56	3.23	2.89	
If waiting for the bus was safer	3.56	3.21	2.83	
If a comfortable temperature was maintained inside the buses	3.49	3.14	2.76	
If you did not have to wait more than 2 minutes for a bus during peak periods	3.47	3.19	2.86	
If the buses always arrived and departed at the scheduled time	3.35	3.06	2.66	
If auto access to and from the park-and-ride lot was more convenient	3.28	3.11	2.89	
If there were telephones at the waiting area	3.23	2.99	2.71	
If you could park your car closer to the bus loading point at the lot	3.22	3.01	2.77	
If there was more leg room, wider aisles, and more comfortable seats	3.21	2.95	2.70	
If the buses were newer and more modern	3.17	2.97	2.73	
If traffic congestion on the North Central Expressway became worse	3.16	2.97	2.71	
If the buses were safer to ride on than they are now	3.02	2.84	2.62	
If the park-and-ride lot was more visible from the roadway	2.96	2.71	2.42	Least Significant
If you had a better understanding of how the service is operated	2.74	2.65	2.47	
If free newspapers/magazines were provided	2.71	2.61	2.50	
If free refreshments were provided	2.69	2.54	2.39	
If everyone on the bus had similar backgrounds	2.66	2.50	2.33	
If the trip did not require sitting next to strangers	2.58	2.44	2.28	

[1]These are the individuals who work downtown, do not use park-and-ride, and do not need an auto available during the workday.
[2]This column represents the total response to the home mail-out survey by people who do not use park-and-ride.
[3]These are the individuals who work downtown, do not use park-and-ride, but do need an auto available during the workday.
[4]To test statistically significant differences in the responses, a Duncan's multiple range test for variable rank was performed to identify significantly different means. The responses fell into the general significance levels shown in the table.

As was expressed in the user survey, it appears that existing buses are acceptable for park-and-ride service. Provision of newer buses, wider seats, more legroom, free newspapers and/or refreshments were all rated low as a means of attracting new park-and-ride patronage.

MAJOR FINDINGS

The park-and-ride surveys performed in Dallas and Garland provide insights into more cost-effective approaches for planning and operating park-and-ride facilities. The existing service being provided in Dallas and Garland, which consists of three park-and-ride lots (two in Garland and one in Dallas) being served by a stable, reliable bus operation with no priority treatment for buses, is able to attract between 8% and 21% of the eligible market. Of the non-users, approximately 50% feel that they need a car available to them during the workday, making them relatively poor candidates to be attracted to park-and-ride.

Importance of Various Park-and-Ride Features

A primary intent of the surveys was to: 1) identify those features of the existing park-and-ride service that were most important to users in deciding to use that service; and 2) identify the additional features that would need to be added to the existing service to attact the greatest number of current non-users to choose to become park-and-ride patrons. The relative importance of certain features to each of the survey groups is discussed in this section.

Priority Treatment, Time/Money Savings

A primary reason that current users have chosen to use the system is that a money savings results; over 90% of current users claim to save money by using park-and-ride, while over 70% of the respondents claimed to lose time by using park-and-ride; a typical one-way trip was envisioned to save 60¢ by paying a 15-minute time penalty. A high downtown parking cost is necessary to

generate these savings, but it is apparent that existing users value money savings more highly than time penalties.

Such does not appear to be the case for non-users. In fact, provision of priority treatment for buses to bring about travel time savings appears to be the single most effective action that can be taken to generate additional park-and-ride patronage. This emphasizes a continued need to evaluate the potential for priority treatment along congested roadways in Texas.

Bus Service

Safe, frequent, and reliable peak period bus service are the most important features of the park-and-ride service to current users of that service. Non-stop bus service from the park-and-ride lot to downtown was also felt to be important, as was having a seat available on the bus. Off-peak period bus service was considered to be unimportant.

Off-peak bus service was rated somewhat higher as a means of attracting non-users (rated 8th out of 29). Frequency and reliability of service were considered to be less important to this group (rated 15th and 16th). However, bus travel time relative to auto travel time was rated as one of the most important potential improvements in generating new park-and-ride utilization. Having a seat available was viewed as being reasonably important.

Bus Equipment

In several instances in Texas, new equipment has been procured to serve park-and-ride operations. However, both users and non-users rated new, modern buses as being unimportant (rated 19th out of 19 in the user survey and 21st out of 29 in the non-user survey). As a means of attracting additional users,

the non-users viewed potential improvements such as more comfortable seats, more legroom, free newspapers, magazines, and/or refreshments as being unimportant.

Park-and-Ride Lot

The users rated having a park-and-ride lot close to home and having convenient access to that park-and-ride lot as being very important in their decision to use the service. Security at the lot was viewed as fairly important. Having a terminal in which to wait and being able to park close to the bus loading area were considered relatively unimportant.

Free parking at the lot was felt to be important by non-users as was lot security (rated 1st and 10th out of 29). Availability of change making machines, good auto access to the lot, and safety while waiting for the bus were ranked 12th, 17th, and 13th, respectively, by the non-users. Being able to park the car close to the bus loading point, having telephones in the waiting areas, and visibility of the park-and-ride lot were considered to be relatively unimportant attributes in terms of generating additional patronage.

Downtown Park-and-Ride Bus Stops

In making the decision to use park-and-ride, the proximity of the bus stop to the place of employment and having a bench/shelter available at the downtown stop were not rated highly by users (12th and 17th out of 19). However, the non-users rated each of these considerations relatively highly (5th and 11th out of 29) as being an effective means of generating additional ridership.

