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An Analysis of the Demand for Airport Bus Services at Washington National and Dulles International Airports

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16. Abstract

This report presents the findings and recommendations from a study of the demand for airport bus services at Washington National and Dulles International Airports. The purpose of the study was to provide FAA's Metropolitan Washington Airports with a better understanding of the existing and potential markets for airport bus services to assist them in planning bus service improvements and marketing strategies.

Data from several recent surveys of Washington metropolitan air passengers and airport bus users were analyzed to develop a profile of the market and to gain an understanding of airport access mode choice behavior. Based on this knowledge, a set of airport access mode choice models were developed and calibrated. The models were used to forecast the share of air passengers who would be attracted to airport bus service under various fare and service scenarios. The results of these model applications formed the basis for recommendations regarding improvements in airport bus service at the two airports.

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PREFACE

This report was prepared under a reimbursable agreement between the Transportation Systems Center (TSC) and the Federal Aviation Administration's Metropolitan Washington Airports (MWA) to provide technical assistance in developing improved ground transportation services for Washington National and Dulles International Airports. Dr. Bruce Spear, of TSC's Service Assessment Division, was the principal investigator and author of this report.

The author wishes to acknowledge the contributions made by the following persons and organizations in the preparation of this report. Mr. Richard Griesbach, Chief of MWA's Commercial Operations Branch, was the sponsor of this study. Mr. Griesbach also supplied us with valuable background and historical information on airport operations in the Washington metropolitan area, and was tremendously helpful in providing us with the key contacts needed to obtain additional data for the study. The technical staff of the Metropolitan Washington Council of Governments supplied us with datatapes of the 1981-82 Baltimore-Washington Regional Air Passenger Survey, and developed the highway and transit network data which we used in calibrating and applying our airport access mode choice models. Special thanks to Mr. Phillip Shapiro, Mr. Jon Williams and Mr. Tom Montanio for their help and advice during the model development process. Datatapes from the 1979 Northern Virginia Transportation Commission survey of Dulles air passengers were obtained from Multisystems, Inc. Thanks also to the Washington Dulles Task Force and its chairman, Mr. Ed Risse, who provided valuable insight and suggestions for the policy scenarios to be investigated in our study.

At TSC, Ms. Yoko Sano conducted most of the data processing and computer analysis in support of our model calibration and application efforts. Early, preliminary data processing was conducted by Ms. Mary Cross and Mr. Allan DeBlasio. Ms. Vera Ward typed most of the original manuscript. Special thanks to Ms. Maria Ragone and Mrs. Carla Heaton who supervised the preparation of an interim version of this report in my absence.

METRIC CONVERSION FACTORS

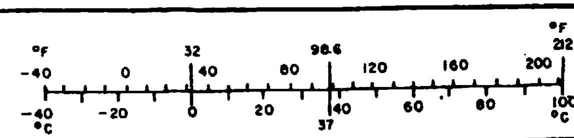
Approximate Conversions to Metric Measures

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

*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.

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



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1. INTRODUCTION

This report presents the findings and recommendations from a study of the demand for airport bus services at Washington National and Dulles International Airports. The study was conducted by the Transportation Systems Center for the Federal Aviation Administration's (FAA) Metropolitan Washington Airports (MWA) -- the owner and operator of these two airports.

The overall purpose of the study was to provide MWA with a better understanding of the existing and potential markets for airport bus services to assist them in planning bus service improvements and marketing strategies. Data from several recent surveys of Washington metropolitan area air passengers and airport bus users were analyzed to develop a profile of the market and to gain an understanding of airport access mode choice behavior. Based on this knowledge, a set of airport access mode choice models were developed and calibrated. The models were used to forecast the share of air passengers who would be attracted to airport bus under various fare and service scenarios. The results of these model applications formed the basis for recommendations regarding improvements in airport bus service to the two airports.

1.1 Data Sources Used in this Study

The data for this analysis came from a variety of sources. Overall air passenger activity volumes and airport bus ridership were obtained from operating data supplied by MWA. Information on airport access mode choice and on the locational distribution of air passenger trip ends came primarily from a survey of enplaning air passengers conducted by the Washington Metropolitan Council of Governments (COG) in 1981-1982. This survey provides the most recent and statistically valid information on air passenger characteristics in the Washington metropolitan area. However, it does not contain any information on the characteristics of deplaning or transferring passengers, or on passengers boarding international flights. Consequently, data from another survey, conducted by the Northern Virginia Transportation Commission in 1979, were used to provide additional information on air passengers. More specifically, the 1979 survey was used to examine the differences between enplaning and deplaning passengers, as well as air passenger awareness of and attitudes toward airport bus service. Since the survey was conducted only of Dulles air passengers, the findings may not necessarily be transferable to air passengers at other airports. Wherever obvious transferability problems arise in the analysis, they are noted and discussed.

Other surveys of Dulles and National air passengers, conducted by various organizations in 1966, 1973, and 1977, have also been used in this study to provide further insight regarding changes in air passengers' travel patterns over time. Since these surveys were not collected or expanded in a manner that is consistent with the 1981 COG survey, direct comparisons across surveys are subject to rather high variances and findings should be interpreted with caution. Nevertheless, these comparisons are still useful in that they present a coarse historical picture regarding the travel behavior of Washington metropolitan air passengers.

Most of the highway and transit network data used in calibrating and applying the airport access mode choice models were prepared by the technical staff of the Washington Metropolitan Council of Governments. The data included average daily zone-to-zone travel times by various airport access modes for two separate years: a base year representing conditions as they existed at the time of the 1981-82 regional air passenger survey, and a design year reflecting planned improvements to the Washington metropolitan area transportation system as of 1990. These data are described in more detail in Section 5.3 of this report.

1.2 Structure of this Report

This report is divided into seven major sections. In Section 2, air passenger activity and the market for airport bus services at Dulles International Airport are examined. Maps are presented showing the Washington area locational distributions of: 1) all Dulles air passengers, 2) the current market share for Dulles airport bus services, and 3) the locational distribution of current Dulles airport bus ridership. In Section 3, a similar presentation is made for air passenger activities at Washington National Airport.

Section 4 summarizes the findings from a preliminary investigation of air passenger characteristics and their influence on airport access mode choice. In addition to sociodemographic and trip-related characteristics, this section also examines air passenger awareness of, and current attitudes toward, airport bus services in the Washington metropolitan area.

Section 5 briefly describes the airport access mode choice model development process to give the reader a basic understanding of the assumptions inherent in the models, their limitations, and how they were applied in testing various policy scenarios.

Section 6 describes and presents the results of six fare and service policy scenarios which were examined using the Dulles airport access mode choice models. In each scenario, the models estimated average daily airport bus patronage between Dulles and zones in the Washington metropolitan area. These patronage estimates also provided the basis for computing expected revenues and vehicle requirements for each proposed service configuration. Because no satisfactory model could be calibrated for access mode choice to National, a single estimate of average daily airport bus patronage was developed. The National and Dulles patronage estimates were then combined to obtain estimates of revenues and vehicle requirements for the overall airport bus system.

In Section 7, recommendations are presented for upgrading airport bus services to Dulles and National Airports. The recommendations are based on results of the Dulles and National policy scenarios, resource limitations given existing and planned equipment purchases, expected trends in the growth of demand for new transportation services, and a recognition of the need for the airport bus operator to run a productive and profitable service.

2. THE MARKET FOR AIRPORT BUS SERVICES AT DULLES INTERNATIONAL AIRPORT

This section examines the existing and potential market for airport bus services at Dulles International Airport. Because airport bus patronage is dependent upon not only the number of potential bus users, but also their distribution in the Washington area and their other airport access alternatives, each of these factors is analyzed in detail.

2.1 Overall Size of the Dulles Air Passenger Market

Over the past decade, air passenger activity at Dulles International Airport has varied between 2.5 and 3.0 million air passengers per year. As shown in Figure 2.1, aside from two major fluctuations (following the Airline Deregulation Act of 1978 and during the recessionary period of 1980-81), Dulles air passenger activity has exhibited a relatively stable annual growth rate of about 2.7 percent.

Approximately 95 percent of the Dulles air passenger market comes from commercial air carriers and air taxi services. The remaining 5 percent comes from general aviation and military aircraft operations. Considering only those passengers using commercial carriers and air taxis, the total potential market for airport bus services at Dulles in 1982 was about 2.5 million passenger trips per year, or about 6800 trips per day.

2.2 Locational Distribution of Dulles Air Passenger Trips

Figure 2.2 maps the Washington area origins of enplaning commercial airline passengers using Dulles. By far, the greatest concentration of Dulles-bound trips originate in downtown Washington (11.4%). Although suburban Virginia, and particularly Fairfax County, generate the largest overall share of Dulles-bound trips (38.9%), these trips are scattered over a sizeable geographic area. Major trip generators in suburban Virginia include Vienna (8.9%), Springfield (5.1%), Alexandria (4.9%) and western Fairfax (4.1%). Other major concentrations of Dulles-bound trips originate from the Montgomery County suburbs of Bethesda, Rockville, and Silver Spring (13.7%), and from Virginia counties lying outside the Washington metropolitan area -- principally the Richmond/Fredricksburg area (4.0%). Table 2.1 summarizes the market share and estimated average daily trip ends (both origins and destinations) for major Dulles trip generators.

Table 2.2 compares the locational distribution of Dulles air passenger trips derived from the 1981 regional air passenger survey with similar data obtained in 1973. Aside from a slight decrease in the share of trip ends originating in the District of Columbia, the locational distribution of Dulles-bound trips appears to have remained remarkably stable over time.

The last column in Table 2.2 presents the locational distribution of those air passengers surveyed in 1981 who cited Dulles as their preferred airport, compared to Washington National and Baltimore-Washington International. Here the distribution changes significantly, with substantial increases in the

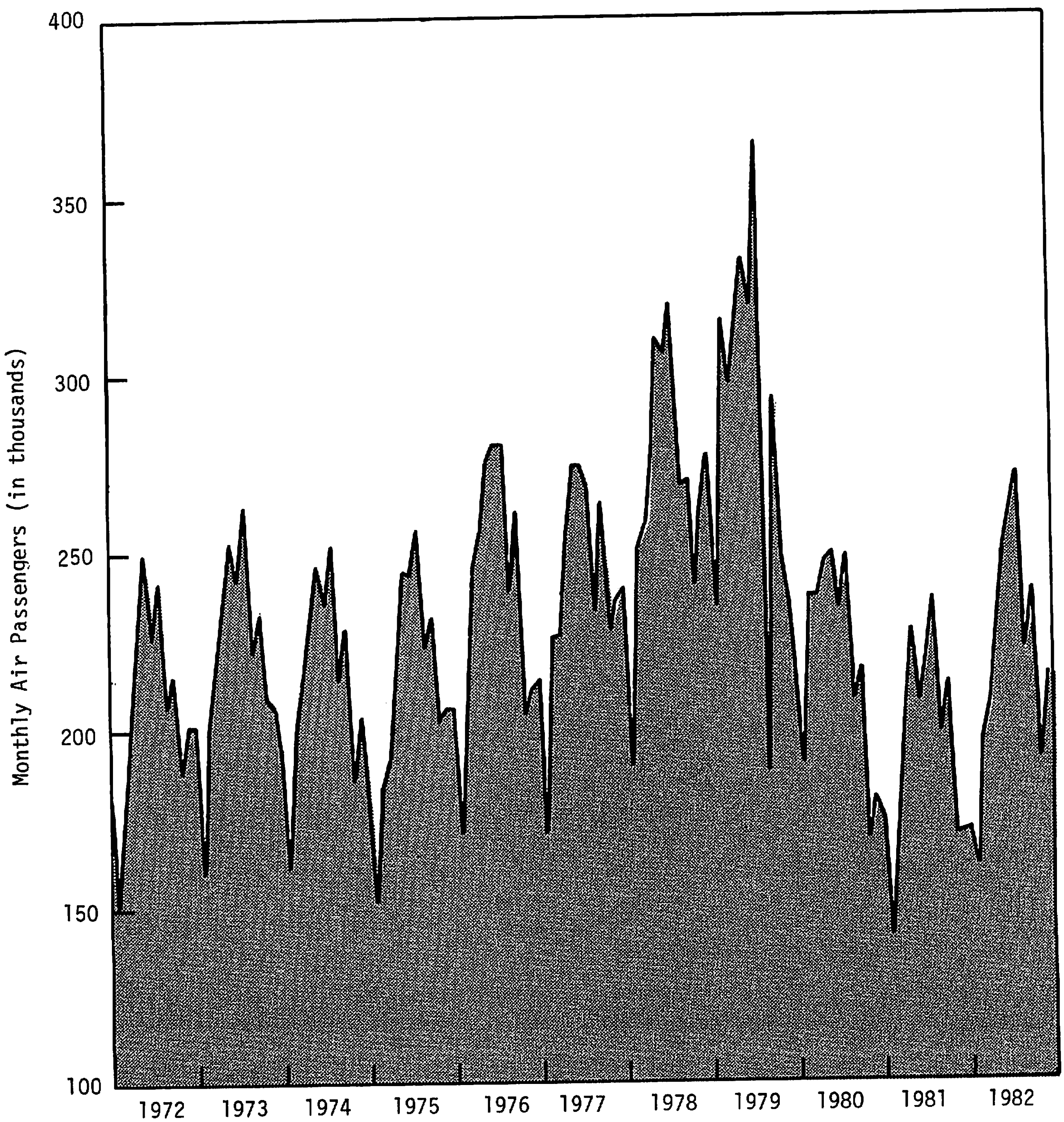


FIGURE 2.1. DULLES AIR PASSENGER ACTIVITY: 1972-1982

FIGURE 2.2

WASHINGTON AREA TRIP ENDS
FOR DULLES AIR PASSENGERS

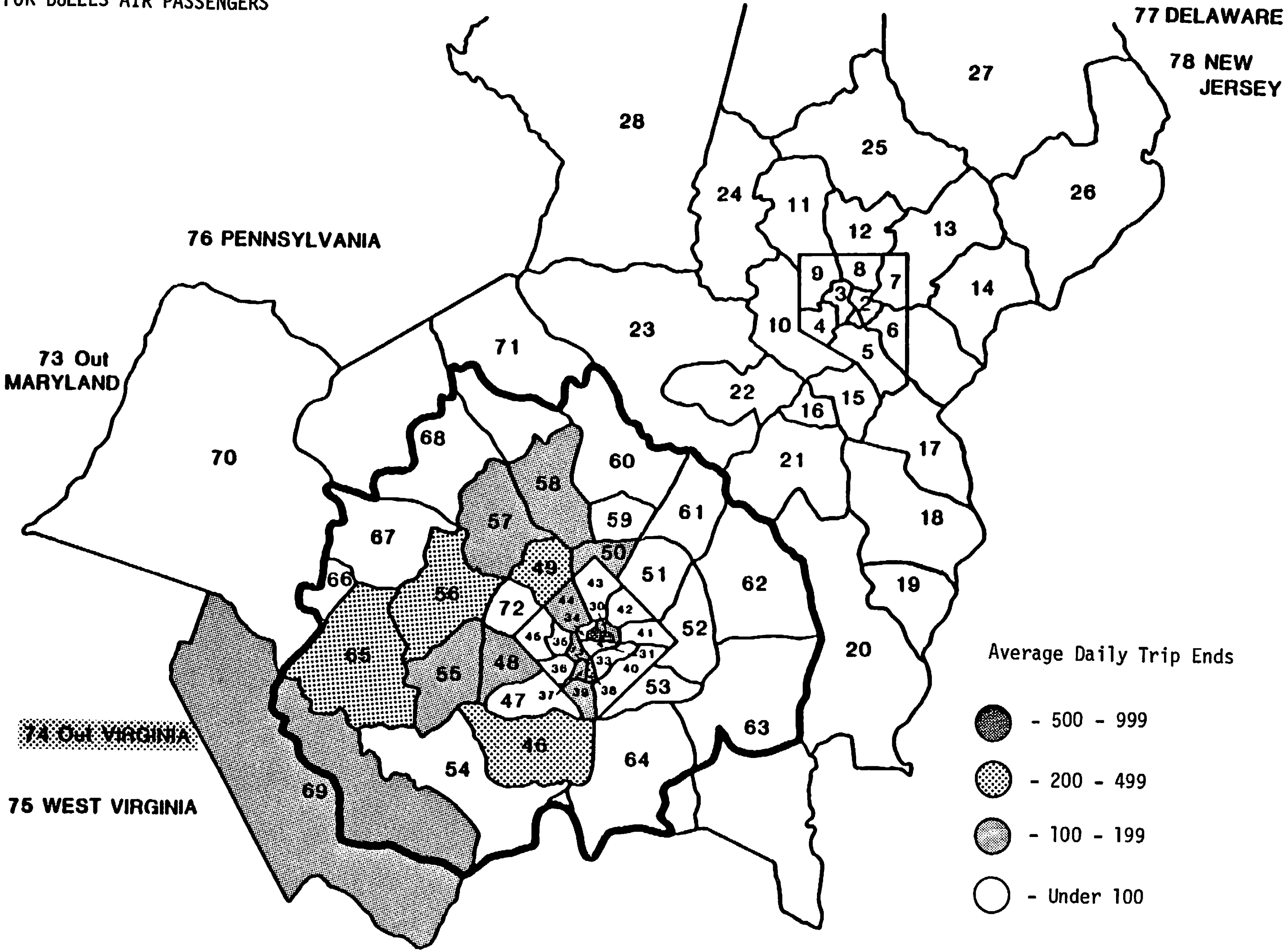


TABLE 2.1. WASHINGTON AREA TRIP ENDS OF DULLES AIR PASSENGERS

Zone Number and Description	Share of Trip Ends (percent)	Average Daily Trip Ends
<u>Over 500 Daily Trip Ends</u>		
29 - Downtown Washington	11.4	614
<u>200 to 499 Daily Trip Ends</u>		
56 - Vienna	8.9	477
74 - Outlying Virginia	6.2	334
49 - Bethesda	6.0	323
46 - Springfield	5.1	274
65 - West Fairfax	4.1	219
<u>100 to 199 Daily Trip Ends</u>		
39 - Oldtown Alexandria	3.6	192
58 - Rockville	3.5	186
44 - Northwest Washington	3.3	175
69 - Prince William County	3.3	175
37 - Crystal City	3.1	164
48 - Falls Church	2.7	148
55 - Fairfax City	2.7	148
30 - Union Station	2.6	142
50 - Silver Spring	2.1	115
57 - Potomac	2.1	115
32 - Pentagon	1.9	104
<u>Under 100 Daily Trip Ends</u>		
Total for 43 zones	27.4	1456
TOTAL AVERAGE DAILY TRIP ENDS FOR DULLES[1]		5361

1. This Table and Figure 2.2 are based on data obtained from the 1981 Washington-Baltimore Regional Air Passenger Survey. That survey only included observations of enplaning air passengers boarding domestic, scheduled commercial air carriers who were not transferring from another aircraft. Consequently, the trip end totals reported herein tend to understate overall air passenger activity for Dulles, due to the exclusion of air taxi, air charter and international flights, and of air passengers transferring between airports.

TABLE 2.2. CHANGES IN WASHINGTON AREA TRIP ENDS OF DULLES AIR PASSENGERS

	Share of Dulles Trip Ends (percent)		
	1973 WCOG Survey	1981 WCOG Survey	1981 Preferred Airport
Washington DC	25.0	22.5	12.6
Fairfax/Falls Church	25.0	25.9	37.0
Arlington County	8.9	8.1	5.7
Alexandria	3.8	4.9	3.5
Loudoun County	2.5	3.1	2.9
Prince William County	3.9	3.3	4.0
Other Virginia	6.5	6.2	6.8
TOTAL VIRGINIA	(50.6)	(51.5)	(59.9)
Montgomery County	16.8	16.4	21.6
Prince Georges County	3.7	3.1	1.4
Other Maryland	3.3	4.3	3.0
TOTAL MARYLAND	(23.8)	(23.8)	(26.0)
Other States	0.5	2.1	1.5

share of air passengers coming from Fairfax and Montgomery Counties and dramatic decreases in the share of air passengers coming from the District, Arlington, and Prince Georges County. Most of these preferences reflect Dulles' proximity to the air passenger's Washington area trip origin. The primary reason why these preferences are not currently realized is the limited availability of flights out of Dulles. In other words, if Dulles were to experience an increase in the number of scheduled, short-haul flights, there probably would occur both an overall increase in air passenger activity at Dulles and a substantial increase in the number and share of Dulles-bound trips originating in suburban Fairfax and Montgomery counties.

2.3 Market Share for Dulles Airport Bus Service

Based on passenger data reported by the current airport bus service operator for 1982, the average share of the Dulles air passenger market captured by airport bus was computed to be just under 9 percent. Given current air passenger activity at Dulles, this market share is equivalent to about 600 revenue bus trips per day.

Figure 2.3 graphs the average daily bus ridership and market shares for Dulles airport bus service over the period 1974 - 1982. Market shares are plotted separately for enplaning and deplaning passengers. As shown by the plots, airport bus' share of deplaning passengers has consistently been about 50 percent greater than its share of enplaning passengers. Reasons for this difference are discussed in the section of this report covering air passenger characteristics.

Both average daily bus ridership and the bus' market share of Dulles air passengers dropped dramatically between 1978 and 1981. Average bus market share dropped nearly 40% (from 15.3% in 1978 to 9.2% in 1981), while average daily bus ridership dropped nearly 55 percent (from 1210 bus riders to 547 bus riders). Certainly, some of the drop in bus ridership can be attributed to the decline in overall Dulles air passenger activity during 1980-81. However, a decrease in the overall size of the market would not necessarily change the bus share of the remaining market. Therefore, it is likely that other factors also played a major role in the decline of Dulles bus service.

Figure 2.4 graphs the market shares observed for Dulles airport access modes at four points in time between 1973 and 1981. These data were obtained from surveys of Dulles air passengers conducted in 1973, 1977, 1979 and 1981, and present a relatively coarse picture of the changes in airport access mode choice within the Washington metropolitan area over the past 10 years.

The graph clearly shows that the market share for airport bus among Dulles air passengers has continually declined, with virtually all of this loss going to the private auto and rental car modes. It should be noted, however, that only the mode choices made by enplaning air passengers are represented. As already illustrated in Figure 2.3, enplaning passengers are much less likely to use the airport bus than deplaning passengers. Consequently, the data tend to exaggerate both the decline in bus mode share and the growth in private auto use when all Dulles passengers are considered. Nevertheless, it does seem reasonable to conclude that the overall market share for airport bus has been and is being eroded by the private automobile. Furthermore, to the extent that the locational distribution of Dulles trip ends becomes more dispersed, away from the District and toward Fairfax and Montgomery Countries, this trend is likely to continue.

The above trends in access mode choice still do not fully explain the drop in the bus' market share between 1978 and 1982, however. Some, if not most of the decline must therefore be attributed to a general deterioration (or at least perceived deterioration) in airport bus service over this time period. In fact, several events did occur during 1979 that could have contributed to an overall degradation of airport bus service. In March 1980, the existing bus operator terminated its contract for service to Dulles and National Airports in reaction to a negative finding from the Virginia State Corporation Commission on a proposed fare increase. During the ensuing several months, airport bus service was in a state of flux as an interim bus operator had to be found, hired, and familiarized with the service. Also during this time, Metropolitan Washington Airports (MWA) was in the process of procuring a new, long-term airport bus service contract which included provisions for new equipment and a marketing program. Until this new contract was awarded, there was little incentive for either MWA or the interim bus operator to invest significant resources to dramatically improve the existing service.

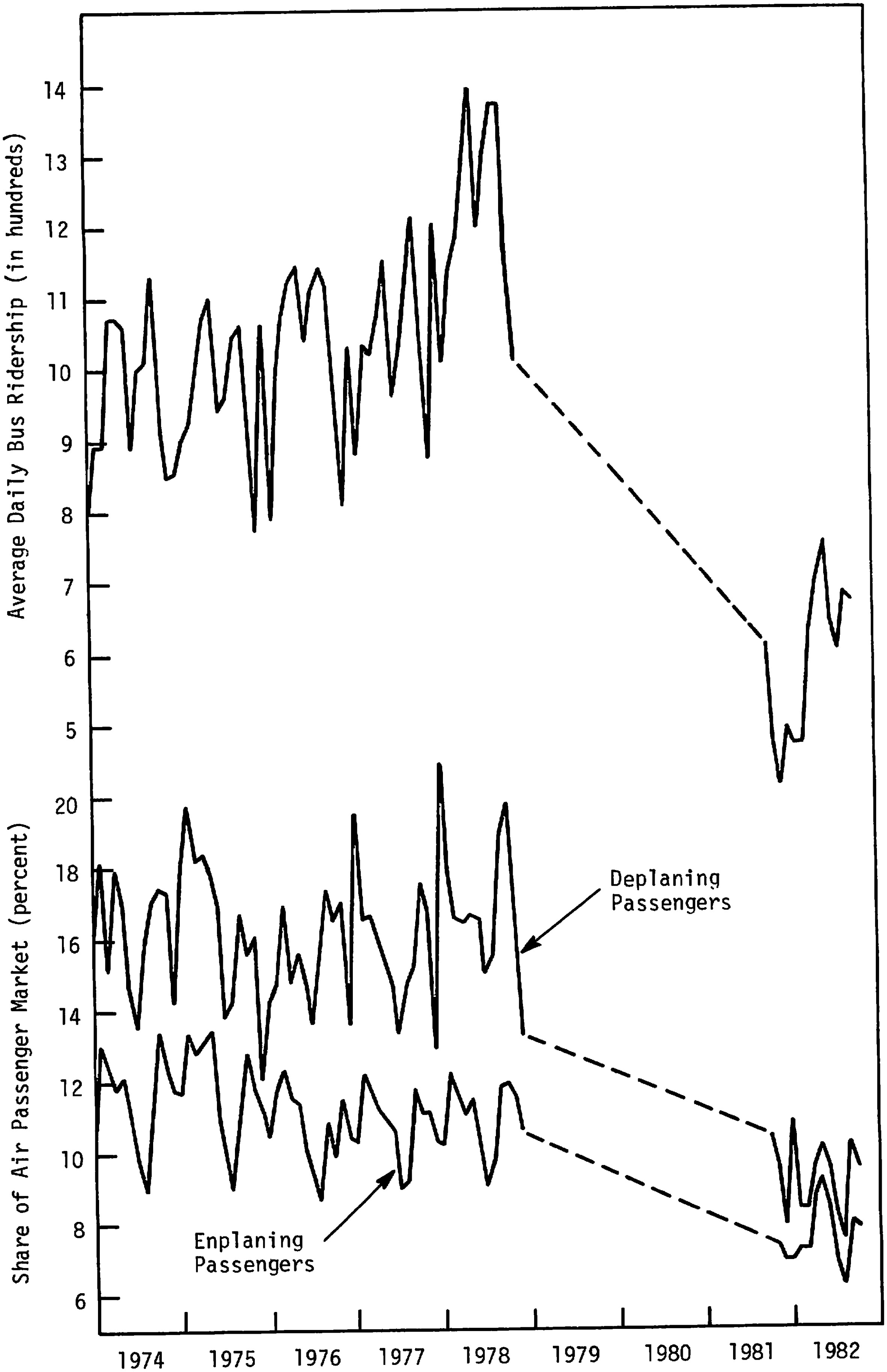


FIGURE 2.3. MARKET SHARE AND DAILY RIDERSHIP FOR DULLES AIRPORT BUS SERVICE

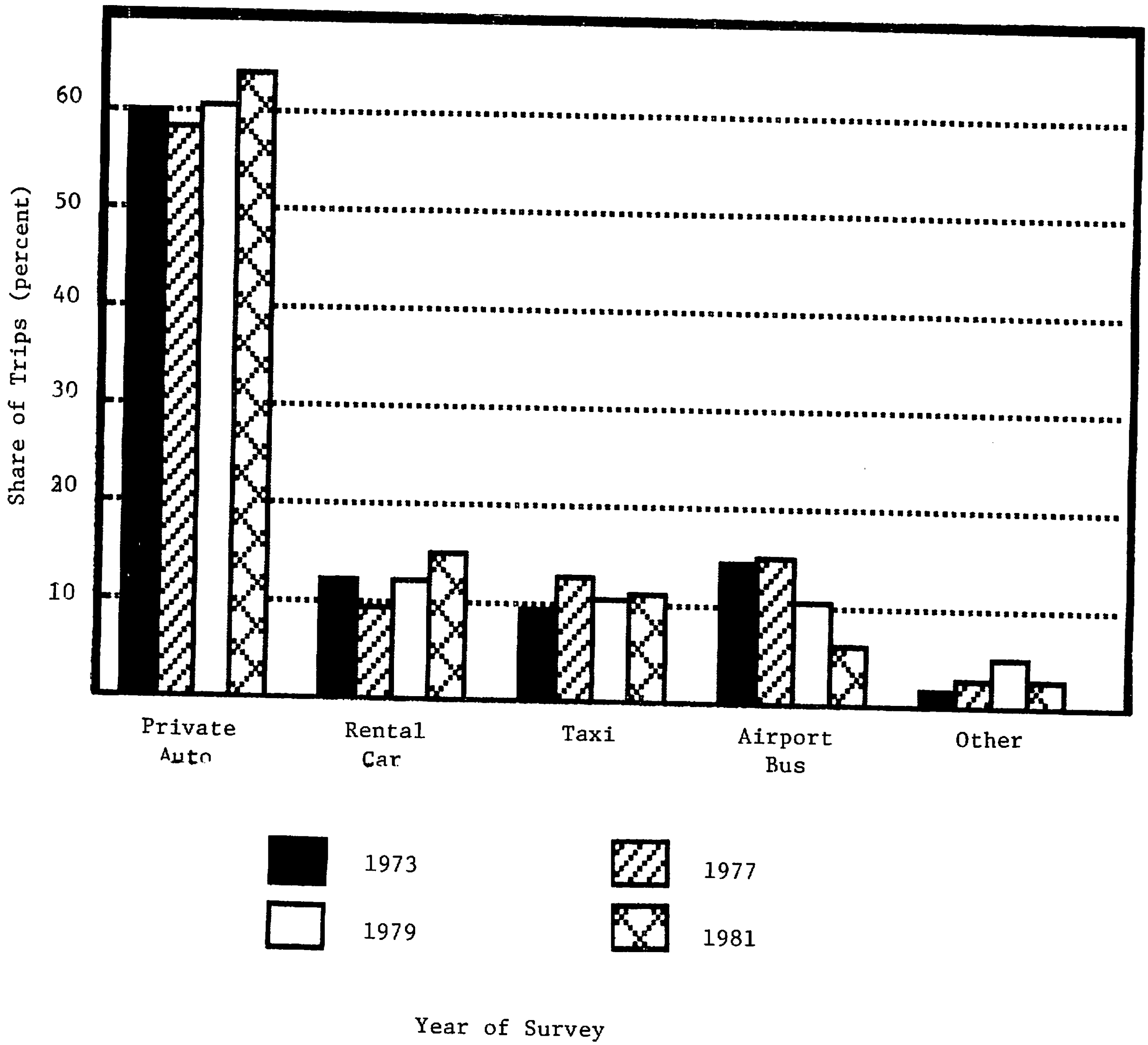


FIGURE 2.4

CHANGES IN AIRPORT ACCESS MODE SHARES OF DULLES AIR PASSENGERS OVER TIME

Unfortunately, the procurement has been delayed well beyond its original schedule, and both existing equipment and marketing efforts have continued to deteriorate. This combination of a major disruption in bus service followed by a caretaker arrangement in anticipation of a new service contract award have undoubtedly led to a perceived decline in service among former bus riders and insufficient marketing efforts to attract new bus riders. Both of these conditions can probably be reversed with the award of a new service contract.

