Analysis

As with office and residential sites, summary tables and figures were prepared including: mode share by retail establishment, transit/auto mode share by trip purpose, and transit/auto mode share by the location of the last stop for the retail patron. Due to the unique character of Union Station a more detailed analysis was undertaken and is presented here.

Results

Mode share for each of the retail establishments by location of the last stop is presented in Table 23. Table 24 summarizes transit mode share for retail sites. These are graphed on Figure 22. Transit mode share ranged from approximately 34% to 55%. This is significantly better than was found when the first study was conducted. Also, it is important to note that transit accounts for the biggest share at most sites ahead of auto. As expected the lower mode shares are found at the suburban sites. However, impressive mode shares were reported at these sites.

Several sites were repeated from the first study allowing a direct comparison with the two studies. In the first study The Underground at Crystal City had a disappointing transit mode share (13.6%), in this survey the transit mode share was found to be just over 40%. The transit mode share at Ballston Common increased from approximately 12% to 27%, although it is important to note that transit mode share varies considerably by the time of day from a peak of over 50% midday to approximately 20% in the evening. At Hecht's Metro Center transit mode share increased slightly from 40.8% to 44.4%.

An increase in the transit mode share at one particular location could be dismissed as just another data point due to the fact that mode shares are likely to vary more from day to day than for office sites based on a number of factors such as the weather, time of year, and hours surveyed. However, given the substantial mode share at all sites and the increases at all three sites that were repeated it can be concluded that Metrorail is becoming an accepted transportation mode for retail sites that are conveniently located near a Metrorail station.

Another important finding is that the retail sites appear to be attracting higher transit mode shares than office sites at the same Metrorail station. This is different than in the first study which found that transit mode share was consistent within a station area. This possibly indicates that it takes longer for retail sites to mature than

Board of Zoning Adjustment
District of Columbia
CASE NO. 17232
EXHIBIT NO. 37A7

Table 23. Mode Share by Location of Last Stop

Retail Location	Mode	D.C.	Fairfax County	Arling. County	Alex.	Other Virginia	P.G. County	Mont. County	Other Maryland	Other	Totals
The	Auto	37.0%	45.5%	19.6%	62.5%	42.9%	57.1%	25.0%	58.8%	38.5%	33.7%
Under-	Transit	59.3	54.5	33.6	37.5	28.6	28.6	66.7	35.3	30.8	42.4
Ground	Other	3.7	0.0	46.7	0.0	28.6	14.3	8.3	5.9	30.8	23.9
	Total	21.2	8.6	42.0	6.3	2.7	2.7	4.7	6.7	5.1	100.0
Crystal	Auto	29.3	84.6	32.1	37.5	71.4	100.0	36.4	56.3	62.5	47.7
Plaza	Transit	65.9	15.4	32.1	50.0	14.3	0.0	63.6	43.8	33.3	42.5
Shops	Other	4.9	0.0	35.7	12.5	14.3	0.0	0.0	0.0	4.2	9.8
	Total	26.8	8.5	18.3	5.2	4.6	3.3	7.2	10.5	15.7	100.0
Ballston	Auto	32.1	68.8	57.6	68.8	56.8	75.0	66.7	53.3	71.4	53.3
Common	Transit	64.1	18.8	31.2	25.0	18.9	25.0	33.3	46.7	14.3	36.6
	Other	3.8	12.5	11.2	6.3	24.3	0.0	0.0	0.0	14.3	10.1
	Total	24.6	10.1	39.4	5.0	11.7	1.3	0.9	4.7	2.2	100.0
Bethesda	Auto	27.5	100.0	16.7	100.0	100.0	33.3	41.4	48.0	12.5	38.6
Metro	Transit	70.6	0.0	50.0	0.0	0.0	66.7	25.7	44.0	37.5	42.7
Center	Other	2.0	0.0	33.3	0.0	0.0	0.0	32.9	8.0	50.0	18.7
	Total	29.8	1.2	3.5	1.2	2.3	1.8	40.9	14.6	4.7	100.0
Mazza	Auto	31.9	100.0	25.0	100.0	100.0	100.0	44.4	34.5	56.3	39.6
Gallerie	Transit	61.1	0.0	75.0	0.0	0.0	0.0	55.6	37.9	12.5	48.7
	Other	6.9	0.0	0.0	0.0	0.0	0.0	0.0	27.6	31.3	11.7
	Total	46.8	1.3	2.6	0.6	1.3	0.6	17.5	18.8	10.4	100.0

Table 23. Mode Share by Location of Last Stop
(Continued)

Retail Location	Mode	D.C.	Fairfax County	Arling. County	Alex.	Other Virginia	P.G. County	Mont. County	Other Maryland	Other	Totals
Hecht's	Auto	12.2	0.0	0.0	33.3	100.0	100.0	0.0	37.5	0.0	13.3
Metro	Transit	45.9	100.0	100.0	66.7	0.0	0.0	100.0	62.5	66.7	49.5
Center	Other	42.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	37.1
	Total	86.2	1.0	1.9	1.4	0.5	0.5	1.9	3.8	2.9	100.0
Union	Auto	19.7	55.6	12.5	50.0	54.5	100.0	22.7	26.5	16.7	23.4
Station	Transit	48.6	44.4	50.0	25.0	45.5	0.0	68.2	58.8	73.3	53.5
	Other	31.7	0.0	37.5	25.0	0.0	0.0	9.1	14.7	10.0	23.0
	Total	52.8	3.3	5.9	1.5	4.1	0.4	8.2	12.6	11.2	100.0
The Shops	Auto	12.7	50.0	0.0	—	50.0	0.0	0.0	25.0	20.0	14.4
	Transit	45.3	0.0	87.5	—	50.0	100.0	100.0	75.0	70.0	50.3
	Other	42.0	50.0	12.5	—	0.0	0.0	0.0	0.0	10.0	35.3
	Total	80.2	1.1	4.3	0.0	4.3	0.5	2.1	2.1	5.3	100.0

Note: For each jurisdiction, the percentage of trips by mode share is indicated in the rows labeled "auto," "transit," and "other." These total vertically to 100%. The overall mode for each retail location is shown in the columns labeled "total." For each retail location, the row labeled "total" indicates the percentage of trips from each jurisdiction. This row totals horizontally.

Table 24. Summary of Transit Mode Share - Retail

	Number of Sites	Percent Transit Range	Percent Transit Average
CBD Locations	4	45.3% - 55.8%	49.5%
Suburban Locations Inside Beltway	4	34.4% - 40.7%	38.9%
Suburban Locations Outside Beltway	0	---	---
All Retail Locations	8	34.4% - 55.8%	44.2%

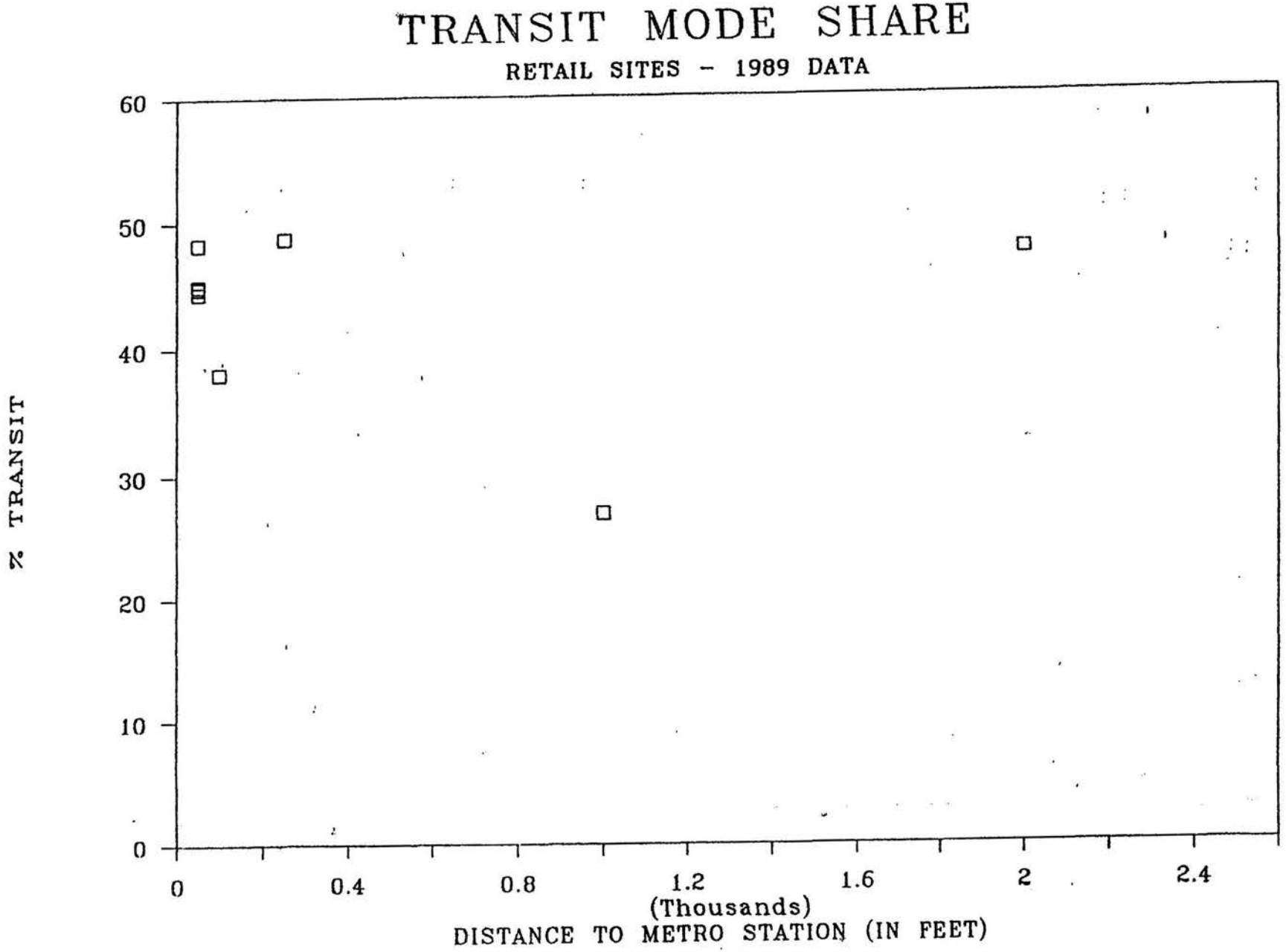

TRANSIT MODE SHARE
RETAIL SITES - 1989 DATA
% TRANSIT
60
50
40
30
20
10
0
0
0.4
0.8
1.2
1.6
2
2.4
(Thousands)
DISTANCE TO METRO STATION (IN FEET)

Figure 22.

Table 25. Mode Share by Purpose for Trips to and from Retail Sites

Retail Site	Purpose	Auto	Rail	Bus	Walk	Taxi	Amtrak	Other Mode	Total	Summary % Auto	Summary % Transit
The	Shopper	27.9%	37.2%	7.6%	22.1%	1.2%	0.0%	4.1%	100.0%	27.9%	44.8%
Under-	Employee	44.2	35.1	5.8	14.3	0.0	0.0	0.6	100.0	44.2	40.9
Ground	Restaurant	30.8	46.2	7.7	15.4	0.0	0.0	0.0	100.0	30.8	53.8
	Other	32.9	27.1	5.8	27.7	2.6	0.0	3.9	100.0	32.9	32.9
Crystal	Shopper	33.3	47.6	0.0	16.7	0.0	0.0	2.4	100.0	33.3	47.6
Plaza	Employee	47.5	39.4	6.9	6.3	0.0	0.0	0.0	100.0	47.5	46.3
Shops	Restaurant	54.5	27.3	0.0	18.2	0.0	0.0	0.0	100.0	54.5	27.3
Center	Other	42.4	30.5	0.0	23.7	0.0	0.0	3.4	100.0	42.4	30.5
Ballston	Shopper	64.4	21.7	5.3	8.0	0.6	0.0	0.0	100.0	64.4	26.9
Common	Employee	47.1	33.7	4.8	10.6	0.0	0.0	3.8	100.0	47.1	38.5
	Restaurant	50.0	18.4	3.9	27.6	0.0	0.0	0.0	100.0	50.0	22.4
	Other	34.4	56.3	0.8	7.0	0.0	0.0	1.6	100.0	34.4	57.0
Bethesda	Shopper	61.9	35.7	2.4	0.0	0.0	0.0	0.0	100.0	61.9	38.1
Metro	Employee	59.1	31.8	4.5	4.5	0.0	0.0	0.0	100.0	59.1	36.4
Center	Restaurant	29.6	29.1	8.4	31.8	0.0	0.0	1.1	100.0	29.6	37.4
	Other	32.9	42.1	7.9	13.2	3.9	0.0	0.0	100.0	32.9	50.0
Mazza	Shopper	43.9	40.4	4.7	11.1	0.0	0.0	0.0	100.0	43.9	45.0
Gallerie	Employee	30.0	56.7	10.0	0.0	3.3	0.0	0.0	100.0	30.0	66.7
	Restaurant	18.8	43.8	18.8	28.8	0.0	0.0	0.0	100.0	18.8	62.5
	Other	37.5	37.5	2.8	19.4	0.0	0.0	2.8	100.0	37.5	40.3

Table 25. Mode Share by Purpose for Trips to and from Retail Sites
(Continued)

Retail Site	Purpose	Auto	Rail	Bus	Walk	Taxi	Amtrak	Other Mode	Total	Summary % Auto	Summary % Transit
Hecht's	Shopper	12.5	25.9	18.5	40.7	2.3	0.0	0.0	100.0	12.5	44.4
Metro	Employee	20.0	60.0	20.0	0.0	0.0	0.0	0.0	100.0	20.0	80.0
Center	Restaurant	12.5	87.5	0.0	0.0	0.0	0.0	0.0	100.0	12.5	87.5
	Other	4.0	26.0	12.0	54.0	2.0	0.0	2.0	100.0	4.0	38.0
Union	Shopper	24.6	39.8	5.9	18.6	5.1	2.5	3.4	100.0	24.6	48.3
Station	Employee	31.3	31.3	25.0	6.3	0.0	6.3	0.0	100.0	31.3	62.5
	Restaurant	32.1	22.6	17.9	25.0	0.0	2.4	0.0	100.0	32.1	42.9
	Other	18.5	23.5	18.1	12.1	5.0	20.1	2.7	100.0	18.5	61.7
The Shops	Shopper 15-30	20.9	34.8	13.9	24.1	4.4	0.0	1.9	100.0	20.9	48.7
	Employee 15-35	13.2	55.3	28.9	0.0	2.6	0.0	0.0	100.0	13.2	84.2
	Restaurant 15-35	0.0	21.2	6.1	69.7	3.0	0.0	0.0	100.0	0.0	27.3
	Other	8.3	22.0	27.5	34.9	6.4	0.0	0.9	100.0	8.3	49.5

Note: For each retail location, the mode split is given for each trip purpose. In the columns labeled "summary," transit includes rail, bus, and Amtrak.

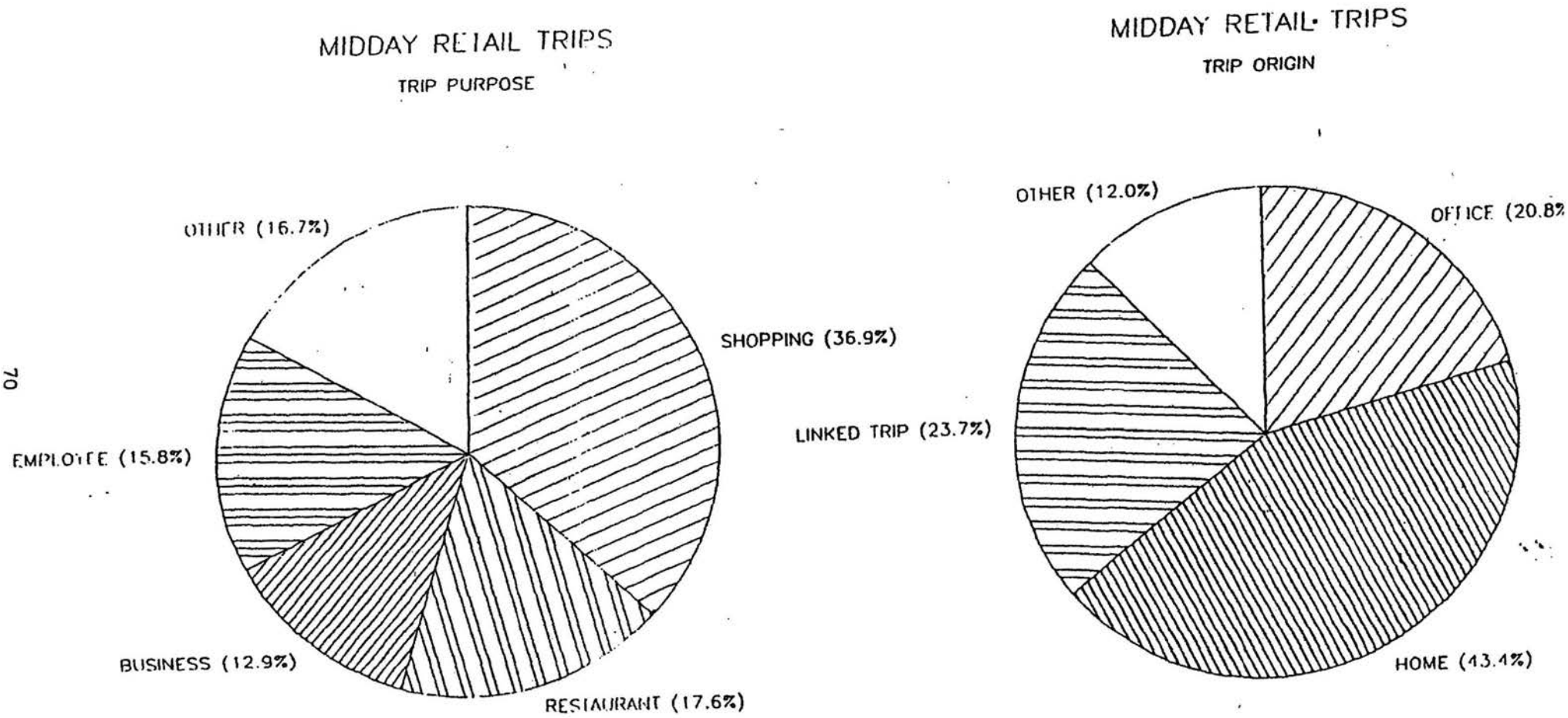

MIDDAY RETAIL TRIPS
TRIP PURPOSE
OTHER (16.7%)
SHOPPING (36.9%)
EMPLOYEE (15.8%)
LINKED TRIP (23.7%)
BUSINESS (12.9%)
RESTAURANT (17.6%)
MIDDAY RETAIL TRIPS
TRIP ORIGIN
OTHER (12.0%)
OFFICE (20.8%)
HOME (43.4%)

Figure 23.

Table 26. Retail Surveys
Respondents Opinions by Mode of Travel

Q15: People should be encouraged to use transit.

Question	Mode of Travel: Auto		Transit		Walk		Other		Subtotal		Missing Values		Total	
Agree	544	(88.9%)	702	(92.9%)	265	(90.4%)	26	(92.9%)	1537	(91.0%)	24	(88.9%)	1561	(91.0%)
Disagree	30	(4.9)	15	(2.0)	9	(3.1)	0	(0.0)	54	(3.2)	1	(3.7)	55	(3.2)
No Opinion	36	(5.9)	35	(4.6)	18	(6.1)	2	(7.1)	91	(5.4)	1	(3.7)	92	(5.4)
Not Answered	2	(0.3)	4	(0.5)	1	(0.3)	0	(0.0)	7	(0.4)	1	(3.7)	8	(0.5)
Total	612	(100.0)	756	(100.0)	293	(100.0)	28	(100.0)	1689	(100.0)	27	(100.0)	1716	(100.0)

Q16: Schedule information is readily available for transit.