Gasoline Price and Availability

Although this is a consideration over which the transit planner/operator has no control, it is apparently a major stimulus for generating park-and-ride usage. The user survey rated the rising cost of gasoline and auto maintenance as the fourth most important reason for using park-and-ride.

The non-user survey suggests that gasoline price and availability will continue to develop park-and-ride patronage. A decrease in gasoline availability was rated as the fourth highest occurrence that could cause non-users to choose to ride park-and-ride; the cost of gasoline was given the sixth highest rating.

Passenger Characteristics

It has been hypothesized that some park-and-ride operations have not been successful because the lots have been located in areas that attracted ridership from different socioeconomic groups; the unwillingness of people to ride in a bus with members of other socioeconomic groups was cited as a possible reason for unexpectedly low patronage. The Dallas and Garland survey results do not confirm this, however. Everyone on the bus having similar backgrounds, and not having to sit next to strangers were rated as the least important considerations in a decision to use park-and-ride.

Marketing

Many of the non-users (35%) have already used park-and-ride. A large majority of those individuals (80%) know the location of the park-and-ride lot closest to their home, and over 40% of the non-users feel they know enough about the available park-and-ride service to begin to confidently use that service. Furthermore, of 29 possible improvements to park-and-ride that were rated by the non-users as to their importance in generating new patronage,

providing a better understanding of how the service is operated was ranked 25th.

Thus, it would appear that marketing, by itself, would not be a means of generating significant new ridership. Rather, any marketing effort might better be employed to complement implementation of some other improvement, such as priority treatment, to the park-and-ride service.

Operational and Planning Guidelines

The surveys suggest that park-and-ride can serve two groups. The first group chooses to use park-and-ride because it saves them money; this group will pay a time penalty in order to realize dollar savings. Obviously, a high downtown parking cost is necessary to generate the potential money savings. The data from the surveys indicate that, by catering the service to this group, modal splits of between 8% and 21% can be obtained. In orienting the service to this group, frequent and reliable peak-period bus service is, perhaps, the most important feature. Park-and-ride lots in close proximity to the residential trip end and with good access are also important.

To attract non-users to the system, the most important improvements appear to be those that will generate travel time savings; this group is apparently much more time sensitive than are the current users of park-and-ride service. This confirms that priority treatment can be expected to have an impact on modal split.

Both users and non-users indicate that gasoline price and availability are significant factors in decisions to use transit. Thus, future increases in gasoline prices and uncertainty as to availability should serve as major factors in generating transit patronage.

REFERENCES

1. University of Illinois. Park and Ride Planning Manual. Prepared for U.S. Department of Transportation, Office of University Research, November 1977.

2. Liou, Peter S. Comparative Demand Estimation Models for Peripheral Park-and-Ride Service. Planning Research Unit, New York State Department of Transportation, September 1974.

APPENDICES

- Appendix A - Survey Instruments
- Appendix B - Survey Procedure

APPENDIX A

SURVEY INSTRUMENTS

Survey instruments were used for both the on-board and the home mail-out surveys. Due to slight differences in the services offered in Dallas and Garland (e.g., fare, parking cost, midday service, methods for paying fare), the survey instruments, although similar, were not identical for the surveys.

Four survey instruments are presented in this Appendix. They are presented in the following order.

- User Survey, Dallas North Central Lot
- User Survey, Garland Lots
- Non-User Survey, Dallas North Central Area
- Non-User Survey, Garland Area

(DALLAS)

Park & Ride User Survey

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

1. **Before you began using the Park & Ride service, how did you normally make this trip?**

   ____Drove self ____Regular route bus ____Other

   ____Carpool/vanpool ____Did not make trip

2. **How long have you used the Park & Ride service?** _____

3. **How did you arrive at the Park & Ride lot this morning?**

   ____Drove alone ____Dropped off by someone ____Bicycle

   ____Rode with someone who also uses Park & Ride ____Motorcycle ____Other

4. **For the Park & Ride service, which would you prefer?**

   ____A lower fare with less frequent bus service

   ____The same fare as now with the same bus service

   ____A higher fare with more frequent bus service

5. **What is the highest <u>one-way</u> daily bus fare you would pay to make this trip?**

   _____

6. **How did you pay your fare today?**

   ____Cash ____Monthly pass ____Commuter card

7. **If a pass/card was used today, how was it acquired?**

   ____Purchased from a DTS card outlet ____Purchased through my employer

8. **Do you save time using the Park & Ride service rather than driving?**

   ____Yes / If "yes," how many minutes do you save one-way? _____minutes

   ____No / If "no," how many minutes do you lose one-way? _____minutes

9. **Do you save money using the Park & Ride service rather than driving?**

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

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

10. **A number of different factors can be important in causing people to use the Park & 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 & Ride.**

In your decision to use Park & Ride, how important is . . .	**Not important**		**Neutral**		**Very important**
Not having to drive in heavy traffic congestion	1	2	3	4	5
The rising cost of gasoline and automobile maintenance	1	2	3	4	5
The rising cost of parking downtown	1	2	3	4	5
Avoiding the stress associated with driving to and from work	1	2	3	4	5

(over)

(DALLAS)