2.4 Locational Distribution of Dulles Airport Bus Markets

While the overall market share for Dulles airport bus service is currently about 9 percent, there is substantial variation in the market share by geographic location. Figure 2.5 maps the share of airport bus users among Dulles-bound air passengers originating from specific Washington area locations. The map is based on data from the 1981 regional air passenger survey which includes only enplaning passengers. Consequently, it presents a somewhat underrepresentative picture of overall bus market shares by geographic location. However, there is no evidence to suggest that the relative differences in bus market shares between locations would change significantly with the inclusion of deplaning air passengers.

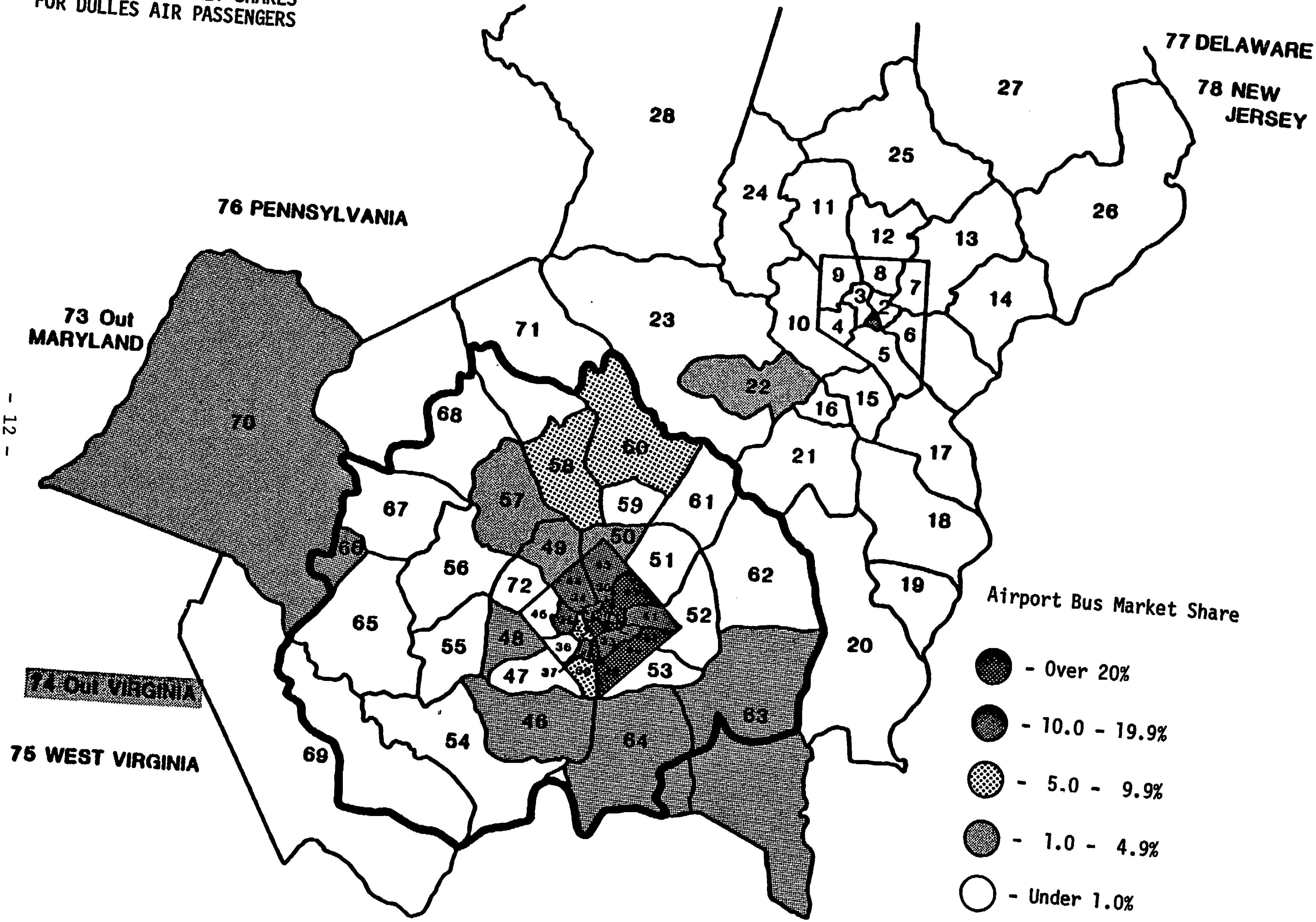
As shown on the map, the market share for airport bus is over 10 percent throughout the District of Columbia and over 20 percent in many District zones. The downtown zones are either directly served by the Dulles-to-Downtown Washington motor coach route or are directly adjacent and easily accessible to it. Although the more residential zones in Anacostia and northeast Washington are not directly served by the airport bus, they do have very good public transportation to downtown. Moreover, these zones are characterized by lower than average income and auto ownership rates, suggesting that zonal residents may have fewer travel options to Dulles.

Other areas with over 10 percent market shares are the Rosslyn, Crystal City, and National Airport zones of Arlington County. All of these areas are directly on or immediately adjacent to the Dulles-to-National Airport motor coach route. Outside of the District and Arlington County, no zone in the Washington metropolitan area has an airport bus market share as high as 10 percent. In fact, only Rockville, Northeast Montgomery County, and Oldtown Alexandria have market shares in excess of 5 percent. The low market shares in the suburbs can be attributed to several factors, not the least of which is the relatively poor level of service provided to these areas by the Dulles airport bus. Beyond this, however, the suburban environment itself makes it very difficult for the airport bus to provide service that would be competitive with other available access modes.

The principal airport access mode from the Washington suburbs to Dulles is, of course, the private auto. Seventy-three percent of all Dulles air passenger enplanements originating in either Montgomery or Fairfax County travel to the airport via private auto. Among residents, private auto is used for 89 percent of the airport access trips. The private auto provides service that is direct, fast, relatively inexpensive, and totally demand-responsive. By comparison, airport bus service is slower, more costly (in terms of out-of-pocket costs), and certainly less direct than the automobile. Thus, while it is not inconceivable for airport bus to increase its market share

FIGURE 2.5

AIRPORT BUS MARKET SHARES
FOR DULLES AIR PASSENGERS



among suburban air passengers, it is likely to do so principally among those for whom private auto is unavailable or for whom use of private auto would seriously inconvenience others; the overall size of this potential market segment may be fairly small.

The other competitors to airport bus service in the suburbs are rental cars and taxis. Almost all rental car use is by nonresidents, and the decision to choose a rental car is determined more by an air passenger's need or desire to travel extensively within the Washington metropolitan area than by an assessment of its attractiveness solely as an airport access mode. Therefore, it is unlikely that airport bus service will be able to capture a significant share of the current rental car market regardless of how much it is upgraded.

Taxi service, on the other hand, competes directly with airport bus, offering fast, direct, door-to-door service at a substantially higher fare. The current market share for airport taxi in Montgomery and Fairfax countries is about 6.2 percent, compared to 1.8 percent for airport bus. If airport bus were to offer more frequent service to suburban terminals, supplemented by demand-responsive feeder service at the suburban end, it is likely that it could capture a significant share of the current taxi market, particularly to the more distant destinations in Montgomery and Fairfax countries.

2.5 Estimated Daily Trip Ends for Dulles Airport Bus Service

Figure 2.6 and Table 2.3 present the locational distribution of daily revenue bus trips for the Dulles airport bus service. The bus trips are based on locational distributions derived from the 1981 regional air passenger survey, and expanded with respect to a control total based on the current bus operator's reported passenger volumes for 1982.

Revenue bus trip ends represent the product of total air passenger trip ends to a specific location and the bus market share for that location. Comparing Figure 2.6 with Figures 2.2 and 2.5, it can be seen that many zones with relatively high volumes of Dulles air passengers are located in the suburbs where bus has a low market share (e.g. Vienna, western Fairfax, Springfield). Similarly, many of the zones in the District where bus has a high market share have very low volumes of Dulles air passengers (e.g. Anacostia, northeast Washington). Consequently, in both of these situations, overall bus ridership tends to be very low.

In fact, only five zones have the combination of a sufficient volume of Dulles air passenger trip ends and a high bus market share to generate more than 20 bus trips per day. Two of these zones, downtown Washington and National Airport, each generate well over 100 daily bus trips. A large percentage of the bus trips between Dulles and National represent air passengers who are transferring between the two airports rather than ending their trip in the Washington metropolitan area.

FIGURE 2.6

WASHINGTON AREA TRIP ENDS
FOR DULLES AIRPORT BUS SERVICE

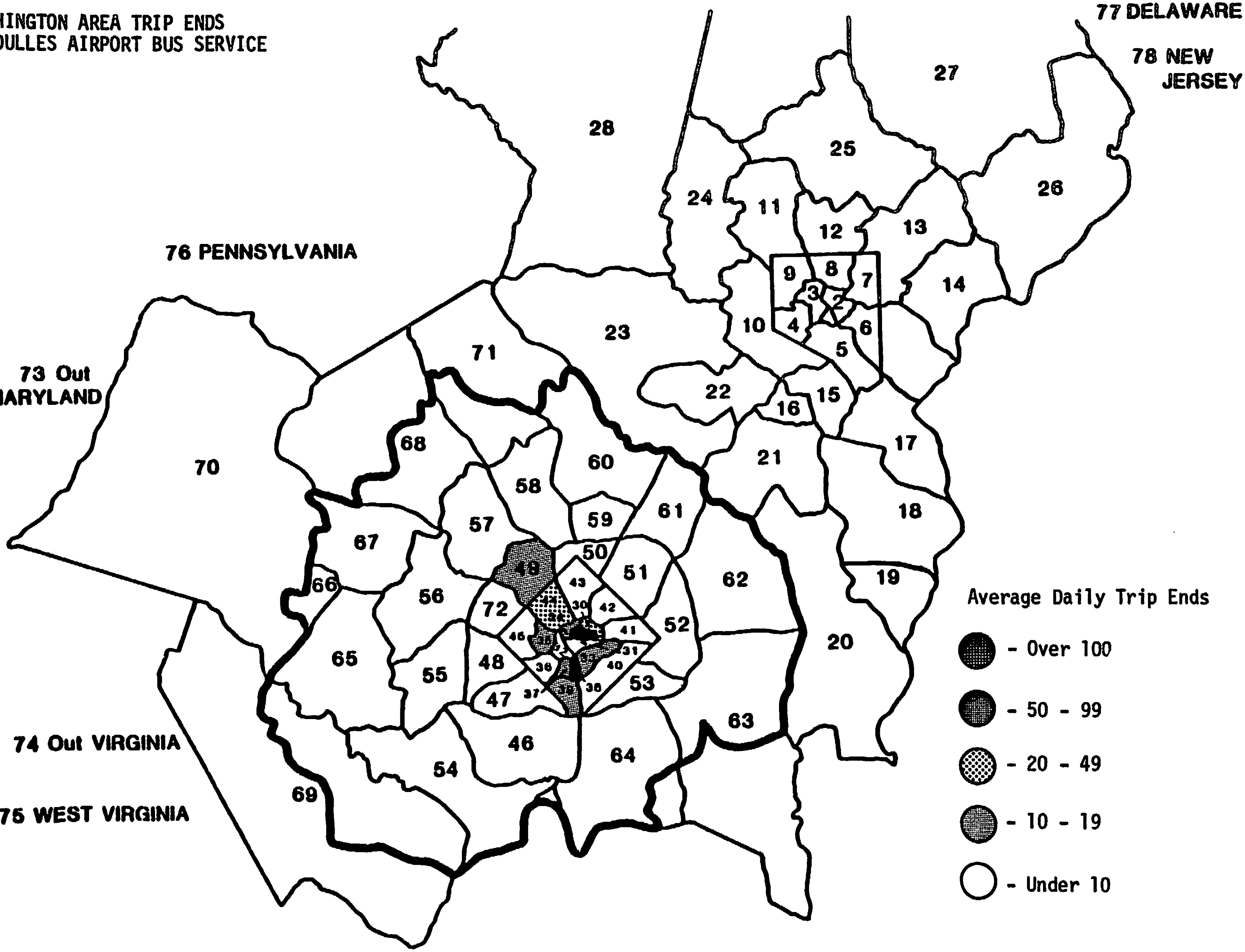


TABLE 2.3. WASHINGTON AREA TRIP ENDS OF DULLES AIRPORT BUS USERS

Zone Number and Description	Average Daily Trip Ends
<u>Over 100 Daily Trip Ends</u>	
29 - Downtown Washington	162
38 - National Airport	163[1]
<u>20 to 50 Daily Trip Ends</u>	
30 - Union Station	40
37 - Crystal City	24
44 - Northwest Washington	36
<u>10 to 19 Daily Trip Ends</u>	
31 - Southwest Washington	12
33 - West Anacostia	14
34 - Georgetown	17
35 - Rosslyn	15
39 - Oldtown Alexandria	17
43 - Rock Creek Park	10
49 - Bethesda	15
58 - Rockville	11
<u>Under 10 Daily Trip Ends</u>	
Total for 16 zones	64
TOTAL AVERAGE DAILY BUS TRIP ENDS TO DULLES	**600**

1. The average daily bus trip ends to National Airport includes 150 trips representing passengers who are transferring between Dulles and National Airports.

All but three of the zones which generate more than 10 bus trips per day are located in the District or Arlington County. One of the outlying zones is Oldtown Alexandria, which is adjacent to National Airport and therefore reasonably well served by the Dulles-to-National motor coach. The other two zones -- Bethesda and Rockville -- are currently served by limousine service running on 2-hour headways. The Bethesda/Rockville service provides some encouragement that there may be additional demand in selected suburban locations that could be attracted with better quality service.

3. THE MARKET FOR AIRPORT BUS SERVICES AT WASHINGTON NATIONAL AIRPORT

This section examines the existing and potential market for airport bus services at Washington National Airport. As in the previous section, each of the major contributing factors to airport bus ridership are examined in detail. These factors include: overall air passenger activity at National, airport access alternatives to National, and the distribution of National airport trip ends throughout the metropolitan Washington area.

3.1 Overall Size of the National Air Passenger Market

As shown in Figure 3.1, air passenger activity at Washington National Airport grew steadily over the past decade from 11.1 million air passengers per year in 1972 to 15.1 million in 1979. This was equivalent to an annual growth rate of a half million new air passengers per year. During the 1980-81 recession, air passenger activity at National dropped off to about 14 million. However, it is expected that air passenger growth will resume as the economy rebounds.

Recent agreements between the FAA and the Washington Metropolitan Council of Governments have established a cap on air passenger activity at National of 16 million air passengers per year. Once this ceiling is reached, all new scheduled aircraft operations will have to be diverted to either Dulles or Baltimore-Washington International. Assuming an annual growth rate of one half million air passengers, the 16 million cap may be reached as early as 1986.

Approximately 98.5 percent of the National air passenger market comes from commerical air carriers and air taxi services, with the remaining 1.5 percent coming from general aviation traffic. Considering only those passengers using commercial carriers and air taxis, the total potential market for airport bus services at National Airport in 1982 was about 13.0 million passenger trips per year, or about 35,700 trips per day. This is over five times the air passenger volume at Dulles.

3.2 Locational Distribution of National Air Passenger Trips

Figure 3.2 maps the Washington area origins of enplaning commercial airline passengers using National Airport. As was the case with Dulles, the greatest concentration of National-bound trips originate in downtown Washington (17.5%). Unlike Dulles, however, most zones in the Washington metropolitan area generate over 100 trips per day to National Airport. Major trip generators (i.e., zones generating over 1000 trips per day) include: the Union Station and northwest sections of the District; Rosslyn, Crystal City, and the Pentagon sections of Arlington; Bethesda, Maryland; Oldtown, Alexandria; and Vienna, Virginia. The combined traffic from these zones alone is equivalent to about 17,000 daily air passengers -- 2.5 times the total daily air passenger activity at Dulles. Table 3.1 summarizes the market share and estimated average daily trip ends for major National Airport trip generators.

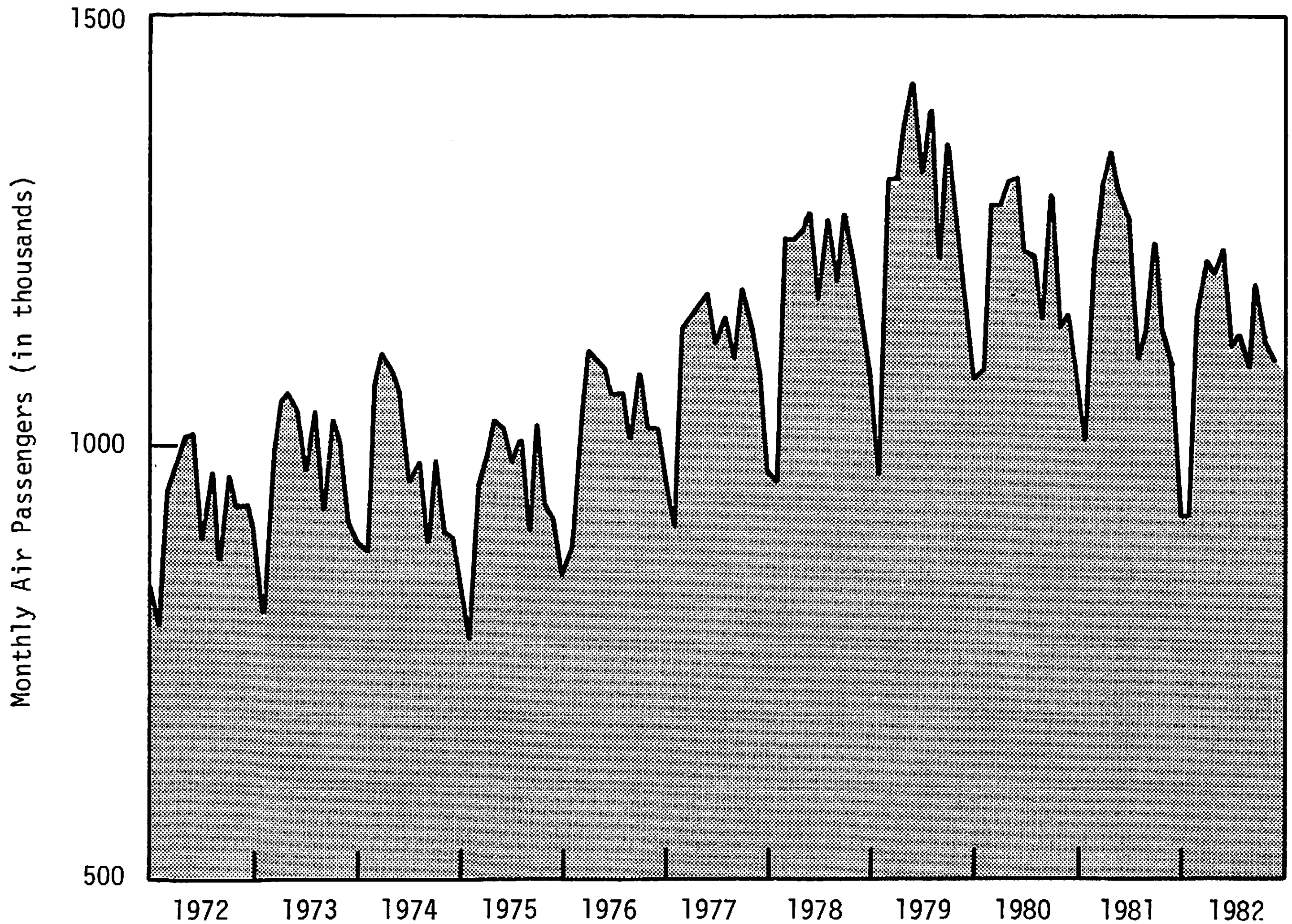


FIGURE 3.1. WASHINGTON NATIONAL AIR PASSENGER ACTIVITY: 1972-1982

FIGURE 3.2

WASHINGTON AREA TRIP ENDS
FOR NATIONAL AIR PASSENGERS

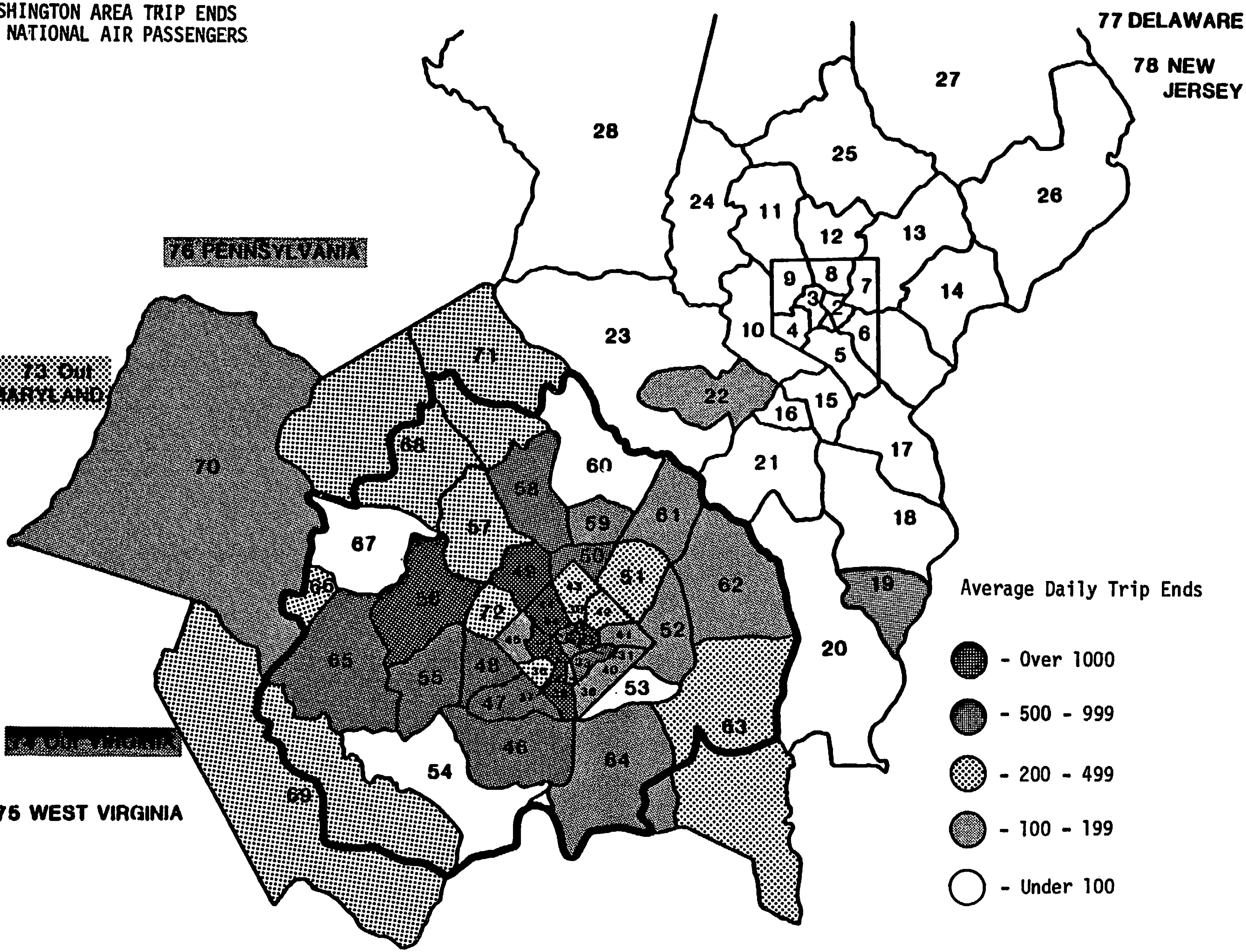


TABLE 3.1. WASHINGTON AREA TRIP ENDS OF NATIONAL AIR PASSENGERS

Zone Number and Description	Share of Trip Ends (percent)	Average Daily Trip Ends
<u>Over 1,000 Daily Trip Ends</u>		
29 - Downtown Washington	17.5	5863
32 - Pentagon	9.6	3233
37 - Crystal City	5.0	1666
30 - Union Station	4.9	1644
44 - Northwest Washington	4.8	1616
49 - Bethesda	4.5	1518
39 - Oldtown Alexandria	3.8	1266
35 - Rosslyn	3.6	1195
56 - Vienna	3.1	1047
<u>500 to 999 Daily Trip Ends</u>		
58 - Rockville	3.0	997
34 - Georgetown	2.5	849
74 - Outlying Virginia	2.4	805
55 - Fairfax City	2.3	756
46 - Springfield	2.1	690
31 - Southwest Washington	2.0	685
47 - Duke Street, Alexandria	1.9	636
48 - Falls Church	1.8	603
33 - West Anacostia	1.7	570
50 - Silver Spring	1.6	553
65 - West Fairfax	1.5	510
<u>200 to 499 Daily Trip Ends</u>		
43 - Rock Creek Park	1.5	493
69 - Prince William County	1.4	460
72 - McLean	1.4	460
57 - Potomac	1.3	449
73 - Outlying Maryland	1.3	433
51 - College Park	0.9	312
71 - Gaithersburg	0.9	301
36 - South Arlington	0.9	290
42 - Northeast Washington	0.8	252
68 - Germantown	0.7	219
63 - Upper Marlboro	0.6	208

TABLE 3.1 (continued)

Zone Number and Description	Share of Trip Ends (percent)	Average Daily Trip Ends
<u>100 to 199 Daily Trip Ends</u>		
45 - North Arlington	0.6	192
62 - Bowie	0.5	181
64 - Oxon Hill	0.5	170
19 - Annapolis	0.5	159
61 - Beltsville	0.4	148
38 - National Airport	0.4	142
40 - East Anacostia	0.4	142
52 - Seat Pleasant	0.4	137
70 - Loudoun County	0.4	137
59 - Wheaton	0.4	132
41 - New York Avenue	0.3	115
76 - Pennsylvania	0.3	115
22 - Columbia	0.3	104
<u>Under 100 Daily Trip Ends</u>		
Total for 30 zones	3.2	1088
TOTAL AVERAGE DAILY TRIP ENDS FOR NATIONAL[1]		33,541

1. This Table and Figure 3.2 are based on data obtained from the 1981 Washington-Baltimore Regional Air Passenger Survey. That survey only included observations of enplaning air passengers boarding domestic, scheduled commercial air carriers who were not transferring from another aircraft. Consequently, the trip end totals reported herein tend to understate overall air passenger activity for National, due to the exclusion of air taxi, air charter and international flights, and of air passengers transferring between airports.