Question	Mode of Travel: Auto		Transit		Walk		Other		Subtotal		Missing Values		Total	
Agree	425	(69.4%)	601	(79.5%)	209	(71.3%)	22	(78.6%)	1257	(74.4%)	23	(85.2%)	1280	(74.6%)
Disagree	113	(18.5)	117	(15.5)	59	(20.1)	2	(7.1)	291	(17.2)	1	(3.7)	292	(17.0)
No Opinion	70	(11.4)	35	(4.6)	24	(8.2)	4	(14.3)	133	(7.9)	2	(7.4)	135	(7.9)
Not Answered	4	(0.7)	3	(0.4)	1	(0.3)	0	(0.0)	8	(0.5)	1	(3.7)	9	(0.5)
Total	612	(100.0)	756	(100.0)	293	(100.0)	28	(100.0)	1689	(100.0)	27	(100.0)	1716	(100.0)

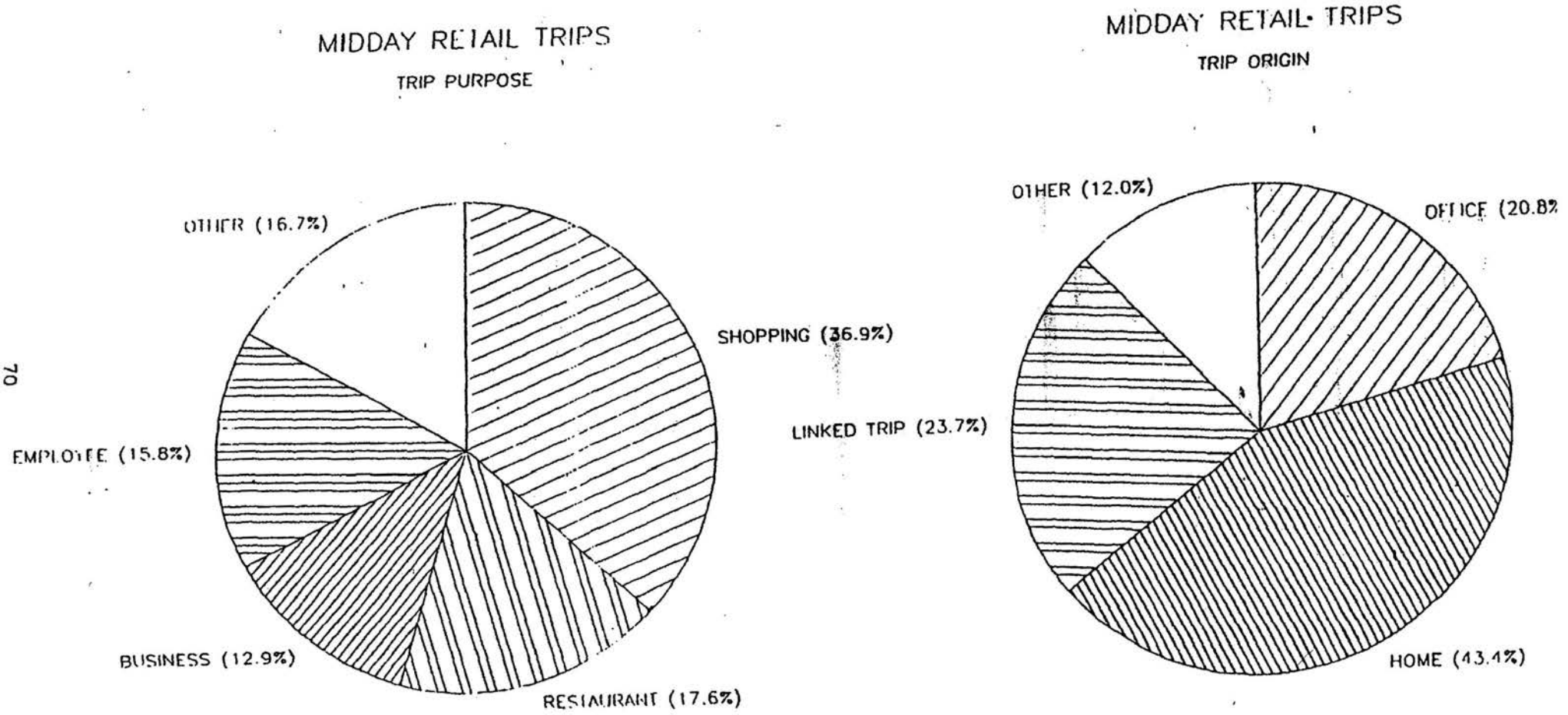

MIDDAY RETAIL TRIPS
TRIP PURPOSE
OTHER (16.7%)
SHOPPING (36.9%)
EMPLOYEE (15.8%)
LINKED TRIP (23.7%)
BUSINESS (12.9%)
RESTAURANT (17.6%)
MIDDAY RETAIL TRIPS
TRIP ORIGIN
OTHER (12.0%)
OFFICE (20.8%)
HOME (43.1%)

Figure 23.

Table 26. Retail Surveys
Respondents Opinions by Mode of Travel

Q15: People should be encouraged to use transit.

Question	Mode of Travel: Auto		Transit		Walk		Other		Subtotal		Missing Values		Total	
Agree	544	(88.9%)	702	(92.9%)	265	(90.4%)	26	(92.9%)	1537	(91.0%)	24	(88.9%)	1561	(91.0%)
Disagree	30	(4.9)	15	(2.0)	9	(3.1)	0	(0.0)	54	(3.2)	1	(3.7)	55	(3.2)
No Opinion	36	(5.9)	35	(4.6)	18	(6.1)	2	(7.1)	91	(5.4)	1	(3.7)	92	(5.4)
Not Answered	2	(0.3)	4	(0.5)	1	(0.3)	0	(0.0)	7	(0.4)	1	(3.7)	8	(0.5)
Total	612	(100.0)	756	(100.0)	293	(100.0)	28	(100.0)	1689	(100.0)	27	(100.0)	1716	(100.0)

Q16: Schedule information is readily available for transit.

Question	Mode of Travel: Auto		Transit		Walk		Other		Subtotal		Missing Values		Total	
Agree	425	(69.4%)	601	(79.5%)	209	(71.3%)	22	(78.6%)	1257	(74.4%)	23	(85.2%)	1280	(74.6%)
Disagree	113	(18.5)	117	(15.5)	59	(20.1)	2	(7.1)	291	(17.2)	1	(3.7)	292	(17.0)
No Opinion	70	(11.4)	35	(4.6)	24	(8.2)	4	(14.3)	133	(7.9)	2	(7.4)	135	(7.9)
Not Answered	4	(0.7)	3	(0.4)	1	(0.3)	0	(0.0)	8	(0.5)	1	(3.7)	9	(0.5)
Total	612	(100.0)	756	(100.0)	293	(100.0)	28	(100.0)	1689	(100.0)	27	(100.0)	1716	(100.0)

Table 26. Retail Surveys
Respondents Opinions by Mode of Travel
(Continued)

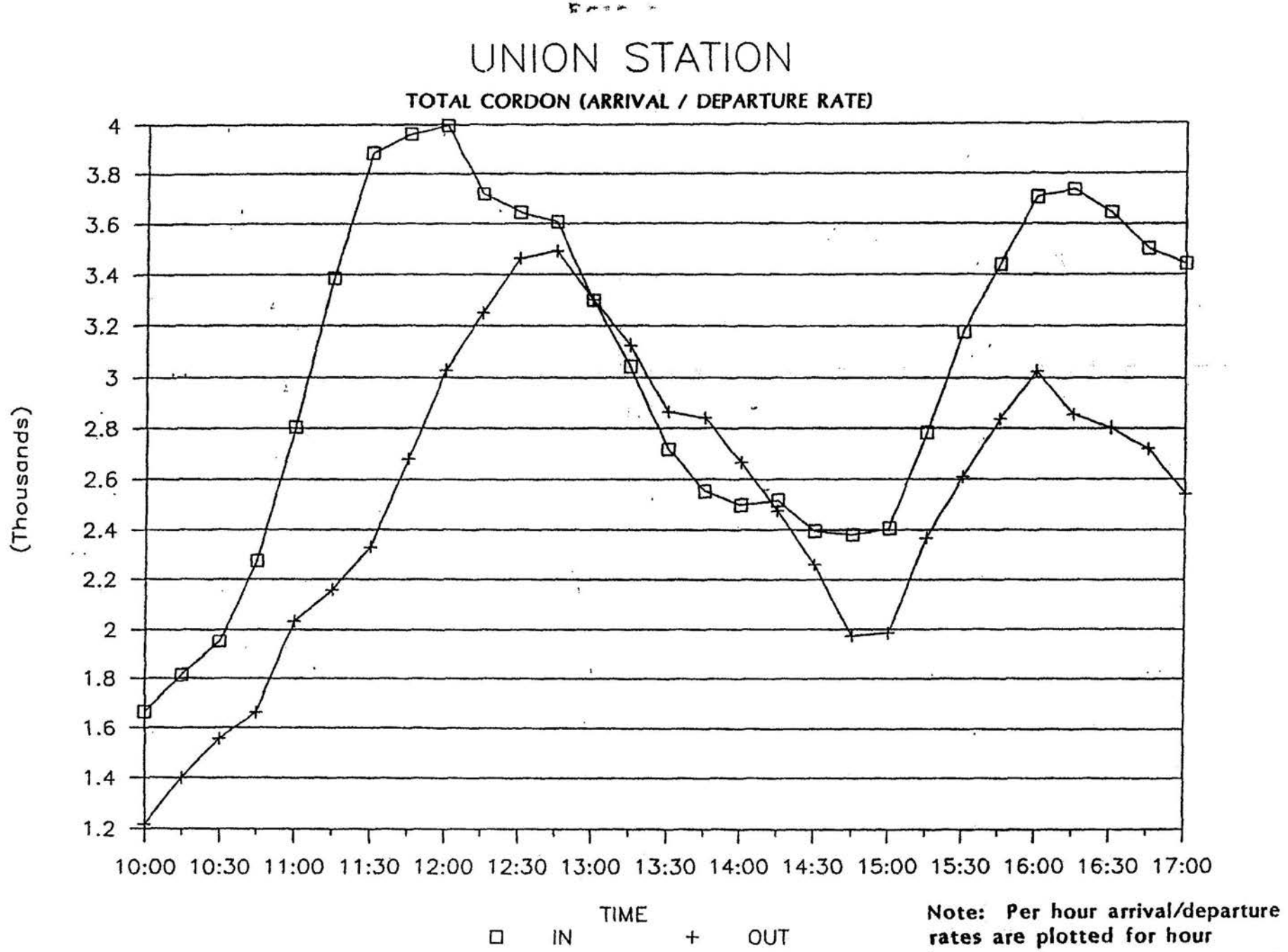
Q17: Metrorail is clean and reliable.

Question	Mode of Travel: Auto		Transit		Walk		Other		Subtotal		Missing Values		Total	
Agree	544	(88.9%)	701	(92.7%)	268	(91.5%)	22	(78.6%)	1535	(90.9%)	21	(77.8%)	1556	(90.7%)
Disagree	18	(2.9)	13	(1.7)	7	(2.4)	0	(0.0)	38	(2.2)	0	(0.0)	38	(2.2)
No Opinion	47	(7.7)	39	(5.2)	16	(5.5)	6	(21.4)	108	(6.4)	5	(18.5)	113	(6.6)
Not Answered	3	(0.5)	3	(0.4)	2	(0.7)	0	(0.0)	8	(0.5)	1	(3.7)	9	(0.5)
Total	612	(100.0)	756	(100.0)	293	(100.0)	28	(100.0)	1689	(100.0)	27	(100.0)	1716	(100.0)

Q18: Metrobus is clean and reliable.

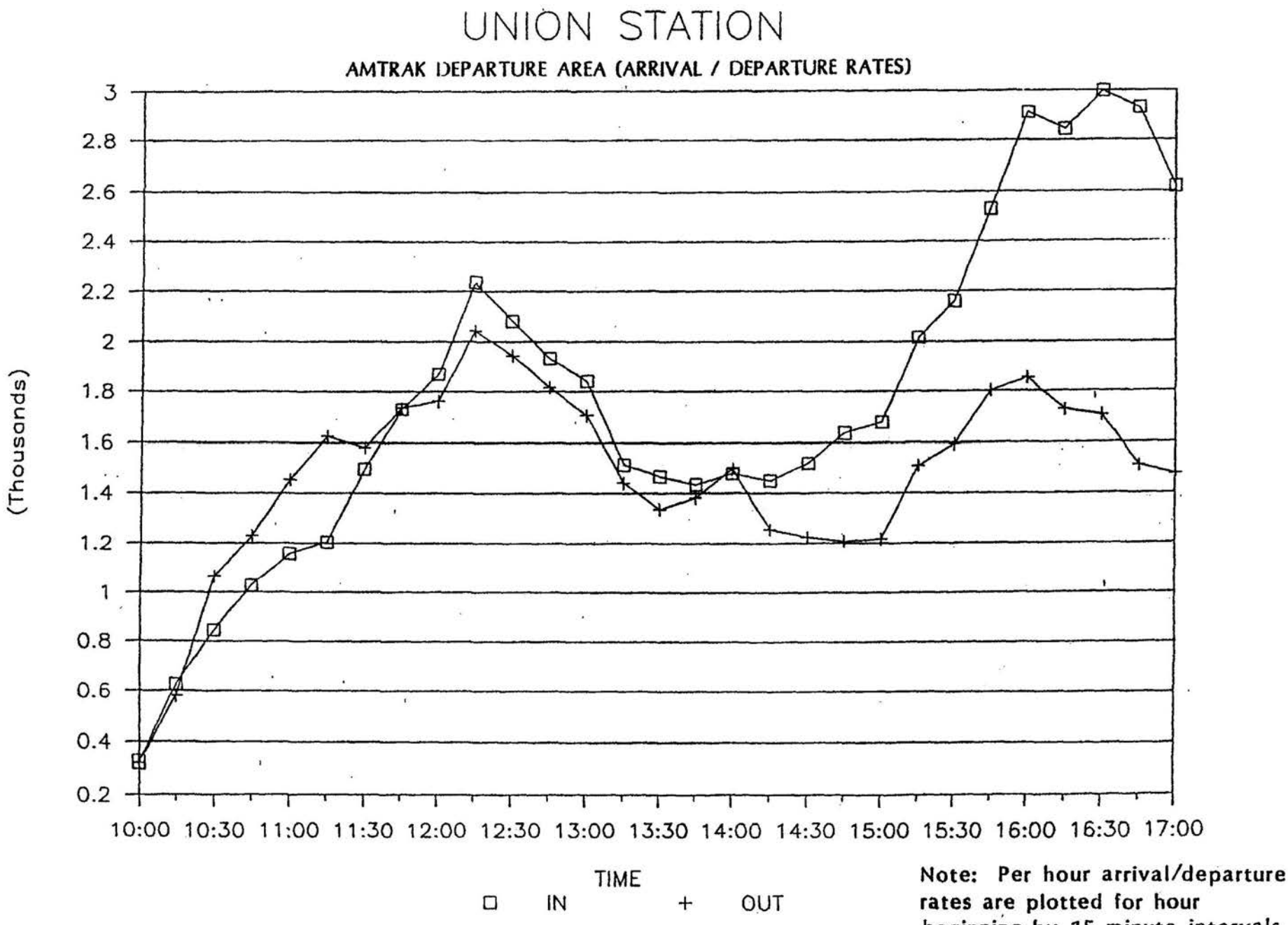
Question	Mode of Travel: Auto		Transit		Walk		Other		Subtotal		Missing Values		Total	
Agree	251	(41.0%)	325	(43.0%)	122	(41.6%)	10	(35.7%)	708	(41.9%)	9	(33.3%)	717	(41.8%)
Disagree	115	(18.8)	210	(27.8)	72	(24.6)	3	(10.7)	400	(23.7)	0	(0.0)	400	(23.3)
No Opinion	242	(39.5)	218	(28.8)	99	(33.8)	15	(53.6)	574	(34.0)	17	(63.0)	591	(34.4)
Not Answered	4	(0.7)	3	(0.4)	0	(0.0)	0	(0.0)	7	(0.4)	1	(3.7)	8	(0.5)
Total	612	(100.0)	756	(100.0)	293	(100.0)	28	(100.0)	1689	(100.0)	27	(100.0)	1716	(100.0)

Note: Not answered refers to people who specified their mode of travel but do not answer the question. Missing values refer to people who answered the question but did not specify their mode of travel.



Note: Per hour arrival/departure rates are plotted for hour beginning by 15 minute intervals

Figure 24.



Note: Per hour arrival/departure rates are plotted for hour beginning by 15 minute intervals

Figure 25.

sites. As more studies are completed in the future, trend analysis may define this tionship better.

Mode share is presented by purpose in Table 25. The transit mode share for loyees is higher than the transit mode share found at the office sites in the ponding station area. A similar geographic distribution of patrons was found as ared to the office sites. This suggests that people chose their shopping location as they are familiar with based on their daily work trips.

Figure 23 illustrates the purpose of mid-day transit trips to the retail areas as the origin of trips based on the last stop reported. It is interesting to note only a little over a third of trips are for the purpose of shopping. This is derably lower than in the evenings or on a weekend. Less than half the reported originate at the patrons home with 23.7% reported as linked trips. This is about ame magnitude of linked trips as found among auto users which is somewhat adictory to the excuse given by many auto users for not using transit. That is, ey use transit they cannot stop off or make multi-purpose trips.

Responses to the attitudinal questions were similar to those for office and ential sites and are presented in Table 26.

Union Station

One of the retail sites chosen was the retail area at Union Station. This site nique in the metropolitan area acting as a multi-modal transfer point for trips up down the east coast via Amtrak, commuter rail (MARC), a Metrorail station, a l area with 210,000 square feet of shops, 100,000 square feet of office, and a tourist ction. There were three components to the data collection at Union Station. First, ntire building was cordoned off and pedestrians entering and exiting the building counted by 15 minute intervals for each entrance. Second, a secondary cordon rded pedestrians entering or exiting the Amtrak arrival/ departure lounge area. lly interviews were conducted for the full counting period of 10:00 AM to 6:00 PM. tables and figures in this section highlight mode share, trip generation, trip purpose other trip characteristics for trips made to and from Union Station.

Over the eight hour count period approximately 43,600 persons were seen to enter t Union Station, the hourly arrival and departure rates by 15 minute increments own in Figure 24. Figure 25 shows the arrival and departure rates for the Amtrak l/departure area. Approximately 57% of all persons entering Union Station enter

the Amtrak arrival departure area, or putting it the other way around, 43% are visitors, for reasons such as shopping, lunch, or just plain sight seeing.

The Union Station Metrorail stop had approximately 26,000 patrons for the same time period. Of these it is estimated that approximately one-half entered Union Station. The arrival and departure rates for the Metrorail station are shown in Figure 26. The Metrorail station was considered outside of Union Station, therefore, it was counted separately. Of the 26,000 patrons it is estimated that approximately 8,000 enter or exit Union Station.

Figure 27 shows the jurisdiction of origin by mode. Just over half of all trips to Union Station originated in DC. Figure 28 shows mode share by trip purpose. It is interesting to note that arrival by car accounts for less than one third of all trips to or from Union Station.

Figure 29 illustrates the expenditures by patrons at Union Station. The average or mean expenditure is $22.00 and the median expenditure is $6.00. Finally Table 27 summarizes some of the information discussed above.

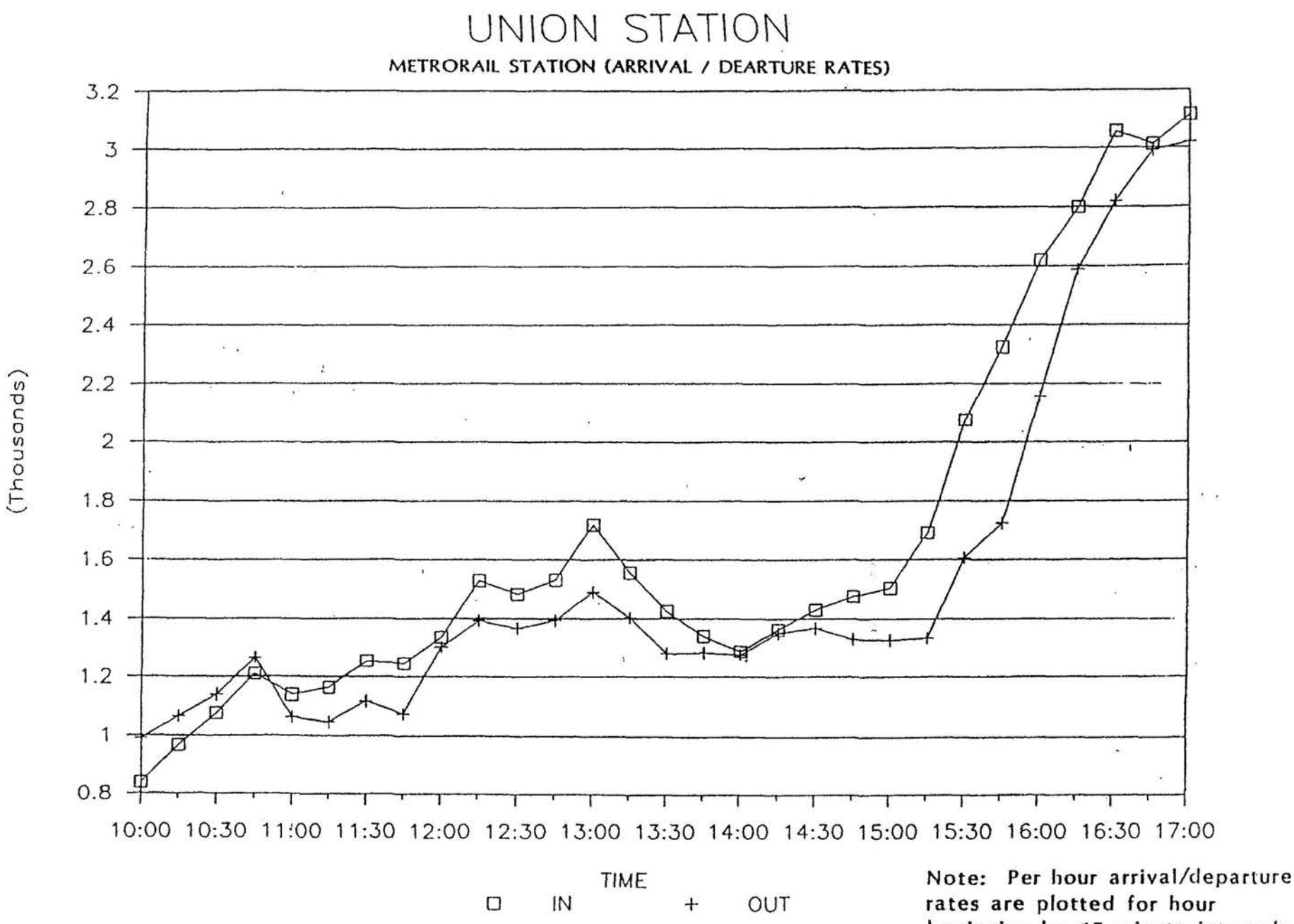
In summary Union Station generates over 4000 trips per hour for most of the day, with the absolute peak occurring at noon hour. The majority of trips to and from Union Station are made by transit or on foot. Union Station generates considerable revenue for WMATA throughout the day, not just the peak periods and represents a mixed use development that appears to encourage transit ridership to a greater extent than these uses would, located on their own.