	Not Important			Neutral	Very Important
The bus travel time relative to auto travel time	1	2	3	4	5
A reliable bus schedule	1	2	3	4	5
Having non-stop bus service to your destination downtown	1	2	3	4	5
Frequent bus service during peak periods	1	2	3	4	5
Bus service being available during off-peak periods	1	2	3	4	5
A bus stop close to your place of work downtown	1	2	3	4	5
A bench/shelter at each bus stop downtown	1	2	3	4	5
Riding in a new, modern bus	1	2	3	4	5
Riding in a safe bus	1	2	3	4	5
Always having a seat on the bus	1	2	3	4	5
Having a Park & Ride lot close to your home	1	2	3	4	5
Convenient access to the Park & Ride lot	1	2	3	4	5
Security at the Park & Ride lot	1	2	3	4	5
Having a terminal to wait in at the Park & Ride lot	1	2	3	4	5
Being able to park your car close to the bus loading point	1	2	3	4	5

11. **How would you rate your satisfaction with the Park & Ride service overall?**

____Very satisfactory ____Neutral ____Unsatisfactory

____Satisfactory ____Very unsatisfactory

12. **How could Park & Ride be best improved for you?** _____

_____

_____

_____

13. **What is your age?** _____ 14. **What is your sex?** ____Male ____Female

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

_____

16. **What is is the last year of school you completed?** _____

17. **In what city do you live?** _____

18. **What is the street intersection nearest to your home?**

_____

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

THANK YOU FOR YOUR COOPERATION.

(GARLAND)

Park & Ride User Survey

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

1. **Before you began using the Park & Ride service, how did you normally make this trip?**

   ____Drove self ____Regular route bus ____Other
   ____Carpool/vanpool ____Did not make trip

2. **How long have you used the Park & Ride service?** _____

3. **How did you arrive at the Park & Ride lot this morning?**

   ____Drove alone ____Dropped off by someone ____Bicycle
   ____Rode with someone who also uses Park & Ride ____Motorcycle ____Other

4. **For the Park & Ride service, which would you prefer?**

   ____A lower fare with less frequent bus service
   ____The same fare as now with the same bus service
   ____A higher fare with more frequent bus service

5. **What is the highest <u>one-way</u> daily bus fare you would pay to make this trip?**

   _____

6. **How did you pay your fare today?** ____Cash ____Commuter card

7. **If a commuter card was used today, how was it acquired?**

   ____Purchased from a DTS card outlet ____Purchased through my employer

8. **Do you save time using the Park & Ride service rather than driving?**

   ____Yes / If "yes," how many minutes do you save one-way? _____minutes
   ____No / If "no," how many minutes do you lose one-way? _____minutes

9. **Do you save money using the Park & Ride service rather than driving?**

   ____Yes / If "yes," how much do you save? $_____per month
   ____No / If "no," how much do you lose? $_____per month

10. **A number of different factors can be important in causing people to use the Park & 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 & Ride.**

In your decision to use Park & Ride, how important is . . .	**Not Important**		**Neutral**		**Very Important**
Not having to drive in heavy traffic congestion	1	2	3	4	5
The rising cost of gasoline and automobile maintenance	1	2	3	4	5
The rising cost of parking downtown	1	2	3	4	5
Avoiding the stress associated with driving to and from work	1	2	3	4	5

(over)

(GARLAND)

	Not Important		Neutral		Very Important
The bus travel time relative to auto travel time	1	2	3	4	5
A reliable bus schedule	1	2	3	4	5
Having non-stop bus service to your destination downtown	1	2	3	4	5
Frequent bus service during peak periods	1	2	3	4	5
Bus service being available during off-peak periods	1	2	3	4	5
A bus stop close to your place of work downtown	1	2	3	4	5
A bench/shelter at each bus stop downtown	1	2	3	4	5
Riding in a new, modern bus	1	2	3	4	5
Riding in a safe bus	1	2	3	4	5
Always having a seat on the bus	1	2	3	4	5
Having a Park & Ride lot close to your home	1	2	3	4	5
Convenient access to the Park & Ride lot	1	2	3	4	5
Security at the Park & Ride lot	1	2	3	4	5
Having a terminal to wait in at the Park & Ride lot	1	2	3	4	5
Being able to park your car close to the bus loading point	1	2	3	4	5

11. **How would you rate your satisfaction with the Park & Ride service overall?**

____Very satisfactory ____Neutral ____Unsatisfactory

____Satisfactory ____Very unsatisfactory

12. **How could Park & Ride be best improved for you?** _____

_____

_____

_____

13. **What is your age?** _____ 14. **What is your sex?** ____Male ____Female

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

_____

16. **What is is the last year of school you completed?** _____

17. **In what city do you live?** _____

18. **What is the street intersection nearest to your home?**

_____

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

THANK YOU FOR YOUR COOPERATION.

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
AUSTIN, TEXAS 78763

Cooperating Agencies:
Dallas Transit System
City of Dallas
City of Garland
North Central Texas Council of Governments
Federal Highway Administration

March 18, 1980

IN REPLY REFER TO FILE NO

PUBLIC TRANSPORTATION SURVEY

Dear Resident:

During the last few months 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. The purpose of this survey is to obtain information about your household's use of the North Central Expressway for work trips to downtown Dallas.

Since we have included only a small number of households in this survey, your participation is essential to insure the success of the project. If you have already completed the survey, we wish to thank you for your cooperation in this undertaking. If you did not respond previously, it will be appreciated if you will answer the following question:

DO YOU OR ANY OTHER HOUSEHOLD MEMBERS WORK IN DOWNTOWN DALLAS? ___Yes ___No

If "NO", please return this letter and the attached survey in the enclosed stamped envelope.

If "YES", please give the attached survey form to a household member who works in downtown Dallas for his or her completion.

We are grateful for your participation in the survey. Please complete the requested information as best you can and return it to us in the stamped envelope within one week.