Table 3.2 compares the locational distribution of National air passenger trips derived from the 1981 regional air passenger survey with similar data obtained in 1973. The table shows a clear increase in the share of National-bound trips coming from suburban Virginia, and in particular, Arlington (13.0% to 19.9%) and Fairfax counties (9.7% to 12.3%). These changes are generally consistent with the growth in residential and commerical development experienced in the Washington metropolitan area over the time period.

TABLE 3.2. CHANGES IN WASHINGTON AREA TRIP ENDS OF NATIONAL AIR PASSENGERS

	Share of National Trip Ends (percent)		
	1973 WCOG Survey	1981 WCOG Survey	1981 Preferred Airport
Washington DC	45.9	36.2	49.8
Fairfax/Falls Church	9.7	12.3	7.7
Arlington County	13.0	19.9	15.3
Alexandria	4.6	5.6	7.8
Loudoun County	0.4	0.6	0.2
Prince William County	1.6	1.4	0.9
Other Virginia	2.2	2.4	1.5
TOTAL VIRGINIA	(31.5)	(42.2)	(33.4)
Montgomery County	11.8	12.5	10.4
Prince Georges County	6.3	3.6	3.4
Other Maryland	3.7	3.8	2.3
TOTAL MARYLAND	(21.8)	(19.9)	(16.1)
Other States	0.8	1.7	0.8

The last column in Table 3.2 shows the locational distribution of those air passengers who cited National as their preferred airport compared to Dulles and Baltimore-Washington International. Here the distribution changes significantly, with nearly 50 percent of those preferring National originating their trips in the District of Columbia. The share of passengers coming from Fairfax and Arlington Counties drops significantly, as does the share of passengers coming from Montgomery County. Virtually all of these current National Airport users said they would prefer to use Dulles, if appropriate flights were available. This suggests that a significant volume of air passenger activity could be drained away from National to Dulles by providing a better mix of scheduled short-haul flights into Dulles.

3.3 Market Share for National Airport Bus Service

Figure 3.3 graphs the average daily bus ridership and market shares for National Airport bus service over the period 1974-1982. These graphs are based on data obtained from airport bus operator ridership reports over this period. Including the National-to-Dulles Airport bus trips, National airport bus service currently provides about 666 revenue bus trips/day. This is equivalent to a 1.8 percent share of the National air passenger market.

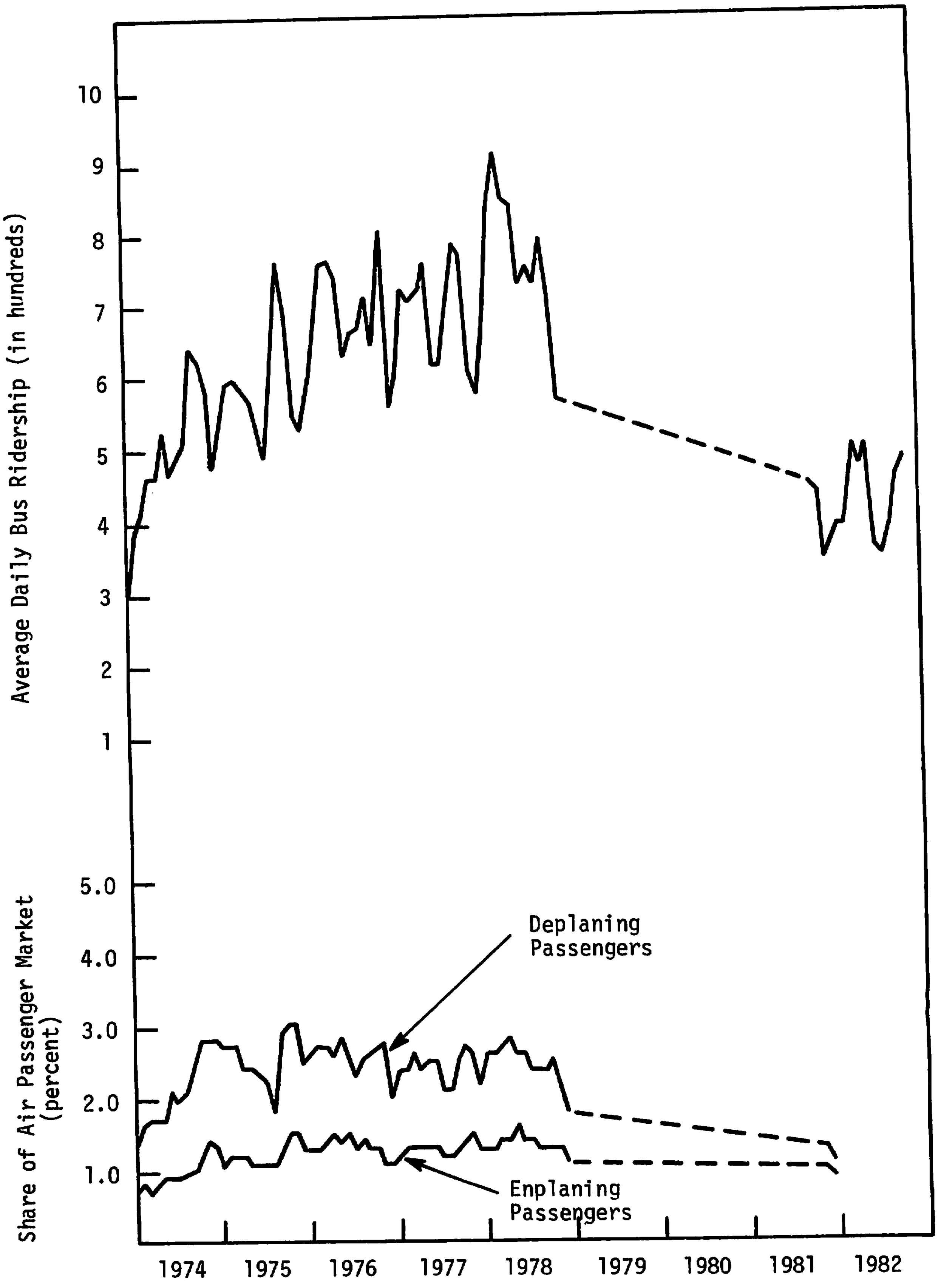


FIGURE 3.3. MARKET SHARE AND DAILY RIDERSHIP FOR NATIONAL AIRPORT BUS SERVICE

Clearly, airport bus service is not nearly as competitive at National Airport as it is at Dulles. One reason for this is National's proximity to its major air passenger trip generators in downtown Washington and Arlington. At these shorter distances, taxi fares become very competitive with the airport bus fares. Therefore, unless the air passenger is going directly to one of the hotels that serve as a terminal for the airport bus, taxis offer a higher level of service -- more direct, less waiting time -- at only a modest increase in cost.

The other major competitor to the airport bus at National Airport is the Washington Metrorail/Metrobus public transit system. As shown in Table 3.3, Metro's share of the National air passenger market increased from less than one percent in 1973 to over ten percent in 1981. Virtually all of this increase can be attributed to the opening of Metrorail's National Airport Station in 1977. With Metrorail access to National Airport, air passengers can travel to any of the downtown locations served by airport bus for less than one third the cost. While Table 3.3 suggests that taxis suffered the biggest losses in market share with the opening of Metrorail, the market that would have been most attracted to airport bus service (i.e., air passengers with downtown trip origins or destinations who are willing to trade off increased travel time for lower cost), would also find Metrorail a satisfactory airport access mode. With Metrorail available, it is unlikely that these air passengers will be attracted back to an airport bus offering similar service at substantially higher cost.

3.4 Locational Distribution of National Airport Bus Markets

Figure 3.4 maps the share of airport bus users among National-bound air passengers originating from specific Washington area locations. Since the map is based on data which includes only enplaning passengers, it presents a somewhat underrepresentative picture of the overall airport bus market. However, as with Figure 2.5, there is no evidence to suggest that the relative distribution of bus market shares would change with the inclusion of deplaning air passengers.

Unlike Dulles, airport bus service to National Airport captures only a very small share of the air passengers leaving from the District or from Arlington. As discussed earlier, this is due primarily to the heavy competition airport bus gets from taxis and Metrorail to these locations.

While no location in the Washington metropolitan area yields a 10 percent market share for national airport bus service, there are at least two areas with relatively high market potential (5 to 10 percent market shares) for airport bus. These sites are: 1) the Bethesda, Silver Spring and Rockville zones in Montgomery County; and 2) the zones around Dulles Airport. Both of these sites are relatively remote from National Airport, making them expensive taxi trips, are not currently served by Metrorail, and are reasonably well served by airport bus service.

TABLE 3.3. CHANGES IN AIRPORT ACCESS MODE SHARES FOR NATIONAL AIR PASSENGERS

Airport Access Mode	Share of Trip Ends (percent) 1973 WCOG Survey	1981 WCOG Survey
Private Auto	43.3	45.3
Drive Alone		(15.3)
Auto Passenger		(30.0)
Rental Car	9.3	9.7
Taxi	43.8	29.3
Airport Bus	2.1	2.2
Metrorail/Metrobus	0.3	10.1
Other	1.2	3.4

3.5 Estimated Daily Trip Ends for National Airport Bus Service

Figure 3.5 and Table 3.4 present the locational distribution of daily revenue bus trips for the National airport bus service. The bus trips are based on locational distributions derived from the 1981 regional air passenger survey, and expanded with respect to a control total based on the current bus operator's reported passenger volumes for 1982.

As was observed with the Dulles airport bus service, relatively few zones have the combination of both a high market share for airport bus and a sufficiently high volume of daily air passenger trips to National Airport to generate a reasonably profitable volume of bus riders. Only two zones, Dulles Airport and downtown Washington, generate more than 100 bus trips per day.

Many of the zones in Arlington and the District generate moderate levels of airport bus ridership simply because of the enormous volumes of air passengers coming from these zones. Aside from the large market, airport bus does not seem to enjoy any particular advantage relative to other modes in serving these zones. In fact, as Metrorail service improves through the opening of the Pentagon to L'Enfant Plaza connector and the extension of the Blue Line into Anacostia, the market share for both taxi and airport bus may decline even further within certain parts of the District.

FIGURE 3.4

AIRPORT BUS MARKET SHARE FOR
NATIONAL AIR TRAVELERS

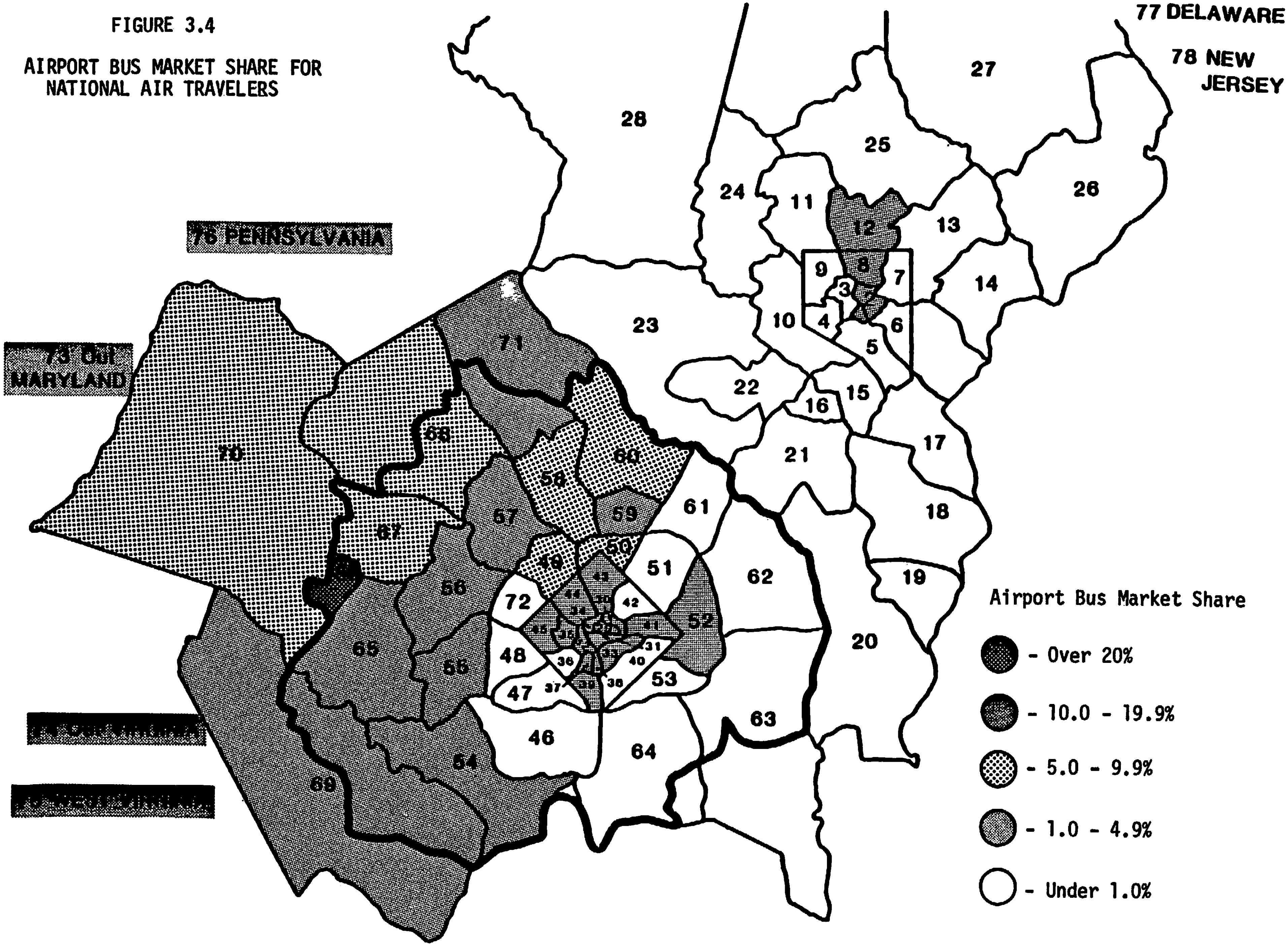


FIGURE 3.5

WASHINGTON AREA TRIP ENDS
FOR NATIONAL AIRPORT BUS SERVICE

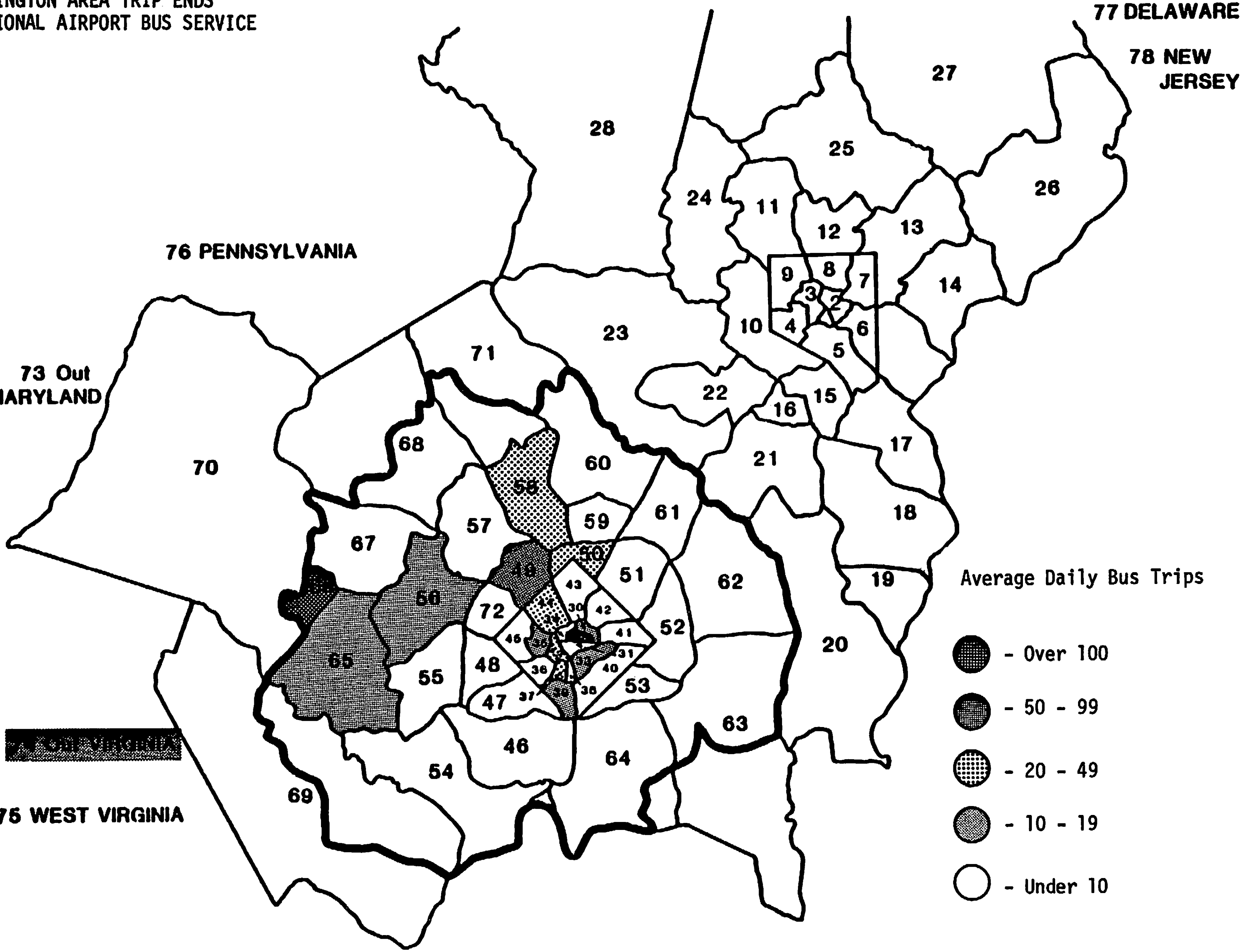


TABLE 3.4. WASHINGTON AREA TRIP ENDS FOR NATIONAL AIRPORT BUS USERS

Zone Number and Description	Average Daily Trip Ends
Over 100 Daily Trip Ends	
29 - Downtown Washington	132
66 - Dulles Airport	153[1]
50 to 99 Daily Trip Ends	
49 - Bethesda	57
20 to 49 Daily Trip Ends	
32 - Pentagon	30
37 - Crystal City	22
44 - Northwest Washington	32
50 - Silver Spring	23
58 - Rockville	44
10 to 19 Daily Trip Ends	
30 - Union Station	16
33 - West Anacostia	11
35 - Rosslyn	17
39 - Oldtown Alexandria	15
55 - Fairfax City	10
56 - Vienna	17
Under 10 Daily Trip Ends	
Total for 25 zones	87
TOTAL AVERAGE DAILY BUS TRIP ENDS TO NATIONAL	**666**

1. The average daily bus trip ends to Dulles Airport include 150 trips representing passengers who are transferring between National and Dulles Airports.

The one market that does show some promise for airport bus service to National Airport is the Bethesda, Rockville and Silver Spring areas of Montgomery County. Even when Metrorail is open to this section of Montgomery County, travel to National Airport will require at least one transfer and will probably be less direct than the existing airport limousine service. Moreover, there are sufficient numbers of air passengers coming from or passing through this area that even a moderate market share of 5 to 10 percent could sustain an airport bus route operating at a relatively high frequency.

4. AIR PASSENGER CHARACTERISTICS AND THEIR INFLUENCE ON AIRPORT ACCESS MODE CHOICE

The choice of which airport ground transportation mode to use is conditioned as much upon the characteristics of the air passenger himself as it is upon the relative level of service of the competing modes. As part of this market study, therefore, an extensive investigation was carried out to determine which air passenger characteristics are most influential in airport access mode choice and whether these characteristics can be used to identify particularly promising markets for airport bus service.

The data for this analysis were obtained from surveys of Dulles air passengers conducted in May 1979 as part of an ongoing evaluation of the Dulles Airport Access Improvement Program. Therefore, a strict interpretation of the findings from this analysis suggests that they are valid only for Dulles air passengers. However, it is likely that many of the characteristics which influence airport access mode choice at Dulles are also likely to have similar influence on air passengers at other airports.

The following sections summarize the findings of the analysis with respect to selected air passenger characteristics:

4.1 Residents vs. Nonresidents

Whether or not an air passenger is a local area resident has a very strong influence on his or her choice of airport access mode. Most Washington area residents either have access to an automobile of their own or have a friend or relative nearby who can drive them to the airport. Nonresidents typically do not have these travel options available. Consequently, as shown in Figure 4.1, use of the private auto as an airport access mode is significantly higher among Washington area residents than among nonresidents (82% vs. 35.5%, respectively).

In fact, it is surprising that nonresidents use the private auto as an access mode as much as they do. Many of these trips undoubtedly represent friends, relatives, or business acquaintances chauffering the air passenger to or from the airport (23.6% of nonresident air passengers are driven to or from Dulles). However, another 12 percent of the nonresident air passengers claimed they drove a private auto to the airport. These individuals may be weekend commuters or temporary residents (e.g., diplomats) of the Washington area. They may have purchased or leased a vehicle while in Washington or have access to a government- or company-owned vehicle. Because of their access to a private auto, this latter group of nonresident air passengers behave more like residents with respect to airport access choice.

Nonresidents use all access modes other than private auto to a greater extent than residents. The greatest difference is in the use of rental cars (24.1% vs. 1.4%), presumably because the rental car provides the mobility of a private auto to those for whom the auto isn't available. Use of the airport bus (16.9% vs. 6.5%), taxis (15.0% vs. 8.0%) and other modes (8.5% vs. 2.0%) are all signficantly higher among nonresidents.

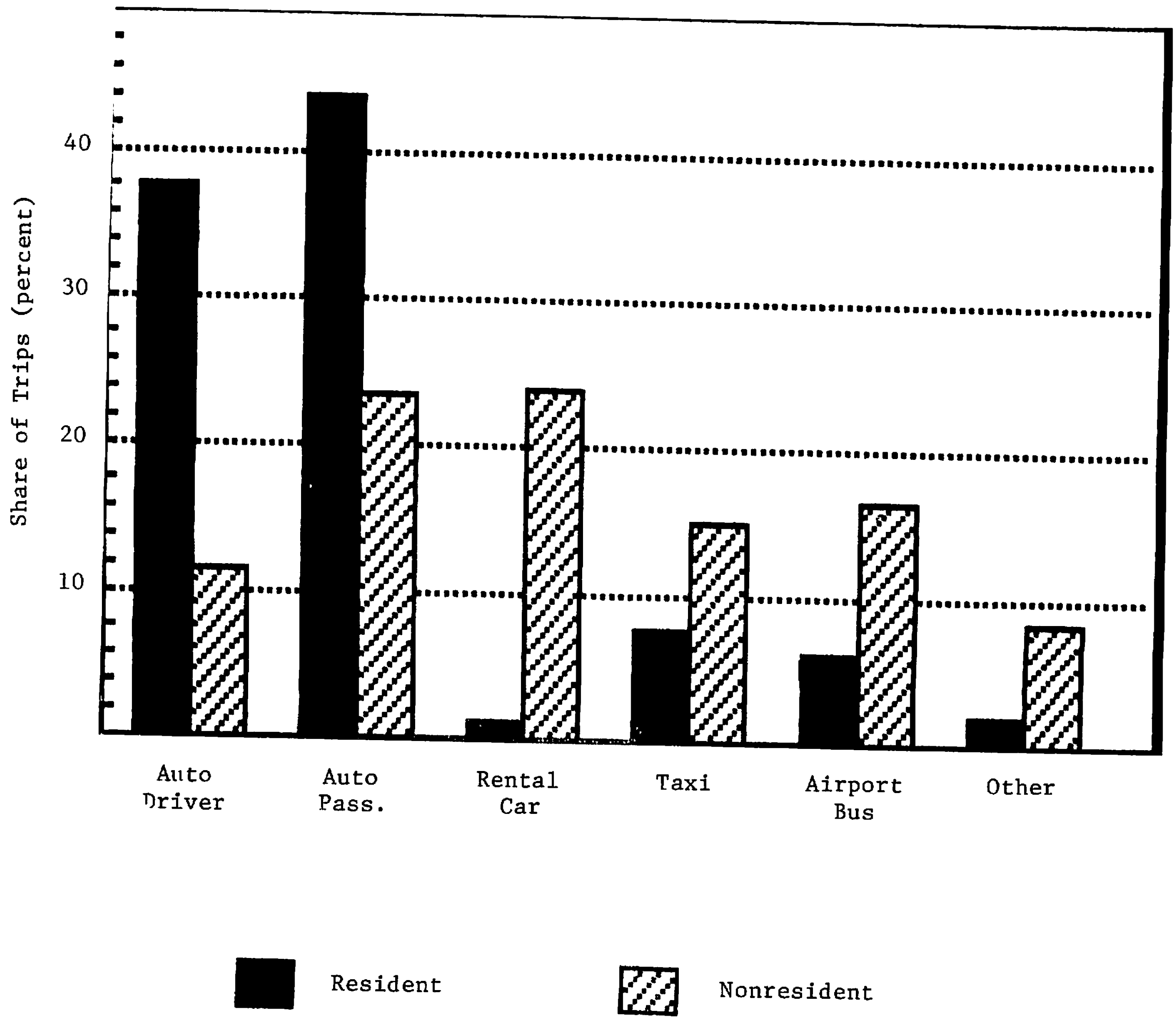


FIGURE 4.1

DISTRIBUTION OF ACCESS MODES: RESIDENTS VERSUS NONRESIDENTS

4.2 Enplaning vs. Deplaning Passengers

Looking at the survey population as a whole, there is no significant difference in the distribution of airport access modes between enplaning and deplaning air passengers. This pattern holds even when residents and nonresidents are analyzed separately. However, in those submarkets where airport bus has a relatively high market share (e.g. the Dulles to downtown Washington market), there is a significant difference between the access mode choices of enplaning versus deplaning air passengers. As shown in Figure 4.2, for example, private auto use is substantially greater among enplaning passengers coming from downtown Washington (37.8% vs. 22.3%), while use of taxi (25.3% vs. 20.1%) and airport bus (41.8% vs. 28.4%) is significantly greater among deplaning passengers.

These differences probably reflect the combined effects of two underlying behavioral forces. First, enplaning air passengers are subject to a very severe penalty for arriving at their destination late (i.e., they may miss their flight). Consequently, there is likely to be more anxiety associated with those modes where the air passenger must wait for a vehicle. Second, friends, relatives, or business acquaintances may be more willing to drive an enplaning air passenger to the airport than to wait for an incoming flight. This is because the driver can simply drop the enplaning air passenger off at the appropriate airline terminal and leave. There is no need to park the vehicle and wait for the plane to arrive, as is necessary with a deplaning passenger. Both of these factors tend to work against the selection of airport bus service by enplaning air passengers and may explain the differences in airport bus ridership observed earlier in Figures 2.3 and 3.3.

4.3 Trip Purpose

Among Washington area residents, the purpose for which an airline trip is being made seems to have little influence on the air passenger's choice of access mode. There is some tendency for business travelers to use the taxi more, while nonbusiness travelers are more likely to be driven by a friend or relative. However, there is no significant difference in the overall distributions of access modes by trip purpose for this submarket.

Among nonresident air passengers, trip purpose has a much more dramatic influence on access mode choice. As shown in Figure 4.3, nonresident business travelers are more likely to use rental cars (31.6% vs. 10.9%), taxis (18.8% vs. 6.6%), and airport bus (20.8% vs. 13.8%) than are nonbusiness travelers. One explanation for this difference is that since business travelers are typically reimbursed for their travel expenses, they are less concerned with ground transportation costs than are nonbusiness travelers. Additionally, many nonbusiness trips involve visits to friends or relatives who may have access to an automobile and are willing to chauffer the air passenger to or from the airport. Indeed, among nonresident nonbusiness travelers, the private auto passenger has the highest share of all access modes.