HOTEL

The ten hotels chosen for study were full service hotels ranging in size from 88 to 907 guest rooms. The characteristics for each hotel were given in Table 28. Conference/meeting space varied from 10,000 to 50,000 gross square feet. A wide range of distances from Metrorail stations was studied. As well, four of the five hotels surveyed in the first study were repeated in this study.

Data Collection

Data were collected at hotel sites using a pedestrian-based survey to gather information from patrons and cordon counts were conducted to determine actual trip generation rates. The format and procedures employed were very similar to those used for retail sites. The objectives were:

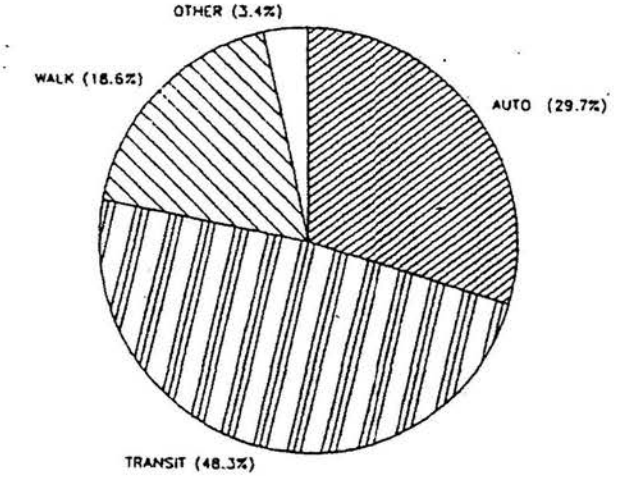


Note: Per hour arrival/departure rates are plotted for hour beginning by 15 minute intervals

Figure 26.

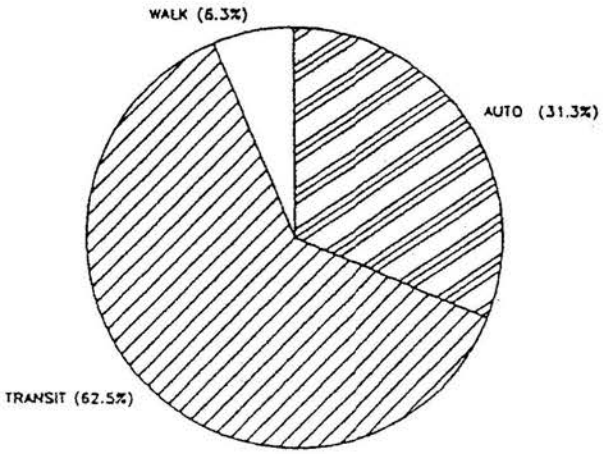
UNION STATION

MODE SPLIT FOR SHOPPERS



UNION STATION

MODE SPLIT FOR EMPLOYEES



UNION STATION

MODE SPLIT FOR RESTAURANT PATRONS

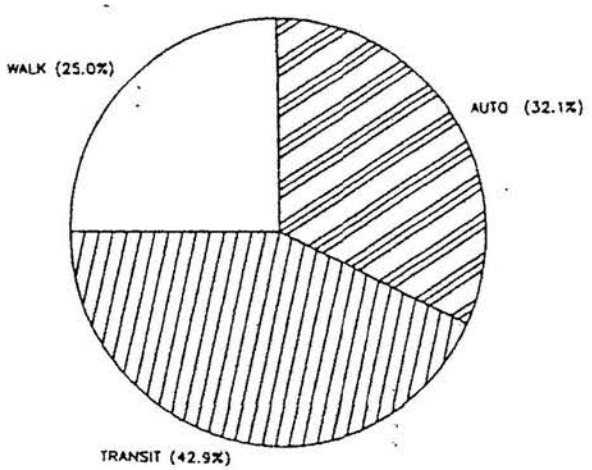
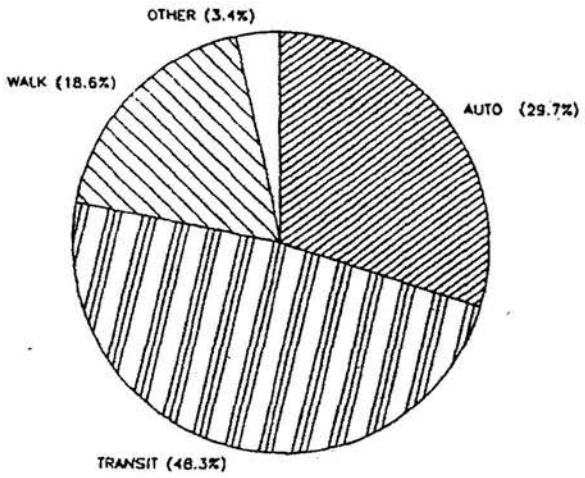


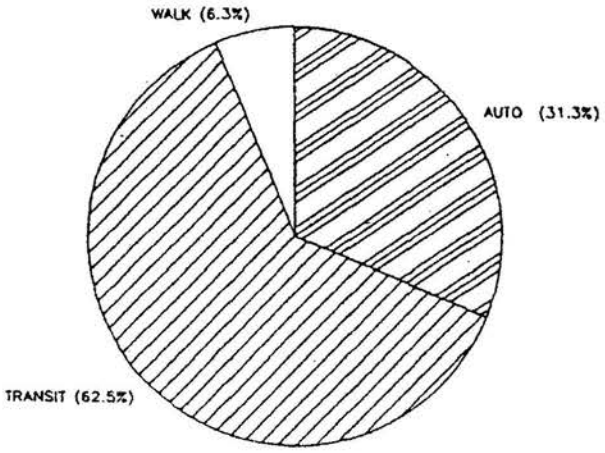
Figure 28.

MODE SPLIT FOR SHOPPERS



UNION STATION

MODE SPLIT FOR EMPLOYEES



UNION STATION

MODE SPLIT FOR RESTAURANT PATRONS

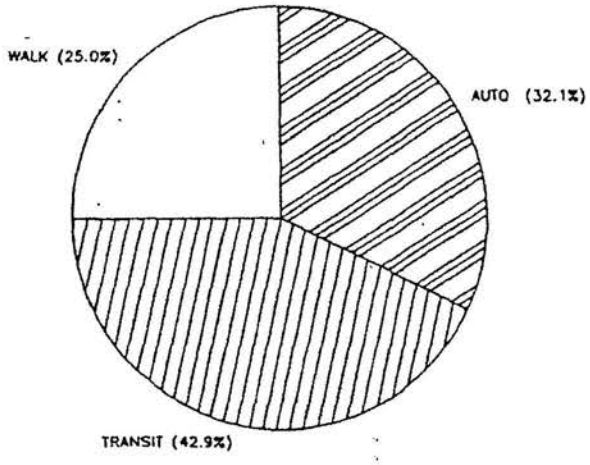


Figure 28.

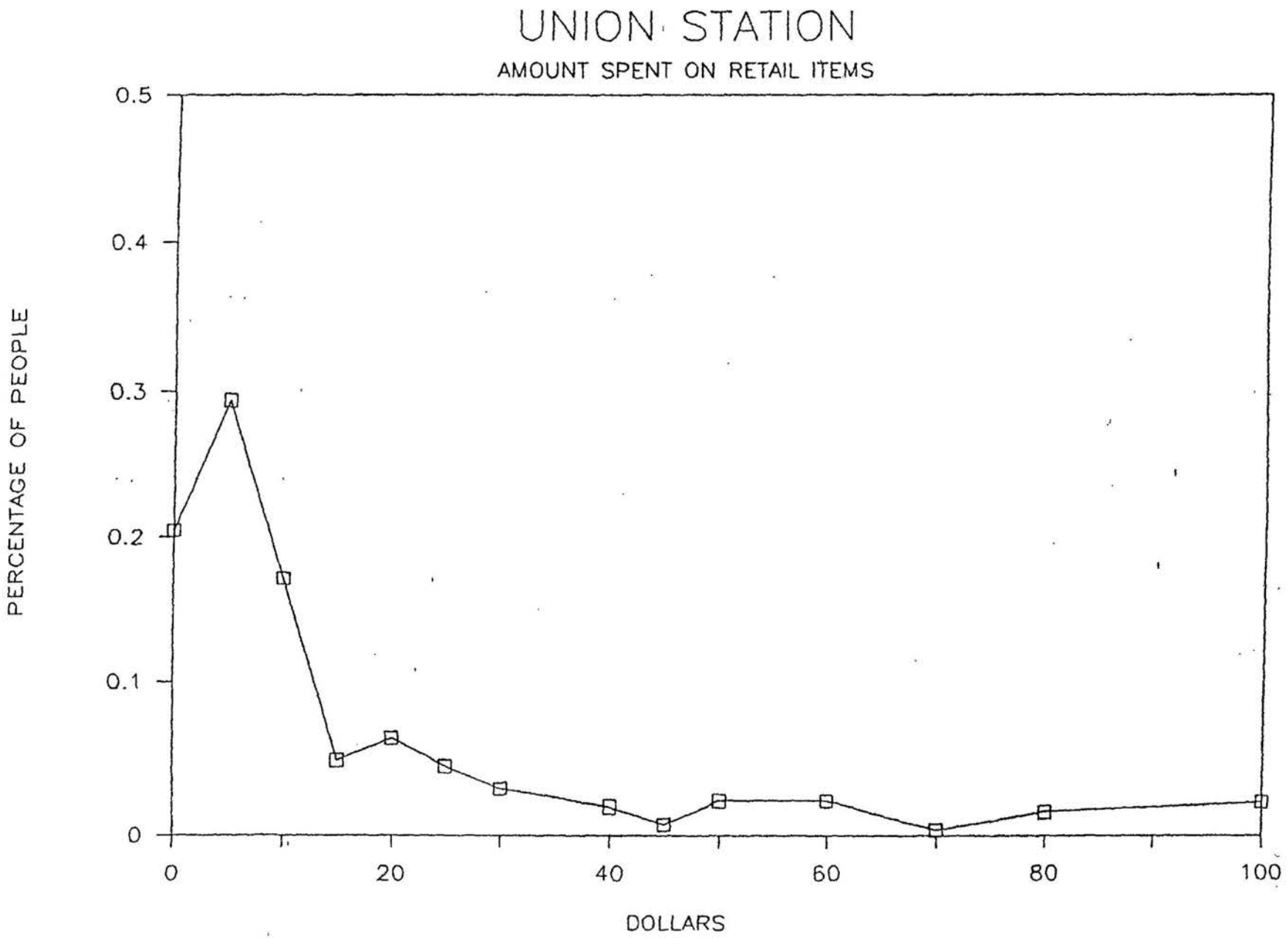

UNION STATION
AMOUNT SPENT ON RETAIL ITEMS
PERCENTAGE OF PEOPLE
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
DOLLARS

Figure 20

Table 27. Union Station

Counting Period: 10:00 AM - 6:00 PM

Peak Hour: 12:30 PM - 1:30 PM
(Metrorail: 4:30 PM - 5:30 PM)

Total Number of Persons:

	IN	OUT
Counting Period		
Union Station	23,817	19,799
Amtrak	13,876	11,279
Metrorail	13,561	12,634

- Approximately 9% of visitors park in the parking structure
- Approximately 57% of visitors enter the Amtrak arrival/departure area

Average (mean) Expenditure: $22.00

Parking Costs: $1.50/hour $7.50/day

Table 28. Site Characteristics of Hotels

Metrorail Station	Hotel	Distance to Station (ft.)	No. Guest Rooms	GSF Conf. Space	Rest./ Lounge Seats	No. Parking Spaces	Parking Costs	Year Constructed
Metro Center	JW Marriott (2)[1]	1300	773	28,360	450			1983
	Hyatt Grand (3)	500	907	50,000				1987
Rosslyn	Hyatt Arlington (45)	300	303	6,020	330	290	guests free conf. varies	1976
Crystal City	Crystal Gateway (10)	100	702	14,800	350	320	guest/conf. pay for parking	1982
	Crystal Hyatt (11)	3800	685	31,900	594	330	guest $7.50/day rest. validates weekend guests free	1982
Woodley Park/Zoo	Omni Shoreham (46)	1050	770					
Bethesda	Hyatt Regency (32)	300	380			1400[2]		
Twinbrook	Holiday Inn–Crowne Plaza (38)	400	315	850[2]				
Union Station	Phoenix Park (43)	900	88	150[2]				
Silver Spring	Holiday Inn (19)	2500	227					

[1] Numbers in parentheses refer to location maps in Figures 2 to 13.

[2] Total parking for project.

- to determine the purpose of the trip to the hotel
- to determine mode of travel used to get to or from the hotel on the survey day.
- to determine where the trips originated
- to determine trip generation rates

The pedestrian surveys contained in the Appendix were conducted at the entrances of the hotel or in the lobby area. Interviews were conducted for a minimum of 6 hours at each site covering both peak periods and portions of the mid-day. Cordon counts were conducted throughout this time and in the suburban locations auto occupancy counts were conducted.

Analysis

As with the other land use categories the responses to each question were tabulated and the person trips by 15 minute period tabulated. Summary tables presenting mode share by site and trip purpose are presented in this section.

Results

As with the retail sites transit mode share (Table 29) was found to be considerably higher than that found in the first study with all four repeat sites showing increase in transit mode share. The highest transit mode share was 37.7% at the Holiday Inn Crowne Plaza near the Twinbrook station, while the lowest was found at the Phoenix Park Hotel near Union Station. Of all the land uses surveyed, hotels can be expected to have the greatest variability in transit mode share.

The expansion of the mode share table to include trip purpose is shown in Table 30. Figure 30 graphs the relationship between transit mode share and distance for hotel sites. The table reveals that as was the case in the first study, overnight guests consistently had a lower transit ridership than meeting/conference attendees. Many factors influence transit ridership. For instance, lack of familiarity with the system may result in fewer overnight guests or out of town conference attendees choosing to take transit. Also, the reason the overnight guest is in town may influence their mode choice. For instance, an overnight guest visiting the area for pleasure rather than

Table 29. Summary of Transit Mode Share - Hotel

	Number of Sites	Percent Transit Range	Percent Transit Average
CBD Locations	4	10.8% - 35.9%	25.0%
Suburban Locations Inside Beltway	5	12.4% - 29.8%	19.3%
Suburban Locations Outside Beltway	1	37.7%	37.7%
All Hotel Locations	10	10.8% - 35.9%	25.2%

Table 30. Mode Share by Purpose for Trips to and from Hotel Sites

Hotel	Purpose	Auto	Rail	Bus	Walk	Taxi/Limo	Shuttle	Total	Summary % Auto	Summary % Transit
Hyatt	Overnight Guest	48.7%	33.3%	2.6%	5.1%	10.3%	0.0%	100.0%	48.7%	35.9%
Regency	Meeting/Conf.	48.4	29.0	0.0	9.7	9.7	3.2	100.0	48.4	29.0
Bethesda	Restaurant	28.6	14.3	7.1	21.4	21.4	7.1	100.0	28.6	21.4
	Other	50.0	20.0	0.0	20.0	0.0	10.0	100.0	50.0	20.0
Holiday	Overnight Guest	54.2	16.7	4.2	20.8	4.2	0.0	100.0	54.2	20.8
Inn	Meeting/Conf.	0.0	0.0	0.0	0.0	100.0	0.0	100.0	0.0	0.0
Silver	Restaurant	—	—	—	—	—	—	—	—	—
Spring	Other	—	—	—	—	—	—	—	—	—
Hyatt	Overnight Guest	23.1	30.8	1.9	23.1	21.2	0.0	100.0	23.1	32.7
Grand	Meeting/Conf.	14.3	39.3	0.0	14.3	28.6	3.6	100.0	14.3	39.3
	Restaurant	36.4	9.1	0.0	54.5	0.0	0.0	100.0	36.4	9.1
	Other	19.2	38.5	7.7	26.9	7.7	0.0	100.0	19.2	46.2
Holiday	Overnight Guest	61.7	33.3	0.0	1.7	3.3	0.0	100.0	61.7	33.3
Inn	Meeting/Conf.	26.8	56.1	9.8	0.0	7.3	0.0	100.0	26.8	65.9
Crowne	Restaurant	100.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0
Plaza	Other	83.3	16.7	0.0	0.0	0.0	0.0	100.0	83.3	16.7
J.W.	Overnight Guest	34.4	18.5	2.1	12.8	30.3	2.1	100.0	34.4	20.5
Marriott	Meeting/Conf.	26.7	20.0	20.0	20.0	13.3	0.0	100.0	26.7	40.0
	Restaurant	61.9	23.8	0.0	0.0	14.3	0.0	100.0	61.9	23.8
	Other	41.7	23.3	6.7	13.3	15.0	0.0	100.0	41.7	30.0

Note: For each hotel location, the mode split is given for each trip purpose. In the columns labeled "summary," transit includes rail and bus.

Table 30. Mode Share by Purpose for Trips to and from Hotel Sites
(Continued)

Hotel	Purpose	Auto	Rail	Bus	Walk	Taxi/Limo	Shuttle	Total	Summary % Auto	Summary % Transit
Crystal Gateway Marriott	Overnight Guest	33.6	28.0	0.9	14.0	11.2	12.1	100.0	33.6	29.0
	Meeting/Conf.	53.8	19.2	0.0	7.7	15.4	3.8	100.0	53.8	19.2
	Restaurant	0.0	50.0	0.0	50.0	0.0	0.0	100.0	0.0	50.0
	Other	45.8	16.7	2.1	29.2	0.0	6.3	100.0	45.8	18.8
Hyatt Arlington	Overnight Guest	23.0	28.0	2.0	21.0	19.0	7.0	100.0	23.0	30.0
	Meeting/Conf.	30.4	52.2	0.0	13.0	4.3	0.0	100.0	30.4	52.2
	Restaurant	78.6	7.1	0.0	7.1	7.1	0.0	100.0	78.6	7.1
	Other	66.7	7.7	2.6	23.1	0.0	0.0	100.0	66.7	10.3
Phoenix Park Hotel	Overnight Guest	17.4	8.7	0.0	21.7	52.2	0.0	100.0	17.4	8.7
	Meeting/Conf.	33.3	0.0	0.0	16.7	50.0	0.0	100.0	33.3	0.0
	Restaurant	100.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0
	Other	16.7	16.7	16.7	33.3	16.7	0.0	100.0	16.7	33.3
Hyatt Regency Crystal City	Overnight Guest	23.3	4.1	1.4	8.2	8.2	54.8	100.0	23.3	5.5
	Meeting/Conf.	10.8	27.0	0.0	0.0	37.8	24.3	100.0	10.8	27.0
	Restaurant	100.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0
	Other	100.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0
Omni Shoreham	Overnight Guest	15.7	25.1	0.5	7.9	46.6	4.2	100.0	15.7	25.7
	Meeting/Conf.	43.5	36.5	1.2	8.2	10.6	0.0	100.0	43.5	37.6
	Restaurant	100.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0
	Other	45.0	20.0	15.0	10.0	10.0	0.0	100.0	45.0	35.0

... given for each trip purpose. In the columns labeled "summary," transit includes rail and bus.