Sincerely,

Phillip L. Wilson
State Planning Engineer, Transportation

PLW/bh
Enclosure

(DALLAS)

Park & Ride Household Survey

Undertaken by the Texas Transportation Institute, Texas A&M University 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 to the questions will remain confidential. Please return this form in the stamped envelope within one week.

1. How do you normally get to work downtown?

____Drive alone ____Park & Ride bus ____Other

____Carpool/vanpool ____Regular route bus

2. Have you ever used a Park & Ride service? ____Yes ____No

3. Do you know enough about the Park & Ride service currently being provided along the North Central Expessway to confidently begin using it tomorrow?

____Yes ____No ____Not sure

4. Do you know the location of the Park & Ride lot nearest your home?

____Yes ____No ____Not sure

5. The following is a list of possible improvements which could be made to the existing Park & Ride service. Please answer by circling the number which best explains how likely you would be to use Park & Ride if the following improvements were made.

How likely would you be to use Park & Ride . . .	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 always arrived and departed at the scheduled time	1	2	3	4	5
If you did not have to wait more than 2 minutes for a bus during peak periods	1	2	3	4	5
If the buses were safer to ride on than they are now	1	2	3	4	5
If there was special highway treatment for buses to reduce travel time (e.g., exclusive bus lane)	1	2	3	4	5
If the buses stopped closer to your place of work downtown	1	2	3	4	5
If traffic congestion on the North Central Expressway became worse . . .	1	2	3	4	5
If gasoline availability were to decrease	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 everyone on the bus had similar backgrounds	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 there was more leg room, wider aisles, and more comfortable seats . .	1	2	3	4	5
If a comfortable temperature was maintained inside the buses	1	2	3	4	5
If free newspapers/magazines were provided	1	2	3	4	5
If free refreshments were provided	1	2	3	4	5

(DALLAS)

	Very Unlikely		No Difference		Very Likely
If the Park & Ride lot was more visible from the roadway	1	2	3	4	5
If auto access to and from the Park & Ride lot was more convenient	1	2	3	4	5
If the Park & Ride bus service was operated all day long	1	2	3	4	5
If you did not have to pay a fee to park your car at the lot	1	2	3	4	5
If you could park your car closer to the bus loading point at the lot	1	2	3	4	5
If there was better security at the Park & Ride lot	1	2	3	4	5
If there were change-making machines available for fare payment	1	2	3	4	5
If there were telephones at the waiting areas	1	2	3	4	5
If waiting for the bus was safer	1	2	3	4	5
If there were bus shelters with seats at the Park & Ride stops downtown	1	2	3	4	5

6. **Below are four 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 for the North Central Expressway	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

7. **For the Park & Ride bus service, which would you prefer?** (Check one)

____A lower fare with less frequent bus service

____The same fare as now ($1.00 one-way) with the same bus service

____A higher fare with more frequent bus service

8. **How often do you ride a regular route bus?**

____Almost every day ____About once a week ____Seldom

9. **Does your work require that you have a car available during the day?** ____Yes ____No

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

_____

11. **What is the last year of school you completed?** _____

12. **What is your age?** _____ 13. **What is your sex?** ____Male ____Female

14. **How many days per week do you work downtown?** _____

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

16. **How many persons of your household (excluding yourself) work downtown?** _____

THANK YOU FOR YOUR COOPERATION.

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
AUSTIN, TEXAS 78763

Cooperating Agencies:
Dallas Transit System
City of Dallas
City of Garland
North Central Texas
Council of Governments
Federal Highway Administration

March 18, 1980

IN REPLY REFER TO
FILE NO.

PUBLIC TRANSPORTATION SURVEY

Dear Resident:

During the last few months 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. The purpose of this survey is to obtain information about your household's use of the North Central Expressway for work trips to downtown Dallas.

Since we have included only a small number of households in this survey, your participation is essential to insure the success of the project. If you have already completed the survey, we wish to thank you for your cooperation in this undertaking. If you did not respond previously, it will be appreciated if you will answer the following question:

DO YOU OR ANY OTHER HOUSEHOLD MEMBERS WORK IN DOWNTOWN DALLAS? ___Yes ___No

If "NO", please return this letter and the attached survey in the enclosed stamped envelope.

If "YES", please give the attached survey form to a household member who works in downtown Dallas for his or her completion.

We are grateful for your participation in the survey. Please complete the requested information as best you can and return it to us in the stamped envelope within one week.

Sincerely,

Phillip L. Wilson
State Planning Engineer, Transportation

PLW/bh
Enclosure

(GARLAND)

Park & Ride Household Survey

Undertaken by the Texas Transportation Institute, Texas A&M University 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 to the questions will remain confidential. Please return this form in the stamped envelope within one week.

1. How do you normally get to work downtown?

____Drive alone ____Park & Ride bus ____Other

____Carpool/vanpool ____Regular route bus

2. Have you ever used a Park & Ride service? ____Yes ____No

3. Do you know enough about the Park & Ride service currently being provided along the North Central Expessway to confidently begin using it tomorrow?

____Yes ____No ____Not sure

4. Do you know the location of the Park & Ride lot nearest your home?

____Yes ____No ____Not sure

5. The following is a list of possible improvements which could be made to the existing Park & Ride service. Please answer by circling the number which best explains how likely you would be to use Park & Ride if the following improvements were made.