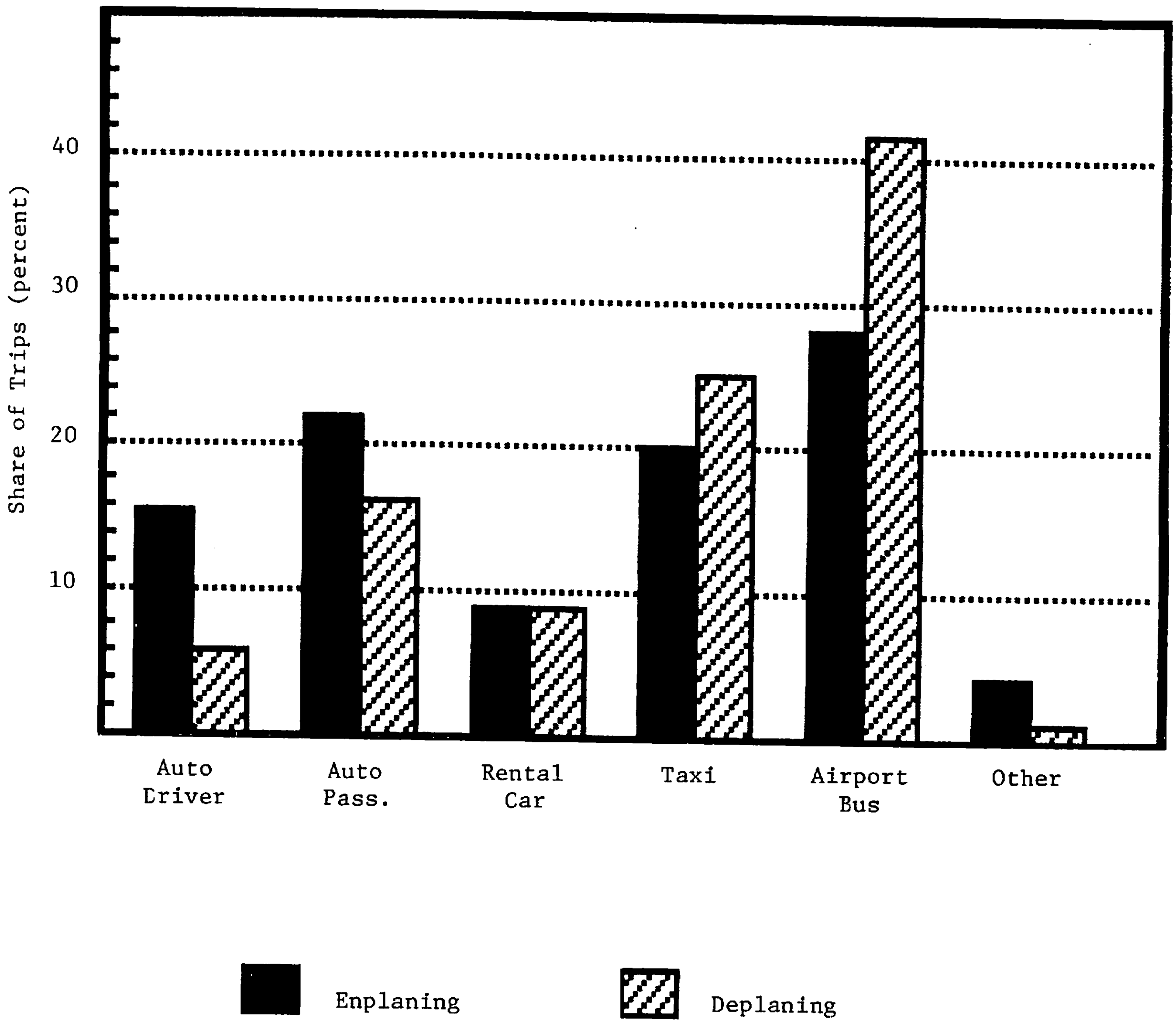


FIGURE 4.2

DISTRIBUTION OF ACCESS MODES FOR TRIPS TO DOWNTOWN WASHINGTON: ENPLANING VERSUS DEPLANING PASSENGERS

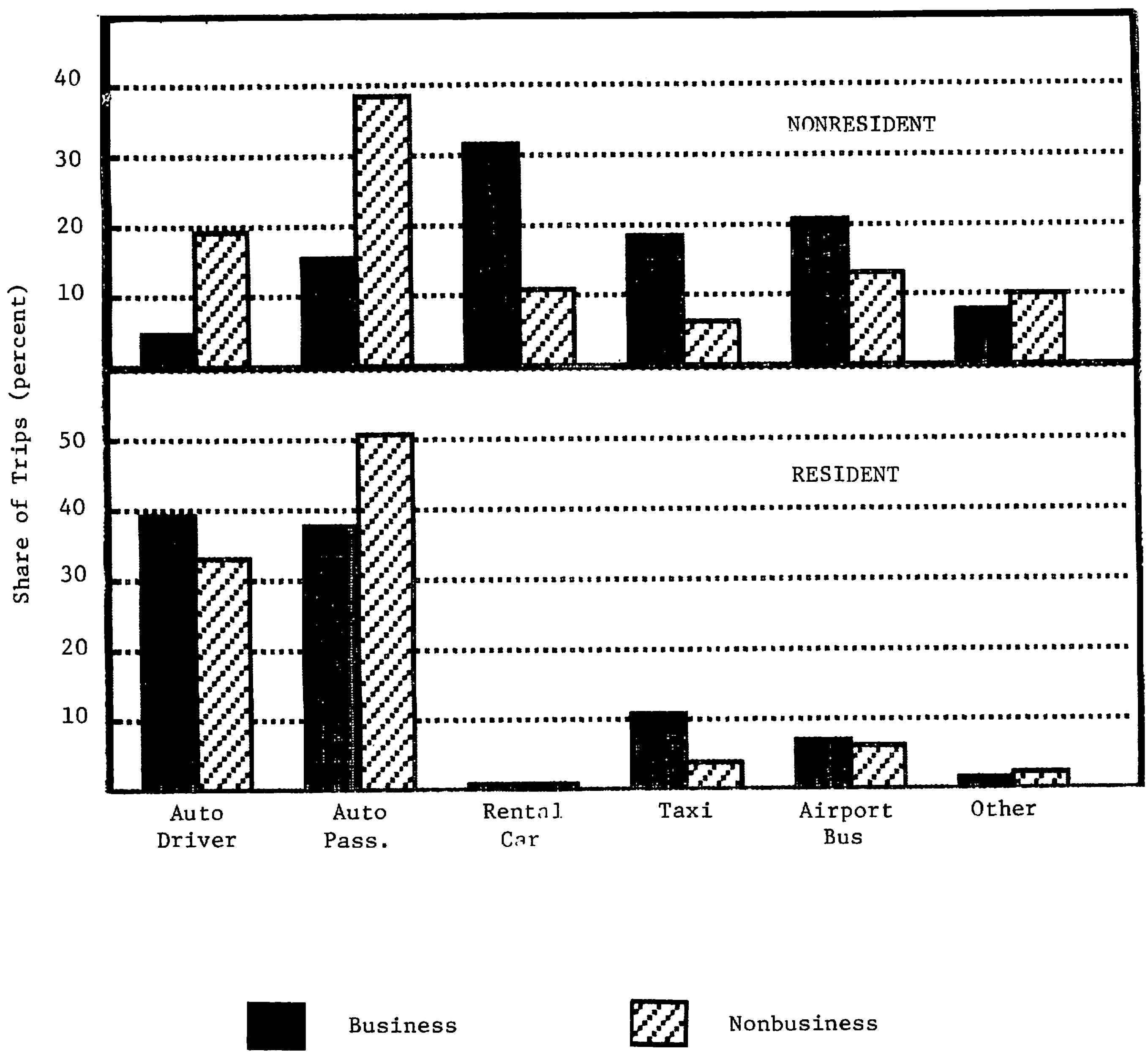


FIGURE 4.3

DISTRIBUTION OF ACCESS MODES: BUSINESS VERSUS NONBUSINESS TRIPS

4.4 Air Trip Origin/Destination

Where an air passenger is going on his/her air trip seems to have some influence on his/her choice of airport access mode. For the purposes of this analysis, air trip end locations were divided into three categories: trips under 650 miles, domestic trips over 650 miles, and foreign trips. Figure 4.4 summarizes the distributions of access modes for residents and nonresidents.

Among Washington area residents, there is no significant difference in the overall distribution of access modes between domestic trips over 650 miles and those under 650 miles, except that for the longer trips the air passenger is more likely to take a taxi. Residents on foreign travel are much less likely to drive and park at the airport, and more likely to be driven by a friend or relative. Presumably this is because foreign trips are typically longer in duration, and the accumulation of airport parking charges makes driving and parking a much more costly travel option.

Among nonresidents, there is a significant decrease in the use of the private auto, both as a driver and a passenger, for domestic trips over 650 miles, and a corresponding increase in the use of rental cars, taxis, and the airport bus. For nonresident foreign travelers, rental car use drops significantly (from 29.5% to 8.0%) while airport bus use increases. The drop in rental car use may be explained by the fact that many foreign travelers do not have valid U.S. drivers licenses or are uncomfortable about driving in a major U.S. urban area.

4.5 Duration of Travel

The length of time an air passenger is away from home on his/her trip also seems to influence access mode choice. The impacts are very different for residents versus nonresidents.

For Washington area residents, travel duration primarily influences whether an air passenger will drive to the airport and park or be driven to the airport by a friend or relative. As shown in Figure 4.5, for travel of one day or less, over 71 percent of resident air passengers drive to Dulles and park. For travel of two to five days duration, this share drops to 48 percent, and for travel over five days, the share drops to 26 percent. Correspondingly, the share of resident air passengers who are driven to the airport increases from 12 percent to 32 percent to 55 percent, respectively. Overall use of the private auto by residents remains relatively unchanged. The primary reason for these shifts, as noted earlier in the analysis of air trip origin/destination, is that leaving an auto at the airport becomes a less attractive option for long air trips due to increased parking charges and the auto being unavailable for use by other members of the household.

For nonresident air passengers, the influence of travel duration on access mode choice is more varied. For travel of one day or less in duration, rental cars (35%) and taxis (23%) are the most heavily utilized airport access modes. Presumably, this is because of the severe time constraints that a one-day traveler is under and, consequently, the high premium he/she places on reducing access travel time.

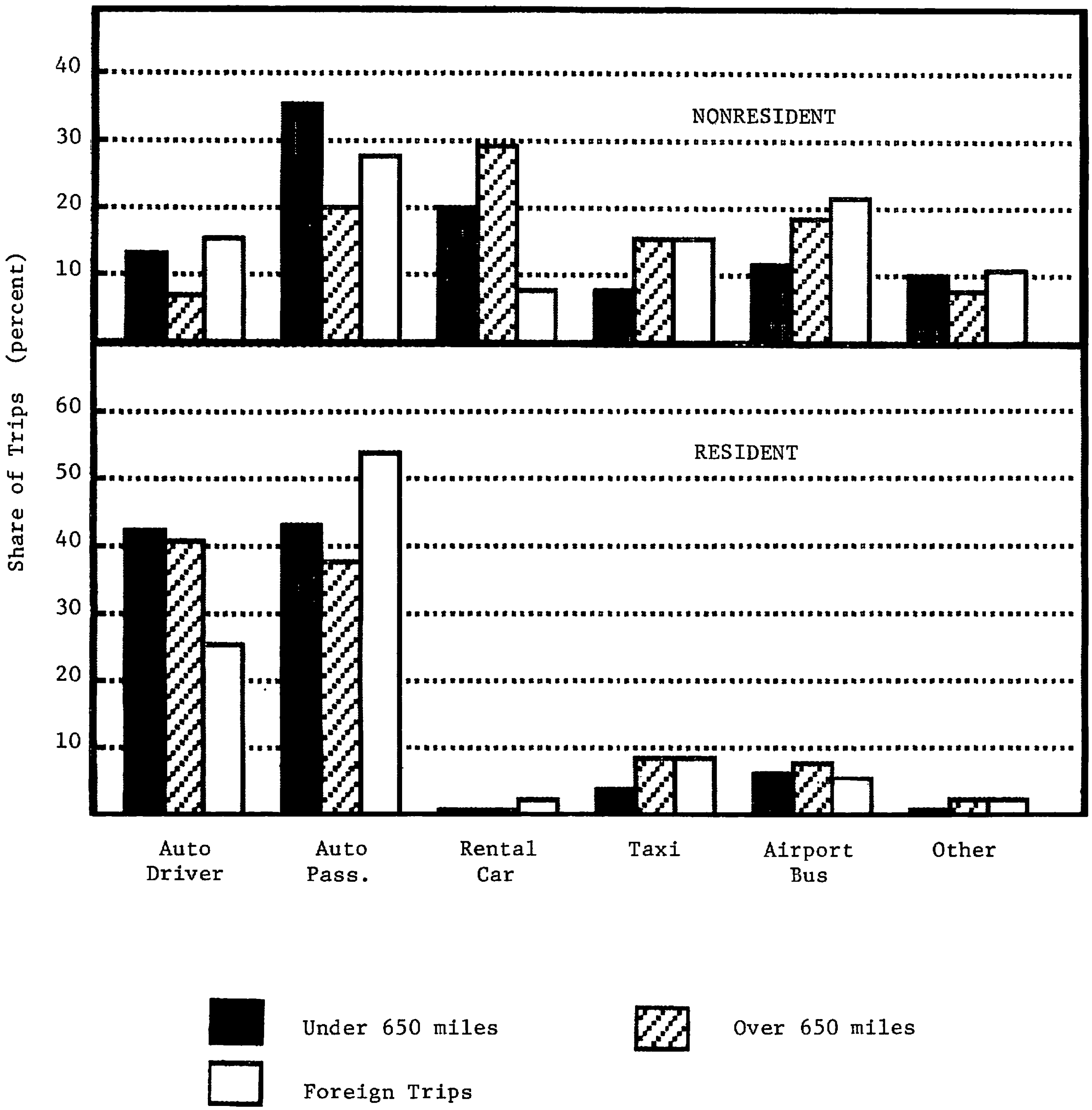


FIGURE 4.4

DISTRIBUTION OF ACCESS MODES: AIR TRIP ORIGIN/DESTINATION

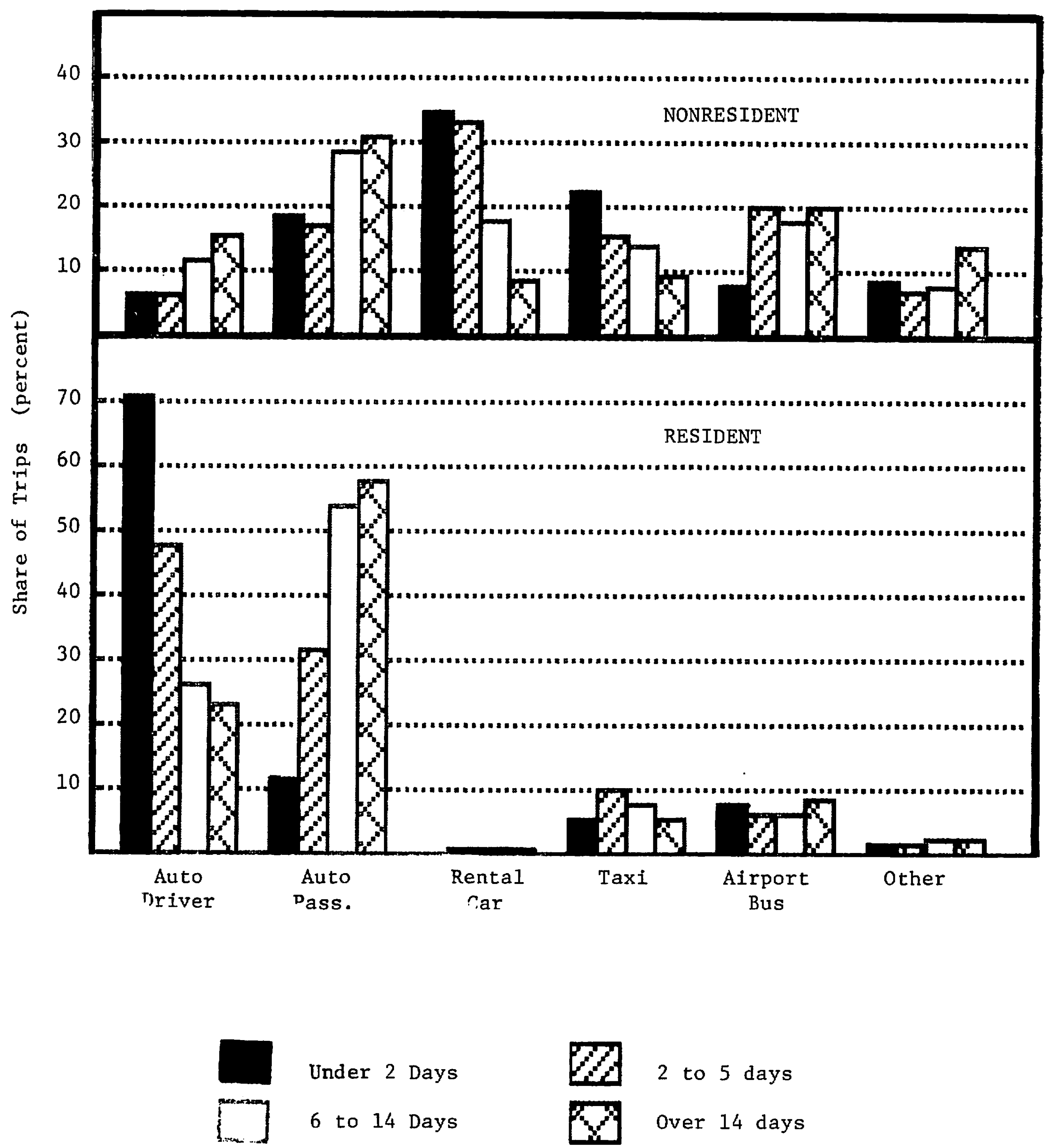


FIGURE 4.5

DISTRIBUTION OF ACCESS MODES: DURATION OF TRAVEL

For travel of two to five days duration, taxi use declines (from 23% to 16%), while airport bus use increases significantly (from 8% to 20%). This shift probably reflects a decreased priority on reduced travel time and an increased likelihood that the air traveler will be going first to his/her hotel which is more likely to be served directly by the airport bus.

Among nonresidents traveling in excess of five days, there is an increase in the use of the private auto (from 24% to 41%) and a corresponding decrease in rental car use (from 33% to 18%). This change probably reflects a shift in the predominant trip purpose from business to nonbusiness travel and the increased likelihood that the air passenger can be driven to the airport by a friend or relative.

4.6 Size of Travel Group

Air passengers who are traveling alone might be expected to behave differently in their choice of airport access mode than those who are traveling as part of a larger group. Among Washington area residents, however, there is no difference in the distribution of access modes by travel group size.

Among nonresident air passengers, travel group size does appear to have a small influence on the choice of airport access mode. As the relative size of the travel group increases, use of rental cars and taxis increase, while use of the airport bus declines. This is because the larger groups can take advantage of the extra passenger capacity offered by the rental car and taxi modes for no additional cost, while the airport bus charges each member of the travel group a separate fare.

The overall impact of travel group size on airport access mode shares is relatively small, however, because approximately 80 percent of all Dulles air passengers are either traveling alone or with only one other traveler. For both of these groups, the airport bus still enjoys a cost advantage over taxis and rental cars.

4.7 Amount of Luggage Carried

The amount of luggage carried by an air passenger is highly correlated with the duration of travel, but it may also have an independent influence on access mode choice due to the inconvenience of having to walk any distance or to transfer between vehicles with several pieces of luggage.

Among Dulles air passengers, as the amount of luggage increases, the likelihood of driving and parking at the airport and use of rental cars decreases. Correspondingly, air passengers with large amounts of luggage are more likely to be driven to the airport. Use of the airport bus and taxi also decline with increases in the amount of luggage, but these changes are relatively small compared to the declines in drive-alone auto and rental car use.

Overall, luggage is unlikely to be a major factor in the selection of airport access modes. Nearly 75 percent of the passengers surveyed carried two or fewer pieces of luggage with them on their trip, and there is no significant difference in the distributions of airport access modes between travelers who carry one or two pieces of luggage. Moreover, passengers carrying more than two pieces of luggage are typically on nonbusiness travel and are more likely to be driven to the airport by a friend or relative.

4.8 Income

An air passenger's income appears to have a small influence on his/her choice of airport access mode, particularly for nonbusiness travel. Over 10 percent of all Dulles airport bus users had incomes below $15,000 per year, compared to an average of 5 percent for all other access modes. Conversely, although 21 percent of the bus users had incomes over $50,000 per year, nearly one-third (32.5%) of the users of other modes reported incomes this high or higher. Thus, while the airport bus service is able to attract riders from all income levels, its comparatively lower fare strengthens its market position among lower income air passengers.

4.9 Auto Ownership

Since auto ownership has little or no relevance to access mode choice at the non-home end of an air trip, this characteristic was examined for Washington area residents only. Of those residents who were surveyed, more than half of the airport bus users (52.2%) came from households with one or fewer autos, compared to less than a quarter of the nonusers (23.2%). These findings further support the hypothesis that airport bus service will be attractive primarily to those resident air passengers who do not have access to an automobile or whose use of auto as an access mode would seriously inconvenience other household members.

4.10 Education

The level of education achieved by an air passenger has no apparent influence on his/her choice of airport access mode. In fact, over 90 percent of all Dulles air passengers reported that they had at least some college education, reflecting the typically higher education of air passengers in general.

4.11 Gender

Nearly three-fourths (74.6%) of all Dulles air passengers are male. Although males make up a slightly greater percentage of airport bus users (79.5%), this difference is not significant enough to suggest any difference in the choice behavior of males vs. females.

4.12 Awareness of Airport Bus Services

Approximately 76 percent of Washington area residents and 55 percent of the nonresident air passengers who use Dulles are aware of the Dulles airport bus service. Awareness of the service is somewhat greater among enplaning residents (78%) and deplaning nonresidents (59%), suggesting that many air passengers become informed of the bus service while at the airport.

Among those air passengers whose Washington area trip end is downtown DC, awareness of the Dulles-to-DC motor coach is even higher than that for Dulles air passengers in general (84% for Washington area residents and 62% for nonresidents). The increase is not unexpected, since awareness of this bus service is useful only to those who are actually travelling to downtown Washington.

Awareness of the Dulles-to-National Airport bus service is somewhat lower than that of the Dulles-to-DC service. Of those air passengers whose Washington area trip end was National Airport, only 75 percent of the residents and 51 percent of the nonresidents were aware of the service.

Awareness of the airport bus service should have an obvious influence on airport access mode choice in that those who are not aware of the bus cannot choose it. Survey responses do indicate significantly greater use of the bus by those who stated that they were aware of it. Twenty-seven percent of the Washington area residents and nearly 44 percent of the nonresidents who stated that they were aware of the bus service used it as their mode of access to the airport. On the other hand, nearly 12 percent of the Washington area residents and 27 percent of the nonresidents who said they were unaware of the bus service also used it. Either the survey itself made these respondents sufficiently aware of the bus to encourage them to use it, or the respondent's interpretation of awareness was different from what was intended in the survey.

4.13 Air Passenger Attitudes toward the Bus Service

In general, airport bus users tend to have favorable opinions about the bus service. A majority of nonresident bus users responded with positive ratings for 8 out of 10 attributes concerning bus service quality (see Table 4.1). Responses were most positive with respect to schedule adherence (73.0% positive), lack of annoyance by other passengers (72.5%), and cost of the trip (71.2%). Nonresident bus users viewed least favorably the ability to get from the bus to their final destination (32.8% positive) and the overall travel time by bus (44.8%).

Resident airport bus users also view the bus service favorably, although on average, they tend to be less favorable than nonresidents (see Table 4.2). Responses were most positive with respect to cost (71.9%), lack of annoyance by others (69.4%), and walking distance to the bus (67.6%). They were least positive regarding the ability to get from the bus to their final destination (34.3% positive), overall travel time by bus (39.4%) and comfort (47.9%). Surprisingly, bus schedule adherence, which was rated most positive by nonresident bus users (73.0%) was rated considerably lower by resident air passengers (61.6%).

Nonusers tend to be more neutral in their opinions about the bus service. A majority of nonresident nonusers responded with positive ratings for only one attribute -- cost (61.5% positive). Among resident nonusers, three service attributes received positive ratings -- schedule adherence (54.6%), lack of annoyance by others (54.4%), and cost (52.3%). Only one attribute -- the ability to get from the bus to their final destination -- was given a negative rating by a majority of both resident (52.2%) and nonresident (51.7%) nonusers.

TABLE 4.1. ATTITUDES TOWARD AIRPORT BUS SERVICE: NONRESIDENT AIR PASSENGERS

	Percent Favorable Rating		Percent Neutral Rating		Percent Unfavorable Rating	
	User	Nonuser	User	Nonuser	User	Nonuser
Schedule Adherence	73.0	45.4	15.9	33.3	11.1	21.3
Travel Fatigue	64.8	46.0	25.6	27.0	9.6	27.0
Annoyance by Others	72.5	46.8	20.8	33.1	6.7	20.1
Ease of Travel to Final Destination	32.8	15.5	37.0	32.8	31.2	51.7
Schedule Flexibility	53.9	22.3	33.0	49.1	13.0	28.6
Cost of Trip	71.2	61.5	19.5	28.9	9.3	9.6
Wait Time	60.7	27.8	23.1	45.5	16.2	26.7
Walk Distance to Bus	64.1	32.7	24.6	42.6	11.4	24.7
Overall Travel Time	44.8	20.3	39.7	49.4	16.5	30.2
Comfort	54.2	29.5	33.9	40.5	11.8	30.0
AVERAGE - ALL ATTRIBUTES	59.2	34.8	27.3	38.2	13.5	24.0

TABLE 4.2. ATTITUDES TOWARD AIRPORT BUS SERVICE: RESIDENT AIR PASSENGERS

	Percent Favorable Rating		Percent Neutral Rating		Percent Unfavorable Rating	
	User	Nonuser	User	Nonuser	User	Nonuser
Schedule Adherence	61.6	54.6	26.0	32.0	12.3	13.4
Travel Fatigue	63.9	48.3	20.8	30.8	15.3	20.9
Annoyance by Others	69.4	54.4	15.3	33.3	15.3	12.4
Ease of Travel to Final Destination	34.3	16.7	21.4	26.1	44.3	52.2
Schedule Flexibility	55.7	26.8	27.1	47.8	17.2	25.4
Cost of Trip	71.9	52.3	16.9	39.0	11.2	8.7
Wait Time	53.7	29.4	26.9	46.9	19.4	23.7
Walk Distance to Bus	67.6	37.1	18.3	46.7	14.1	16.2
Overall Travel Time	39.4	29.7	43.7	49.2	16.9	21.1
Comfort	47.9	36.6	38.0	47.3	14.1	16.2
AVERAGE - ALL ATTRIBUTES	56.6	38.6	25.4	39.9	18.1	21.5

All Dulles air passengers, regardless of residential status or mode choice, are fairly consistent in their assessment of the best and worst features of the bus service. Cost, lack of annoyance by others, and absence of fatigue were consistently ranked at or near the top by all four groups, while travel time and the ability to get from the bus to their final destination were ranked near the bottom. Air passengers were least in agreement with respect to schedule adherence. While nonresident bus users and resident nonusers ranked this attribute highest, the other groups ranked it near the middle of the set of bus attributes.

5. DEVELOPMENT OF AN AIRPORT ACCESS MODE CHOICE MODEL

One of the principal tasks in this study was to develop and calibrate policy-sensitive models of airport access mode choice for Dulles and National Airports. These models would enable Metropolitan Washington Airports (MWA) staff to investigate the ridership and revenue impacts of alternative airport bus service configurations, fare levels, and airport ground transportation policies to aid them in developing an improved ground transportation system for the two airports. This section briefly summarizes the model development process to give the reader a basic understanding of the assumptions inherent in the models, their limitations, and how they were applied in testing various policy scenarios. Specific policies and service configurations proposed by MWA staff and studied using the models are presented in Section 6.

5.1 Basic Modelling Assumptions

For an individual traveler, airport access is a joint decision consisting of 1) the decision to make an air trip, 2) the choice of airport, and 3) the choice of transportation to the airport. For the purposes of this modelling effort, it was assumed that these choices are made sequentially and conditionally. In other words, air travelers were assumed to choose their mode of access after they selected which airport to use. This allowed us to develop access mode choice models for each airport without having to explicitly model the airport choice decision.

The above assumption is, of course a simplification that may not be appropriate in all circumstances. In some cases, the availability and convenience of ground transportation may indeed be an important factor in airport choice. However, in the 1981-82 Washington-Baltimore Regional Air Passenger Survey, "better public ground transportation" was cited by less than two percent of the respondents as the primary reason for choosing one airport over another. The two most important reasons for selecting an airport were "convenience of airport location" (47%) and factors relating to the availability and convenience of the flight itself (39%). Since the policies and service changes to be examined by the models would not radically change the accessibility of one airport relative to another, it was felt that the assumption was reasonable for the purposes of this study.

5.2 Model Structure

The airport access mode choice decision was modelled using individual choice models. These mathematical models have been used extensively in urban transportation planning studies to forecast the demand for alternative travel modes under various transportation policy scenarios. They were also used in earlier airport access demand studies for the Washington metropolitan area.[1]

1. Peat, Marwick, Mitchell and Co., Airport Access in the Baltimore-Washington Region: Immediate-Action Improvement Program and Planning Guide, final report, March 1971.

Individual choice models are all based on the following relationship:

> The probability that an individual will choose a particular alternative is a function of the characteristics of the individual and the desirability of the chosen alternative relative to all other alternatives.