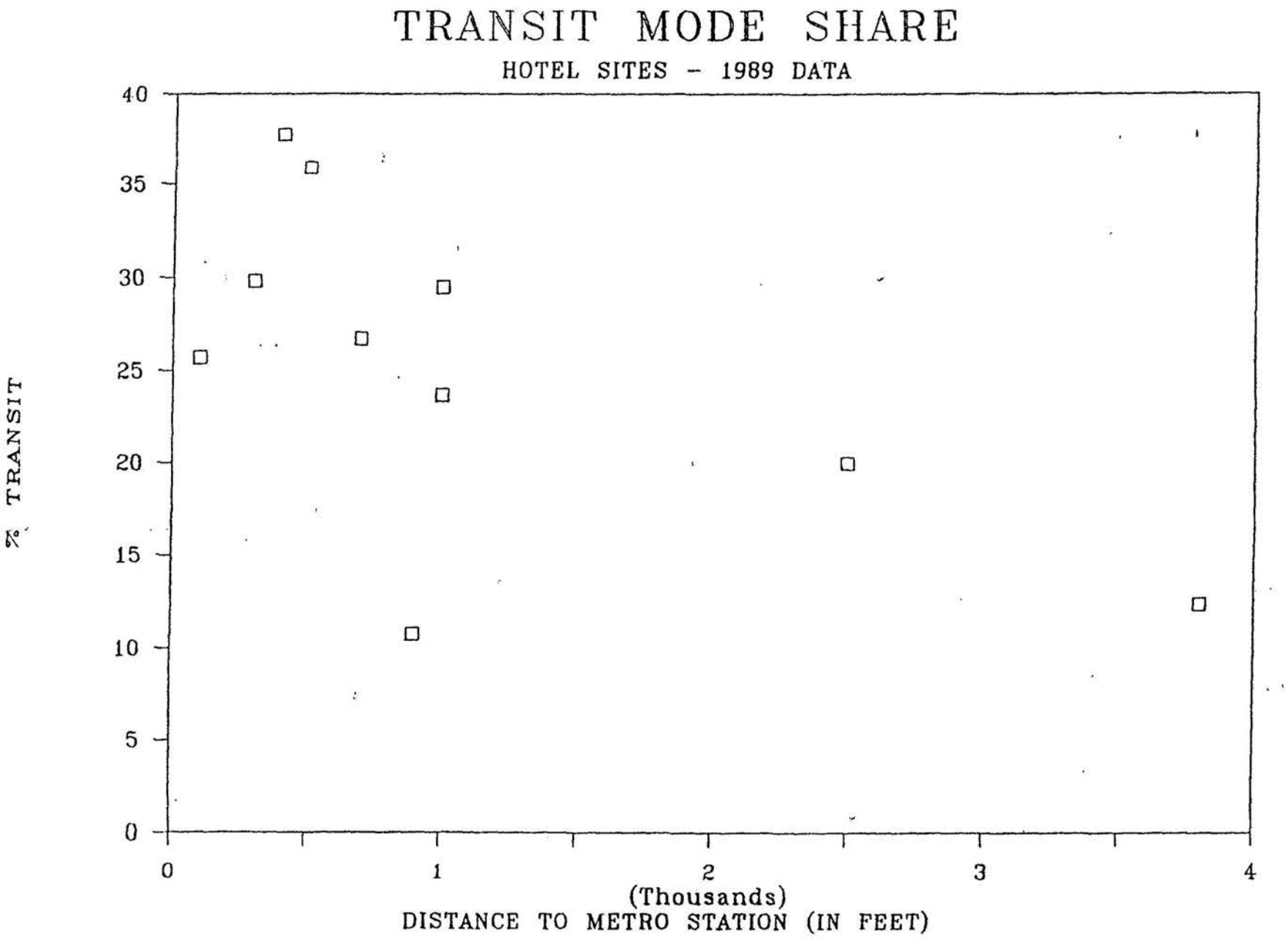

TRANSIT MODE SHARE
HOTEL SITES - 1989 DATA
% TRANSIT
40
35
30
25
20
15
10
5
0
0
1
2
3
4
(Thousands)
DISTANCE TO METRO STATION (IN FEET)

Figure 30.

business may choose transit more often than the business person on a travel expense account. During the interviews common observations from overnight guests from out of town were that they did not know that Washington had a rail system or that it took them 2 or 3 days to discover the system. While this is admittedly a subjective statement, it again suggests that a marketing strategy targeted at individual station areas may be appropriate. Responses to the attitudinal questions from the hotel surveys are presented in Table 31.

DATA FROM OTHER SOURCES

There are several other sources of data, similar to that collected in this study, that provide insight into travel behavior at sites near Metrorail stations. The first study which has been referred to throughout this report provided data on 34 sites. Another study completed by JHK & Associates for the Maryland-National Capital Park and Planning Commission involved the collection of mode split and trip generation data at sites along the Metrorail Red Line in Montgomery County. The Council of Governments (COG) has also conducted studies at several sites in the downtown and at the Van Ness-UDC station. Mode share and trip generation data has been collected over the past year and half at the NRC Building near the White Flint station.

Data from a number of other sites in these studies has been included in the appendix B of this report. This data can be used for comparative purposes or for additional points of reference at rail stations other than those included in this study In general, the data from the several studies support one another. Data from the downtown sites, collected by COG suggest a high transit mode share, as would be expected. Several tables of data from these studies are provided in Appendix B.

Table 31. Hotel Surveys
Respondents Opinions by Mode of Travel

Q12: People should be encouraged to use transit.

Question	Mode of Travel: Auto		Transit		Walk		Other		Subtotal		Missing Values		Total	
Agree	308	(89.8%)	149	(93.7%)	49	(92.5%)	78	(94.0%)	584	(91.5%)	520	(87.5%)	1104	(89.6%)
Disagree	9	(2.6)	2	(1.3)	1	(1.9)	1	(1.2)	13	(2.0)	12	(2.0)	25	(2.0)
No Opinion	23	(6.7)	6	(3.8)	3	(5.7)	4	(4.8)	36	(5.6)	59	(9.9)	95	(7.7)
Not Answered	3	(0.9)	2	(1.3)	0	(0.0)	0	(0.0)	5	(0.8)	3	(0.5)	8	(0.6)
Total	343	(100.0)	159	(100.0)	53	(100.0)	83	(100.0)	638	(100.0)	594	(100.0)	1232	(100.0)

Q13: Schedule information is readily available for transit.

Question	Mode of Travel: Auto		Transit		Walk		Other		Subtotal		Missing Values		Total	
Agree	219	(63.8%)	123	(77.4%)	40	(75.5%)	64	(77.1%)	446	(69.9%)	354	(59.6%)	800	(64.9%)
Disagree	61	(17.8)	21	(13.2)	10	(18.9)	11	(13.3)	103	(16.1)	118	(19.9)	221	(17.9)
No Opinion	60	(17.5)	13	(8.2)	3	(5.7)	8	(9.6)	84	(13.2)	120	(20.2)	204	(16.6)
Not Answered	3	(0.9)	2	(1.3)	0	(0.0)	0	(0.0)	5	(0.8)	2	(0.3)	7	(0.6)
Total	343	(100.0)	159	(100.0)	53	(100.0)	83	(100.0)	683	(100.0)	594	(100.0)	1232	(100.0)

Table 31. Hotel Surveys
Respondents Opinions by Mode of Travel
(Continued)

Q14: Metrorail is clean and reliable.

Question	Mode of Travel: Auto		Transit		Walk		Other		Subtotal		Missing Values		Total	
Agree	264	(77.0%)	144	(90.6%)	47	(88.7%)	65	(78.3%)	520	(81.5%)	424	(71.4%)	944	(76.6%)
Disagree	3	(0.9)	3	(1.9)	1	(1.9)	2	(2.4)	9	(1.4)	2	(0.3)	11	(0.9)
No Opinion	74	(21.6)	10	(6.3)	5	(9.4)	16	(19.3)	105	(16.5)	166	(27.9)	271	(22.0)
Not Answered	2	(0.6)	2	(1.3)	0	(0.0)	0	(0.0)	4	(0.6)	2	(0.3)	6	(0.5)
Total	343	(100.0)	159	(100.0)	53	(100.0)	83	(100.0)	683	(100.0)	594	(100.0)	1232	(100.0)

Q15: Metrobus is clean and reliable.

Question	Mode of Travel: Auto		Transit		Walk		Other		Subtotal		Missing Values		Total	
Agree	128	(37.3%)	61	(38.4%)	19	(35.8%)	26	(31.3%)	234	(36.7%)	188	(31.6%)	422	(34.3%)
Disagree	26	(7.6)	16	(10.1)	6	(11.3)	3	(3.6)	51	(8.0)	23	(3.9)	74	(6.0)
No Opinion	181	(52.8)	77	(48.4)	28	(52.8)	53	(63.9)	339	(53.1)	380	(64.0)	719	(58.4)
Not Answered	8	(2.3)	5	(3.1)	0	(0.0)	1	(1.2)	14	(2.2)	3	(0.5)	17	(1.4)
Total	343	(100.0)	159	(100.0)	53	(100.0)	83	(100.0)	683	(100.0)	594	(100.0)	1232	(100.0)

[illegible] to people who specified their mode of travel but do not answer the question. Missing values refer to people who

ANALYSIS OF TRENDS AND RELATIONSHIPS

This chapter discusses the development of mathematical relationships between transit ridership and the characteristics of building sites, and provides peak hour generation rates for the buildings based on cordon counts and/or estimates made based on the survey results. Data from the previous study has been included in this analysis and the differences are highlighted. The primary objective of these analyses was to refine and if possible, expand the tools developed in the first study for use in land use and transportation planning in the vicinity of Metrorail stations. The development of mathematical relationships is presented first, followed by summaries of trip generation rates.

MATHEMATICAL RELATIONSHIPS BETWEEN TRANSIT RIDERSHIP AND SITE CHARACTERISTICS

- What type of development is most appropriate?
- What percent of employees, residents, or patrons will come by transit?
- How many vehicle trips will be generated?
- How can vehicle trips be minimized while transit ridership is encouraged?

The answer to these questions and others has implications on the roadway facilities required, on the amount of parking needed, and on the utilization of the transit system.

There is no foolproof method of predicting what transit mode share will be. Each building and its occupants are unique, in terms of the travel habits and O/D characteristics of its employees, the cost and supply of parking, age, sex, income etc. For example, a building that houses primarily real estate and insurance personnel will be different than for a building that houses primarily medical professionals. However, trends and typical relationships between transit ridership and certain site factors can be developed. In this study and the previous WMATA study the technique applied was multiple regression analysis. Regression analysis enables the development of mathematical equations that best explain the variation in a dependent variable (transit mode share in this case) on the basis of one or more independent variables such as distance to a metrorail station, number of employees, size of building etc. The resulting equations provide a reliable estimate of the transit mode share. It must be understood, however, that these are not perfect predictors but only tools to be used for general

planning purposes. Individual sites may have transit ridership characteristics that vary widely from the norm. This study has focused on site characteristics that influence transit ridership. However, characteristics of the transit system and the road network also influence transit ridership along with land use characteristics of the general area. Other studies have developed tools based on these and other characteristics. The tools developed in this study must be used in conjunction with the other planning tools available.

The data collection for this study was designed to collect data related to site characteristics, however some of the data collected relates to characteristics of the system and the region as a whole. The implications of these data are discussed where possible. However, to gain the full benefit of the data it must used to supplement other data sources such as demographic and socioeconomic data provided by COG.

The analysis of the data was undertaken in three steps. The first step was to tabulate the data and perform a comparison between this study and the first WMATA study. The data from this survey was in general very similar to that of the first study with the exceptions noted previously. The first study undertook a stepwise regression and produced correlation matrices between pairs of dependent and independent variables. The second step verified correlations between selected variables developed in the first WMATA study based on the survey results and then equations were developed that were practical for planning purposes. The final step involved the merging of the results from the two studies and other data sources where possible to produce a composite set of equations based on the total data available. While some variables that are highly correlated are not practical for inclusion in the equations, their possible implications are discussed.

The candidate dependent and independent variables considered throughout the two studies are discussed below. Suggested planning equations are presented, and the equations are portrayed graphically.

Office

The following candidate dependent and independent variables were identified in the office regression analysis:

Candidate dependent variables

- percent of work trips by auto

- percent of work trips by transit
- percent of work trips by walking
- percent of all mid-day trips by auto
- percent of all mid-day trips by transit
- percent of all mid-day trips by walking
- percent of non-walk mid-day trips by auto
- percent of non-walk mid-day trips by transit
- average auto occupancy

Candidate independent variables

- auto availability
- distance from the DC core, measured in airline miles between the Metrorail station and the closet edge of the DC core area. This distance was considered to be 0 for Farragut West, Metro Center, and Union stations.
- development setting: downtown DC, inside the Beltway, outside the Beltway
- employer type: multiple tenant, single tenant, private sector, government
- number of employees
- employees per 1000 square feet
- GSF gross square feet of building floor area
- percent of those residing in the same state as they work
- distance of the building from the station portal
- percent of drivers with free parking
- cost of parking
- parking spaces per 1000 GSF
- cost for transit users (dollars per day for round trip)
- household size

The philosophy in developing the candidate variables was to include all possible factors that could explain variations in travel characteristics and for which data were available. There are very fine differences between some of the variables (e.g., those

related to cost). Others, such as the auto and transit variables, are complements of one another. Emphasis was placed primarily on developing equations to explain the variations in transit mode share, both for work trips and mid-day trips. Experimenting was also done with several of the other candidate dependent variables.

Factors were only included in an equation if they added significantly to the explanatory power of the equation as a whole. The explanatory power is summarized in the R-squared statistic and is the proportion of the variance in the dependent variable that can be "explained" by the independent variables. If all the variance could be explained, the R-squared value would be 1.0. Several other tests also need to be conducted to determine the extent to which the given equation is valid. Several observations from the regression analysis are discussed below:

When all sites from both studies are included in the data set, the development type is the most correlated with the percent of work trips by transit. This is because of the dramatic difference between the transit mode share for downtown and suburban sites.

When broken into groups by location within the metropolitan area, the most important variable is the distance from the building to the Metrorail station portal.

Including other variables such as auto availability, transit costs, parking, costs, etc. does not significantly increase the R-squared value and are not as easily used in planning applications.

Considered on their own several other non-site factors (household size, auto availability, transit availability) do exhibit mathematical relationships which can be used if information is available to confirm predictions based on site factors.

The expanded data set was used to refine the two sets of equations developed in the first study, one for downtown sites and another for suburban sites. Equations were developed to predict transit mode share for commute trips and for non wall midday trips.

Equations for Downtown Offices

Only one building was surveyed in downtown Washington for this study. The addition of this site to the data base resulted in only a slight change to the suggested equation. The suggested equation is:

$$T = 61.37 - 0.76 * (M)$$

(T = Transit Mode Share)
(M = distance from Metro)

The R-squared value for this equation is a moderate .57, only a slight improvement over the original equation. The equation is graphed in Figure 31. The equation indicates that the transit mode share for a building directly adjacent to a station portal would be slightly over 60 percent. This would decrease by 0.76 percent for each 100 feet distance from the station portal. Intuitively one would not expect the relationship between transit mode share and Metro to be linear. It is more likely that the transit mode share would stay fairly level up until a certain distance is from Metro and then begin to fall off more dramatically as the distance from the station is increased and then leveling off again at the farthest distances. Testing of a non linear relationship with the current data resulted in a curve that dropped off quicker near the station portal and than leveled off similar to the relationship found in two Canadian cities as illustrated in Figure 32. The R^2 of a non-linear equation was slightly better, however, it was felt that without more data the linear relationship was the most appropriate and would suffice as an approximate planning tool producing similar results for distances between 200 and 2,000 feet. Based on the available data from these studies and similar studies elsewhere the proposed equation probably underestimates transit mode share for building sites near a rail station and overestimates transit mode share at more distant sites. This equation should not be considered to be the final answer, but should be modified as the system and the land around it develops. More data is required to better define the equation and improve its validity.

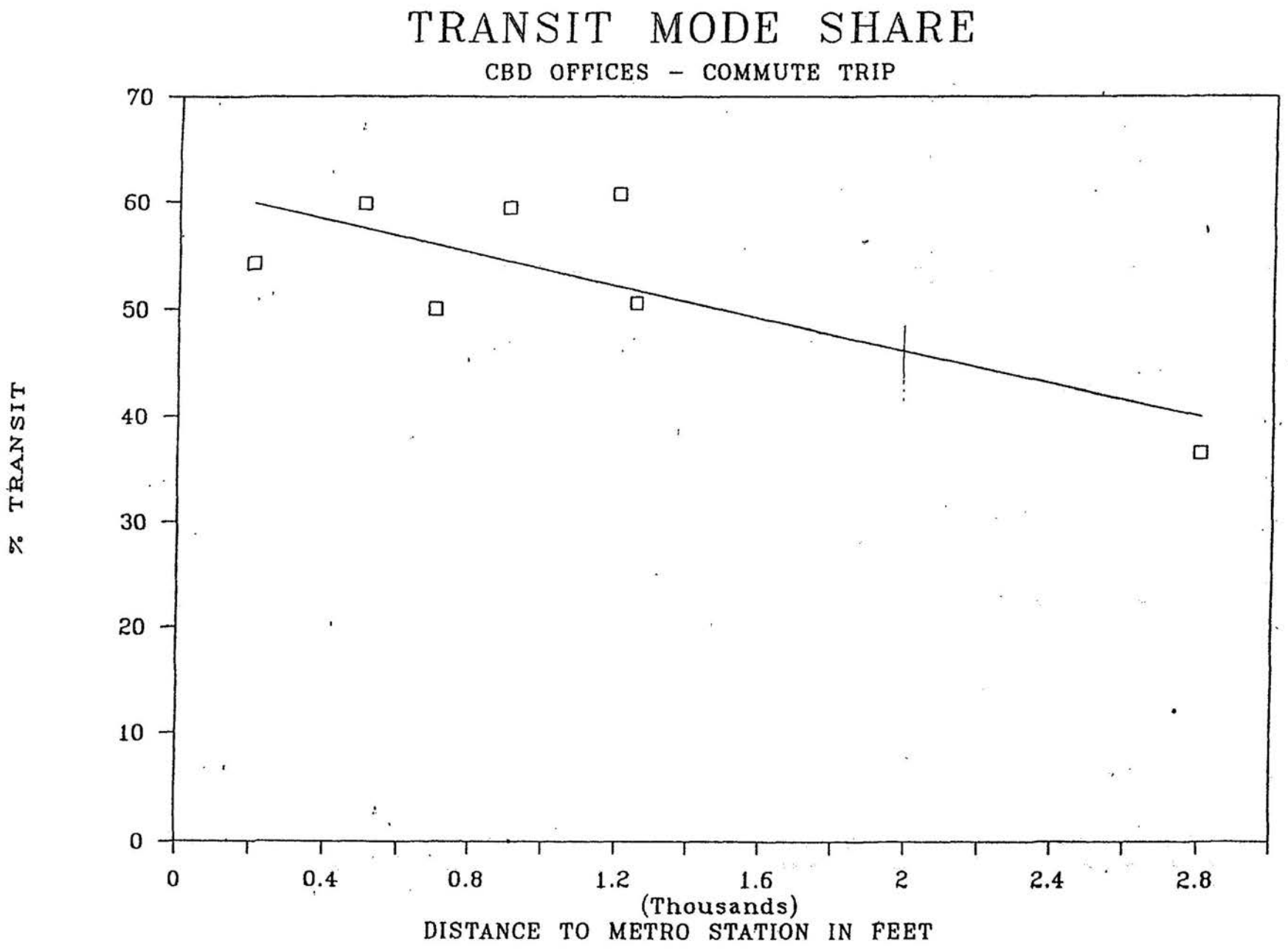
The following equation is suggested to explain the transit mode share for mid-day non-walk trips:

$$T = 62.76 - 1.12 * (M)$$

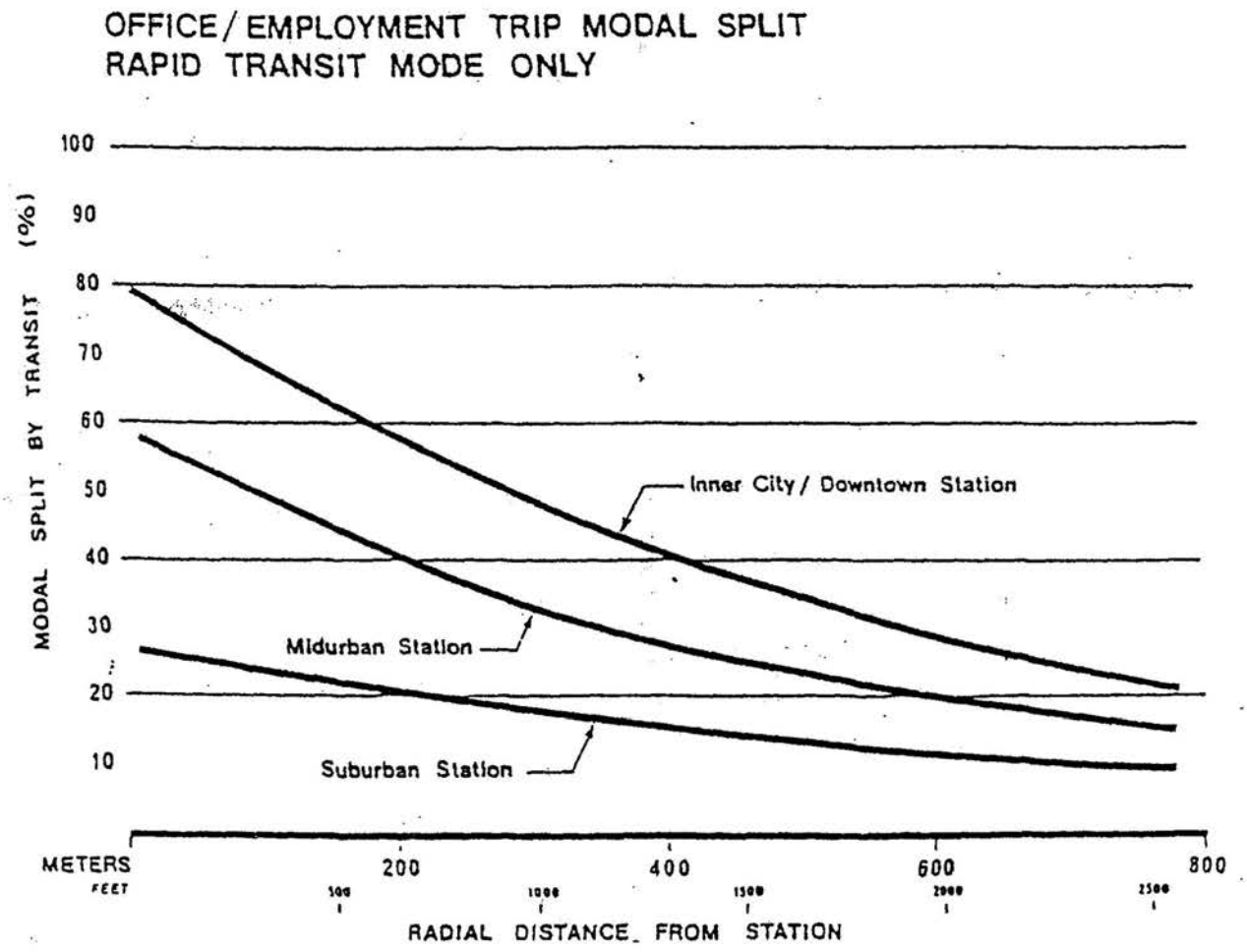
(T = Transit Mode Share)
(M = distance from Metro)

The R-squared for this equation is 0.33 which is relatively poor. The fact the addition of one site reduced the R-squared from 0.52 to 0.33 illustrates the need for a larger database to improve validity.