How likely would you be to use Park & Ride . . .	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 always arrived and departed at the scheduled time	1	2	3	4	5
If you did not have to wait more than 2 minutes for a bus during peak periods	1	2	3	4	5
If the buses were safer to ride on than they are now	1	2	3	4	5
If there was special highway treatment for buses to reduce travel time (e.g., exclusive bus lane)	1	2	3	4	5
If the buses stopped closer to your place of work downtown	1	2	3	4	5
If traffic congestion on the North Central Expressway became worse	1	2	3	4	5
If gasoline availability were to decrease	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 everyone on the bus had similar backgrounds	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 there was more leg room, wider aisles, and more comfortable seats	1	2	3	4	5
If a comfortable temperature was maintained inside the buses	1	2	3	4	5
If free newspapers/magazines were provided	1	2	3	4	5
If free refreshments were provided	1	2	3	4	5

	Very Unlikely		No Difference		Very Likely
If the Park & Ride lot was more visible from the roadway	1	2	3	4	5
If auto access to and from the Park & Ride lot was more convenient	1	2	3	4	5
If the Park & Ride bus service was operated all day long	1	2	3	4	5
If you could park your car closer to the bus loading point at the lot	1	2	3	4	5
If there was better security at the Park & Ride lot	1	2	3	4	5
If there were change-making machines available for fare payment	1	2	3	4	5
If there were telephones at the waiting areas	1	2	3	4	5
If waiting for the bus was safer	1	2	3	4	5
If there were bus shelters with seats at the Park & Ride stops downtown	1	2	3	4	5

6. **Below are four 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 for the North Central Expressway	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

7. **For the Park & Ride bus service, which would you prefer?** (Check one)

____A lower fare with less frequent bus service

____The same fare as now (95¢ one-way) with the same bus service

____A higher fare with more frequent bus service

8. **How often do you ride a regular route bus?**

____Almost every day ____About once a week ____Seldom

9. **Does your work require that you have a car available during the day?** ____Yes ____No

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

_____

11. **What is the last year of school you completed?** _____

12. **What is your age?** _____ 13. **What is your sex?** ____Male ____Female

14. **How many days per week do you work downtown?** _____

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

16. **How many persons of your household (excluding yourself) work downtown?** _____

THANK YOU FOR YOUR COOPERATION.

APPENDIX B

Most of the data presented in this report were obtained through two surveys performed in Dallas and Garland (a Dallas suburb). One survey was an on-board survey of park-and-ride users (user survey). The other was a home mail-out, designed to survey those persons who worked in downtown Dallas and could use park-and-ride but did not use the service, and is referred to in the report as the non-user survey. The sample design and procedures used in these two surveys are described in this appendix. The specific survey instruments used are included in Appendix A. The locations of the park-and-ride lots are shown in the main body of this report, Figure 1. Characteristics of those lots are presented in Table 1 in the main text.

On-Board Survey: Design and Procedures

The intent of this survey was to obtain user attitudes concerning the park-and-ride service. User characteristics were also obtained from the survey. The survey instruments used are included in Appendix A of this report.

Approaches for undertaking on-board surveys are presented in TTI Research Report 1052-4. Because a representative sample of patrons provides responses highly similar of those of the total ridership, a 30 percent sample of daily users was selected for the on-board survey. For the Dallas North Central lot, a total of 1089 one-way, or 545 two-way, passengers occur each day. Thus, 163 riders comprise a 30 percent sample. The two Garland lots average 800 two-way passengers daily; 245 patrons comprise a 30 percent sample. The number of surveys conducted at the two Garland lots are proportional to the number of bus departures at those lots and are not proportional to patronage at the lots (refer to Table 1). The actual number of surveys completed does not correspond

precisely to the 30 percent values since all riders on the buses surveyed completed survey instruments. The actual number of surveys completed, by lot, is summarized in Table B-1.

Table B-1: Number of On-Board Surveys Completed, By Park-and-Ride Lot

Park-and-Ride	Surveys Completed
Garland North	141
Garland South	77
Dallas North Central	205
Total User Survey	423

To obtain a reliable sample, buses for sampling were chosen at both peak and off-peak periods based on the proportion of total ridership carried by each vehicle. Table B-2 shows the schedule for the buses selected for surveying as part of this project. Color-coded surveys were provided at each of the Garland lots to differentiate patrons according to the location at which they boarded the bus. A small proportion of riders boarded between the two lots (from on-street stops) and were classified as North lot patrons. In all, surveys were performed on 17 scheduled bus trips; a 100 percent survey sample of riders was obtained for each bus surveyed.

Table B-2: Schedule of Buses Surveyed As Part of the User Survey

Garland Express (Inbound)			North Central Express (Inbound)	
	North Lot	South Lot		
Train 1[1]	6:00 a.m.	6:15 a.m.	Train 1	6:16 a.m.
	7:30	7:45		7:22
	9:20	-		
	11:10	-	Train 3	6:31
				7:33
Train 10	6:30	6:45		
			Train 7	6:46
Train 15	-	6:30		7:48
	7:40	7:55		

[1]Train refers to the runs made by specific vehicle

Confidence intervals for the on-board survey sample can be generated based on estimated responses to one item on the questionnaire. The single item, "Do you save time using the Park-and-Ride service rather than driving?" was selected for determining the potential confidence levels of the on-board sample. This item is shown with the following hypothetical results:

Response I. Yes	Response II. No
28%	72%

To estimate the standard error associated with this response, the following equation is used.

$$S = \sqrt{\frac{PQ}{n}}$$

where P, Q = the population parameters for the binomial. If 28 percent of those surveyed responded "yes" to the survey item described above and 72 percent said no, P and Q are 0.28 and 0.72 respectively.
n = the number of cases in the sample for each Park-and-Ride lot
S = The standard error, indicating the extent to which the sample estimates will be distributed around the population parameter.