The desirability of an alternative is usually expressed as a linear combination of level of service variables known as a linear utility expression and illustrated in equation 5.1:

$$U_{bus} = 0.56 - 0.12 \text{ (in vehicle time)} - 0.28 \text{ (out of vehicle time)} - 0.04 \text{ (bus fare)} \qquad (5.1)$$

Each variable represents some characterestic of the alternative which helps to distinguish it from other alternatives. The relative influence of each variable in determining the overall desirability of the alternative is given by its associated coefficient. The constant term in equation 5.1 can be interpreted as representing the net influence of all factors not explicitly included as variables in the model. Specific values for the variable coefficients and the constant term are estimated as part of the model calibration process. These coefficients can then be used to compute values for the linear utility expression when new variable values are input.

In order to predict whether or not a particular alternative will be chosen, the value of its linear utility expression must be transformed into a probability value, ranging between zero and one. There are a number of mathematical functions that can be used to make this transformation, but the one used most often in individual choice modelling is the logit fuction. The mathematical expresion for a logit model is given in equation 5.2.

$$P_i = \frac{\exp(U_i)}{\sum_{j=1}^{n} \exp(U_j)} \qquad (5.2)$$

where P_i = the probability of choosing alternative i

U_i = the value of the linear utility expression associated with alternative i

n = the full set of choice alternatives available

Individual choice models cannot be calibrated using simple curve fitting techniques like linear regression models. This is because the dependent variable of the model is a probability, which cannot be directly observed.

What is observed are the actual choices made by individuals when they are faced with two or more alternatives. A technique known as maximum likelihood estimation is therefore used to calibrate the models. This procedure searches for coefficient values which, when multiplied by the observed values of the model variables, generate probabilities which are most likely to produce the observed distribution of choices for the calibration dataset. Various computer programs have been developed to perform maximimum likelihood estimation for logit models. The input data needed to run these programs include variables describing the individual and each available alternative and a dependent variable indicating which alternative was actually chosen. The output of these programs include computed values for each coefficient and constant term, and statistical measures indicating how well the calibrated model fits the observed data.

5.3 Calibration Data and its Limitations

Data for calibrating the airport access mode choice models were obtained from the 1981-82 Washington-Baltimore Regional Air Passenger Survey. This dataset contains survey records for 4861 air passengers enplaning at Dulles and 16,178 air passengers enplaning at National. Each survey record includes sociodemographic information on the air passenger, purpose of the air trip, mode of access to the airport, and the location in the Washington metropolitan area where the airport access trip began -- coded to one of COG's 78 aviation access zones.

The geographic coding was particularly important for calibrating and applying the models. The coding enabled us to link sociodemographic and choice information from the survey records with level of service information on alternative access modes, obtained from highway and transit networks developed by COG. The highway network data included over-the-road mileage and average off-peak travel times from each of the 72 internal aviation access zones to Dulles and National Airports. A separate network for airport bus/limousine service included scheduled travel times between off-site bus terminals and the two airports, walk or auto access times from each zone to the nearest bus terminal, and wait times based on scheduled headways. A third network was created for Metrorail access to National Airport. Like the airport bus/limousine network it included scheduled travel times from each Metrorail station to the National Airport Station, access times from each zone to the nearest Metrorail Station and from the National Airport Station to the terminal building, and wait and transfer times based on scheduled headways.

Both a base-year and a forecast-year set of networks were created by COG. The base year network reflected highway, Metrorail and airport bus/limousine service levels at the time of the 1981-82 Regional Air Passenger Survey. This network was used to calibrate and validate the airport access mode choice models. The forecast-year network incorporated planned improvements to the highway and Metrorail systems which would be operational by 1990. Major improvements reflected in the forecast-year network included completion of I-66 and the Dulles Access Road connector; completion of the Dulles Toll Road parallel lanes; extension of Metrorail service to Vienna, Huntington, Wheaton, Shady Grove, Anacostia, and the northern part of the District; and the creation of airport bus terminals in Bethesda, Springfield, and West Falls Church. The 1990 network served as the initial scenario for testing alternative airport bus service configurations.

The 1981-82 Regional Air Passenger Survey was used because: 1) it represented the most current data on airport choice for the Washington metropolitan region, and 2) it could be linked, as described above, to level-of-service data for both model calibration and forecasting purposes. On the other hand, the survey data also lacked several important pieces of information:

1. **There were no observations of deplaning or transferring passengers, or of passengers boarding international flights.**

   While the decisions not to survey these groups were undoubtedly made in order to improve sampling efficiency and to simplify survey administration procedures, in each case a market with a higher than average share of airport bus users was excluded from the sample. Consequently, the resulting calibration dataset exhibited some bias against airport bus use when compared to the entire population of air travelers.

2. **There was no information on the air passenger's awareness of airport bus service.**

   Although it is obvious that individuals who are not aware of airport bus service will not use it, it is not evident from the dataset just who those individuals were. The absence of this information had two important implications for model development. First, it created additional bias against airport bus use by not enabling us to distinguish between air passengers who would choose airport bus if they were aware of it and those who were aware of the bus but chose another airport access mode. Second, it precluded us from explicitly investigating the ridership impacts of a marketing campaign to increase awareness of airport bus service among Washington air passengers.

3. **There was no information on auto availability or duration of air travel for Washington area residents.**

   Both of these attributes exhibited a significant correlation with the choice of airport access mode in the analysis presented in Section 4. More specifically, as the duration of the air trip increased, individuals were less likely to drive to the airport alone and more likely to be driven. And by not knowing whether an air passenger had an auto available for the trip to the airport, we could not distinguish between those who would choose the auto if it were available and those for whom it was available but chose another mode anyways. Consequently, the data also exhibited some bias against the private auto mode.

5.4 Variable Selection and Model Building

Given the above limitations, model development proceeded with the creation of calibration files containing those variables most likely to be included in the access mode choice models. Each calibration file consisted of a set of records, with each record containing information on an individual air passenger and his or her ground transportation alternatives to the airport. Figure 5.1 lists and briefly describes the sociodemographic and level of service variables contained in each record.

Level of Service Variables

(values developed separately for each airport access mode)

TTIME - zone-to-zone travel times derived from 1981 highway and transit networks developed by COG

XTIME - all times other than zone-to-zone travel times, including walk and auto access to transit and airport bus, wait and transfer times, intrazone travel times, and auto parking time

TCOST - all out-of-pocket costs associated with the airport access trip, including fares for transit, taxi and airport bus, mileage costs for auto, and prorated rental charges for rental car

HDWAY - a dummy (0,1) variable which takes on a value of one if the airport bus mode is on a route that runs at least one bus per hour

Traveler Characteristics

(values developed for each airport traveler observation)

RESID - Residential Status; separate models developed for Washington area residents and nonresidents

INCOME - a dummy (0,1) variable which takes on a value of one if the traveler's annual household income is $10,000 or more

PURP - a dummy (0,1) variable which takes on a value of one if the traveler's air trip is business related

STAY - a dummy (0,1) variable which takes on a value of one if the traveler's stay in the Washington metropolitan area is one day or less (Because of data limitations, this variable could be computed only for nonresidents.)

FIGURE 5.1. VARIABLES USED IN MODEL DEVELOPMENT AND CALIBRATION

Four separate calibration files were created:

1. Washington area residents enplaning at Dulles
2. Nonresident air passengers enplaning at Dulles
3. Washington area residents enplaning at National
4. Nonresident air passengers enplaning at National

Each of these files represented a clearly identifiable submarket of airport users. More importantly, it was felt that the characteristic differences between these submarkets could be better represented by separate models, containing different variables and coefficients, than by one or more additive terms in a single composite model.

The separate calibration files also made it easier to specify the set of access modes available to each submarket. It was assumed that two modes -- taxi and auto passenger -- were available to all air passengers. Airport bus service was also available to all air passengers except those originging from zones where the travel time to reach the nearest bus terminal was greater than the time required to reach the airport itself. Metrorail service was assumed to be available only to passengers enplaning at National Airport. The auto driver mode was assumed to be available only to Washington area residents, while the rental car mode was limited to nonresidents. All other modes were eliminated from the files because the numbers of observations were insufficient for model calibration.

Prior to creating the calibration files, the original survey dataset was screened to eliminate observations containing missing data, travel by modes other than those specified above, or trips originating from zones outside the internal 72-zone network. In addition, the size of the National Airport dataset was reduced by taking a 1/6 random sample. These screening and sampling procedures resulted in calibration files containing 1654 observations of residents enplaning at Dulles, 1433 observations of nonresidents enplaning at Dulles, 683 observations of residents enplaning at National, and 906 observations of nonresidents enplaning at National.

Model building and calibration were carried out using the TROLL logit analysis program.[2] Models built using this program must specify one choice alternative as a "base", against which all other alternatives are compared. For our modelling efforts, the "auto passenger" was specified as the base mode because it was available to all observations, and it generally had the highest mode share for each market. By specifying the auto passenger as the base mode, the calibrated coefficients would more readily reveal the relative strengths and weaknesses of the other available access modes.

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2. TROLL is a computer-based package of econometric analysis programs developed under a National Science Foundation Grant by the Massachusetts Institute of Technology and the National Bureau of Economic Research, Inc.

A number of alternative model specifications were tested for each of the four markets. The models were evaluated on the basis of three criteria:

1. The reasonableness of the sign and magnitude of each variable coefficient

2. The statistical significance of each coefficient

3. The statistical goodness-of-fit of the overall model

Early model specifications emphasized the inclusion of level-of-service variables over sociodemographic variables. However, it soon became evident that variables based on zone-to-zone travel times could not be incorporated into the models in any meaningful way. Not only were the calibrated coefficients for these variables statistically insignificant, but the signs of the coefficients were often counterintuitive -- they implied that air passengers preferred those access modes which took longer to get to the airport. Travel cost coefficients were also found to be statistically insignificant and small in magnitude, implying that this variable's contribution to the mode choice decision was negligible. However, in those models where the sign of the coefficient was intuitively correct, the variable was included anyway.

Level of service variables which were found to be both reasonable with respect to sign and magnitude and statistically significant included access time and airport bus frequency. Access time was a composite of all times associated with using a particular access mode excluding actual zone-to-zone travel time. Airport bus frequency was a dummy (0,1) variable which identified those zones where airport bus/limousine service ran at least one bus per hour. Sociodemographic variables which were generally found to be both reasonable and statistically significant included 1) a dummy variable indicating whether the air trip was business or nonbusiness, and 2) a dummy variable indicating whether the duration of the trip was one day or longer. Because of data limitations discussed earlier, this latter variable was available only for nonresident air passengers.

5.5 Model Results

Figures 5.2 and 5.3 present the final calibrated models and their associated goodness-of-fit statistics for each of the four major airport access markets.

All of the models were relatively weak in their ability to "explain" the access mode choice behavior of air passengers. While the individual variable coefficients were, in general, statistically significant, the goodness-of-fit measures for the overall models were low relative to other urban mode choice models. In general, the models tended to overassign trips to the more frequently used access modes and to underassign trips to less frequently used modes. This problem is characteristic of most models calibrated using maximum likelihood estimation techniques, however, and is not necessarily an indication of a serious defect in the models themselves.

1. RESIDENT MODEL

Model Coefficents and t-scores

	Constant	XTIME	TCOST	HDWAY
Airport Bus	0.793 **(2.04)**	-0.213 **(10.75)**	-0.0004 (0.67)	1.854 **(7.49)**
Taxi	-0.441 **(4.07)**	-0.213	-0.0004	
Auto Driver	0.098 (1.19)	-0.213	-0.0004	
Auto Passenger		(base mode)		

Pseudo R^2 = 0.20

2. NONRESIDENT MODEL

Model Coefficients and t-scores

	Constant	XTIME	TCOST	HDWAY	PURP	STAY
Airport Bus	0.217 (0.56)	-0.163 **(9.11)**	-0.0014 (2.00)	1.536 **(6.99)**	1.433 **(6.65)**	-0.796 **(3.26)**
Taxi	-0.830 **(5.54)**	-0.163	-0.0014		1.594 **(9.39)**	-0.520 **(2.97)**
Rental Car	1.431 **(4.74)**	-0.163	-0.0014		1.947 **(13.30)**	-0.627 **(4.18)**
Auto Passenger		(base mode)				

Pseudo R^2 = 0.16

(Student's t-scores are given in parentheses below the coefficient values; t-scores in **bold type** indicate significance at the 95% confidence level.)

FIGURE 5.2. DULLES AIRPORT ACCESS MODE CHOICE MODEL

1. RESIDENT MODEL

	Model Coefficients and t-scores		
	Constant	XTIME	PURP
Airport Bus	-2.991 (7.15)	-0.002 (3.34)	-0.305 (0.46)
Metrorail	-1.679 (7.07)	-0.002	0.746 (2.49)
Taxi	-0.744 (4.72)	-0.002	0.695 (3.36)
Auto Driver	-1.022 (6.01)	-0.002	1.242 (5.93)
Auto Passenger		(base mode)	

Pseudo R^2 = 0.19

2. NONRESIDENT MODEL

	Model Coefficients and t-scores				
	Constant	XTIME	TCOST	PURP	STAY
Airport Bus	-2.365 (7.13)	-0.0008 (0.47)	-0.0001 (0.06)	1.669 (4.13)	-1.404 (3.08)
Metrorail	-1.764 (7.44)	-0.0008	-0.0001	1.092 (3.79)	0.613 (2.28)
Taxi	-0.691 (4.39)	-0.0008	-0.0001	1.913 (9.43)	-0.159 (0.82)
Rental Car	-1.687 (7.36)	-0.0008	-0.0001	2.128 (7.78)	-0.332 (1.42)
Auto Passenger			(base mode)		

Pseudo R^2 = 0.19

(Student's t-scores are given in parentheses below the coefficient values; t-scores in bold type indicate significance at the 95% confidence level.)

FIGURE 5.3. NATIONAL AIRPORT ACCESS MODE CHOICE MODEL

5.6 Model Application Strategy

Each of the models presented in figures 5.2 and 5.3 estimates the airport access mode shares for one or more distinct air traveler markets. In addition to the obvious distinction between Washington area residents and nonresidents, the models also distinguish between business and nonbusiness travelers and, for nonresidents, between one-day and multi-day air trips. Each of these markets represents some portion of the overall air passenger market for the Washington metropolitan area.

In order to calculate the overall mode share for some defined geographic area such as an aviation access zone, the mode shares for each of the above air traveler markets must be combined. This was done by 1) weighting each market's mode share by the relative size of that market in the zone, then 2) adding together all of the weighted market mode shares to get an overall mode share for the zone.

The relative sizes of the resident/nonresident and business/nonbusiness markets were estimated using the distributions found in the 1981-82 Washington-Baltimore Regional Air Passenger Survey. These distributions are displayed in figures 5.4 and 5.5. The proportion of one-day versus multi-day air trips was assumed to be equal across all zones since there was no reason to believe that travel duration should be related to the traveler's origin zone.

5.7 Model Validation

Using the procedures outlined above, the calibrated models were applied to zonal level of service data from COG's 1981 highway and transit networks. These model runs provided a validation test of the models' ability to replicate observed zonal mode shares. Moreover, they established a base set of model-derived zonal mode shares against which alternative scenarios could be compared.

The zonal distributions of airport bus mode shares for Dulles and National, as derived from the models, are presented in figures 5.6 and 5.7, respectively. These distributions may be compared with the observed airport bus market shares shown in figures 2.5 (Dulles) and 3.4 (National).

A comparison of figure 5.6 with figure 2.5 reveals some difference between the model-derived and the observed airport bus mode shares to Dulles. There is a fairly consistent tendency for the model to overestimate bus use from more affluent zones (e.g., McLean and Vienna) while underestimating bus use from less affluent zones in the District (e.g., Northeast Washington and Anacostia). The model also exhibits a slight distance bias by overestimating bus use from zones closer to the airport and underestimating bus use from more distant zones. Finally, certain zones whose travel time to an airport bus stop exceeded the travel time to the airport itself were excluded altogether from the model, resulting in an underestimation of bus trips from these zones.

Although the validation results could probably be improved by inclusion of both an income variable and a travel time or distance variable in the Dulles models, it was decided not to do this. In developing and calibrating the

FIGURE 5.4

DISTRIBUTION OF RESIDENT TRIPS IN THE BALTIMORE-WASHINGTON AREA

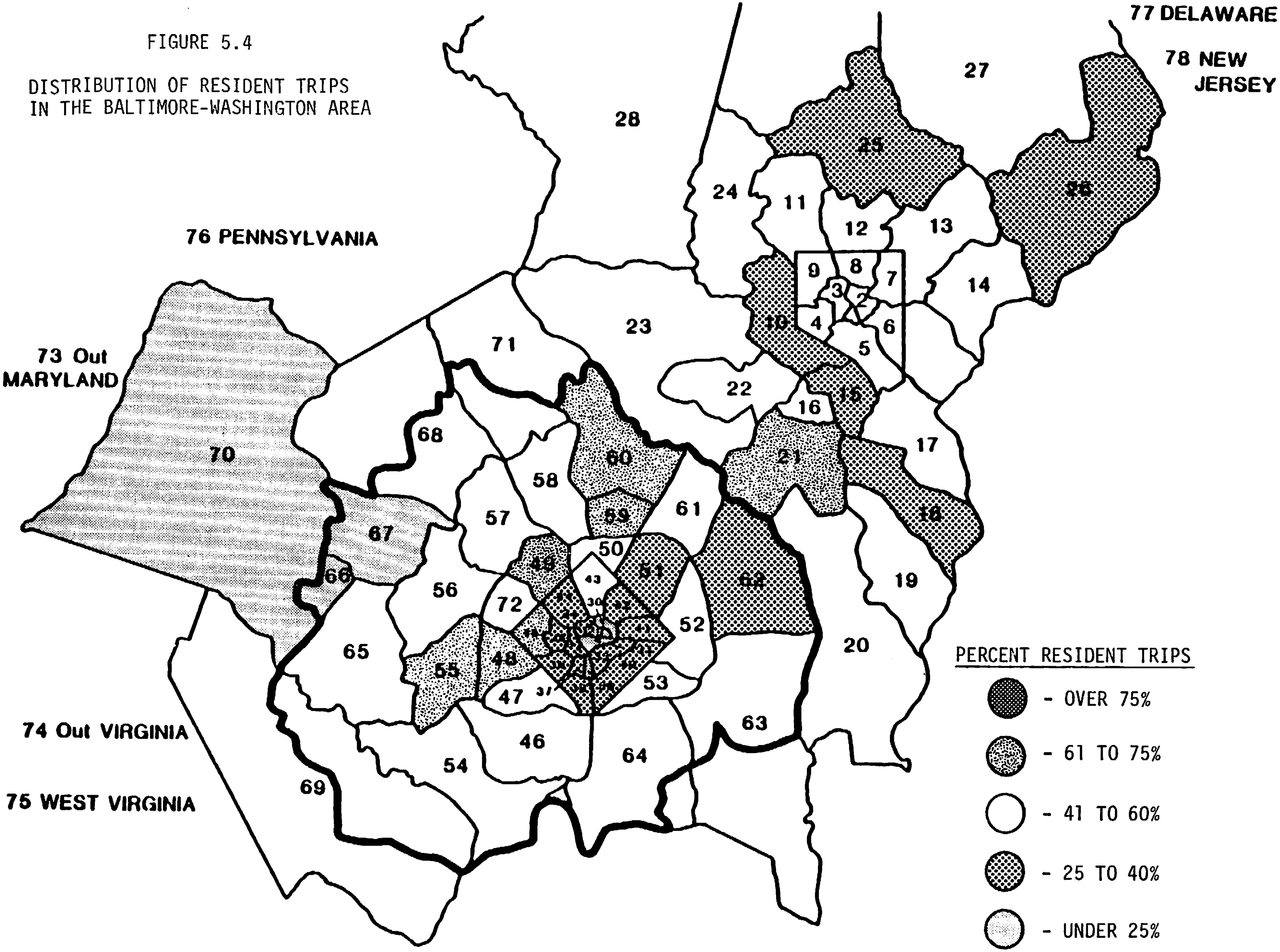


FIGURE 5.5

DISTRIBUTION OF BUSINESS TRIPS IN THE BALTIMORE-WASHINGTON AREA

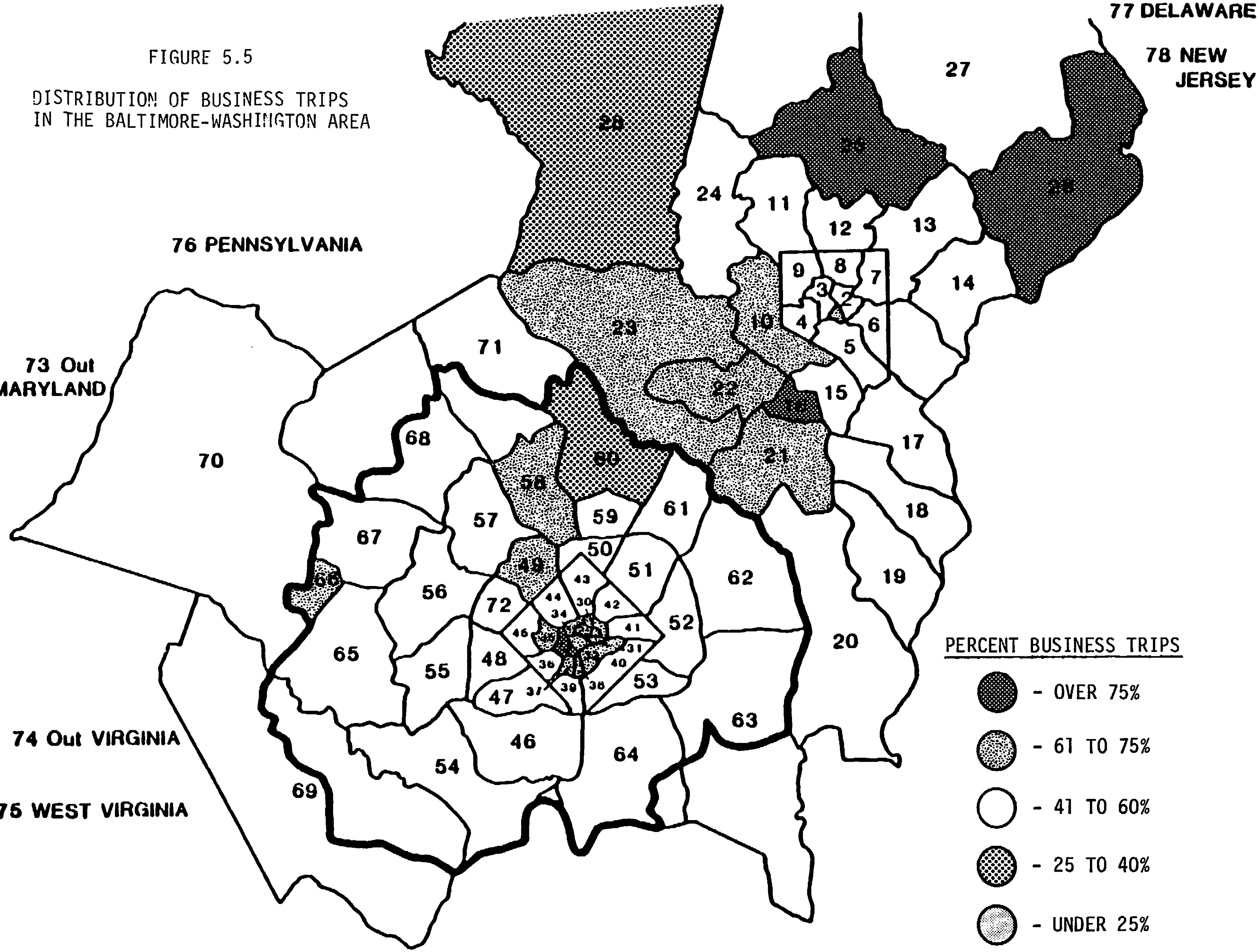


FIGURE 5.6

DULLES 1981 AIRPORT BUS
MARKET SHARE FROM MODELS

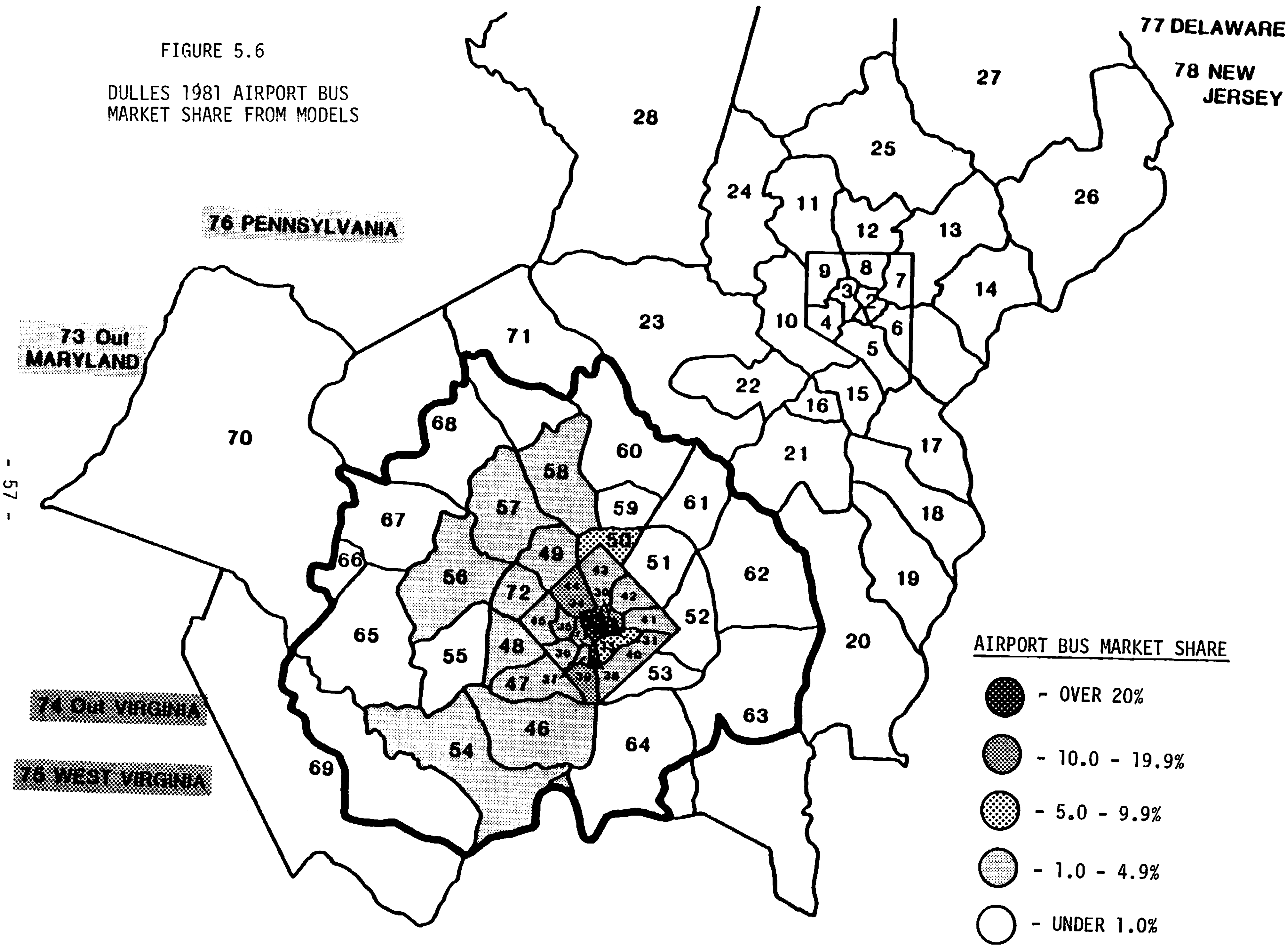
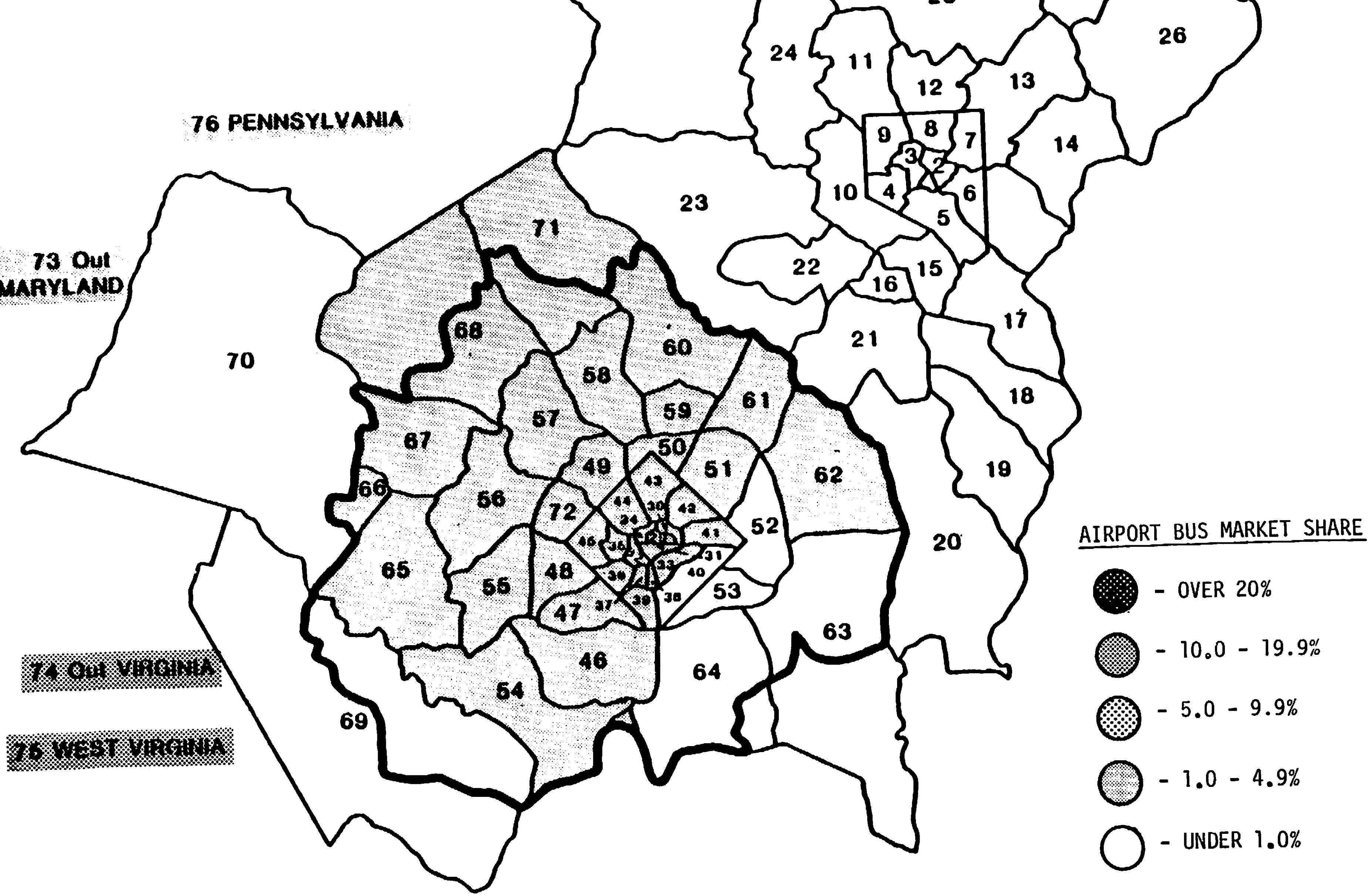


FIGURE 5.7

NATIONAL 1981 AIRPORT BUS MARKET SHARE FROM MODELS



Dulles models, both income and travel time were tested and neither of these variables were found to be statistically significant. Moreover, the inclusion of zone-to-zone travel times in the models seemed to adversely affect the explanatory power of other level of service variables -- most notably, access time and travel cost. The decision not to include income was based largely on the difficulty of forecasting this variable, especially at the zonal level.