The mid-day equation is shown in Figure 33. It is important to note that the equations should not be extended beyond the limits of the available data without more data collection.

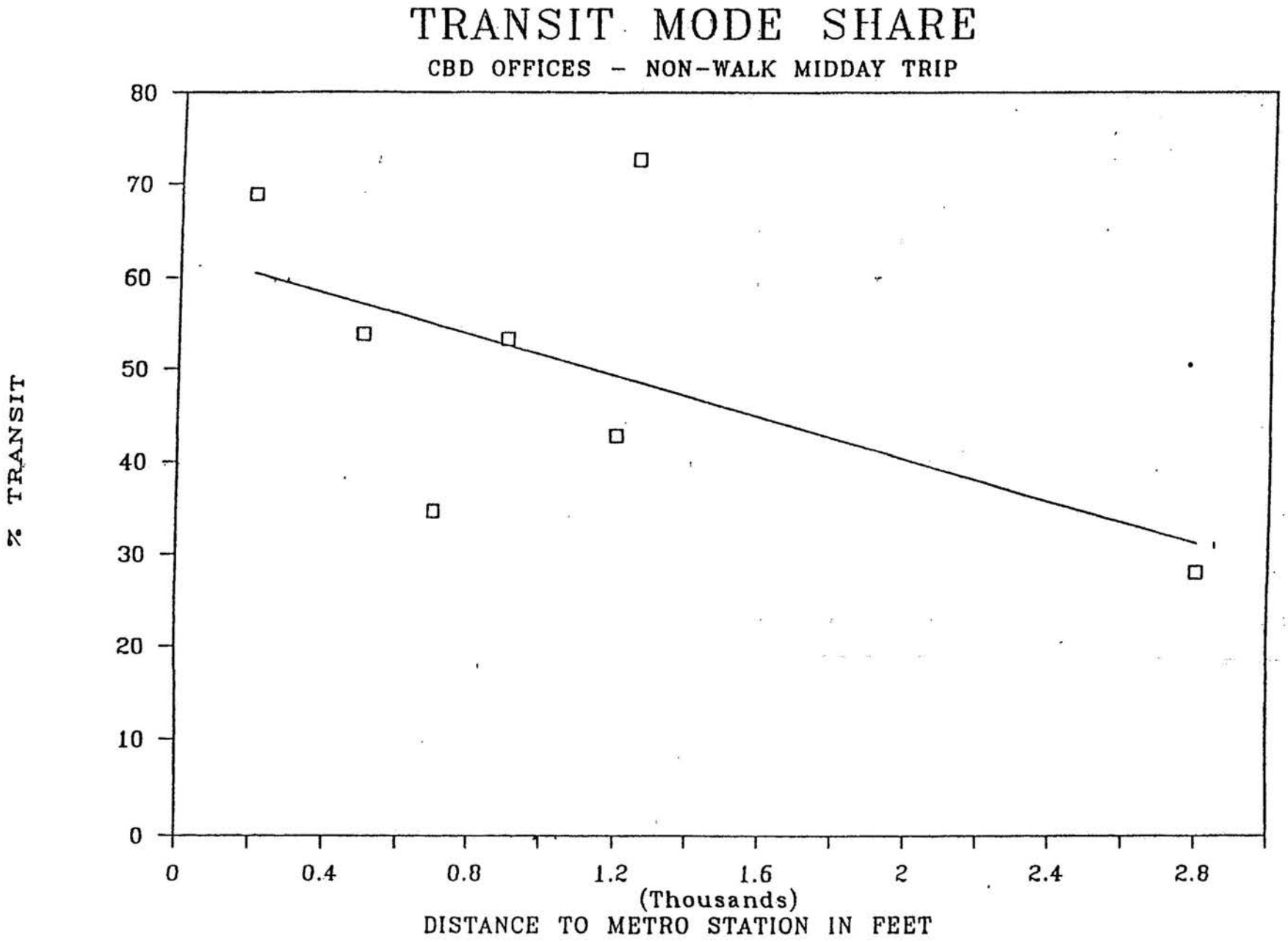

TRANSIT MODE SHARE
CBD OFFICES - COMMUTE TRIP
% TRANSIT
70
60
50
40
30
20
10
0
0
0.4
0.8
1.2
1.6
2
2.4
2.8
(Thousands)
DISTANCE TO METRO STATION IN FEET

RAPID TRANSIT MODE SPLIT FOR OFFICE WORK TRIPS
VERSUS WALK DISTANCE TO STATION



Source: Stringham 1983

Figure 32.


TRANSIT MODE SHARE
CBD OFFICES - NON-WALK MIDDAY TRIP
% TRANSIT
80
70
60
50
40
30
20
10
0
0
0.4
0.8
1.2
1.6
2
2.4
2.8
(Thousands)
DISTANCE TO METRO STATION IN FEET

Equations for Suburban Offices

For suburban offices, the following equations are suggested incorporating two independent variables - distance from the DC core, and distance from Metro. Equations that incorporate all applicable data from the first study, the Red Line study and this study are recommended. The equation for the commute trip is:

$$T = 27.16 - 0.61(M) - 0.84(D)$$

(T = Transit Mode Share)
(M = distance from Metro)
(D = distance to downtown)

The R-squared is 0.57. The equation for mid-day non-walk trip is:

$$T = 33.31 - 0.86(M) - 1.63(D)$$

The R-squared for this equation is 0.47.

These equations are considered to be more valid as they include 40 sites for the commute trip and 18 sites for the mid-day trips. This is considerably more than in the first study. As well there are buildings covering the full range of distances. As indicated by the R-squared values there is a better relationship for the commute trip. The two equations are graphed on Figures 34 and 35 respectively.

Residential

The candidate variables for residential sites were as follows:

Candidate dependent variables

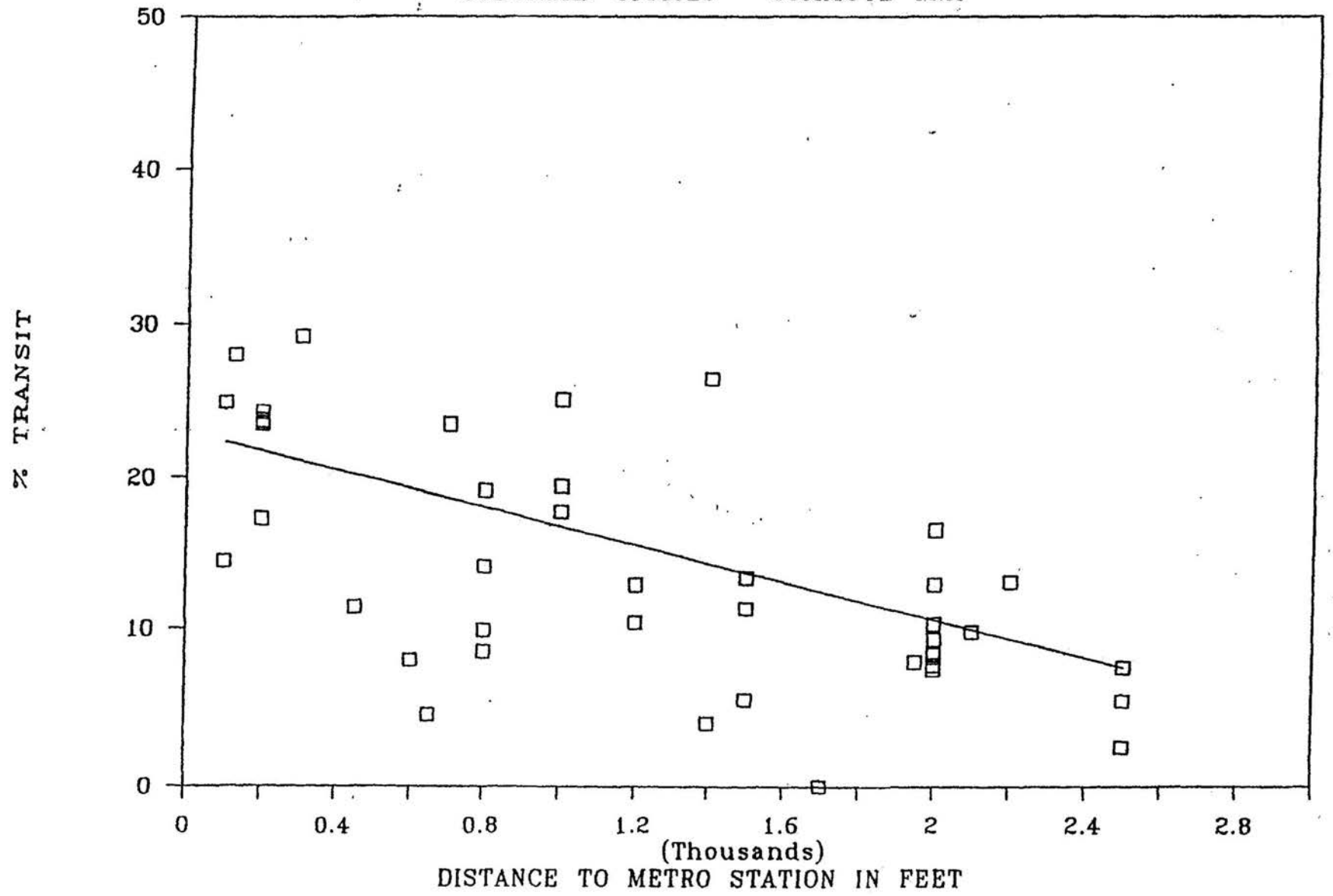
- percentage of all trips by auto
- percentage of work trips by auto
- percentage of all trips by transit
- percentage of work trips by walking

Candidate independent variables

- average age of residents
- distance from the DC core

TRANSIT MODE SHARE

SUBURBAN OFFICES - COMMUTE TRIP



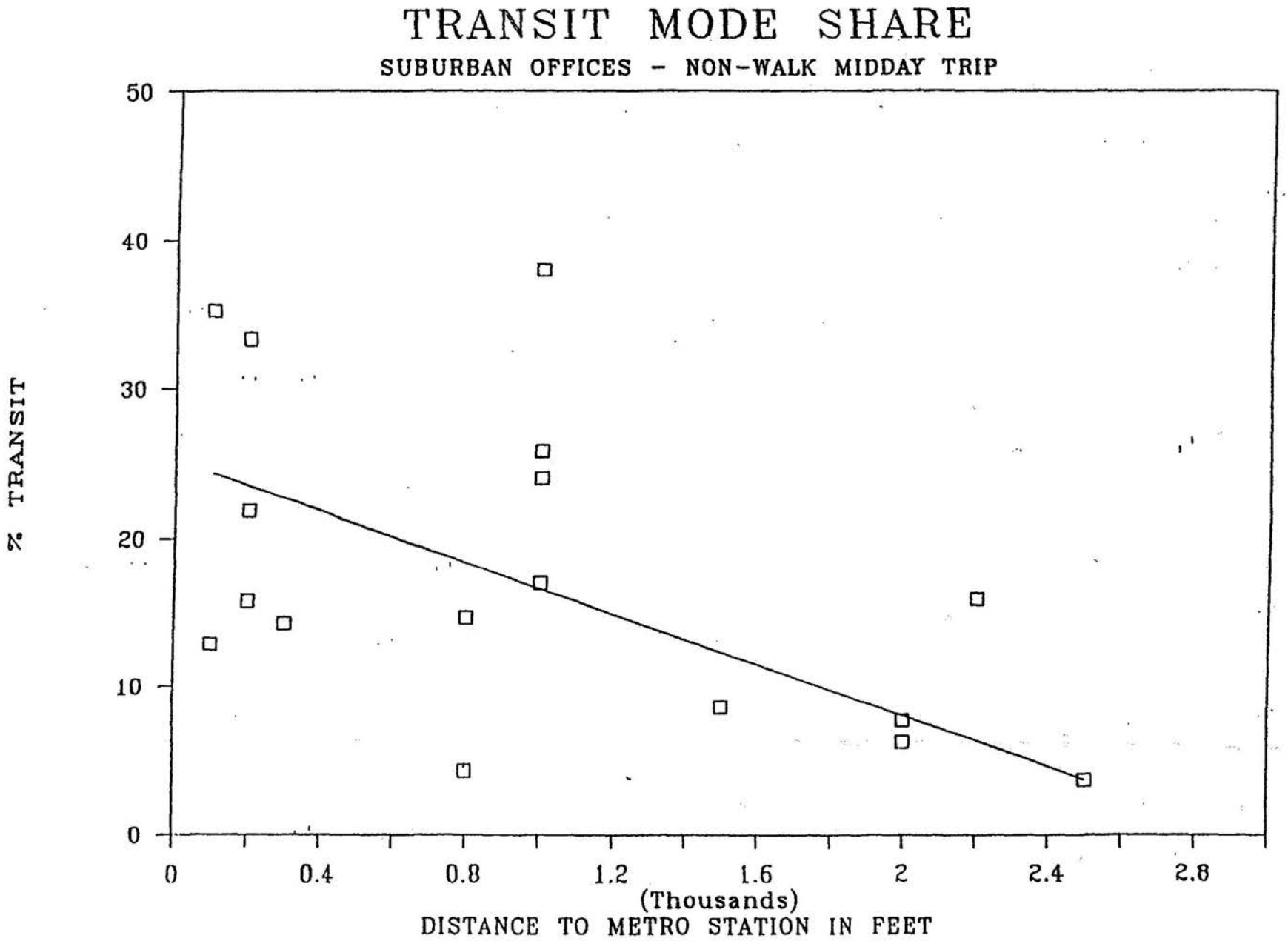

TRANSIT MODE SHARE
SUBURBAN OFFICES - NON-WALK MIDDAY TRIP
% TRANSIT
50
40
30
20
10
0
0
0.4
0.8
1.2
1.6
2
2.4
2.8
(Thousands)
DISTANCE TO METRO STATION IN FEET

Figure 35.

- percentage of those employed
- distance from the station portal
- average number of residents per dwelling unit
- number of parking spaces per dwelling unit
- monthly parking cost per vehicle
- number of dwelling units
- average number of vehicles per dwelling unit

Based on the expansion of the data base the equation was modified to the following:

$$T = 66.52 - 1.56\ (M)$$

(T = Transit Mode Share)
(M = distance from Metro)

The R-squared of 0.40 is slightly improved over the original equation but is still relatively poor. The database has been expanded to include 18 buildings. Sites further than half a mile from the station and those sites outside the Beltway were excluded. If these sites are included the R-squared is reduced noticeably. Due to limitations in the data collected for this study the equation for all trips from residential studies remains unchanged:

$$T = 51.5 - 0.66 * (M)$$

(T = Transit Mode Share)
(M = distance from Metro)

The R-squared for this equation is 0.34. The new equation is graphed in Figure 36.

Retail

The candidate variables for the retail analysis included:

Candidate dependent variables

- percentage of shopping trips by auto
- percentage of shopping trips by transit

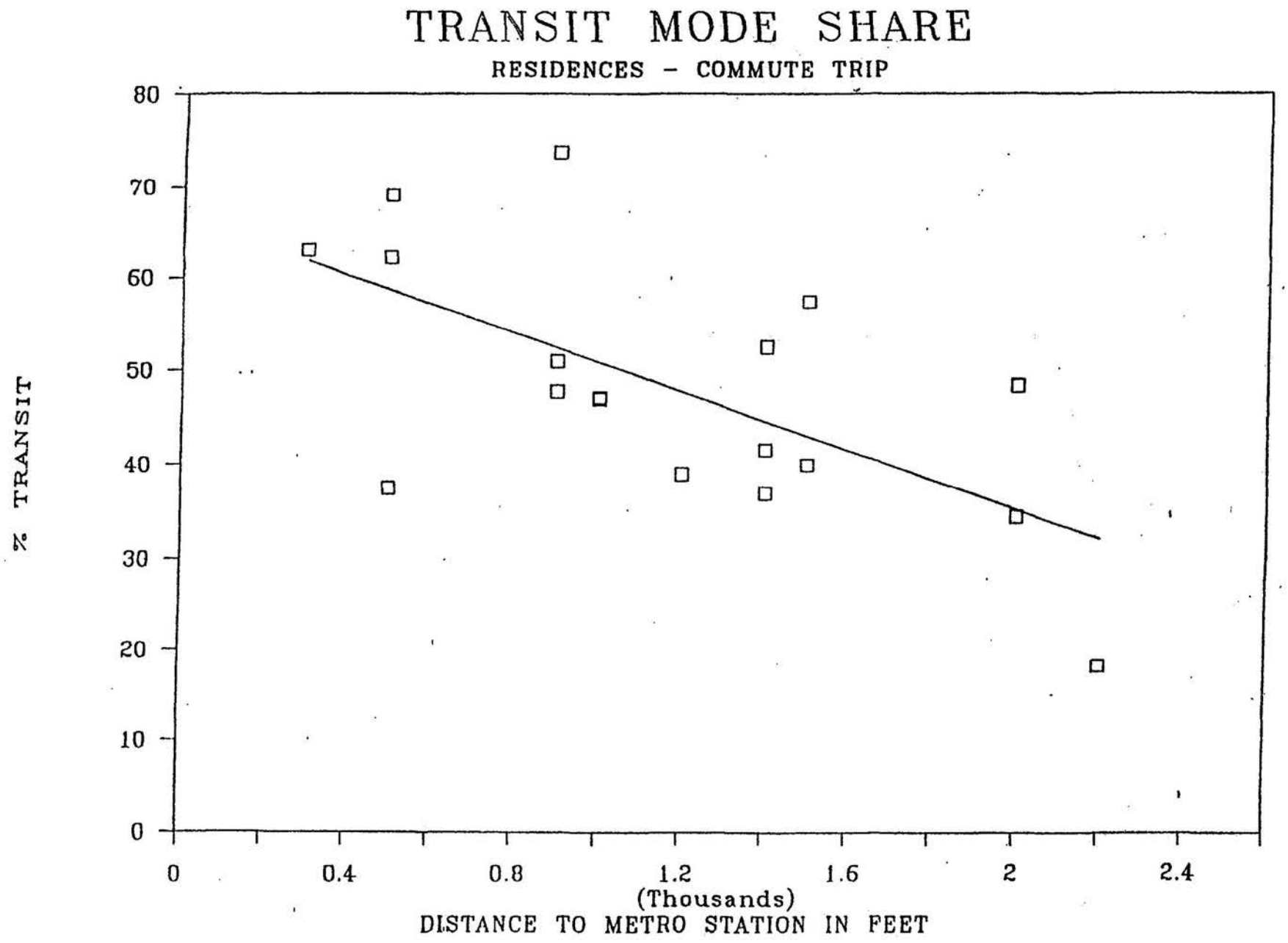

TRANSIT MODE SHARE
RESIDENCES - COMMUTE TRIP
% TRANSIT
80
70
60
50
40
30
20
10
0
0
0.4
0.8
1.2
1.6
2
2.4
(Thousands)
DISTANCE TO METRO STATION IN FEET

Figure 36.