Thus, based on the responses from the Dallas North Central lot (n=205), the standard error would be computed as shown below

$$S = \sqrt{\frac{0.28 \times 0.72}{205}} = 0.03136$$

Thus, using the appropriate statistical values, approximately 68 percent of all patrons will provide similar responses within one standard error (plus or minus 3.1 percent) of the 28 percent who answered "yes" in this example case. Ninety-five percent of the riders will furnish identical answers within two standard errors, or between 31.1 and 24.9 percent will respond "yes" to the survey item used in the example.

Because standard error is an inverse function of sample size, in many instances it is necessary to combine the responses for all three park-and-ride lots when evlauating the on-board surveys. Combining respondents for the hypothesized example, n = 423 (or 30 percent of the ridership from each lot). For respondents from all three Park-and-Ride lots:

$$S = \sqrt{\frac{PQ}{n}} = 0.02183$$

Based on this standard error, it is known that between 30 percent and 26 percent of those riders surveyed will respond "yes" to the example question 68 percent of the time. We are 95 percent confident that they will reply "yes" using the range of 32 percent and 24 percent (0.04366 plus or minus the 28 percent suggested above). In this manner, ridership samples from all three lots are combined for analysis, and generalizations are made for all patrons who utilize park-and-ride services at these three sites.

Home Mail-Out Survey: Design and Procedures

A home mail-out survey was undertaken. This survey was designed to collect information that could be used in the planning and operation of park-and-ride facilities. Table 2 in the main text documents the number of surveys mailed out and the return rate. An initial mail out and two "follow-ups" were used to obtain the return rate shown in that table.

In setting up the survey procedures, initially it is necessary to estimate the magnitude of non-users so that an appropriate sample size can be selected. Census data (1970) and Texas Transportation Institute analysis of those data were the primary sources of information.

Based on 1970 census data regarding the percent of the work force employed in the CBD in major metropolitan areas (Research Report 205-3), it is estimated that an average of 13 percent of the work force commutes to a downtown work

destination. Of those CBD employees who reside in the watershed or catchment area[1] surrounding existing Dallas Park-and-Ride lots, an estimated 10 percent actually make use of the service (TTI evaluation of park-and-ride lots for the I-45N contraflow in Houston). For the mail-out survey to residents in the watersheds surrounding the Park-and-Ride lots, it was estimated that one out of every eight households had at least one member having a CBD destination for work trips (estimated from census data). It should be noted that these initial estimates were generally substantiated by the home mail-out survey (refer to Tables 2 and 8 in the main text).

Consideration was given to performing home interviews. However, interviews with randomly selected households concerning park-and-ride usage would encompass approximately 87 percent of the households unable to use the service because of non-CBD work location. Thus, a more cost efficient approach was undertaken in the form of a mail-out questionnaire, using the Cole's Directory of the Dallas area to develop an address file. The Directory represents an address listing of all residents' names and addresses in Dallas County and contiguous portions of other counties defined as being in the Dallas trading area. Those addresses, with names of heads of households (obtained from telephone files), were included in the sample. In addition, reconnaissance of large apartment complexes was required to obtain specific names and apartment numbers for these multiple family dwellings.

Criteria For Sample Size

The watershed area had to be identified in order to select the sample for the home mail out. The size of the geographical area designated as the watershed area can vary according to many factors including:

[1]Park-and-ride lots generally have a rather well defined geographical area from which their ridership is drawn; this area is commonly referred to as the catchment or watershed area. Research Reports 205-2 and 205-3 provide a more detailed description of this watershed.

1. Population and population density;

2. Percentage of land use devoted to residential (this also can relate to population density);

3. Percentage of the work force employed in the Dallas CBD;

4. Quality of access to the park-and-ride lot;

5. Distance of the lot from the CBD and congestion on the roadways leading to the CBD;

6. Availability of other lots, regular bus routes, and other transportation options; and

7. Bus headways and other service features at the lot.

Several approaches could have been used to estimate this market area. Two of these, and the reasons for rejecting those two are briefly described below.

- The watershed could have been assumed to be typical of park-and-ride lots (Research Reports 205-2 and 205-3). However, known travel patterns to the lots were not necessarily typical. A higher percentage of total patronage at the Garland lots originates closer to the lots.

- The on-board survey could have been used to estimate the watershed. This approach was not compatible with the schedule of the project and, due to the availability of a third approach, was not pursued.

A third approach was used to estimate the watershed areas. The City of Garland, using license plate surveys, had already identified the origins of users of the Garland lots. The North Central Texas Council of Governments had identified a license plate sample at the Dallas North Central lot and had developed an estimate of that watershed. The geographical areas identified in those surveys were used as the watershed for the Dallas/Garland home mail-out survey.

Trade zones (which relate directly to census tracts) are used in providing the address listings in the Cole's Directory. Thus, the watersheds were defined based on trade zones or census tracts.

In estimating the number of surveys to mail to each trade zone in the watershed, the following general criteria were used.

- A percentage sample from all trade zones in concentric circles of two miles or less from the park-and-ride lot;
- A percentage sample from all trade zones (outside of the concentric zones) that were known to represent origins of current patrons;
- A percentage sample from all cities (outside of the concentric zones) that were known to represent origins of current patrons; and
- For the Garland lots (based on the license plate survey results), a percentage sample based on origins of not more than three miles from the lot. Based on the license plate survey at Dallas North Central, an eight mile radius was used for that lot.