The airport access mode choice models for National Airport exhibit very little sensitivity to any level of service variable. Consequently, there is virtually no variation in the airport bus mode shares across zones, as illustrated in figure 5.7. This general insensitivity to level of service variables was exhibited in all of the models developed for National Airport. It strongly indicates that airport bus users at National are essentially a captive market; that is, they will not be greatly affected by either moderate improvements or degradation of service. Moreover, it suggests that application of the National Airport mode choice model would provide little useful information under most of the alternative service scenarios to be studied. Consequently, a decision was made to not apply the National Airport mode choice models in any of the policy scenarios. Instead, a single forecast of National Airport bus patronage was generated by scaling up 1981 ridership distributions to levels consistent with 1990 National Airport air passenger activity forecasts. This forecast is presented in the next Section.

6. ESTIMATES OF AIRPORT BUS PATRONAGE UNDER ALTERNATIVE POLICY SCENARIOS

The airport access mode choice models described in Section 5 were used to estimate airport bus patronage under a variety of scenarios representing different service configurations and fare levels. This Section presents the results of those scenarios and interprets those results with respect to revenues and vehicle requirements.

6.1 Dulles Airport Bus Policy Scenarios: An Overview

Six future scenarios, representing different combinations of airport bus service headways, fares, and means of access to the bus terminal were examined using the Dulles airport access mode choice models described in Section 5. The six scenarios identified below are discussed in Sections 6.2 through 6.7:

1. 1990 Base Network
2. Metrorail Access to West Falls Church
3. Limousine Access to Downtown Washington, Springfield and Bethesda
4. Reduction of Airport Bus Headways at Suburban Terminals
5. Reduced Headways and Limousine Access
6. Increased Airport Bus Fares

In order to assure maximum comparability among the scenarios, a single design year -- 1990 -- was selected. Highway and transit network data used in the scenarios were modified by COG to reflect new facilities or major upgrades to existing facilities scheduled to be operational by 1990. Planned improvements having potentially significant impacts on airport access trips to Dulles and National Airports included:

1. Completion of I-66 inside the I-495 Beltway, and completion of the I-66/Dulles Access Road Connector;

2. Completion of the Dulles Access Road parallel toll lanes from I-495 to Dulles Airport;

3. Upgrading of Virginia Route 28 from U.S. 29/211 to the Prince William County line;

4. Extension of the Metrorail Orange Line to Vienna, including the opening of the West Falls Church Station;

5. Extension of the Metrorail Blue Line to Huntington Station;

6. Extension of the Metrorail Red Line to Wheaton and to Shady Grove;

7. Opening of the Metrorail Yellow Line Potomac River Bridge connecting the Pentagon and L'Enfant Plaza Stations;

8. Opening of the Metrorail Green Line between Anacostia and U Street.

Estimates of overall Dulles air passenger activity were based on a design year of 1990. According to latest FAA Terminal Area Forecasts for Washington area airports, annual enplanements at Dulles International Airport are expected to reach 3.018 million by 1990. However, this figure does not reflect any diversion of air passengers from National Airport in response to the FAA's proposed cap of 16 million passenger movements per year. If this cap is strictly enforced, and if the spillover were to be distributed proportionally between Dulles and Baltimore-Washington International, then Dulles could expect an additional 193,000 enplanements in 1990. For the purposes of this study, therefore, it was assumed that in the design year 1990, annual enplanements at Dulles would reach 3.211 million. This is roughly equivalent to 6.422 million total air passenger movements (enplanements and deplanements) per year, or 17,600 air passenger trips per day. This last figure represents the potential daily market for airport bus services at Dulles airport.

A basic airport bus service configuration was developed for the Dulles demand analysis. It was assumed that direct, nonstop motor coach service would be available between Dulles and each of five offsite airport bus terminals located throughout the Washington metropolitan area. These terminals and their proposed locations are presented below:

1. Downtown Washington (zone 29) - 16th & K Streets, NW
2. National Airport (zone 38) - Outside Main Terminal
3. West Falls Church (zone 48) - Metrorail Station
4. Springfield (zone 46) - Springfield Hilton
5. Bethesda (zone 49) - Marriott Bethesda

Each of these terminals was assumed to serve a specific, nonoverlapping geographic section of the Washington metropolitan area. The marketsheds for each terminal are shown in Figure 6.1.

Enplaning air passengers would be able to access the bus terminals from their origin zones by auto or, in the case of certain zones in downtown Washington (zone 29) or National Airport (zone 38), by walking. In addition, under certain scenarios, other means of access to the bus terminals would be available, including Metrorail and dial-a-ride limousine feeder service. Specific assumptions regarding these other access modes are discussed in the relevant scenarios.

The minimum number of buses required to serve each of the above routes is a function of 1) the total time required for a bus to complete one round trip circuit of the route, and 2) the scheduled headway between buses. Actual bus requirements could exceed this minimum if the anticipated demand on a route were greater than that route's daily passenger capacity. Estimates of daily passenger capacity were computed for each route based on the following assumptions:

1. Airport bus service was assumed to be in operation from 6:00 am to 11:00 pm daily on all five routes.

2. The seating capacity for an airport bus motor coach was assumed to be 45 passengers.

FIGURE 6.1

MARKETSHEDS FOR DULLES AIRPORT BUS TERMINALS

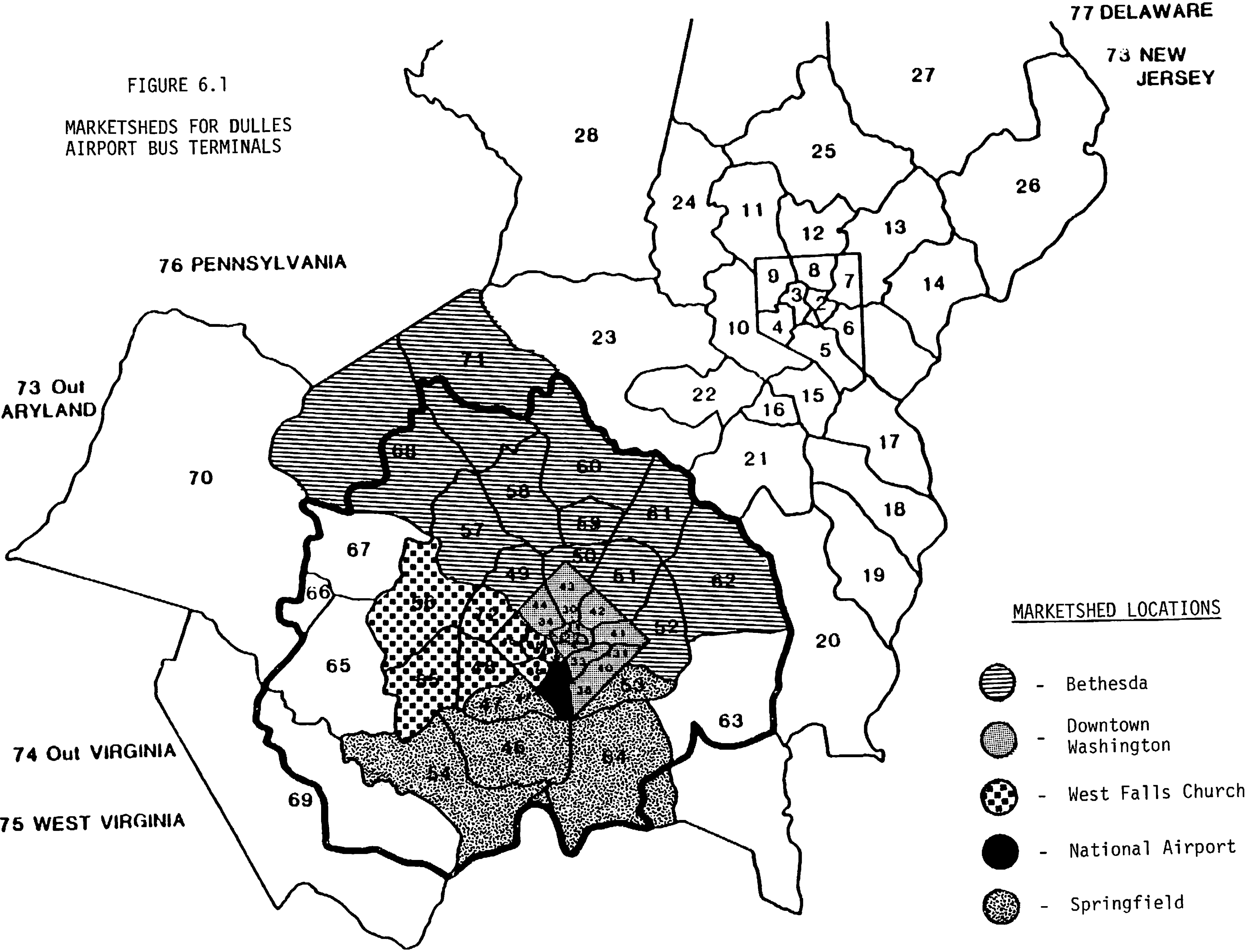


Table 6.1 presents the minimum vehicle requirements and daily passenger capacity on each of the five proposed routes serving Dulles Airport. Two different headway options are included for the Springfield, Bethesda, and West Falls Church routes.

TABLE 6.1. VEHICLE REQUIREMENTS AND DAILY PASSENGER CAPACITY FOR DULLES AIRPORT BUS SERVICE

	Circuit Travel Time[1]	Minimum Vehicles Required	Total Veh-Hrs per Day[2]	Daily Passenger Capacity
Downtown Washington (30 minute headways)	2 hr.	4	68	3060
National Airport (30 minute headways)	2 hr.	4	70[3]	3150
West Falls Church (30 minute headways)	1 hr.	2	34	3060
(15 minute headways)	1 hr.	4	68	6120
Bethesda (1 hour headways)	2 hr.	2	34	1530
(30 minute headways)	2 hr.	4	68	3060
Springfield (1 hour headways)	2 hr.	2	34	1530
(30 minute headways)	2 hr.	4	68	3060

1. Round-trip circuit travel time estimates include actual over-the-road travel times plus scheduled layover times to pick up and discharge passengers and luggage at each stop.

2. Total vehicle hours are computed as the product of the number of vehicles operating on a route under a given headway option times the number of operating hours (i.e., 17 hours/day).

3. Bus service between Dulles and National Airports include two extra vehicle trips per day.

6.2 SCENARIO 1: 1990 Base Network

This scenario provides a base against which alternative airport bus service configurations and policies can be compared. It represents the minimum change from current airport bus operating practices in terms of fares and schedules.

6.2.1 Airport Bus Service Configuration

Under this scenario, airport bus service to Dulles is assumed to be available from each of the five offsite terminals. Bus service headways and fares are listed below:

TABLE 6.2. 1990 BASE NETWORK SERVICE LEVELS

	Average Headway (minutes)	Minimum Vehicles Required	Fare (dollars)
Downtown Washington	30	4	8.00
National Airport	30	4	8.00
West Falls Church	30	2	5.00
Springfield	60	2	9.00
Bethesda	60	2	9.00

Access to the airport bus terminals is assumed to be only via auto or by walking.

6.2.2 Demand Forecasts under this Scenario

Based on forecasts from the models, Dulles airport bus patronage under this scenario was estimated to average 1466 trips per day. Figure 6.2 shows the distribution of airport bus trip ends by zone; Table 6.3 aggregates these trip ends by bus route.

Compared to airport bus patronage reported by the current operator for 1982, these estimates represent an increase in average daily ridership of 144 percent, but a decrease in airport bus market share from 8.8 to 8.3 percent. Thus, the entire gain in airport bus ridership under this scenario can be attributed solely to the overall growth (159%) in air passenger activity at Dulles. Moreover, on only two routes -- National Airport and West Falls Church -- did the growth in airport bus ridership exceed the overalll growth in air passenger activity.

FIGURE 6.2

DULLES AIRPORT BUS PATRONAGE
UNDER 1990 BASE NETWORK

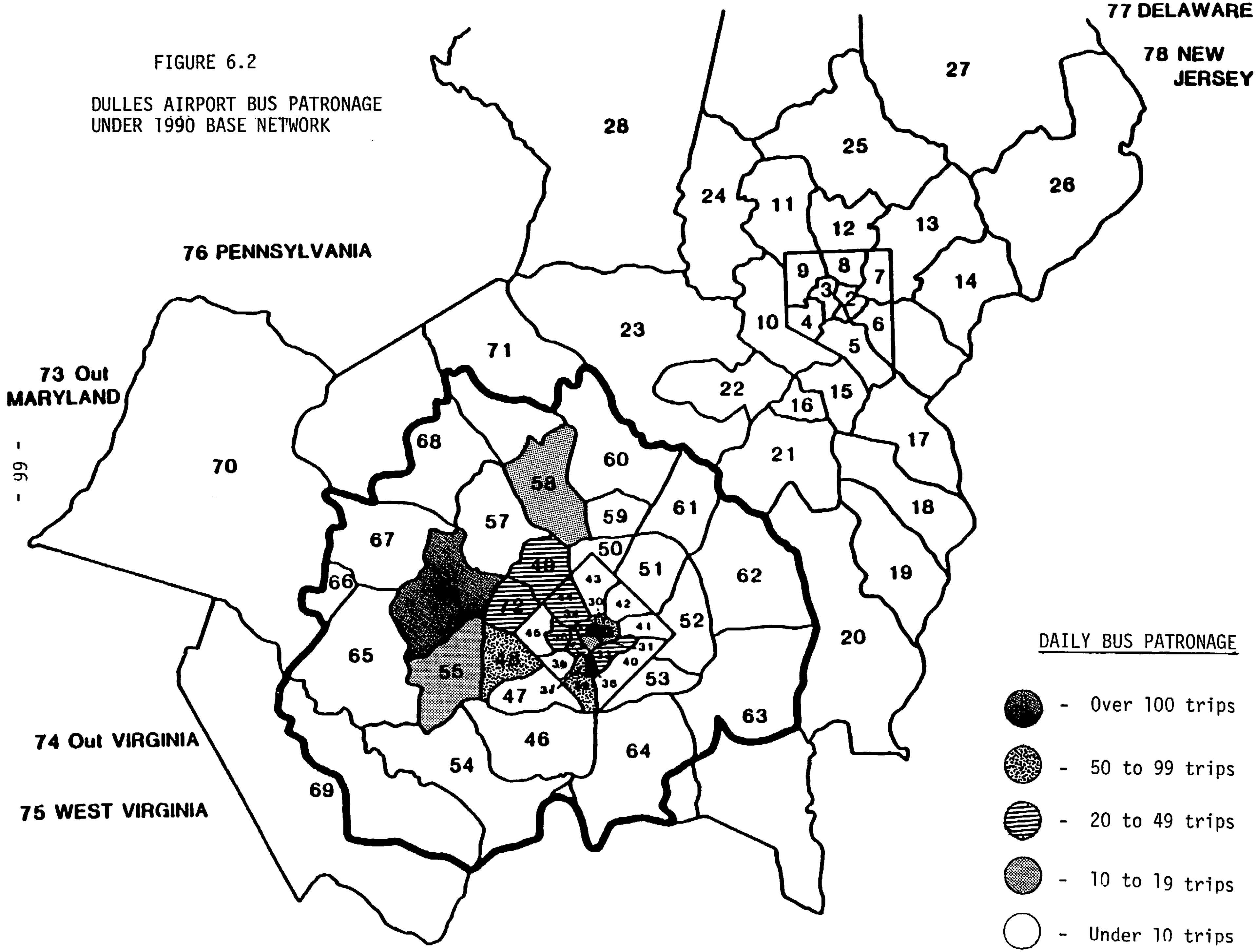


TABLE 6.3. 1990 BASE NETWORK PATRONAGE AND REVENUE FORECASTS

	Total Daily Patronage	Revenue ($/Veh-Hr.)
Downtown Washington	557	65.53
National Airport	539[1]	61.60
West Falls Church	309	45.44
Springfield	11	2.91
Bethesda	50	13.24
TOTAL	1466	45.64

1. Total daily patronage estimates for the National Airport route include 300 bus trips per day taken by air passengers transferring between Dulles and National Airports which were not explicitly accounted for in the models.

The projected growth in airport bus patronage from zones served by the West Falls Church terminal is 836 percent, with most of this increase coming from suburban zones adjacent to the terminal. Since West Falls Church does represent a new terminal not in existence in 1982, it should be expected to induce some new demand from adjacent zones. However, it is unlikely that it would be able to generate the volume of bus trips predicted by the models when one considers that virtually all access from these zones would be via auto and that air passengers originating from Fairfax City (zone 55) and Vienna (zone 56) would have to travel away from Dulles to get to the West Falls Church terminal. Therefore, this forecast should be regarded as optimistic.

6.2.3 Estimated Revenues and Vehicle Requirements

The last column in Table 6.3 presents estimated average revenues per vehicle-hour, derived from the patronage forecasts, fares, and daily revenue vehicle-hours by route. If we assume that airport bus operating costs average between 25 and 35 dollars per vehicle-hour, the Downtown Washington, National Airport, and West Falls Church routes all appear to generate sufficient revenues to make them profitable. On the other hand, the Bethesda and the Springfield routes are clearly money losers. By cross-subsidizing these low patronage routes from the more profitable routes, the overall bus system can be operated at a profit, as indicated by the average systemwide revenue.

Comparing the estimated daily patronage under this scenario against the average daily passenger capacity per route given in Table 6.1, it is clear that the minimum vehicle requirements needed to maintain scheduled headways are more than sufficient to accommodate projected passenger demand. In fact, the projected demand on all five routes could be accommodated even if the 45-passenger motor coaches were replaced by 9-passenger limousines. However, this would mean that the Downtown Washington route would be operating at 91 percent of capacity and the National Airport route would be at 85 percent of capacity. In order to provide adequate capacity to handle peak demand loads during the day, no route should be operated at an average load factor above 80 percent. Consequently, both the Downtown Washington and National Airport routes should be served using 45-passenger motor coaches at all times. Overall vehicle requirements under this scenario would therefore include eight motor coaches for the Downtown Washington and National Airport routes, plus six 9-passenger limousines for service to West Falls Church, Springfield, and Bethesda.

6.3 SCENARIO 2: Metrorail Access to West Falls Church

This scenario examines the change in both overall demand for airport bus trips and the distribution of demand among the five airport bus terminals when some portion of the Dulles air passenger market is assumed to use Metrorail to get to the bus terminal.

6.3.1 Airport Bus Service Configuration

Airport bus headways and fares are assumed to be the same as in Scenario 1. Also as in Scenario 1, air passengers may access the offsite terminals by auto or walking. In addition, however, the West Falls Church terminal is assumed to serve as a single collection point for all airport bus passengers who use Metrorail as their access mode. The marketshed for Metrorail service includes zones having direct Metrorail service as well as those zones where the access time to a Metrorail station is less than that to the nearest airport bus terminal. Figure 6.3 identifies those zones in the Metrorail marketshed.

6.3.2 Demand Forecasts under this Scenario

Under this scenario, airport bus patronage was estimated to increase by 44 trips per day to 1510, with nearly all of this additional patronage coming from zones located in the District and along Metrorail lines. While the distribution of bus trip ends by zone is not significantly different from that shown in Figure 6.2, there is a significant difference in the distribution of those bus trips by terminal. As shown in Table 6.4, the number of airport bus patrons using the West Falls Church terminal increased by nearly 100 percent over Scenario 1, with corresponding decreases in use of the Downtown Washington and National Airport terminals. Airport bus use out of the Bethesda and Springfield terminals was unaffected by the availability of Metrorail access.

FIGURE 6.3

MARKETSHED FOR METRORAIL SERVICE TO WEST FALLS CHURCH

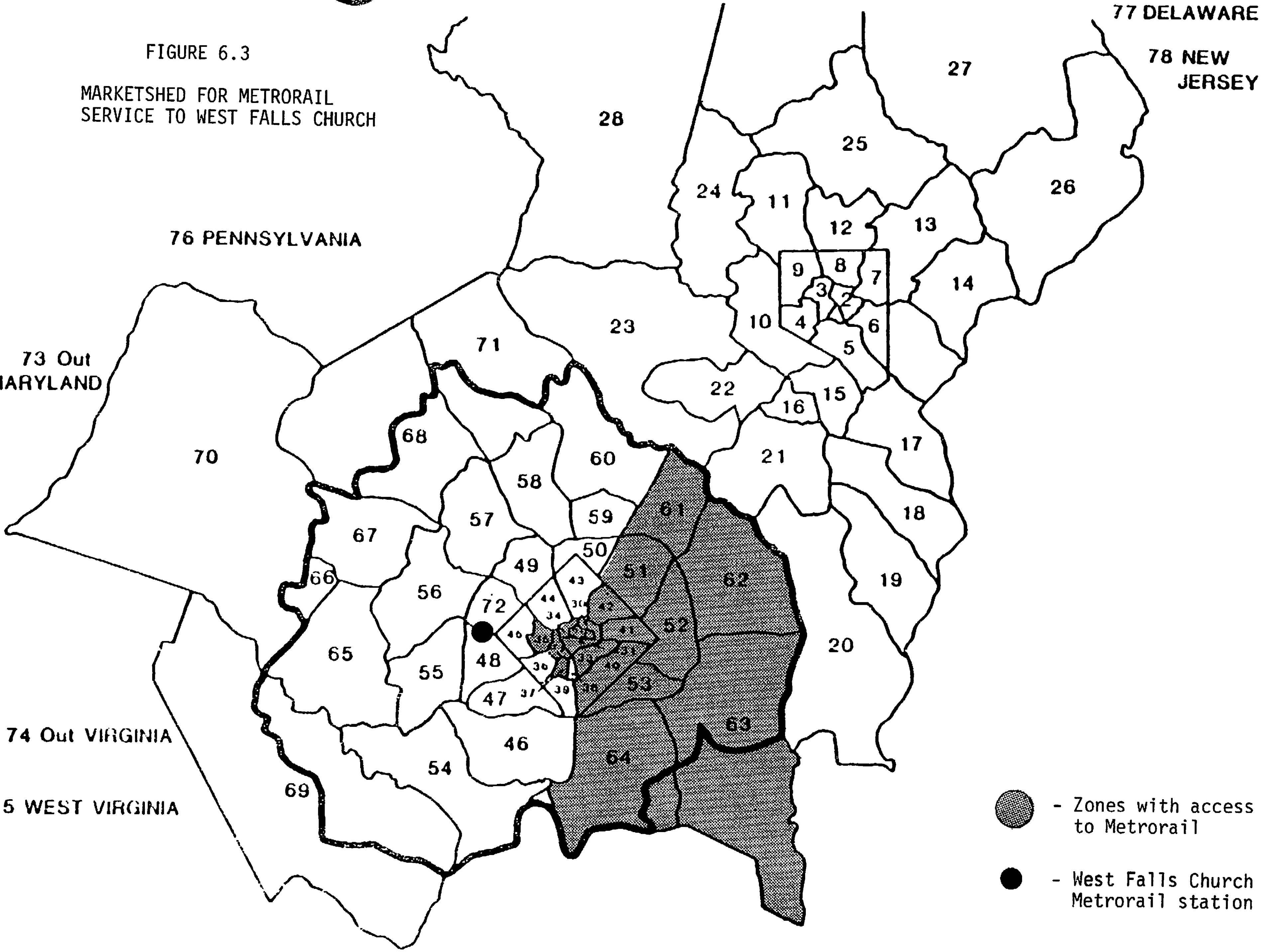


TABLE 6.4. BUS PATRONAGE AND REVENUES UNDER METRORAIL ACCESS

	Average Daily Patronage			
	Auto Access	Metrorail Access	Total Daily Trip Ends	Revenue ($/Veh-Hr.)
Downtown Washington	349		349	41.05
National Airport	495		495	56.57
West Falls Church	291	314	605	88.97
Springfield	11		11	2.91
Bethesda	50		50	13.24
TOTAL	1196	314	1510	43.03

6.3.3 Estimated Revenues and Vehicle Requirements

As shown in the last column of Table 6.4, the diversion of nearly 300 airport bus trips to the West Falls Church terminal would result in a decrease in average bus revenues of about 5.7 percent. This is because most of the diverted trips would have used either the Downtown Washington or National Airport routes, at a fare of $8.00. By using the West Falls Church terminal, these passengers would pay only $5.00.

The minimum number of vehicles required under this Scenario is the same as that required under Scenario 1. As in Scenario 1, this minumum is more than sufficient to accommodate projected demand, using 45-passenger motor coaches. On the Springfield and Bethesda routes, the projected demand could also be accommodated using 9-passenger limousines. On the West Falls Church route, however, projected average daily ridership would be at 99 percent of daily vehicle capacity, leaving no excess capacity for handling peak load conditions during the day. Therefore, under this scenario, West Falls Church should be served with at least some mix of motor coaches and limousines.

Overall vehicle requirements under this scenario would include eight motor coaches for the Downtown Washington and National Airport routes, plus at least one more motor coach for peak period service on the West Falls Church route. At least five limousines would be needed for service to Springfield, Bethesda, and West Falls Church (assuming that the West Falls Church route runs one limousine and one motor coach continously through the day). If a motor coach were used on the West Falls Church route only during peak periods, then one additional limousine would be needed to maintain scheduled headways during the off-peak.

6.4 SCENARIO 3: Limousine Feeder to Downtown Washington, Springfield, and Bethesda

This scenario examines the change in demand for airport bus trips resulting from the introduction of door-to-door, demand-responsive limousine feeder service to three of the terminals.

6.4.1 Airport Bus Service Configuration

Airport bus headways and fares for the line-haul trip from the terminals to Dulles are assumed to be the same as in Scenario 1. Air passengers may access the terminals by auto, walking, or Metrorail as in Scenario 2. In addition, air passengers originating from selected zones in the marketsheds of the Downtown Washington, Springfield, and Bethesda terminals may get to these terminals using a door-to-door, demand-responsive limousine feeder service. This service would pick up the air passenger at his/her residence or place of employment and deliver him/her to the airport bus terminal no more than 5 minutes before the next bus is scheduled to depart for the airport. The fare for this feeder service is assumed to be two dollars per trip. Figure 6.4 identifies those zones where the limousine feeder service is assumed to be available.