Candidate independent variables

- development setting (downtown or suburban)
- distance from the DC core
- GSF gross square feet in 1000's
- distance from a Metrorail station
- Market draw (regional or local)[1]

With the expanded database available it was possible to include both distance to DC and distance to a Metro station in the proposed equation. The equation when based on data from this study is:

$$T = 49.18 - 0.15(M) - 2.16(D)$$

(T = Transit Mode Share)
(M = distance from Metro)
R-squared = 0.50

When an equation using the most recent data available from all studies is developed the equation is as follows:

$$T = 41.07 - 0.75(M) - 1.92(DC)$$

(T = Transit Mode Share)
(M = distance from Metro)
R-squared = 0.64

This equation includes 28 sites covering the full range of distances. The R-squared values are lower than for the first study but represent a much bigger database and should therefore be considered more valid. Caution should be exercised when using these equations as one of the findings of this study is that transit mode share to retail sites has increased from the time of the first WMATA study. This emphasizes the fact that these equations must be reviewed over time as the system and the areas it serves develop. These equations are graphed in Figures 37 and 38 respectively.

[1] Market draw refers to the target market of the establishment. An example of a retail site with local draw would be a shopping center with tenants such as a bank, a 7-11 store, dry cleaners, etc. A retail site with regional draw would be a larger shopping center with major anchor tenants. An example would be Ballston Common.

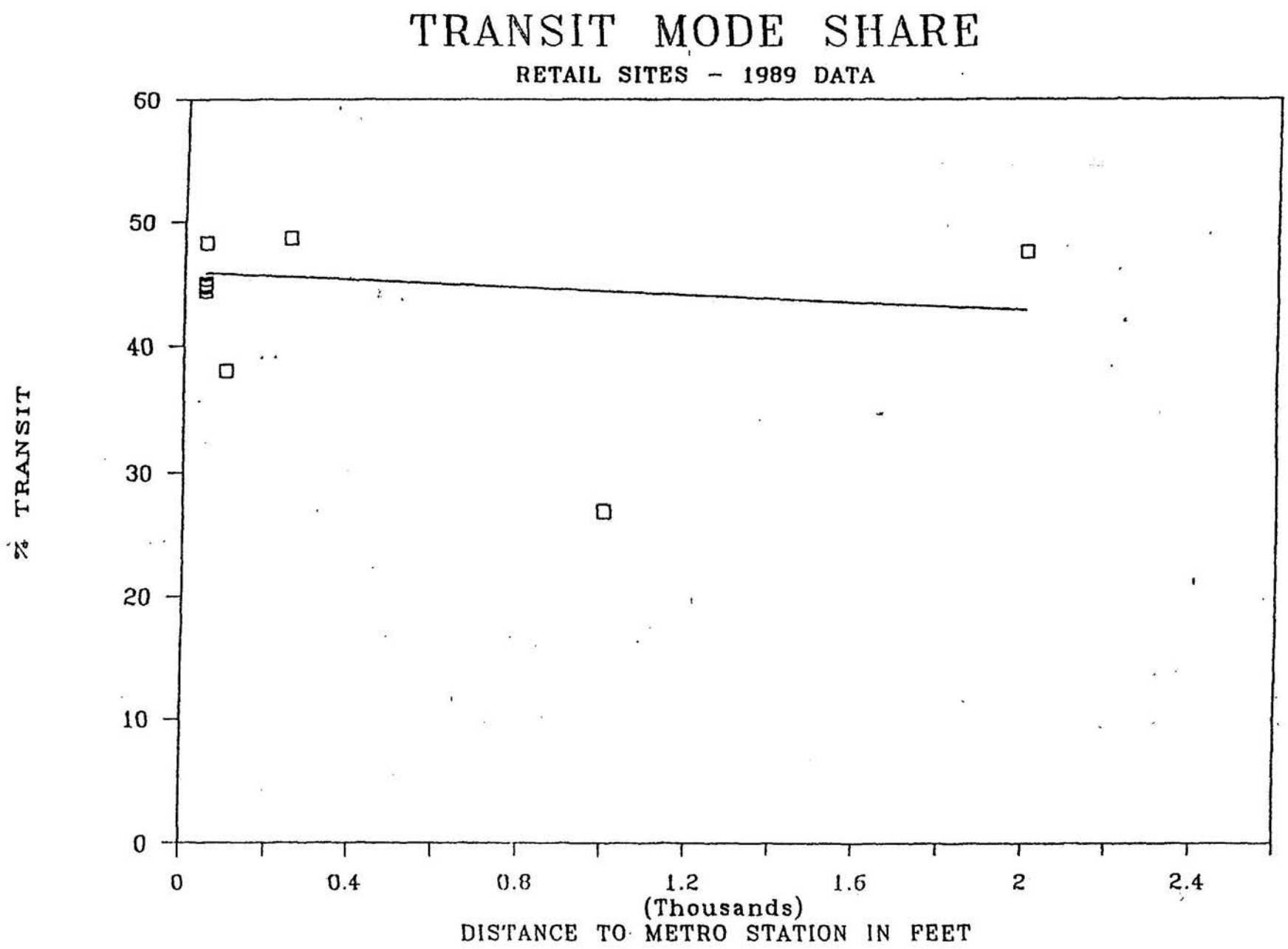
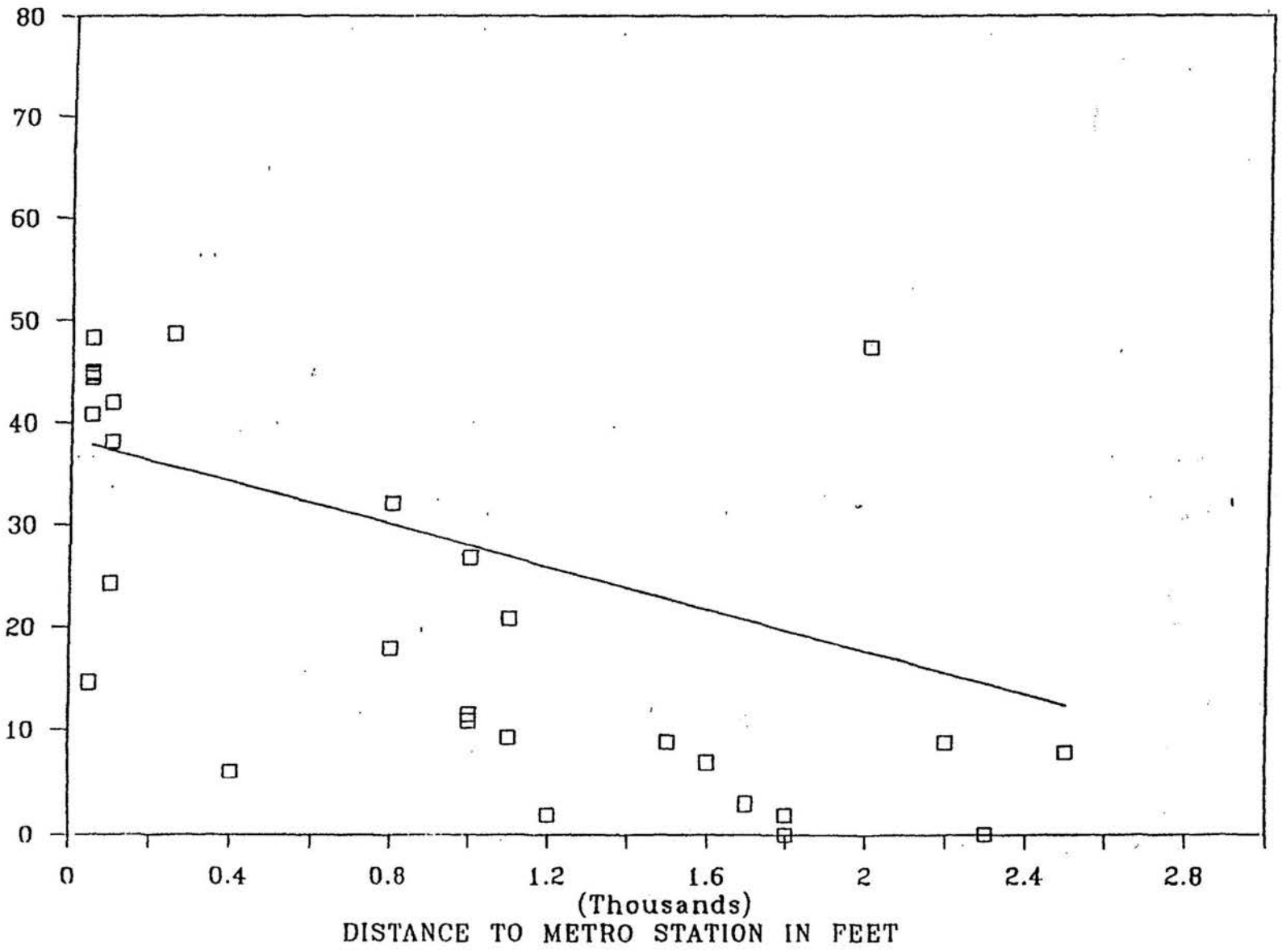

TRANSIT MODE SHARE
RETAIL SITES - 1989 DATA
% TRANSIT
60
50
40
30
20
10
0
0
0.4
0.8
1.2
1.6
2
2.4
(Thousands)
DISTANCE TO METRO STATION IN FEET

Figure 37.

TRANSIT MODE SHARE



Hotel

The candidate variables for the hotel regression analysis included:

Candidate dependent variables

- percent of trips by transit for conference attendees
- percent of transit by overnight guests

Candidate independent variables

- development setting
- distance from DC core
- distance from a Metro Station
- number of parking spaces
- number of guest rooms

Due to the wide variance in results between the two studies the results were not combined. Unlike the first study there was no apparent relationship between transit mode share and the distance to DC. No correlation was apparent for conference attendees. For hotel guests there was a correlation between transit mode share and the distance to a Metro station portal. The equation suggested for hotel guests is:

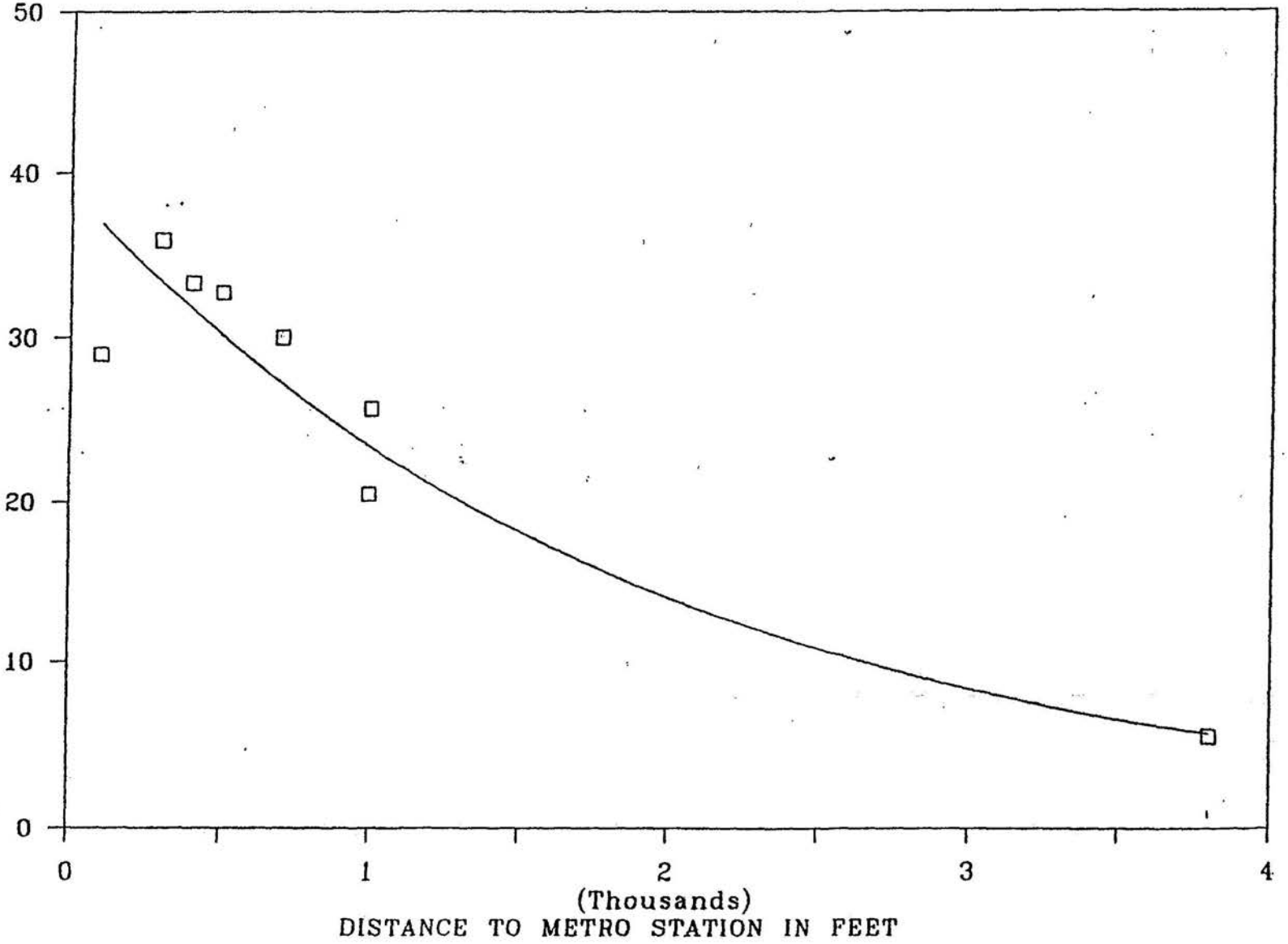
T = 34.09 - 0.77(M)	R-squared 0.87	(T = Transit Mode Share)
LN(T) = 3.20 - 0.038(M)	R^2 = 0.63	(M = distance from Metro)

This equation is graphed on Figure 39.

As with the retail sites the fact that the results differ substantially from the first study indicates that caution must be exercised when attempting to use the results and the equation developed herein. As was discussed previously transit mode share for hotels is no doubt subject to more variability from day to day than for any of the other land uses and the data from hotels to date does not allow any "average" or "typical" transit mode share to be established with any degree of confidence.

TRANSIT MODE SHARE

HOTEL GUESTS - 1989 DATA



Relationships for Non-Site Factors

As discussed earlier in this report other factors also influence transit mode share. Distance to a Metrorail station or the distance from DC can only be used to predict transit mode share and ridership assuming these other factors remain constant from site to site. Of course this is not true, and despite the fact that specific information concerning many of these other factors is often not available during the planning for many developments, an effort should be made to estimate their impact. It should be noted that while individual factors may be well correlated with transit mode, they are not necessarily well correlated with the distance to a Metrorail station. Thus a combined equation will not always produce a higher R^2. However, the relationship between a number of these factors is well correlated with transit mode share and should be considered, at least in a subjective manner.

Transit mode share decreases as average household size increases. This relationship is due to a number of factors such as the fact that larger households prefer single family or lower density housing which is often located further from rail stations and transit is not considered an alternative. If the distribution of household size is known for potential "origin stations," estimates of transit mode share by distance can be modified up or down. The equation suggested by the data from the workplace surveys is:

$$T = 201.6 - 67.7 \text{ (persons/household)} \qquad R^2 = 0.73$$

This is graphed on Figure 40.

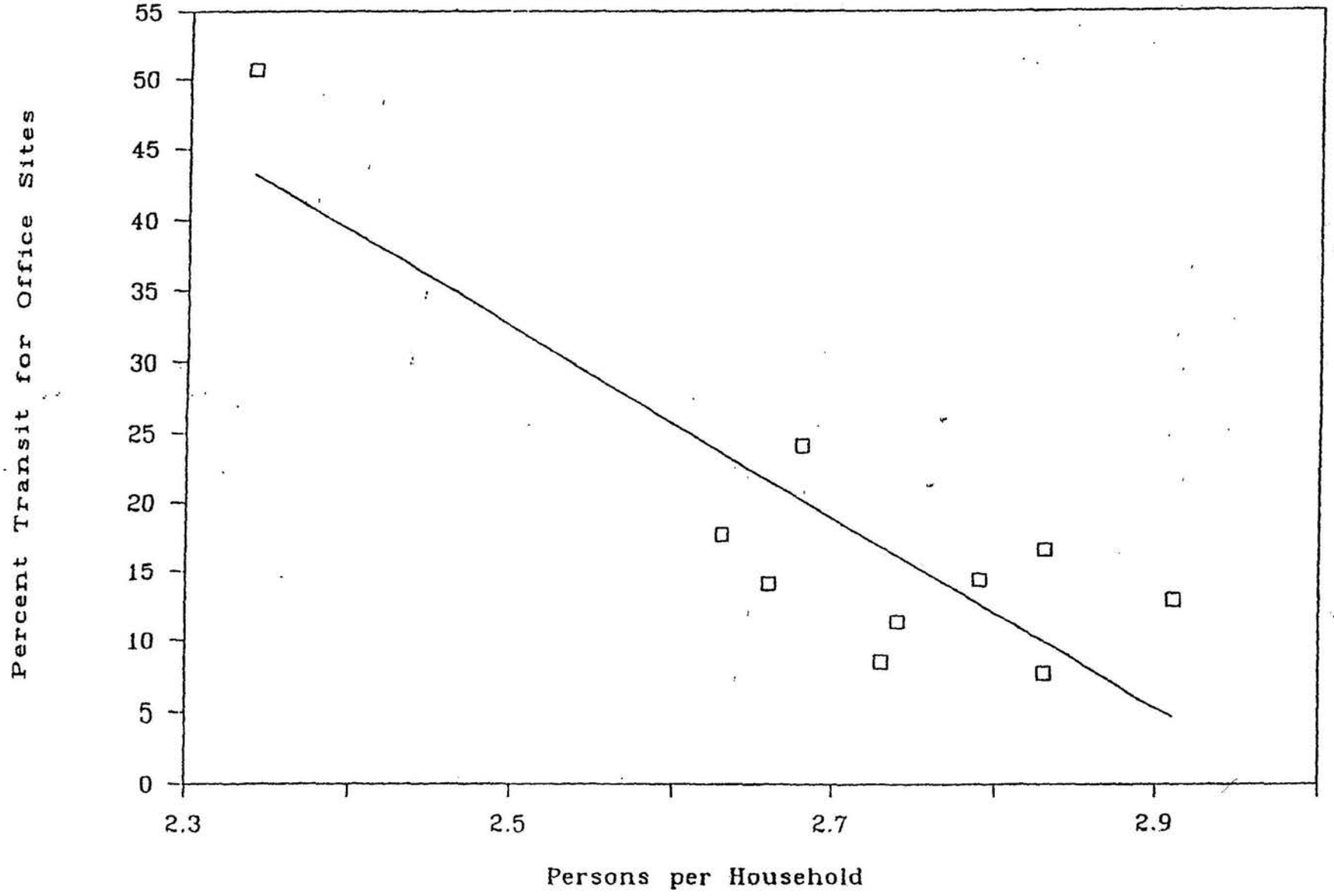
Another relationship with a relatively good correlation is that of transit availability. The suggested equation is:

$$T = 35.6 + 1.23 \text{ (\% surveyed with convenient transit connections)} \qquad R^2 = 0.54$$

This is graphed on Figure 41. The fact that some sites with low transit mode share were close to a Metrorail station are explained to a large extent by examining the data concerning transit availability. Respondents at these offices reported poor transit availability, since the availability is known at the site this indicates the problem is at the origin end. In summary this relationship illustrates the somewhat obvious fact that good transit connections are required at both ends. As with household size there

WORKPLACE SURVEYS

HOUSEHOLD POPULATION/TRANSIT USE



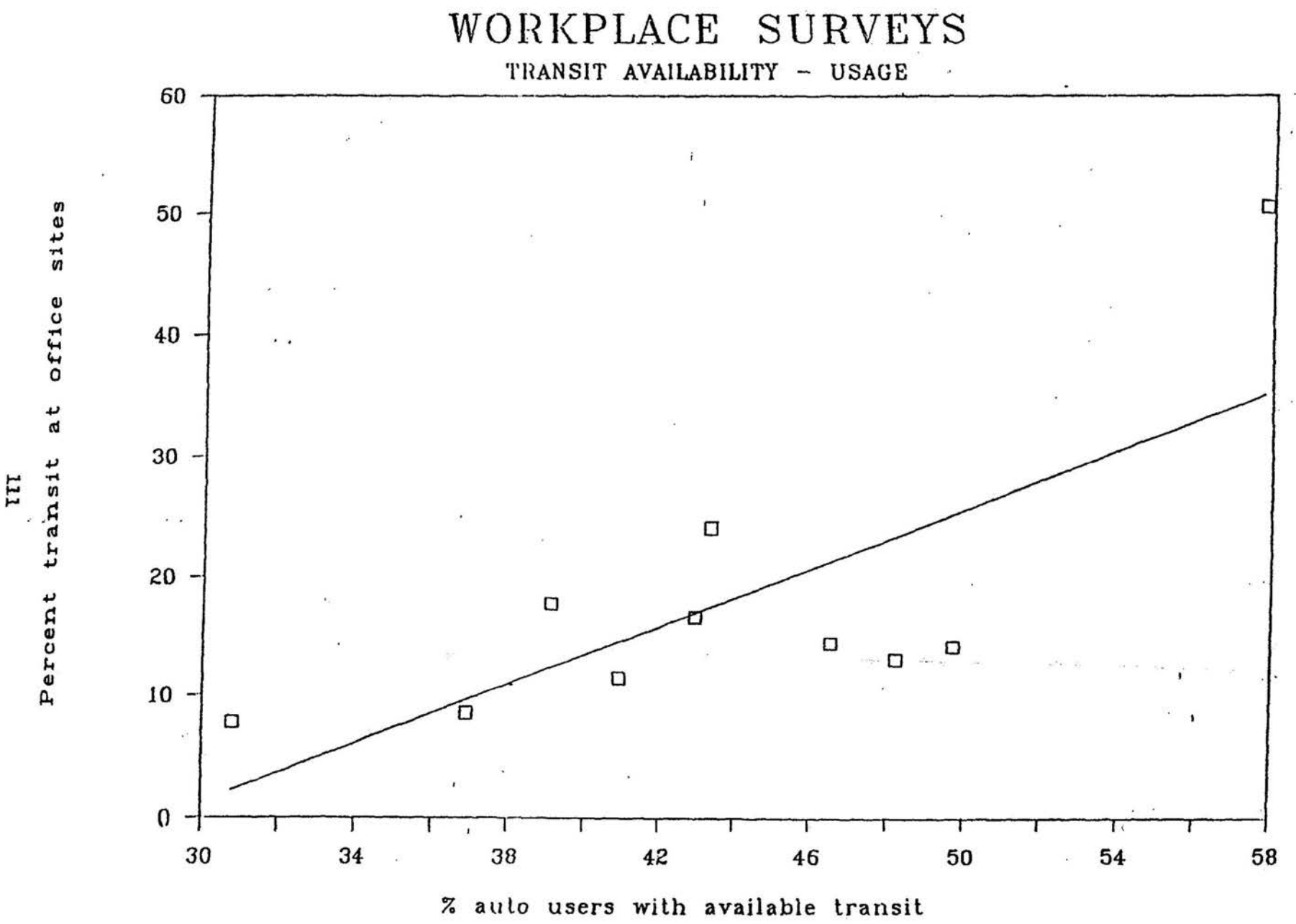

WORKPLACE SURVEYS
TRANSIT AVAILABILITY - USAGE
Percent transit at office sites
60
50
40
30
20
10
0
30
34
38
42
46
50
54
58
% auto users with available transit

Figure 41.

is often not enough information available at planning level to justify incorporating this in planning equations but is a relationship that can be used to modify results.