The survey sample is termed a "disproportionate sample" based on probability to size (PPS) ratios. Tables B-3, B-4, and B-5 show the specific trade zones (or census tracts) sampled,and the number of surveys mailed to each trade zone for the Garland North Lot, the Garland South Lot, and the Dallas North Central lot. The location of the trade zones (census tracts) shown in Tables B-3 through B-5 are depicted in Figure B-1.

Table B-3: Sampling Procedure For Home Mail-Out Survey, Garland North Lot

Trade Area or Census Tract[1]	Population 1970	Percent of Total Mail-Out Sample	No. of Households Receiving Mail-Outs
181.01	5,624	19.0	181
182	12,170	11.5	110
183	7,842	4.3	40
186	4,305	10.4	99
187	4,982	13.1	125
188	5,244	16.4	156
189	3,810	12.6	122
190.02[2]	repeat[3]	0.9	8
190.05	14,626	5.2	50
190.06	216	4.2	40
190.07	895	2.4	23
Total	64,772	100%	n=954

[1]The location of these trade areas are shown in Figure B-1.
[2]Due to overlapping watersheds, some trade areas are located in the watershed of more than one park-and-ride lot.
[3]Included also in Dallas North Central sample.

Table B-4: Sampling Procedure For Home Mail-Out Survey, Garland South Lot

Trade Area or Census Tract[1]	Population 1970	Percent of Total Mail-Out Sample	No. of Households Receiving Mail-Outs
126	5,374	1.9	16
127	8,532	1.9	16
130.02	9,705	0.9	8
181.03	5,413	11.6	99
182[2]	repeat[3]	18.8	161
183[2]	repeat[3]	21.0	180
184	7,635	29.8	255
185.01	3,718	14.1	121
Total	60389	100%	n=856

[1]The location of these trade areas are shown in Figure B-1.
[2]Due to overlapping watersheds, some trade areas are located in the watershed of more than one park-and-ride lot.
[3]Included also in Dallas North Central sample.

Table B-5: Sampling Procedure For Home Mail-Out Survey, Dallas North Central Lot

Trade Area or Census Tract[1]	Population 1970	Percent of Total Mail-Out Sample	No. of Households Receiving Mail-Outs
78.01	894	0.9	8
78.02	6,633	0.9	8
78.03	7,107	1.1	10
131	7,755	0.9	8
132	2,217	4.5	40
136.02	7,639	5.4	48
136.03	11,272	6.3	56
190.02	4,085	6.3	56
190.03	553	6.7	59
191	6,106	9.6	85
192.01	4,718	6.6	58
192.02	5,058	7.7	68
192.03	5,713	6.7	58
192.04	6,482	6.5	57
192.05	3,065	5.4	48
192.06	6,241	5.4	48
192.07	9,555	6.4	57
Plano	-	12.7	112
Total	95,093	100%	884

[1]The location of these trade areas are shown in Figure B-1.