6.4.2 Demand Forecasts under this Scenario

Under this scenario, airport bus patronage was estimated to be 2153 trips per day -- an increase of more than 42 percent over that in Scenario 2. All of this increase was concentrated in those zones where the feeder service was available. Figure 6.5 shows the distribution of airport bus trip ends by zone; Table 6.5 aggregates these trip ends by terminals and mode of access.

TABLE 6.5. BUS PATRONAGE UNDER LIMOUSINE FEEDER ACCESS

	Auto Access	Metrorail Access	Limousine Access	Total Daily Trip Ends
Downtown Washington	303		656	959
National Airport	495			495
West Falls Church	291	288		579
Springfield	8		31	39
Bethesda	30		51	81
TOTAL	1127	288	738	2153

FIGURE 6.4

MARKETSHEDS FOR LIMOUSINE FEEDER SERVICE

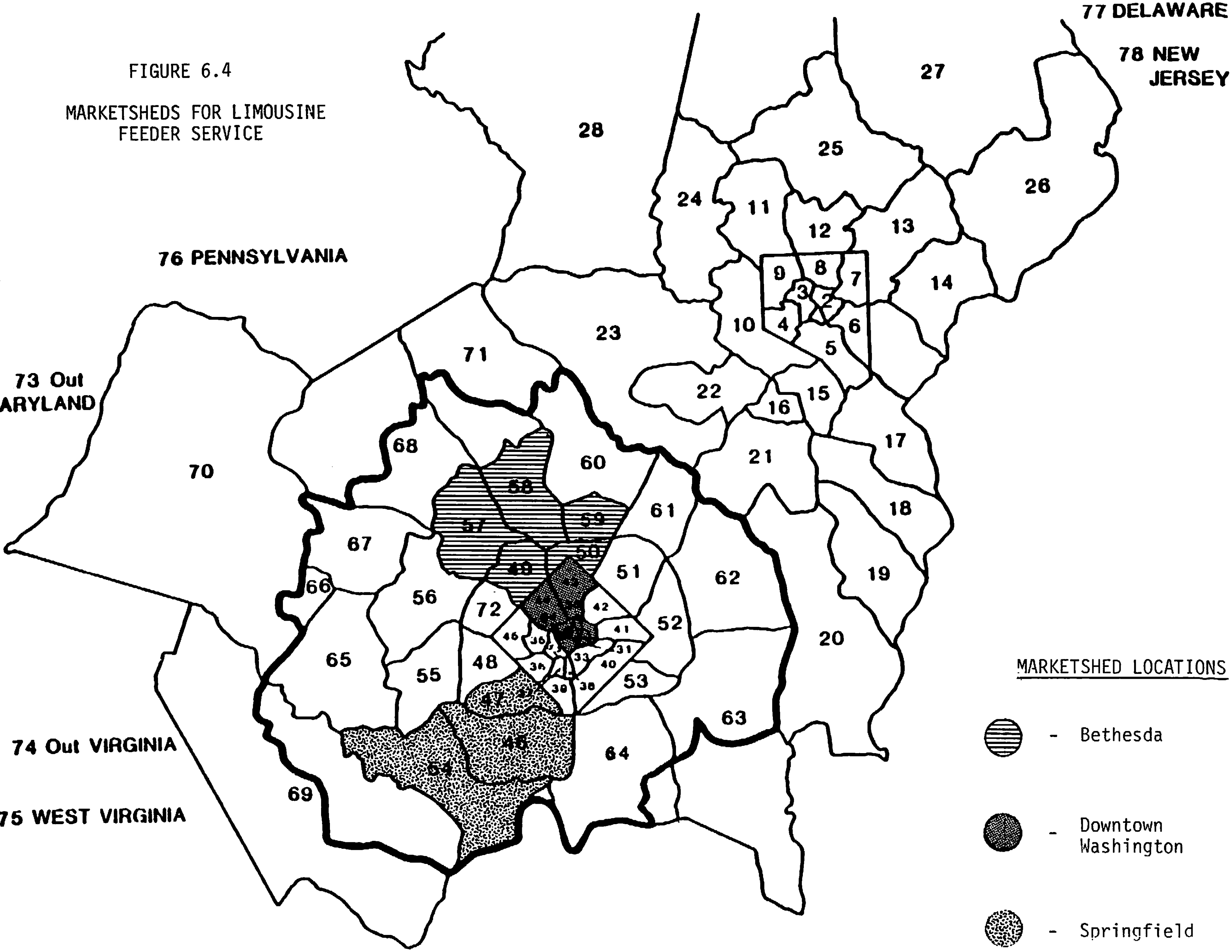
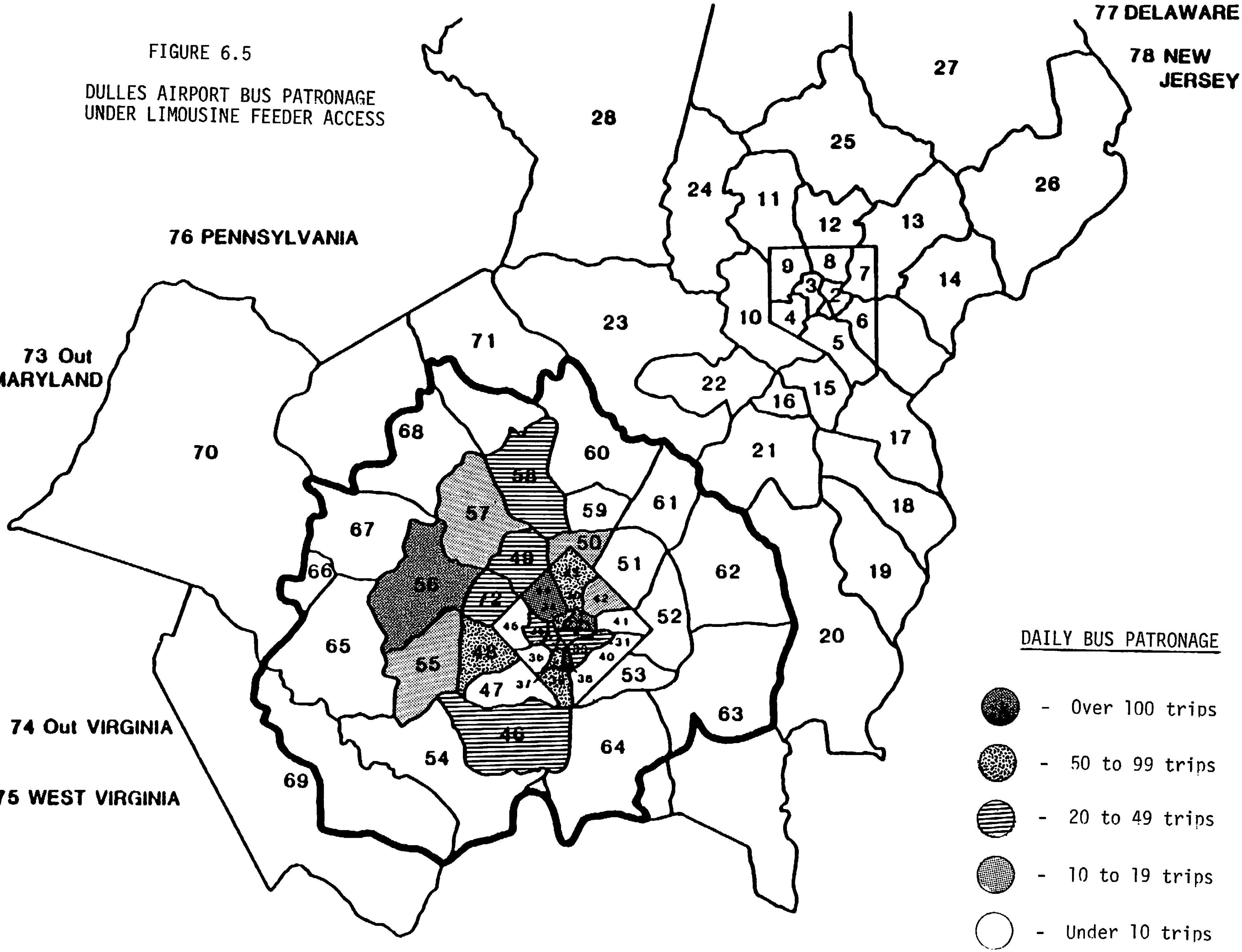


FIGURE 6.5

DULLES AIRPORT BUS PATRONAGE
UNDER LIMOUSINE FEEDER ACCESS



The introduction of limousine feeder service to the three airport bus terminals would draw some trips away from the auto mode, but would also induce substantially greater use of the airport bus mode overall. Use of the Downtown Washington terminal, in particular, was estimated to increase by over 300 trips per day. This increase can be attributed to two sources: 1) a drawing away of some Metrorail access trips that would have used the West Falls Church terminal, and 2) new airport bus trips by nonresident air passengers who would, in the absence of the feeder service, have taken a taxi directly from their hotel to Dulles Airport. The reasonableness of this estimated increase, as in the case of Scenario 2, depends on how willing air passengers would be to transfer from the limousine to the bus and whether they would view the combination of limousine feeder and airport bus as a convenient, reliable alternative to the taxi.

6.4.3 Estimated Revenues and Vehicle Requirements

Overall demand levels on the Downtown Washington, National Airport, and West Falls Church routes could be accommodated with the minimum number of vehicles needed to maintain scheduled headways, using 45-passenger motor coaches. Demand levels on the Springfield and Bethesda routes are sufficiently low that they could be accommodated using 9-passenger limousines instead of the motor coaches.

The provision of limousine feeder service to Downtown Washington, Springfield, and Bethesda generates the need for additional vehicles on those routes. The actual number of vehicles required depends on the demand for feeder service and on the efficiency with which the feeder vehicles are routed. Table 6.6 presents the estimated average number of requests for feeder service per airport bus arrival or departure at each of the three terminals.

TABLE 6.6. LIMOUSINE FEEDER SERVICE REQUESTS AND VEHICLE REQUIREMENTS

	Airport Bus Headways	Limousine Requests per Bus	Additional Vehicles Required
Downtown Washington	30 min.	9.6	3
Springfield	60 min.	0.9	1
Bethesda	60 min.	1.5	1

The numbers indicate that the demand for limousine feeder service to Springfield and Bethesda under a one-hour headway option could easily be accommodated with one additional limousine at each site. By using the limousines as both feeder and line-haul vehicles, an even higher level of service could be provided at these two sites by eliminating the need for bus patrons to transfer between vehicles.

Demand for feeder service to the Downtown Washington terminal would average just under 10 requests for each airport bus arrival or departure. Although in terms of vehicle capacity, this demand could be accommodated with 2 additional limousines, it is unlikely that these vehicles could be routed efficiently enough to assure that they would complete their circuit within the half-hour window dictated by the airport bus headways. Therefore, at least three, and possibly four, limousines would be needed to provide feeder service to the Downtown Washington terminal.

Table 6.7 presents the average expected revenues per vehicle-hour on each of the five airport bus routes. Revenues are further broken down into line-haul and limousine feeder services.

TABLE 6.7. AIRPORT BUS REVENUES UNDER LIMOUSINE FEEDER ACCESS

	Revenues in $ per Vehicle-Hour		
	Airport Bus	Limousine Feeder	Combined Service
Downtown Washington	112.82	25.73	75.50
National Airport	56.57		56.57
West Falls Church	85.15		85.15
Springfield	10.32	3.65	8.10
Bethesda	21.44	6.00	16.29
TOTAL	65.03	17.36	52.56

Comparing the last column of Table 6.7 with that of Table 6.4 reveals that the provision of demand-responsive limousine feeder service would increase average revenues on each of the three routes, and would increase average revenues, systemwide, by over 22 percent. Even though the average revenue per vehicle-hour for the feeder services would be relatively low in Springfield and Bethesda, the additional patronage they would generate would more than offset any deficits they might incur. The feeder service in Downtown Washington, on the other hand, could probably operate on a break-even basis independent of its contribution to line-haul patronage.

Overall vehicle requirements under this scenario would include eight motor coaches for the Downtown Washington and National Airport routes, plus either one or two additional motor coaches for service on the West Falls Church route. Depending on whether the motor coaches are used continuously or only during peak periods on the West Falls Church route, between zero and two limousines would also be needed on this route. An additional nine limousines would be needed for line-haul service to Springfield and Bethesda, and for feeder service to Springfield, Bethesda, and Downtown Washington.

6.5 SCENARIO 4: Reduction of Airport Bus Headways at Suburban Terminals

This scenario examines the change in demand resulting from a 50 percent reduction in airport bus headways on the West Falls Church, Springfield, and Bethesda routes. Bus headways from Downtown Washington and National Airport are assumed to remain the same.

6.5.1 Airport Bus Service Configuration

Airport bus headways and fares under this scenario are given in Table 6.8.

TABLE 6.8. SERVICE LEVELS FOR REDUCED HEADWAYS SCENARIO

	Average Headway (minutes)	Minumum Vehicles Required	Fare (dollars)
Downtown Washington	30	4	8.00
National Airport	30	4	8.00
West Falls Church	15	4	5.00
Springfield	30	4	9.00
Bethesda	30	4	9.00

Air passengers may access the terminals by auto, walking or Metrorail to West Falls Church. Limousine feeder service is assumed not to be available under this scenario.

6.5.2 Demand Forecasts under this Scenario

Under this scenario, airport bus patronage was estimated to increase by more than 77 percent over that in Scenario 2, to 2678 trips per day. Figure 6.6 shows the distribution of these trips by origin zone while Table 6.9 aggregates the bus trips by terminal and mode of access.

TABLE 6.9. BUS PATRONAGE AND REVENUES UNDER REDUCED HEADWAYS AND METRORAIL ACCESS

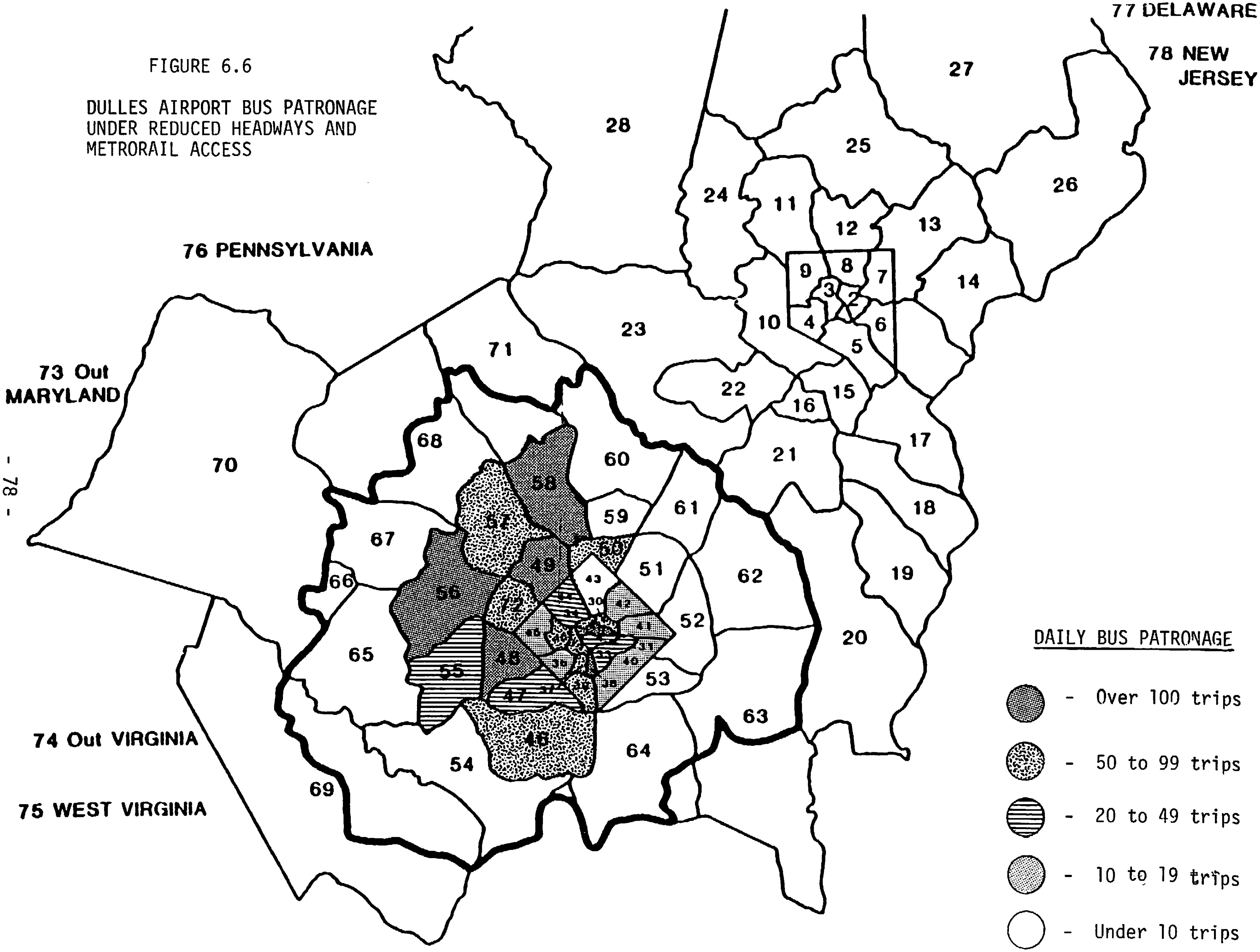
	Average Daily Patronage			
	Auto Access	Metrorail Access	Total All Modes	Revenue ($/Veh-Hr.)
Downtown Washington	362		362	42.59
National Airport	495		495	56.57
West Falls Church	646	589	1235	90.81
Springfield	117		117	15.49
Bethesda	469		469	62.07
TOTAL	2089	589	2678	53.52

The greatest increases in airport bus patronage occurred at the Springfield and Bethesda terminals, with gains of 900 and 800 percent, respectively, over demand levels in Scenario 2. These increases may be somewhat optimistic, since they suggest airport bus market shares of 22 to 23 percent in such zones as Springfield, Bethesda, Potomac, Silver Spring and Rockville. On the other hand, it is certainly reasonable to expect that airport bus service operating on half-hour headways will be perceived as much more competitive with such access modes as taxi or auto passenger, and could therefore capture a significant share of these markets.

Demand for airport bus service at West Falls Church also increased, by over 100 percent. While a significant portion of this increase could be attributed to new Metrorail trips made by air passengers leaving from zones in the District, an even greater share of the increase came from air passengers in adjacent zones accessing the terminal via auto. Evidently, the 15-minute headways from West Falls Church enable the airport bus to capture virtually all of the taxi market and a sizeable share of private auto trips from these zones.

FIGURE 6.6

DULLES AIRPORT BUS PATRONAGE
UNDER REDUCED HEADWAYS AND
METRORAIL ACCESS



6.5.3 Estimated Revenues and Vehicle Requirements

The last column in Table 6.9 presents the expected average revenues per vehicle-hour under this reduced headway scenario. Revenues on the West Falls Church route increased very little because the increase in demand was almost entirely offset by the increased vehicle requirements. On the Bethesda and Springfield routes, however, there was a significant increase in average revenues. In fact, revenues on the Bethesda route rose to make it the second most profitable route in the system, surpassed only by West Falls Church. Even though revenues on the Springfield route rose 400 percent over what they were in Scenario 2, this route would still be unable to operate on a breakeven basis, assuming average operating costs of 25 to 35 dollars per vehicle-hour.

Estimated demand levels on the Downtown Washington and National Airport routes changed very little from those in Scenario 2, and could therefore be accommodated within the minimum vehicle requirements using 45-passenger motor coaches. Although demand levels on the Springfield and Bethesda routes rose significantly, the minimum vehicle requirements to support the reduced headways also increased by 100 percent. Consequently, demand on these two routes could still be accommodated using either motor coaches or 9-passenger limousines. Demand on the West Falls Church route, however, exceeds the capacity that would be available if limousines were used for all trips. Therefore, this route would have to be served using either motor coaches for all trips or some combination of motor coaches and limousines. Overall vehicle requirements under this scenario would include at least 10 motor coaches for coverage on the Downtown Washington, National Airport, and West Falls Church routes, and 10 to 12 limousines for the Bethesda, Springfield, and low-demand periods on the West Falls Church routes.

6.6 SCENARIO 5: Reduced Headways and Limousine Feeder Access

This scenario combines the reduced headways postulated under Scenario 4 with limousine feeder access to Downtown Washington, Springfield, and Bethesda. The combination of these two service improvements offers the best feasible level of service to the two suburban airport bus terminals. The resulting demand therefore represents a practical upper bound on airport bus patronage in 1990.

6.6.1 Airport Bus Service Configuration

As in Scenario 4, average airport bus service headways are assumed to be 30 minutes at all terminals except West Falls Church, where they are reduced to 15 minutes. Airport bus line-haul fares remain unchanged. In addition, air passengers leaving from selected zones in the marketsheds of the Downtown Washington, Springfield, and Bethesda terminals may access these terminals using the demand-responsive limousine feeder service described in Scenario 3.

FIGURE 6.7

DULLES AIRPORT BUS PATRONAGE UNDER REDUCED HEADWAYS AND LIMOUSINE FEEDER ACCESS

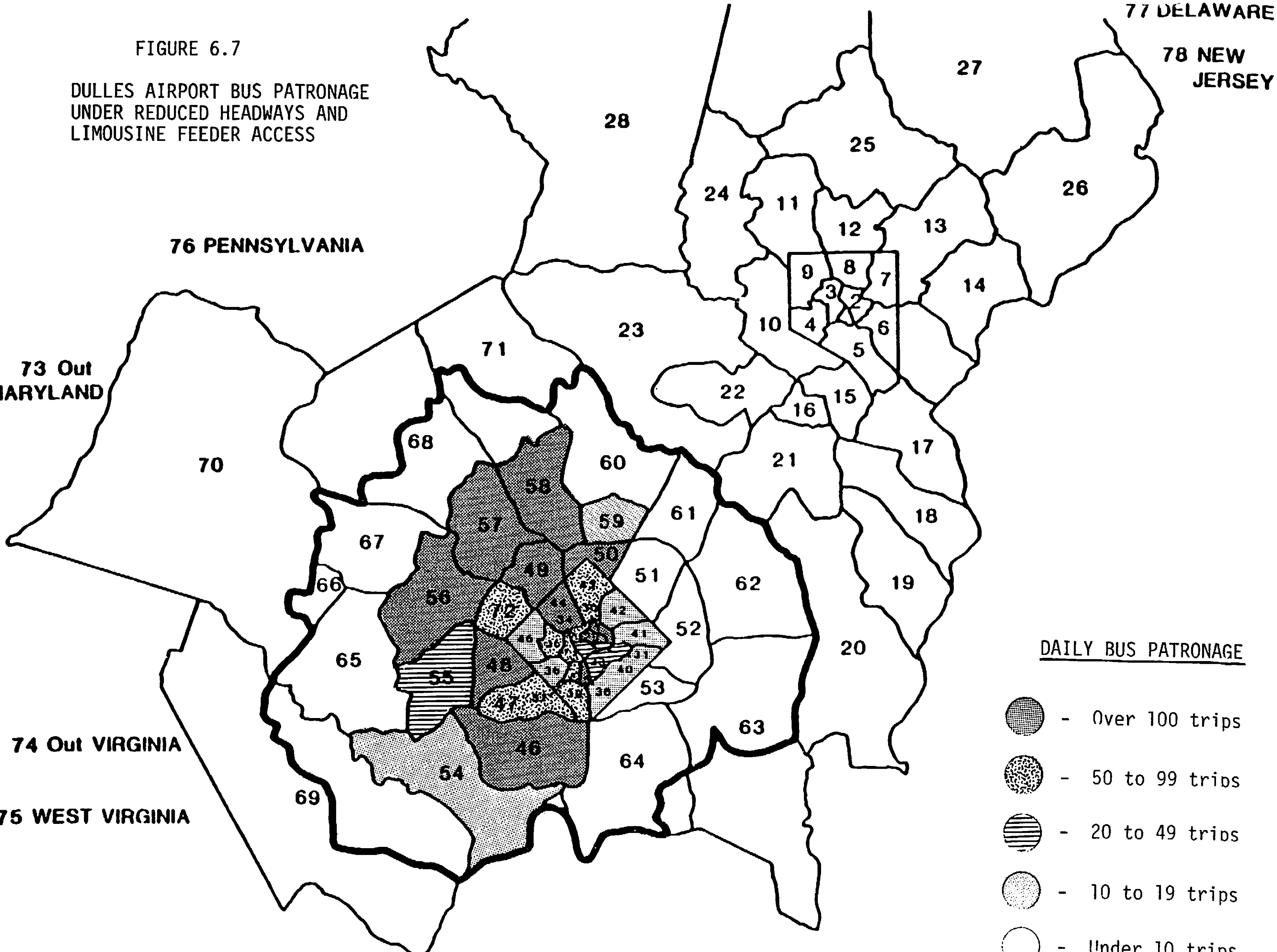


TABLE 6.10. BUS PATRONAGE UNDER REDUCED HEADWAYS AND LIMOUSINE FEEDER ACCESS

	Auto Access	Metrorail Access	Limousine Access	Total Daily Trip Ends
Downtown Washington	265		583	848
National Airport	495			495
West Falls Church	646	450		1096
Springfield	88		251	339
Bethesda	282		429	711
TOTAL	1776	450	1263	3489

6.6.2 Demand Forecasts under this Scenairo

Under this scenario, airport bus patronage is estimated to increase to just under 3500 trips per day. This represents a 30 percent increase over Scenario 4, without the limousine feeder, and a 62 percent increase over Scenario 3, without the reduced headways. Figure 6.7 shows the distribution of these airport bus trips by zone; Table 6.10 aggregates these trips by terminal and access mode.

The combination of reduced headways and limousine feeder service clearly increased the attractiveness of the airport bus in those zones served by the Springfield and Bethesda terminals. In fact, the market share for airport bus averaged almost 23 percent in those zones served by limousine feeder to either Springfield or Bethesda.

Airport bus patronage from Downtown Washington also increased substantially with the addition of almost 600 trips made via limousine feeder service. About 250 of these trips appear to have been drawn from former auto or walk trips to the Downtown Washington terminal or from Metrorail trips to West Falls Church. The rest of these trips were apparently attracted from other airport access modes, such as taxi and auto.

Overall, the market share for airport bus under this scenario was estimated to be just under 20 percent. As was stated in Scenario 4, this estimate may be somewhat optimistic. However, the service changes postulated in this scenario would certainly make airport bus strongly competitive with other airport access modes, and could conceivably attract enough air passengers away from the taxi and auto passenger modes to realize a market share on the order of 15 to 20 percent.

6.6.3 Estimated Revenues and Vehicle Requirements

Line-haul vehicle requirements on the Downtown Washington, National Airport, and Springfield routes do not change under this scenario from what they were under Scenario 4. Demand levels on the West Falls Church route actually decline from Scenario 4 by almost 150 trips per day. However, in order to maintain sufficient capacity for peak demand periods, the West Falls Church route would still require a mix of motor coaches and limousines.

The only route requiring an increase in vehicle capacity under this scenario is the Bethesda route. With a projected demand of over 700 trips per day, this route could no longer be served within minimum vehicle requirements using only limousines. It would require at least a mix of limousines and motor coaches deployed so as to provide extra capacity during peak demand periods.

In addition to the line-haul vehicle requirements, the Downtown Washington, Bethesda, and Springfield routes also require vehicles for the limousine feeder service. Table 6.11 presents the estimated additional vehicles needed to provide feeder service at each of the three terminals.

TABLE 6.11. LIMOUSINE FEEDER SERVICE REQUESTS AND VEHICLE REQUIREMENTS UNDER REDUCED HEADWAY OPTION

	Airport Bus Headways	Limousine Requests per Bus	Additional Vehicles Required
Downtown Washington	30 min.	8.6	3
Springfield	30 min.	4.0	2
Bethesda	30 min.	6.3	3

The increased demand for limousine feeder service at the suburban terminals suggest that two additional vehicles would be required at Springfield, while three additional vehicles might be needed at Bethesda. Altghough the projected demand could physically be accommodated by a single 9-passenger limousine at each site, the additional vehicles would be needed to handle the dispersed demand patterns and 30-minute time window between bus departures.

Demand for limousine feeder service to the Downtown Washington terminal was estimated to decrease by about 75 trips per day from that observed in Scenario 3. Thus, the three additional vehicles required under Scenario 3 would also be sufficient to accommodate the demand projected under this scenario. It does not appear that the estimated reduction in demand would be large enough to actually reduce the number of feeder vehicles to less than three, however.

Overall vehicle requirements under this scenario would include 10 motor coaches for the Downtown Washington, National Airport, and West Falls Church routes, plus another two motor coaches for peak periods on the Bethesda route. At least eight limousines would be required to provide line-haul service on the Springfield, West Falls Church, and Bethesda routes (assuming the Bethesda and West Falls Church routes run two limousines and two motor coaches throughout the day). If motor coaches were used on the Bethesda and West Falls Church routes only during peak demand periods, four additional limousines would be needed to maintain scheduled headways during off-peak periods. Another eight limousines would be needed for the feeder service to Downtown Washington, Bethesda, and Springfield.