Finally as discussed previously autos per household is well correlated with transit mode share. The equation suggested is:

$$T = 130.1 - 56.1 \text{ (autos/household)} \qquad R^2 = 0.60$$

If a planner knows the average auto ownership for the labor market surrounding a proposed office development, transit mode share estimate based on distance can be refined. This relationship is graphed in Figure 42.

Summary of Regression Analysis

The equations presented in the above sections represent an updated version of equations developed in the first study reflecting both an increased database and to the degree possible the current development level of both the system and the station areas. As has been stated previously, however, it is important to recognize the limitations of the data, such as the limited sample sizes and ranges of independent variables and the variability of mode share for land uses such as hotels when considering an application of the equations. Well correlated relationships between independent and transit mode share often provide contradictory results for any specific site. The planner/engineer must exercise professional judgment in interpreting results for a specific site. As has been illustrated by changes between the two studies, it must be recognized that these relationships will change over time, based on the extent of the transit system and development trends in the urban area. With these cautions in mind, the suggested equations should be reasonable approximations of average transit mode shares for the next several years.

TRANSIT TRIP GENERATION RATES

Knowledge of the transit trip generation potential of various development types would significantly assist in land use planning decisions to optimize the development of land around each Metrorail station area. With this in mind cordon counts were conducted for extensive periods at most sites. The only sites excluded were those sites where through trips were impossible to keep track of or where it was difficult to cordon

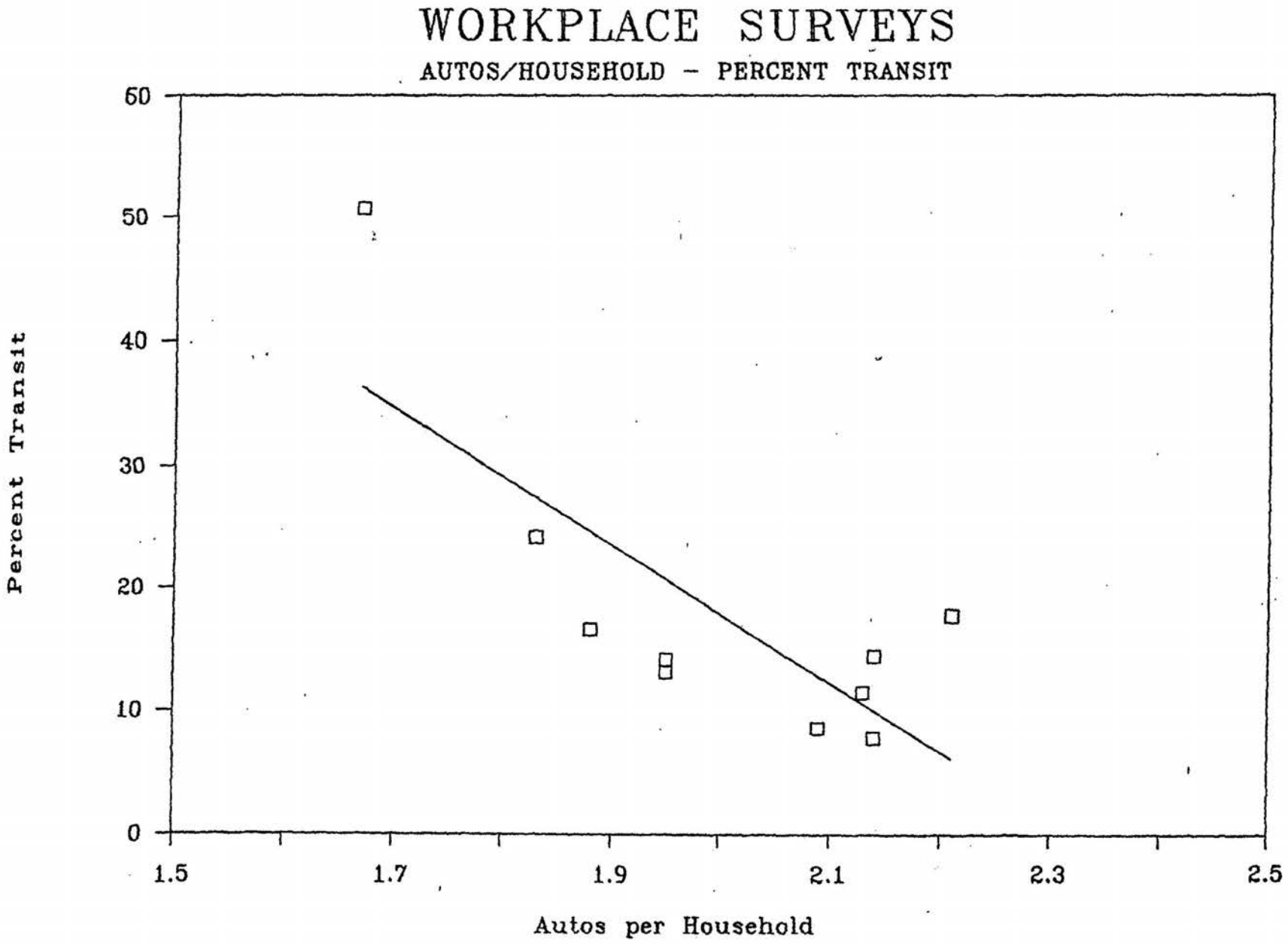

WORKPLACE SURVEYS
AUTOS/HOUSEHOLD - PERCENT TRANSIT
Percent Transit
60
50
40
30
20
10
0
1.5
1.7
1.9
2.1
2.3
2.5
Autos per Household

Figure 42.

off. The counts are expressed in terms of person trips and where possible vehicle trips. Although it must be noted that the vehicle trips represent only those trips from the site itself. At many locations, particularly offices, there is considerable off-site parking. At residential sites the counts do accurately represent the auto trip generation. Combined with the results of the surveys, transit trips can be estimated.

Tables 32 to 35 summarize the results of the cordon counts. Copies of the cordon counts are contained in the technical appendix. In general, the daily person trip generation rate is consistent with rates found in other literature. However, the peak hour trip generation rates are lower than average. This is explained by the flatness of the peak, there are 2 to 3 hours of almost equal trip generation for most sites.

A summary analysis similar to that undertaken in the first study was conducted to bring together the results in a form that could be interpreted for land use and transportation planning purposes. Table 36 presents a comparison of the transit trip generation rates for the four land use types on a consistent basis of trips per 1000 GSF of floor space. Residential and hotel rates are not normally expressed this way, and assumptions had to be made regarding the ratio of square footage to dwelling units and the number of hotel rooms. Exact figures were not available for the buildings studied. To allow comparison between the two studies the same assumptions were made this time. For residential units, 750 square feet per unit was assumed. For hotel, 750 square feet per unit was assumed. Although the actual size of guest rooms for hotels is much smaller, the factor incorporates the large conference, dining and lobby areas associated with the hotels of the type surveyed. Based on this analysis the trip generation rates derived in the first study were revised to reflect to some extent the increased transit mode share for retail and hotel sites. It was felt that the rates should be conservatively increased considering all data available. Previous values are shown in brackets where revisions were made.

As was the case in the first study, retail sites generate two to six times the number of person trips as other land uses. In all likelihood this applies only to those retail sites having a regional market draw. Convenience oriented retail or those attracting only local trips, will have a small transit trip generation rate.

In conclusion, office transit trip generation rates have remained relatively constant over the last two years, hotel and retail appear to be improving thus providing increased potential for off peak usage. All four land uses have significant potential for transit trip generation. At the risk of stating the obvious, this study reinforces past findings that transit is highly dependent on convenient walk access and, therefore,

Table 32. Office Trip Generation

Site	Count Period	Total Ped. In	Total Ped. Out	Peak Hours Hr. Beg.	Peak Hour Trips: Pedestrians In	Pedestrians Out	Vehicles In	Vehicles Out	Auto Occ.	Mode Share: Auto	Mode Share: Non-Auto	Peak Hour Trip Gen. Rate Persons
1701 Penn.	7 am-10 am	266	58	8:45	153	36	–	–	–	–	–	1.08 per 1000 sq.ft.
	3 pm-6 pm	145	240	3:15	64	63	–	–	–	–	–	.72
Ballston One	8 am-10 am	245	72	8:30	159	37	91	9	1.00	51%	49%	.81
	3 pm-6 pm	73	414	4:15	7	258	4	78	1.00	31%	69%	1.10
Silver Spring Metro Center	7 - 10	265	47	7:00	136	9	18	4	1.00	13%	87%	.97
	3 - 6	46	196	4:00	8	123	0	13	1.3	9%	91%	.87
Bell Atlantic	6 - 9	1059	106	7:30	654	55	284	12	1.16	42%	58%	2.01
	3 - 6	191	928	4:30	66	516	10	240	1.10	43%	57%	1.65
East West Towers	7 - 10	602	94	8:15	325	37	–	–	–	–	–	2.01
	3 - 6	299	599	4:45	159	414	–	–	–	–	–	3.18
Bethesda Metro Center	6:30-9:00	267	91	8:00	204	54	–	–	–	–	–	.86
	3 - 6	481	659	3:00	192	267	–	–	–	–	–	1.53
Twinbrook Office Center	1:00 - 6:00 pm	369	354	4:15	78	80	–	–	–	–	–	.95
Parklawn Building	6:00 - 9:00	3253	311	7:15	1637	129	250	5	1.26	–[1]	–[1]	1.71
	3:00 - 6:00	611	4345	4:00	902	2168	40	483	1.43	–	–	2.97
Crystal Square II	7 - 10	1652	843	7:30	659	260	–	–	–	–	–	2.16
	3 - 6	745	1243	3:45	306	469	–	–	–	–	–	1.82
Bethesda Office Ctr.	6:30 - 9:30	541	115	8:30	285	65	123	5	1.00	36%	64%	2.08
	3:00 - 6:00	327	579	5:00	108	319	11	121	1.00	31%	69%	2.54

[1] Mode share for site only.

Table 33. Residential Trip Generation

Site	Count Period	Total Ped. In	Total Ped. Out	Peak Hours Hr. Beg.	Peak Hour Trips: Pedestrians In	Pedestrians Out	Vehicles In	Vehicles Out	Auto Occ.	Mode Share: Auto	Mode Share: Non-Auto	Peak Hour Trip Gen. Rate[1]: Persons	Vehicles
Crystal Plaza	6:00 - 10:00 AM	245	636	7:45	56	129	22	55	1.32	35%	65%	.34	.14
	2:00 - 6:00 PM	658	671	4:00	155	79	39	87	1.33	42%	58%	.44	.23
Crystal Park	6:00 - 10:00	204	201	7:45	48	45	10	8	1.28	21%	79%	.52	.10
Condo	2:00 - 6:00	228	199	4:45	59	42	11	8	1.26	19%	81%	.56	.11
Crystal Square	6:00 - 10:00	140	383	7:15									
West	2:00 - 6:00	460	382	4:45									
Georgian	6:00 - 10:00	264	763	8:00	48	236	65	69	1.21	24%	76%	.33	.16
Towers	2:00 - 6:00	664	499	4:45	210	98	48	92	1.15	34%	66%	.36	.17
Randolph	6:00 - 10:00	142	414	7:45	34	148	27	42	1.26	32%	68%	.36	.14
Towers	2:00 - 6:00	561	302	5:00	167	93	46	23	1.04	22%	78%	.51	.14
Grosvenor	6:45 - 10:00	423	384	7:45	41	48	98	79	1.28	72%	18%	.22	.45
House	2:00 - 6:00	355	347	4:00	28	29	70	54	1.21	72%	18%	.11	.31
Stoneybrook	7:00 - 10:00	50	224	7:45	2	33	19	63	1.32	79%	21%	.32	.75
	2:00 - 6:00	152	96	4:45	19	0	35	24	1.20	75%	25%	.04	.54
Bethany House	7:00 - 10:00	46	72	9:10	31	47	–	–	–	–	–	.28	–
	2:00 - 6:00	162	182	3:15	51	63	–	–	–	–	–	.41	–
Twin Towers	6:00 - 10:00	300	326	8:15	87	98	87	29	1.05	50%	50%	.59	.37
	2:00 - 6:00	284	269	4:30	75	56	16	53	1.00	31%	69%	.42	.22
Grosvenor	6:00 - 10:00	55	181	7:15	7	18	13	49	1.10	27%	73%	.06	.16
Park I	2:00 - 6:00	148	104	3:30	3	9	27	19	1.13	19%	81%	.03	.12

[1] Trip generation rates are expressed as persons or vehicles per hour per unit.

Table 34. Retail Trip Generation

Site	Count Period	Total In	Total Out	Peak Hours Hr. Beg.	Peak Hour In	Peak Hour Out	Peak Hour Trip Generation Rate[1]	Size 1000 Sq. Ft.
Ballston Common	10:00 AM - 6:00 PM	10036	9838	5:00	1817	1944	7.1	530,000
Hecht's Metro Center	10:00 - 6:00	4603	4070	12:30	936	903	3.34	270,000
Union Station	10:00 - 6:00	23817	19799	12:30	3645	3465	9.48	750,000*

[1] per 1,000 square feet.

* Total Development

Table 35. Hotel Trip Generation

Site	Count Period	Total In	Total Out	Peak Hours Hr. Beg.	Peak Hour In	Peak Hour Out	Peak Hour Trip Generation Rate (per room)	No. Rooms
Hyatt Regency	7:00 - 10:00 AM	358	467	8:00	173	245	1.10	380
Bethesda	3:00 - 6:00 PM	492	378	4:00	158	146	.80	
Holiday Inn	7:00 - 10:00	333	305	7:00	148	132	1.23	227
Silver Spring	3:00 - 6:00	393	231	5:00	237	108	1.52	
Hyatt Grand	7:00 - 10:00	620	629	8:30	412	438	.94	
	11:00 - 2:00	1266	1265	12:30	525	522	1.15	907
	3:00 - 6:00	1290	1095	4:45	603	475	1.19	
Holiday Inn	7:00 - 10:00	313	265	8:15	169	128	.94	315
Crowne Plaza	3:00 - 6:00	337	374	3:45	121	160	.89	
JW Marriott	7:00 - 10:00	2132	2094	7:45	831	877	2.21	
	11:00 - 2:00	4965	4653	12:15	2073	1790	5100	773
	3:00 - 6:00	3230	2360	6:45	1635	886	3.26	
Crystal Gateway	7:00 - 10:00	1269	1665	7:45	549	674	1.74	702
Marriott	3:00 - 6:00	1653	1112	5:00	713	482	1.7	
Hyatt Arlington	7:00 - 10:00	251	473	7:15	130	189	1.05	303
	3:00 - 6:00	384	177	5:00	165	87	.83	
Phoenix Park	7:00 - 10:00	107	164	8:45	52	84	1.55	88
Hotel	3:00 - 6:00	76	48	5:00	32	30	.70	
Hyatt Regency	7:00 - 10:00	510	619	7:45	242	369	.89	685
Crystal City	3:00 - 6:00	727	485	5:00	356	170	.77	
Omni Shoreham	7:00 - 10:00	778	774	8:45	399	457	1.11	770
	3:00 - 6:00	842	806	5:00	391	307	.91	

Table 36. Estimate of Transit Trip Generation Potential Near Metrorail Stations, by Land Use Type

Land Use	Typical Daily Person-Trip Generation Rate (per 1,000 S.F. GFA)	Typical Daily Transit Mode Share[1]	Estimated Transit Trip Generation Potential (per 1,000 S.F. GFA)
Office			
Downtown	15	35%	5.3
Close-in suburban stations	15	15	2.3
Residential[2]			
Close-in suburban stations	5	40 (35)[3]	2 (1.8)
Retail (major complex)			
Downtown	30	40 (35)	12 (10.5)
Close-in suburban stations	30	25 (15)	7.5 (4.5)
Hotel[4]			
Downtown	14	20 (15)	2.8 (2.1)
Close-in suburban stations	14	15 (10)	2.1 (1.4)

[1] Transit as a percentage of all trips, including walk trips. Transit mode shares as a percentage of non-walk trips would be substantially higher, especially for office and retail uses.

[2] Assumes 750 square feet of building floor space per dwelling unit.

[3] ( ) - values derived as part of Development Related Ridership Survey, 1987.

[4] Assumes 750 square feet of hotel floor space per guest room.

Note: Person-trip generation rates are "typical" rates, derived from a combination of sources, inlcuding data collected in this study, data from the M-NCPPC study of the Metrorail Red Line, and data from the Institute of Transportation Engineers' Trip Generation Manual. Rates for any individual site could vary widely from these typical rates.

relatively dense, compact land use arrangements are essential within most station areas. This development philosophy is good for the metropolitan region as a whole. By locating sizable developments near Metrorail stations transit ridership is increased, thus reducing the overall number of trips in the metropolitan region as a whole. While relatively dense compact development in the station areas can have a dramatic effect in terms of reducing the number of vehicle trips in the region as a whole, local traffic often increases. This can have the effect of increasing the resistance of the surrounding communities towards higher densities. To avoid or minimize this, WMATA must work with the local jurisdictions and various planning agencies to ensure that road network in the station area is adequate. Strategies must be devised to ensure that traffic resulting from station area development does not infiltrate the surrounding communities.

Land use decisions around rail stations are crucial to the continued optimization of available transportation resources. It is difficult to overstate the importance of these decisions and possible benefits of rational land use planning around the stations. For example, a 200,000 square foot office building being considered for development in the suburbs could achieve an annual reduction of some 500,000 vehicle miles of travel by locating near a Metrorail station. This study has expanded the database and refined the planning tools developed in the first study. Hopefully this will increase their usefulness in planning for growth in the areas surrounding Metrorail stations.

OBSERVATIONS AND CONCLUSIONS

There has been a large volume of data generated in this project, requiring a substantial amount of time to assimilate and interpret. WMATA and other agencies will be able to draw their own conclusions directly from the data. However, a number of conclusions and observations have been derived from the analysis of the data. A summary of these observations is presented below, beginning first with general observations, followed by conclusions relating to each of the land use types. Many of these observations were originally made as part of the first study and are worth repeating; others reflect the expanded database.