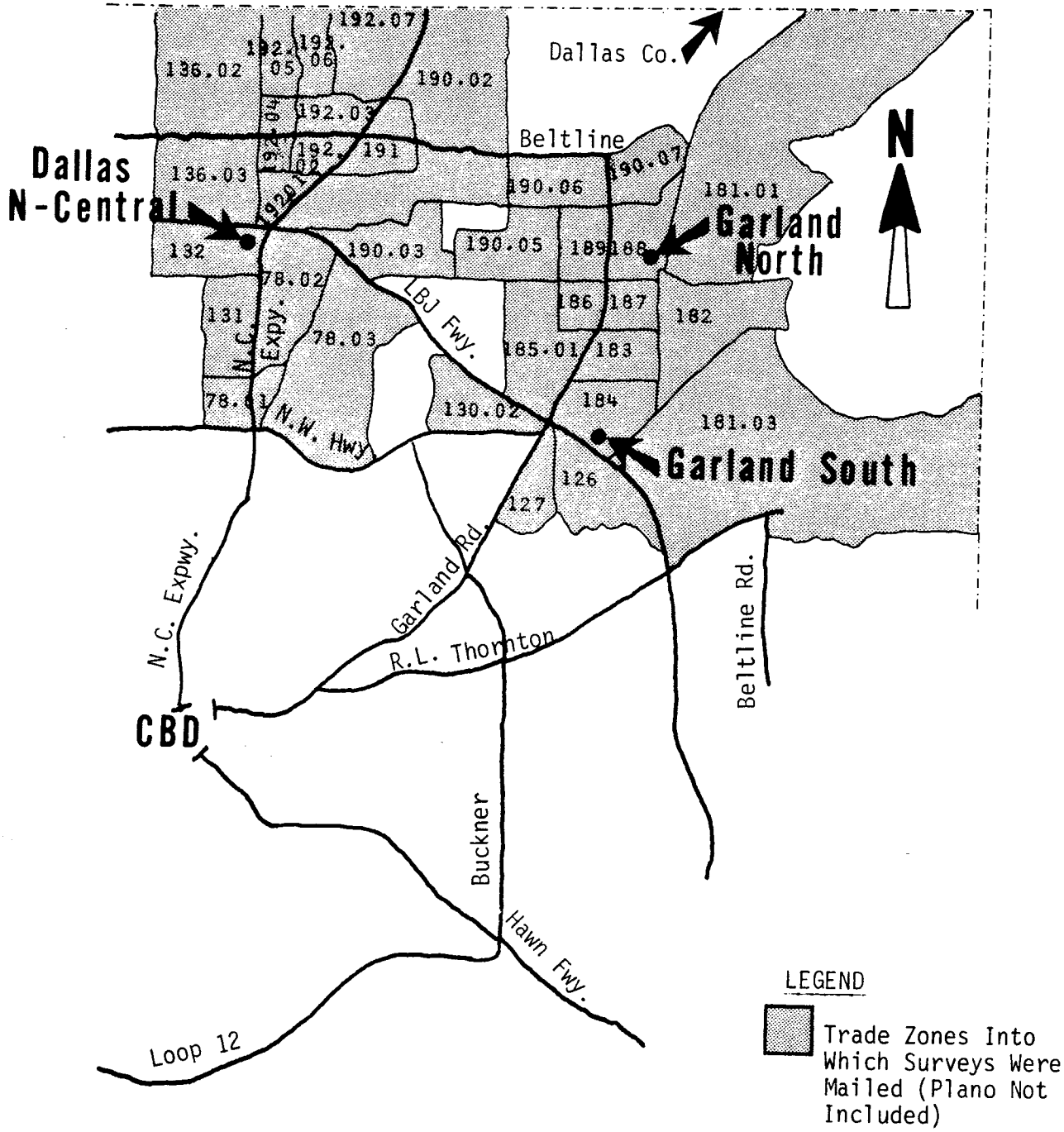


Figure B-1: Trade Zones Surveyed As Part of The Home Mail-Out

Table B-6 depicts the percentage of the total survey broken down by distance from the lot. As shown in Tables B-3 through B-5, about 900 households were surveyed for each park-and-ride lot.

Table B-6: Percentage of Home Mail-Out Surveys For Each Park-and-Ride Lot, Categorized by Distance From the Lot

Distance From Park-and-Ride Lot (Miles)	Percentage of Total Households Surveyed		
	Garland North	Garland South	Dallas N. Central
0-0.5	4.0%	14.2%	0%
0.5-1.0	8.8	12.6	4
1.0-1.5	28.5	20.2	6
1.5-2.0	26.4	14.6	14
>2.0	32.3	38.4	76
Total	100%	100%	100%

For the trading areas encompased in the study sites, the average population size varied from an average of 5,594 (in the North Central watershed area) to 7,526 (for the Garland South lot watershed area), based on 1970 census data. Total population per watershed area varied from 95,093 for the North Central lot (excluding portions outside Dallas county) to 60,389 for the Garland South lot.

Based on 1979 estimates for the City of Garland, approximately 68 percent of all adults 18 years old and over were in the work force, and 65 percent of the population is 18 years of age and older, or 47,472. Thus, approximately 32,281 (68 percent x 47,472) persons are in the work force per watershed area. Current levels of park-and-ride patronage are under 500 riders per lot per day. Assuming that an average of 13 percent of the workers commute to the downtown Dallas area, the potential market is an estimated 4,196 (32,281 x 13 percent) riders per day. In sum, an estimated 12 percent of the potential market is

currently being served by each of the park-and-ride facilities. This estimated value is in general agreement with the average value found in the actual mail-out survey (refer to Table 8 in the main text).

For a sample of households per area with a work force of 32,281 and 1.46 workers per household, a total of 3.62 percent of the work force will be contacted with the mail-out survey. Confidence intervals can be developed using a sample of 560 returned, completed questionnaires per area (or 63 percent of all households). The confidence intervals based on a single survey item, "Do you or any other household members work in downtown Dallas?", showed the following hypothesized results:

Response I Yes	Response II No
29%	71%

$$S = \sqrt{\frac{PQ}{n}}$$

where P, Q = the population parameters for the binomial. If 29 percent of those surveyed responded "yes" to the survey item described above and 71 percent said "no," P and Q are 0.29 and 0.71 respectively.

n = the number of cases in the sample per catchment area

S = the standard error, indicating the extent to which the sample estimates will be distributed around the population parameter.

$$S = \sqrt{\frac{0.29 \times 0.71}{560}} = .01917$$

Thus, approximately 68 percent of the residents will provide similar answers within one standard error (plus or minus less than 2 percent) of the 29 percent who responded "yes" in any given watershed area. Ninety-five percent of the residents will furnish identical answers within two standard errors, or between 32.8 and 25 percent will respond "yes" to the survey item used in the example.

Because the main body of the questionnaire will be completed by only those responding "yes" to the questionnaire described above, the standard error is larger for other survey items. Also, as the proportion of a binomial response set becomes closer to 0.5, the standard error becomes larger.

Because standard error is an inverse function of sample size, it was necessary to combine most responses across all three study areas when assessing the mail-out survey findings. Assume that 210 out of a total of 1,680 respondents (hypothetical numbers) work in the downtown area and provided answers to the question "Do you know the location of the Park-and-Ride lot nearest your home?" Collapsing "no" and "not sure" as responses, the following breakdown is obtained:

$$\text{"Yes"} = P = 0.73$$

$$\text{"No"} = Q = 0.27$$

$$13 \text{ percent of total sample} = n = 210$$

$$S = \sqrt{\frac{.73 \times .27}{210}} = .03064$$

Based on this standard error, it is known that between 76.1 percent and 69.9 percent of those surveyed will respond "yes" 68 percent of the time, and we are 95 percent confident that they will reply "yes" using the range of 79.1 percent and 66.9 percent (or .06128 plus or minus the 73 percent suggested in the description above). In this manner, in many instances all three watershed areas are combined for analysis, and generalizations are made for the entire metropolitan sector encompassing the three park-and-ride lots.