Table 6.12 presents the average expected revenues per vehicle-hour on each of the five airport bus routes under this scenario. As in Scenario 3, revenues are further broken down into line-haul and feeder services.

TABLE 6.12. AIRPORT BUS REVENUES UNDER REDUCED HEADWAYS AND LIMOUSINE FEEDER ACCESS

	Revenues in $ per Vehicle-Hour		
	Airport Bus	Limousine Feeder	Combined Service
Downtown Washington	99.76	22.86	66.81
National Airport	56.57		56.57
West Falls Church	80.59		80.59
Springfield	44.87	14.76	34.83
Bethesda	94.10	16.82	60.98
Total	75.07	18.57	59.00

The table clearly shows that Springfield and Bethesda could become profitable routes under the combination of reduced headways and limousine feeder service. Total system revenues would also increase by about $7 per vehicle-hour under this scenario.

Revenues on the Downtown Washington and West Falls Church routes appear to decline somewhat, but for different reasons. The decline at West Falls Church results from the fact that the increase in patronage attributable to the reduced headways is more than offset by the increase in vehicle-hours needed to provide the additional service. The Downtown Washington route actually loses patronage under this scenario as compared to Scenario 3. This loss can be attributed to air passengers who would use Metrorail to West Falls Church to take advantage of the 15-minute airport bus headways. Thus, although the reduction in headways at West Falls Church would increase overall airport bus patronage by more than 400 trips per day, this action would not generate any additional revenues to the operator.

6.7 SCENARIO 6: Increased Airport Bus Fares

This scenario examines the sensitivity of airport bus patronage to changes in fares. Using the reduced bus headways and limousine feeder service postulated in Scenario 5, airport bus fares are assumed to rise by 50 percent.

6.7.1 Airport Bus Service Configuration

Airport bus headways and fares under this scenario are given in Table 6.13:

TABLE 6.13. SERVICE LEVELS FOR INCREASED FARE SCENARIO

	Average Headway (minutes)	Minimum Vehicles Required	Fare (dollars)
Downtown Washington	30	4	12.00
National Airport	30	4	12.00
West Falls Church	15	4	7.50
Springfield	30	4	13.50
Bethesda	30	4	13.50

Air passengers may access the terminals by auto, walking, or Metrorail to West Falls Church. In addition, air passengers leaving from selected zones in the marketsheds of the Downtown Washington, Springfield, and Bethesda terminals may access these terminals via limousine feeder service.

6.7.2 Demand Forecasts under this Scenario

Despite the 50 percent increase in airport bus fares postulated under this scenario, airport bus patronage was estimated to decline by less than 0.2

percent. This is equivalent to a decrease of less than seven bus trips per day. It should be noted that the models on which these estimates were based are extremely insensitive to changes in travel cost and are therefore likely to understate the impacts of any fare change. Nevertheless, it is reasonable to expect that airport bus patrons would not be greatly influenced in their access mode choice by any moderate increase in airport bus fares from current levels. Airport bus fares are currently only about one-third those of its principal competitor -- taxi. Even with a 50 percent fare increase, the resulting fares would still be only half that of the taxi. While this fare difference might encourage travel groups of three or more persons to use taxi, airport bus would still remain the least expensive access mode for the vast majority of air passengers who are travelling alone.

6.7.3 Estimated Revenues and Vehicle Requirements

Since there was virtually no change in demand under this scenario, vehicle requirements would remain the same as they were under Scenario 5. Revenues, on the other hand, would increase approximately 50 percent on all routes, as shown in Table 6.14.

TABLE 6.14. AIRPORT BUS REVENUES UNDER A 50 PERCENT FARE INCREASE

	Revenues in $ per Vehicle-Hour		
	Airport Bus	Limousine Feeder	Combined Service
Downtown Washington	149.65	34.41	100.26
National Airport	84.86		84.86
West Falls Church	120.44		120.44
Springfield	67.10	22.06	52.09
Bethesda	140.76	25.12	91.20
Total	112.40	27.84	88.34

Subject to the caveats presented in Section 6.7.2., it appears that the introduction of a moderate fare increase on the airport bus system may be a reasonable strategy for assuring profitability on all routes. However, the institution of any fare increase should definitely be made in concert with the service improvements postulated in these scenarios.

6.8 Estimates of Airport Bus Patronage at Washington National Airport

As discussed at the end of Section 5, efforts to develop policy-sensitive airport access mode choice models for Washington National Airport were largely unsuccessful. Consequently, instead of developing a series of specific policy scenarios for airport bus service to National, a single forecast of National Airport bus patronage was prepared by scaling up 1981 ridership distributions to levels consistent with 1990 air passenger activity forecasts (i.e., 16 million total annual air passenger movements). This section presents the results of that forecast.

6.8.1 Airport Bus Service Configuration

Demand forecasts based on simple projections of current patronage levels implicitly assume that current service levels will remain the same in the forecast year. Table 6.15 lists the airport bus headways, minimum vehicle requirements, and fares assumed in our forecast of National Airport bus patronage.

TABLE 6.15. NATIONAL AIRPORT BUS SERVICE LEVELS

	Average Headway (minutes)	Minimum Vehicles Required	Fare (dollars)
Downtown Washington	30	2	3.50
Dulles Airport	30	4	8.00
West Falls Church	- no service available -		
Springfield	120	1	7.00
Bethesda	60	2	6.50

The table indicates that no service would be available between the West Falls Church terminal and National Airport. This is because West Falls Church was conceived principally to provide a transfer point between Metrorail and the Dulles Airport bus. Since National Airport already has a Metrorail terminal on site, there would be no need to establish another airport bus route which would only compete with Metrorail for available trips.

Bus service to Dulles Airport reflects service levels used in the Dulles scenarios. Since National and Dulles are simply two ends of the same route, demand and revenue estimates for this route will be the same as those projected under Dulles Scenario 2.

6.8.2 Demand Forecasts for National Airport Bus Service

The scaling procedure increased average daily bus ridership at National Airport from about 660 trips per day in 1981 to 975 trips per day in 1990, or about a 46 percent increase overall. Figure 6.8 shows the distribution of 1990 National Airport bus trip ends by zone; Table 6.16 aggregates these trips to one of the five terminals used in the Dulles scenarios.

TABLE 6.16. NATIONAL AIRPORT BUS PATRONAGE AND REVENUE FORECASTS

	Total Daily Trip Ends	Revenue ($/Veh-Hr.)
Downtown Washington	278	28.62
Dulles Airport[1]	495	56.57
West Falls Church	No Service	
Springfield	8	3.29
Bethesda	194	37.09
Total	975	26.94[2]
Unassigned[3]	68	

1. Patronage on the National to Dulles route was set equal to the forecast obtained in the Dulles Scenario 2.

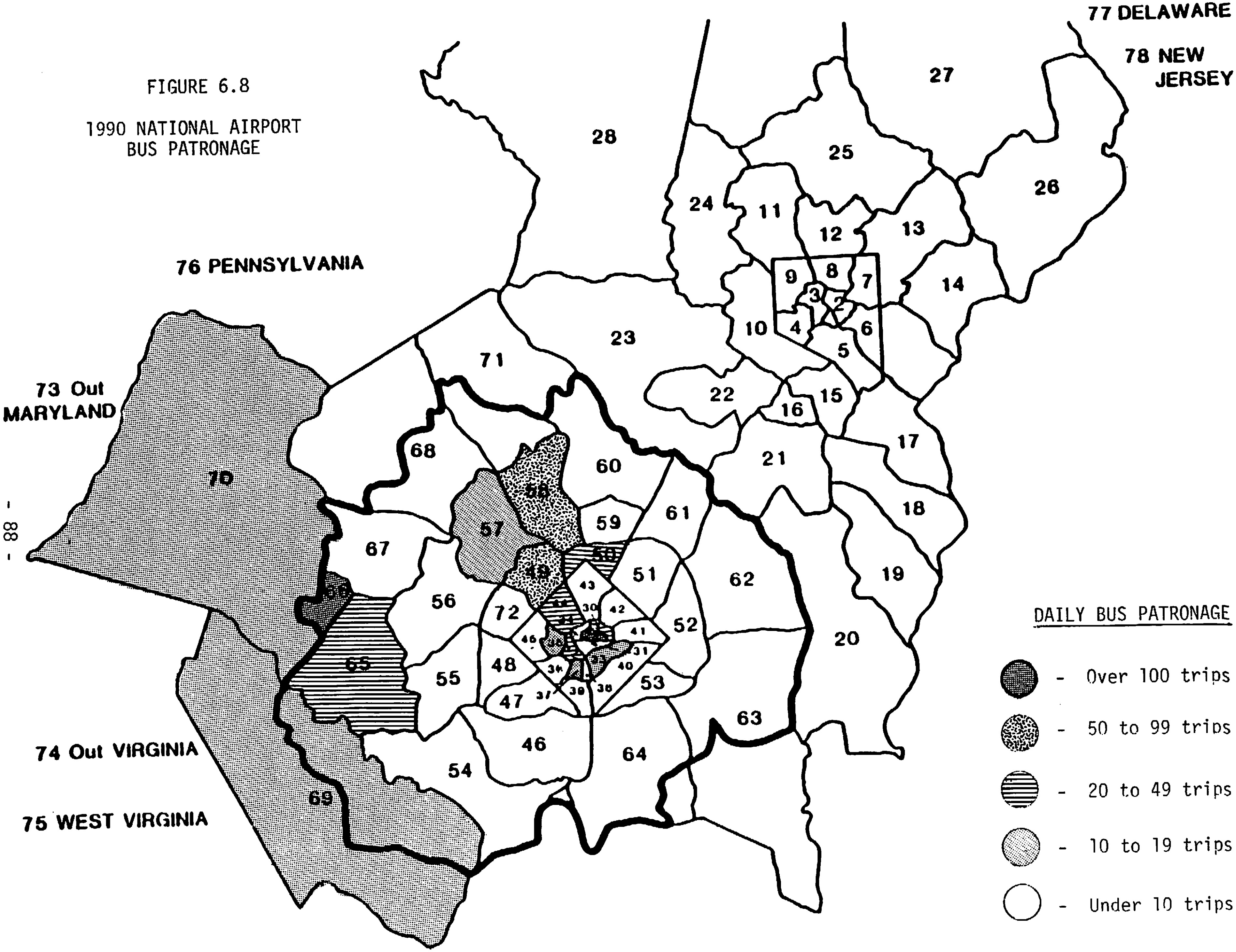
2. Average total revenues include only the Downtown Washington, Springfield, and Bethesda routes. National to Dulles revenues were already accounted for in the Dulles scenarios.

3. Unassigned trips reflect zones in Arlington County which had access to airport bus service in 1981 via stops in Rosslyn and Crystal City. Under the proposed five terminal configuration, these trips could not be conveniently served by any of the terminals and therefore would probably be lost to other access modes.

These 1990 estimates of National Airport bus patronage indicate that reasonably sized markets for airport bus services may exist at two of the terminal locations -- Downtown Washington and Bethesda. It should be further noted that these estimates were made strictly on the basis of overall growth

FIGURE 6.8

1990 NATIONAL AIRPORT
BUS PATRONAGE



in air passenger activity at National Airport; no improvements in airport bus service levels from what existed in 1981 were assumed. Therefore, to the extent that any improvements are made to the National Airport bus service, either directly or as a by-product of improvements to the Dulles routes, these patronage estimates should be regarded as conservative.

6.8.3 Estimated Revenues and Vehicle Requirements

Daily patronage estimates between National Airport and Downtown Washington, Springfield, and Bethesda were projected to be sufficiently low that each of these routes could be easily served using 9-passenger limousines operating on scheduled headways. A total of five limousines would therefore be needed to provide service on these three routes.

Estimated revenues per vehicle-hour, as derived from the patronage estimates and assumed vehicle operating hours, are presented in the last column of Table 6.16. Even with no improvement in airport bus service from current levels, the Downtown Washington and Bethesda routes would still be at least marginally profitable, assuming average operating costs of 25 to 35 dollars per vehicle-hour. While the Springfield route would clearly be unprofitable, the combined average revenues from all three routes would probably be high enough to enable the National Airport bus system to operate on at least a break-even basis.

6.9 Estimated Patronage, Revenues, and Vehicle Requirements for Combined Dulles and National Airport Bus Services

Table 6.17 summarizes the patronage forecasts and corresponding revenues and vehicle requirements for the eight proposed routes in the combined Dulles/National airport bus system. Dulles estimates are derived from Dulles Scenario 5: Reduced Headways and Limousine Feeder Access. National estimates are based on the forecasts presented in Section 6.8.

Total daily patronage on the combined system would average just under 4000 trips per day. This is equivalent to about 6.4 percent of the total air passenger market at the two airports in 1990.

The total number of vehicles required to accommodate this projected demand at specified service levels would include 12 45-passenger motor coaches and 21 to 25 9-passenger limousines. The variability in limousine requirements results from alternative deployment options on the Dulles-to-West Falls Church and Dulles-to-Bethesda routes. Estimated passenger loads on these two routes require that a mix of limousines and motor coaches be used for line-haul service. If the motor coaches are used continuously throughout the day, then fewer limousines would be required. However, if the motor coaches were used only during periods of peak demand, then two additional limousines per route would be needed to maintain scheduled headways during the off-peak.

TABLE 6.17. PATRONAGE, VEHICLE REQUIREMENTS, AND REVENUES FOR COMBINED DULLES/NATIONAL AIRPORT BUS SYSTEM

	Total Daily Patronage	Vehicle Requirements		Revenue ($/Veh-Hr.)
		Motor Coach	Limousine	
Dulles to:				
Downtown Washington	848	4	3	66.81
West Falls Church	1096	2	2-4	80.59
Bethesda	711	2	5-7	60.98
Springfield	339	-	6	34.83
National Airport	495	4	-	56.57
National to:				
Downtown Washington	278	-	2	28.62
Bethesda	194	-	2	37.09
Springfield	8	-	1	3.29
Total	3969	12	21-25	49.67

In addition to the active vehicle fleet, extra reserve vehicles should be available to maintain service levels in the event of a vehicle breakdown or scheduled vehicle maintenance, or to provide extra capacity during periods of extraordinary demand. Assuming the size of this reserve fleet is equivalent to 10 percent of the active fleet, then total fleet requirements for the combined Dulles/National airport bus system would be 14 motor coaches and 25 to 28 limousines.

Estimated revenues on the combined system indicate that only one of the eight routes would be unable to operate on at least a break-even basis, assuming average operating costs of 25 to 35 dollars per vehicle-hour. Revenues on all other routes would average over $28.00 per vehicle-hour, and over $55.00 per vehicle-hour on those routes where motor coaches are required. Combined average revenues across all eight routes would be nearly $50.00 per vehicle-hour -- sufficient to operate the Dulles/National airport bus system without the need for additional subsidies.

6.10 Additional Considerations Regarding the Accuracy of Airport Bus Patronage Forecasts

The forecasts presented in the preceding sections represent the best estimates of airport bus patronage, given currently available information. However, these forecasts rest on a number of assumptions about future air passenger travel patterns and transportation service levels that are themselves forecasts and therefore subject to some degree of uncertainty. In addition, the base-year data from which the Dulles models and the National projections were developed contained certain biases which were subsequently reflected in the patronage forecasts. This section briefly reviews the most significant of those assumptions and biases and discusses their likely impacts on our estimates of airport bus patronage.

6.10.1 Neither the Dulles nor the National patronage estimates account for the influence which new vehicles, improved terminal facilities, and increased advertising may have on the demand for airport bus service.

None of the above-mentioned improvements were in place at the time the base-year data were collected in 1981, nor did the data contain any information that would have enabled us to explicitly account for these improvements in the forecasts. Consequently, the resulting airport bus patronage estimates implicitly exclude any effects of these improvements. Although a precise estimate of the influence of these improvements is impossible, it is reasonable to expect that overall demand could increase from 3 to 10 percent.

6.10.2 Patronage forecasts for the three National airport bus routes do not account for the influence which limousine feeder service may have on demand.

Since airport bus routes to Dulles and National share the same offsite terminal facilities, it is likely that where limousine feeder service is available, it will be available to air passengers accessing either airport. This constitutes a major improvement in the level of airport bus service to National Airport which was not explicitly accounted for in the demand projections. If we assume that the impact of limousine feeder service is the same on the National routes as it was on the Dulles routes, then the increases in airport bus patronage that could be expected are presented in Table 6.18.

If these increases did occur, they would have a significant effect on both revenues and vehicle requirements for the three routes. More specifically, the Downtown Washington route would require up to three additional limousines for feeder service and would have to run a mix of limousines and motor coaches on the line-haul portion of the route. The Bethesda route would also require at least one additonal limousine for feeder service. No additional vehicles would be needed on the Springfield route.

TABLE 6.18. ESTIMATED INCREASES IN NATIONAL AIRPORT BUS PATRONAGE WITH LIMOUSINE FEEDER SERVICE

	Total Daily Patronage		
	Without Limousine	With Limousine	Percent Increase
Downtown Washington	278	765	175
Bethesda	194	314	62
Springfield	8	28	255

6.10.3 Projections of 1990 Dulles air passenger activity may be too high.

The mode choice models developed for the Dulles scenarios simply estimated the share of the air passenger market which airport bus could expect to capture. Forecasts of total airport bus patronage were obtained by multiplying these shares by the number of air passenger movements (enplanements and deplanements) expected in the forecast year. Consequently, the airport bus patronage forecasts are very sensitive to changes in the estimates of total air passenger activity.

Estimates of Dulles air passenger activity for 1990 were obtained from FAA terminal area forecasts for the Washington metropolitan area. These forecasts predict that total air passenger activity at Dulles will increase from 2.3 million in 1981 to over 6 million in 1990; this is equivalent to an annual growth rate of over 11 percent. Since the average annual growth rate in Dulles air passenger activity over the period 1972 to 1979 (preceding the recessionary period of 1980-1982) was only 5 percent, the reasonableness of the 1990 terminal area forecasts are open to question.

If the annual growth in Dulles air passenger activity continued to average only 5 percent, total air passenger activity in 1990 would be 3.57 million, or just under 9800 trips per day. Assuming that the airport bus service retained the same share of this market (19.8%), then overall patronage on the Dulles airport bus routes would average only 1943 trips per day. This number represents, for all practical purposes, a lower bound on Dulles airport bus patronage, given assumed service levels.

6.10.4 Dulles' share of overflow trips from National may be too low.

In additon to the growth projected in its own air passenger market, it was assumed that Dulles would also receive a proportional share (45.5%) of that portion of National's market which exceeded the proposed cap of 16 million air passenger movements per year. The remaining share of this spillover (54.5%) was assumed to be diverted to Baltimore-Washington International Airport (BWI).

Although a proportional distribution of these extra air trips is a reasonable first estimate, it is very likely that Dulles will actually receive a larger share of the National overflow that BWI, depending on how the cap is actually implemented. If Dulles' share of the overflow were to increase to 75 percent, air passenger activity would increase by 250,000 trips per year, or 685 trips per day. At assumed service levels, this increase would translate into an additional 135 airport bus trips per day.

6.10.5 Current distribution patterns of air passenger trips within the Washington metropolitan area may change over time.

In every scenario presented in this study, the distribution of air passenger trip ends was assumed to be the same as that observed in the 1981-82 Baltimore-Washington Regional Air Passenger Survey. However, given current Washington area growth trends, it is very likely that the distribution of air passenger trip ends will change significantly by 1990. For example, areas like Rockville, Vienna, and western Fairfax County will probably generate a higher volume of trips than they do presently, while the share of air passenger trips going to downtown Washington may level off or even decline.

These changes could have profound impacts on airport bus patronage. Since the market penetration of airport bus service is somewhat lower in the suburbs than it is to downtown Washington, any significant shift in air passenger trips away from the District will probably be reflected as a decrease in airport bus patronage. On the other hand, if most of these trip ends shift to western Fairfax and Montgomery Counties, potential demand for Dulles Airport should increase. Assuming that this demand could be satisfied at Dulles, the overall increase in Dulles air passenger activity should more than offset any decrease in airport bus patronage attributable to lower suburban market penetration. Although the net impact of these changes is impossible to estimate, it is likely that they are reflected to some extent in the Dulles air terminal forecasts.

6.10.6 Projected highway and transit network improvements may not occur on schedule.

Highway and transit travel time data used in the Dulles scenarios were based on current planning schedules and projected completion dates for major new facilities. Any significant delays in the completion of certain critical projects could change the service levels of airport bus relative to other competing airport access modes and thereby influence airport bus patronage.

The most critical project in terms of its potential impact on airport bus patronage is the Metrorail link to West Falls Church. Delays in the opening of this station would leave Dulles without a convenient Metrorail transfer point and could dcrease airport bus patronage by over 500 trips per day.

6.10.7 Combined effects and confidence ranges on Dulles/National airport bus patronage forecasts.

The preceding considerations and uncertainties significantly increase the size of the confidence band surrounding the patronage estimates presented in Section 6.9. However, they do enable us to compute upper and lower bounds on the estimates reflecting likely "best" and "worst" case situations.

The worst case scenario for Dulles occurs when Dulles air passenger activity grows at only 5 percent per year, when unaccounted for improvements produce only a 3 percent additional increase in patronage, and when the opening of the West Falls Church terminal is delayed beyond 1990. Estimated total patronage on the five Dulles routes under these conditions could average only 1500 trips per day.

The best case scenario for Dulles occurs when air passenger activity grows at its projected rate of 11 percent per year, when up to 75 percent of the overflow trips diverted from National switch to Dulles rather than BWI, and when unaccounted for improvements result in a 10 percent additional increase in patronage. Under these conditions, estimated total patronage on the Dulles routes could rise to 4000 trips per day.

The worst case scenario for National airport bus patronage is actually presented in Section 6.9, because it assumes no significant improvement in service levels and strict enforcement of National's proposed 16 million cap, which will almost certainly be reached well before 1990. The best case scenario for National occurs when the additional trips attributable to limousine feeder service are considered and when accounted for improvements result in a 10 percent additional increase in patronage. Under these conditions, estimated patronage on the three National airport bus routes could rise to 1200 trips per day. Of course, patronage could rise even further if headways were decreased on the National-to-Bethesda and National-to-Springfield routes.

7. RECOMMENDATIONS FOR IMPROVING AIRPORT BUS SERVICES AT WASHINGTON NATIONAL AND DULLES INTERNATIONAL AIRPORTS

Based on the demand analyses conducted in this study, there appears to be a sizeable potential market for high quality airport bus services in the Washington metropolitan area. In order to tap this market, airport bus service providers must be prepared to offer service that is reliable, convenient, attractive, and reasonably priced. FAA's Metropolitan Washington Airports has already made a substantial investment to upgrade the attractiveness and comfort of airport bus service through its purchase of new luxury motor coaches, and will initiate a major marketing campaign to increase public awareness and upgrade the image of the airport bus as an access mode.

The following recommendations suggest a general strategy for upgrading airport bus service between now and 1990. These recommendations are based on careful consideration of potential demand and its distribution throughout the Washington metropolitan area, current availability of equipment, and a recognition of the need for the airport bus operator to run a productive and profitable system.

The recommendations progress from a deployment strategy designed to satisfy current demand, to future deployment options that should be implemented as warranted by increased demand.

7.1 Immediate Action Plan -- upgrade service on Dulles-to-National and Dulles-to-Downtown Washington routes; establish suburban terminals at Springfield and Bethesda.

In accordance with MWA requirements, service on the Dulles-to-National and Dulles-to-Downtown Washington routes are to be upgraded immediately by reducing headways from one hour to 30 minutes on both routes. In addition, airport bus service is to be provided to multiple, unspecified locations in Maryland and Virignia. As an alternative to providing fixed-route bus service to several stops, the bus operator may provide service to one or more suburban terminals in each State and provide limousine feeder service from surrounding areas to the terminals. These suburban terminals have the advantage of creating a permanent identifiable presence for the airport bus service that should help attract new patrons over time.

Bus service headways to the suburban terminals should be commensurate with expected demand levels. Initially, the headways could be set at one hour on each of the routes serving the suburban terminals. Given these headways, vehicle requirements would be two buses or limousines per route.

Requests for feeder service, given one-hour headways, could be adequately handled with only one additional vehicle for a terminal in Springfield and two additional vehicles in Bethesda. Using limousines to handle both the line-haul and feeder portions of the trip also give the airport bus operator the option of using the feeder vehicle as the line-haul vehicle during periods of low demand, thereby eliminating the need for passengers to transfer.

7.2 Initial marketing efforts for the airport bus service should endeavor to increase awareness among nonresidents.

The greatest opportunity for attracting new airport bus riders comes from the submarket of nonresident air passengers. With only 55 percent of this market even aware of airport bus service at Dulles, and undoubtedly even a lower level of awareness at National, there already exists a substantial untapped market of potential bus users that can be reached relatively easily. Alternatively, awareness of the bus service among Washington area residents is already fairly high. Additional efforts to increase awareness among this market would have limited impact.

7.3 National Airport to Downtown Washington route should be retained.

This service currently attracts over 100 riders per day, due principally to the large volume of airport access trips between National Airport and Downtown Washington. The service requires only 2 vehicles of limousine size. It should be retained, at least for the near future, because it helps maintain the image of a complete airport bus system and its demand levels are sufficient to keep it profitable.

7.4 Limousine feeder service to Downtown Washington should be implemented following negotiations with major hotels in the area.

Since the principal beneficiaries of a downtown limousine feeder service would be guests staying at hotels in the area, it seems reasonable that the characteristics of such a service should be worked out in concert with the hotel management. Among the issues needed to be resolved are: 1) the type of service to be implemented (e.g., fixed-route versus demand-responsive), 2) the price charged for the service and whether the hotels would be willing to subsidize part of it, and 3) marketing of the service through the hotels. Because these issues have not yet been resolved, it may not be possible to initiate the downtown feeder service concurrent with the introduction of the service changes discussed above. However, because of its potential impact on demand for airport bus services in the downtown area, efforts to initiate the downtown feeder service should proceed as quickly as possible.

7.5 Consideration should be given to providing airport bus service on an interim basis between Dulles and the Rosslyn Metrorail Station.

Completion of the Vienna Metrorail line and opening of the West Falls Church Station are not scheduled to occur before 1986. In the interim, there is no convenient transfer point between the airport bus service and Metrorail. Since Metrorail access does appear to induce additional airport bus ridership, serious consideration should be given to providing a convenient transfer point between the airport bus service and Metrorail at an existing station.

While any of the currently open stations along the Vienna line could be used as a transfer point, the Rosslyn Station seems to be the best candidate for at least three reasons. First, it is a transfer terminal between two Metrorail lines and therefore offers more frequent and more direct service than other stations. Second, it is situated so as to provide easy access and egress to I-66. Third, its location in Rosslyn provides walk access for a significantly larger market of potential airport bus patrons than other stations.

Rosslyn service could be provided by simply diverting the Dulles to National Airport bus to stop at the Metrorail Station. The only drawback to this approach is that it would probably increase the overall travel time between Dulles and National by 10 to 15 minutes. Adding this extra time to the schedule may require the addition of more buses to the route. The extra travel time may also discourage some potential riders. This tradeoff between new Metrorail riders versus riders lost because of greater airport-to-airport travel times should be carefully weighed.

7.6 Consideration should also be given to providing airport bus service between Dulles and major commercial/office centers in Vienna.

A sizeable market of Dulles air passengers already exists among the major businesses located along the I-495 Beltway near Vienna (e.g., Tyson's Corner, Westgate Research Park, etc.). A significant share of this market could be attracted by an airport bus service that offered frequent and convenient service at a reasonable cost. As in the case of the downtown feeder service, the characteristics of such a service should be developed in collaboration with the specific sites. However, because of the potential patronage which such a service could attract, preliminary contacts with prospective users should be initiated as soon as possible.

7.7 Upgrading of airport bus service to Springfield and Bethesda should be carried out with respect to current and anticipated demand levels.

The demand analyses conducted as part of this study suggest that potential markets in Springfield and Bethesda may be very different, and thereby warrant very different approaches to service expansion. The airport bus patronage from Bethesda could, by 1990, exceed that on the Dulles-to-National route. This demand should be cultivated early by providing the highest level of service possible, subject to avoidance of large deficits on the route for an extended period of time. One strategy would be to reduce bus headways to a half-hour during peak periods of air traffic (e.g., from 3 pm to 7 pm for bus service to Dulles). This would offer more convenient service during those times of greatest potential patronage and might provide sufficient inducement to attract new riders.

The potential market in Springfield, on the other hand, appears to be much weaker. Service expansion in this area should be approached much more cautiously. This means, for example, that headways should be reduced only in reaction to higher demand, rather than in anticipation of it. It also suggests that both the Springfield to Dulles and Springfield to National routes should be closely monitored and evaluated at the end of their first year of operation to determine whether the routes should be continued.