General Observations

Many factors influence the choice of mode for trips to and from any type of land use. This study confirmed that the most significant and readily used factors for planning purposes are: 1) the location of the site within the urban area, (downtown sites have the highest transit mode shares, sites within the Beltway have significant transit mode shares, and sites outside the Beltway have relatively low transit mode shares); and 2) the proximity of a building to a Metrorail station entrance. Other factors influence transit ridership such as parking, cost, travel times, connectivity of the transit system, distance from transit connections at the other end of the trip, auto ownership etc. However, the location of the site within the metropolitan area and the proximity of a building to a Metrorail station entrance are well correlated and provide an easily used planning tool.

In contrast to the first study significant transit mode shares were recorded for all land uses. This indicates that while the commute trip is typically the first to be taken by transit, other trips will be increasingly taken by transit as the system and surrounding development mature. Transit users reported almost as many linked trips as auto users indicating that the general level of development along the transit line as a whole influences the propensity to use transit.

Origin destination pairs heavily influence the propensity to take transit. Poor transit accessibility at either end of the trip results in poor transit ridership between those pairs.

Responses to attitudinal questions are similar for surveys conducted at all land use types. Metrorail in general receives very good ratings. The most significant finding from these questions is that even among these groups who live, work, or shop in these

areas that are well served by transit in a visible way, an average of 28% of respondents hold the perception that information regarding the system and schedules is not readily available. At some sites over 40% of the respondents believe that information is not readily available.

Observations on Office Development

Transit mode share for work trips to downtown office buildings is in excess of 50% for offices located near Metrorail stations.

The distribution of residence location for office employees indicates that the transit commuters to any given office building are drawn from throughout the region.

A much higher percentage of work trips occurs by transit where the trip crosses jurisdictional boundaries. (e.g. a site in Virginia from either the District or Maryland). This is probably due to both the length of the trip and the accessibility at the origin end. It is difficult for transit to compete on relatively short trips where wait times make up a significant percentage of the total. As well, connectivity of the trip is important. There is a strong propensity to take transit from either Maryland or Virginia to the District but transit mode share is much lower between Montgomery County and Fairfax County despite competitive travel times. The data from both studies indicate that there is considerable trip interchange between Montgomery County and Virginia.

Most mid-day trips by employees at office buildings near Metrorail stations are walk trips. Of the non-walk mid-day trips, a significant number of the trips to and from the District are made by transit.

The regression analysis of office sites indicates that the work trip transit mode share decreases by 0.76 percent for each 100 foot increase in distance of the site from the station portal. Although this relationship was found to be valid for the sites studied, it is expected that the actual relationship is not linear. The percentage of mid-day non walk trips captured by transit decreases by approximately 1.12% for each 100 foot increase in distance from the station.

Transit mode share for trips by visitors to office buildings was relatively low. The data indicates that between 10% and 15% of visitor trips are by transit. The difference between this study and the first study is probably explained by the fact that all but one of the buildings in this study are located outside of the downtown.

Residential Buildings

A high percentage of trips to and from multi-family residential buildings near Metrorail stations are via transit. The transit mode share for this study ranged from 30 to over 70 percent. The ten sites studied included both rental and owner occupied developments over a range of income levels. Relationships based on the type and cost of the unit could not be correlated with transit mode shares probably due to the limitations of the sample size.

Auto ownership was found to be significantly lower at all sites surveyed, as compared to the regional average and even when compared to areas with similar development located away from a Metrorail station. The implication is that convenient connections to Metrorail influence the tendency to purchase second or third cars. With fewer cars available overall trip generation will be lower, as many trips will simply not be taken.

The percentage of trips by transit decreases by approximately 0.66% for each 100 foot increase in distance of a residential site from a station portal.

Retail Uses

All of the retail sites surveyed had significant transit mode shares. Those sites repeated from the first study showed significant increases in the transit mode share. The transit mode share, particularly at the suburban sites, varies by time of day. For instance at Ballston Common Mall transit mode share drops to less than a third of its midday value in the evenings.

The percentage of trips by transit decreases by approximately 2.0% for each 100 feet of distance from a station portal.

Hotels

Like the retail areas, hotels showed a significant increase in the transit mode share when compared to the first study. Conference attendees are more likely to take transit than overnight guests but there is no correlation with distance from a Metrorail station. Hotel trip generation rates vary from day to day more so than other land uses. Data should be collected for several days at a site to establish an average trip generation rate.

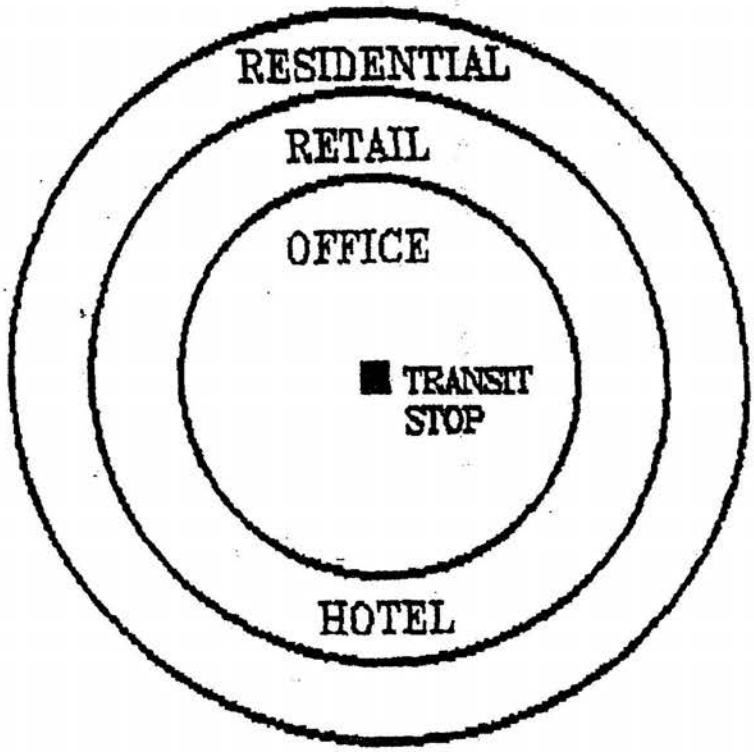
Conclusions

The results of these studies and the analysis of the growing database have a number of significant implications on land use and transportation planning in the Washington Metropolitan area. Metrorail is increasingly a major factor in transporting persons not only to and from the downtown but also to and from suburban sites. However, despite the relationships to distance from the sites, the propensity to take transit is dependent on origin destination relationships. Several land use and transportation factors are critical to making the best possible use of the transit system. These include:

- Locating the types of uses that tend to generate the most transit trips in Metrorail station areas.
- Locating these land uses in close proximity to the station portals.
- Providing high density land development around Metro stations, including suburban stations.
- Providing convenient walk and feeder bus access to the stations to expand the transit market.

Adequate road networks must be constructed in conjunction with the development of station areas. Poor road networks not only will create a negative image of station areas but will restrict the transit market to relatively tight areas surrounding the station. People will not use Metrorail if they must fight congestion to reach the station.

The suburban transit stations and the areas surrounding them are critical to gaining the maximum benefit from the Metrorail system. Figure 43 illustrates a general concept for development surrounding a typical station. Office uses with the associated convenience retail should be located closest to the station entrances since they are the most sensitive to distance from the station. The distance people are willing to walk can be increased by careful planning of the pedestrian systems. For example utilizing underground walkways or skywalks between buildings can be used to separate pedestrians from vehicle traffic. Major retail and hotel uses could occupy the next ring. Mid to high density residential developments would occupy the outer ring. The highest densities would be located closer to the station, transitioning down to single family residential as distance from the station increases. This is a generalized concept only and could be varied from station to station along a corridor.



GENERAL HIERARCHY OF PROXIMITY OF LAND USES TO A TRANSIT STATION

Figure 43.

The data suggests that linked trips increase as the system matures. This encourages the use of the system for non work trips. To maximize this, development in the corridor must provide a variety of facilities allowing the patron to complete many of the day to day errands that have been done by car (i.e. shopping, banking etc.) This suggests that slightly different emphasis could be placed on development around different stations, for instance major destination type retail development will not be located at each station. However, it appears to be desirable to have this type of development within each corridor. Where destination retail is planned it should be as close as possible to the station. While the emphasis of each station area should be varied, mixed-use development surrounding each station is the most desirable in terms of reducing vehicle trips.

Land use planning beyond the station areas of these four rings of development is also critical. Feeder bus routes to and from the stations need to be considered during the planning for lower density developments. For instance bus only connections can be used to provide more direct bus routes through subdivisions that are planned to discourage through traffic. In short, transit operations should be considered in conjunction with all land use planning in the region.

In addition to development at the station areas, marketing must be targeted at individual station areas providing those who live, work, or shop in these areas specific information about the system and how they can use it.

The data collected by the Development-Related Ridership Surveys provides WMATA and other local agencies with information that can be used in comparing alternate development scenarios for station areas.

APPENDIX A
DETERMINING CONFIDENCE LIMITS FROM SURVEY DATA

A sample drawn from a given population is not likely to be an exact representation of the true characteristics of the population. However, it is possible to estimate the likelihood that the true value lies within a certain a range about the estimated value derived from the data. This range, or "confidence limit," can be determined assuming that the data correspond to an appropriate statistical distribution. This appendix provides the reader with a simple means of establishing confidence limits for the survey results, based on sample size and the travel characteristics being examined.

Table A has been prepared to permit the direct determination of 95 percent confidence limits for all data based on percentages. The typical way of expressing the statistical accuracy is that the percentage derived from the data is within plus or minus X percentage points with 95 percent confidence. The use of the 95th percentile is common, but other percentiles could also be used.

In Table A-1, the sample size for the value being investigated is located on the left side of the table. The percentage of respondents specifying a given answer is located in the column headings. If the percent frequency in the column heading is termed "p," it can be seen that both p and 1-p yield the same results for a given sample size. The 95 percent confidence limit is identified by the intersection of the appropriate sample size row and percent frequency columns. For example, if the percentage of trips by transit is 10 percent and the sample size upon which that estimate is based is 100, it could be said that the estimate is within 5.6 percent of the true value with 95 percent confidence. The equation used to derive Table A-1 can also be used directly, if desired.

Table A-1. Confidence Limits (±%) for 95% Significance Level

Actual Sample Size	Percent Frequency											
	1 or 99	2 or 98	3 or 97	4 or 96	5 or 95	7 or 93	10 or 90	15 or 85	20 or 80	30 or 70	40 or 60	50
10	±6.2%	8.7	10.6	12.1	13.5	15.8	17.8	22.1	24.8	28.4	30.4	31.0
25	3.9	5.5	6.7	7.7	8.5	10.0	11.2	14.0	15.7	18.0	19.2	19.6
50	2.8	3.8	4.7	5.4	6.0	7.1	7.9	9.9	11.1	12.7	13.6	13.9
75	2.3	3.2	3.9	4.4	4.9	5.8	6.5	8.1	9.1	10.4	11.1	11.3
100	1.9	2.7	3.3	3.8	4.3	5.0	5.6	7.0	7.8	9.0	9.6	9.8
150	1.6	2.2	2.7	3.1	3.5	4.1	4.6	5.7	6.4	7.3	7.8	8.0
200	1.4	1.9	2.4	2.7	3.0	3.5	4.0	4.9	5.5	6.3	6.8	6.9
300	1.1	1.6	1.9	2.2	2.5	2.9	3.2	4.0	4.5	5.2	5.5	5.7
400	1.0	1.4	1.5	1.9	2.1	2.5	2.8	3.5	3.9	4.5	4.8	4.9
500	0.9	1.2	1.5	1.7	1.9	2.2	2.5	3.1	3.5	4.0	4.3	4.4
700	0.7	1.0	1.3	1.5	1.6	1.9	2.1	2.6	3.0	3.4	3.6	3.7
900	0.6	0.9	1.1	1.3	1.4	1.7	1.9	2.3	2.6	3.0	3.2	3.3
1200	0.6	0.8	1.0	1.1	1.2	1.4	1.6	2.0	2.3	2.6	2.8	2.8
1500	0.5	0.7	0.9	1.0	1.1	1.3	1.5	1.8	2.0	2.3	2.5	2.5
2000	0.4	0.6	0.7	0.9	1.0	1.1	1.3	1.6	1.8	2.0	2.1	2.2
2500	0.4	0.5	0.7	0.8	0.9	1.0	1.1	1.4	1.6	1.8	1.9	2.0
3000	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.3	1.4	1.6	1.8	1.8

Equation:

$$\text{Confidence Limits } (d) = \sqrt{\frac{(\%\text{Freq.})(1-\%\text{Freq.})(1.96^2)}{\text{Sample Size}}}$$

APPENDIX B

Relevant Data from Other Sources

Table B-1. Residential/Retail/Hotel Data from Additional Sources[1/]

Residential Development	Station Location	Distance to Station (feet)	Distance to DC Core (miles)	AM Peak Hour[2/] Percent Transit and Walk	Number Dwelli Units
The Willoughby	Friendship Heights	1,200	5.0	53	804
Topaz House	Bethesda	2,000	6.9	50	365
Stoneybrook	Grosvenor	1,000	10.3	24	200
Parkside	Grosvenor	2,000	10.3	8	340
The Forum	White Flint	1,000	12.0	14	227
Americana	Rockville	500	16.0	34	425

Retail Development	Station Location	Distance to Station (feet)	Distace to DC Core (miles)	Mid-day[3/] Peak Hour Percent Transit	GSF (x 1,0(
Woodward & Lothrop	Friendship Heights	100	5.0	39	180
Saks Fifth Avenue	Friendship Heights	1,600	5.0	4	103

Hotel	Station Location	Distance to Station (feet)	Distance to DC Core (miles)	AM I eak Hour[4/] Percent Transit	Numl of Ro
Holiday Inn	Friendship Heights	1,800	5.0	9	22
Hyatt (Metro Center)	Bethesda	100	6.9	11	38

1/ Additional sources include: The Maryland-National Capital Park and Planning Commission st of the Metrorail Red Line (1986).

2/ AM Peak hour percentage includes transit plus walk.

3/ Transit percentage includes all persons to the retail developments.

4/ Transit percentage includes all persons to the hotels.

Table B-2. Office Building Data from Additional Sources[1/]

Office Building	Station Location	Distance to Station (feet)	Distance to DC Core (miles)	AM Peak Hour Percent Transit	GSF (x1,000)
National Place/ National Press Bldg.	Metro Center	100	0.0	59.3	409
1920 L Street	Farragut North	1,000	0.0	53.0	74.8
Van Ness Center	Van Ness-UDC	100	2.9	32.0	182.6
7500 Old Georgetown Road	Bethesda	100	6.9	13.3	
The Barlow Bldg.	Friendship Heights	700	5.0	23.5	240
Chevy Chase Bldg.	Friendship Heights	1,500	5.0	13.5	250
One Park North	Friendship Heights	2,000	5.0	9.0	132
Montgomery Bldg.	Bethesda	450	6.9	12.0	82.5
7315 Wisconsin	Bethesda	600	6.9	30.6	
Fairmont Bldg.	Bethesda	1,400	6.9	27.0	136
Landow Bldg.	Bethesda	2,000	6.9	9.0	225
7101 Wisconsin	Bethesda	2,000	6.9	17.8	
NRC Building	Bethesda	2,100	6.9	10.0	134

1/ Additional sources include: The Maryland-National Capital Park and Planning Commission study of the Metrorail Red Line (1986), and the National Capital Region Transportation Planning Board Trip Generation Studies of the National Place (1986) and the Van Ness Office Building (1985).

APPENDIX C

Survey Instruments

WASHINGTON METROPOLITAN AREA WORK PLACE SURVEY

This survey is part of a continuing effort, approved by Regional Transportation Authorities, to plan for the transportation needs of employees within the Washington Region. We would appreciate your help in this effort by filling out this questionaire. The information obtained from this survey is completely confidential and will only be documented in summary form. Please complete this questionaire and return it to the person who gave it to you as soon as you can.

THANK YOU FOR YOUR TIME AND COOPERATION.

Today's Date ___/___/89

RESPONDENT INFORMATION

1. What is the name and address of the place where you report for work?

   _____
   Name of Employer

   _____
   Street Address

2. Where do you live?

   1. District of Columbia
   2. Fairfax County
   3. Arlington County
   4. Alexandria
   5. Falls Church
   6. Fairfax City
   7. Prince Georges County
   8. Rockville
   9. Bethesda
   10. Silver Spring
   11. Elsewhere in Montgomery County
   12. Elsewhere in Virginia
   13. Elsewhere in Maryland
   14. Other

3. What is the intersection nearest your home? _____
   Zip Code? _____

4. How many autos, pickups , vans and motorcycles are available for use by members of your household? _____

5. Your sex? (circle one)
   1. Male
   2. Female

6. Your age on your last birthday? (circle one)
   1. 18 years or under
   2. 19 to 24 years
   3. 25 to 34 years
   4. 35 to 44 years
   5. 45 to 54 years
   6. 55 to 64 years
   7. 65 years or over

7. Including yourself, how many people live in your household?

   Total number of people ____
   Number under 16 years of age ____
   How many work full time? ____
   How many work part time? ____

8. What is your occupation? (circle one)

1. Professional/technical
2. Manager/administrator
3. Sales worker
4. Clerical
5. Craftsman (mechanic, etc)
6. Equipment operator
7. Laborer
8. Service worker
9. Other

9. At what time did you start work today, even if atypical. _____:_____ AM PM
At what time did you leave work yesterday even if atypical. _____:_____ AM PM
(Please fill in time and circle AM or PM)

9. What means of travel did you use to get to work today? (circle one)

1. Drove alone
2. Drove others (how many others, excluding yourself ___)
3. Rode as a passenger (how many total were in the vehicle ___)
4. Metrorail only
5. Metrorail and bus
6. Metrorail and auto
7. Metrorail and other combination (specify) _____
8. Bus only
9. Walked all the way
10. Taxi
11. Bicycle
12. Other (specify) _____

COMMUTE CHARACTERISTICS

10. Answer these questions if you rode transit for any portion of your trip to work today, otherwise skip to 11.

10a. Was a privately owned vehicle available for your trip to work today? (circle one) 1. Yes 2. No

10b. Do you normally ride transit? (circle one) 1. Yes 2. No

10c. How long did it take you to travel from your home to work today?

From your house to transit?	___ Min.
From last transit vehicle to your building entrance	___ Min.
Total (including time on transit)	___ Min.

10d. What is your estimated round-trip cost to and from work? Please include all transit fares and parking charges. (Fill in amount)

$ ___.___

10e. Does your employer: (circle one)

Subsidize your transit costs?	1. Yes 2. No
Provide a car for business purposes during the day?	1. Yes 2. No
Have a program to encourage car or vanpooling?	1. Yes 2. No
Allow flexible working hours?	1. Yes 2. No

11. Answer these questions if you drove to work today.

11a. Are there convenient transit connections available for your trip to work? (circle one) — 1. Yes 2. No 3. Don't know

11b. Do you normally drive to work? (circle one) — 1. Yes 2. No

11c. Did you require your car during the day TODAY? (circle one) — 1. Yes 2. No

11d. How long did it take you to travel to work TODAY?
To drive from your residence to the parking lot? ___ min.
To walk from the parking lot to your building entrance? ___ min.

11e. Does your employer: (circle one)
Subsidize your automobile expenses or parking costs? 1. Yes 2. No
Have a program to encourage car or van-pooling? 1. Yes 2. No
Allow flexible working hours? 1. Yes 2. No

12. Do you agree, disagree, or have no opinion with respect to the following statements? (circle one)

People should be encouraged to use transit. — 1. Agree 2. Disagree 3. No opinion

Schedule information for transit services is readily available. — 1. Agree 2. Disagree 3. No opinion

Metrorail is clean and reliable. — 1. Agree 2. Disagree 3. No opinion

Metrobus is clean and reliable. — 1. Agree 2. Disagree 3. No opiniion

TRIP MAKING CHARACTERISTICS

We would like to find out about all the trips you made on the way to work TODAY, as well as the trips you made during the day and on the way home from work yesterday (or your last weekday at work). For each trip write in the corresponding code numbers from the lists below for Purpose of Trip and Means of Travel and Destination of Trip.

Purpose of Trip
1. Work related
2. Personal business
3. Meal or snack
4. Shopping
5. Educational
6. Recreational
7. Other (specify)

Means of Travel
1. Drove a car
2. Rode in a car
3. Metrorail and walk
4. Metrorail and drive
5. Metrorail and bus
6. Bus only
7. Walk
8. Bicycle
9. Other (specify)

Destination
1. Within half a mile
2. District of Columbia
3. Fairfax County
4. Arlington
5. Alexandria
6. Falls Church
7. Fairfax City
8. Prince Georges County
9. Bethesda
10. Silver Spring
11. Rockville
12. Elsewhere in Montgomery County
13. Elsewhere in Maryland
14. Elsewhere in Virginia
15. Other (specify)

The example indicates a work related trip (1) made from Rockville to the District of Columbia (2) by Metrorail and walking (3) with a shopping stop over in Bethesda (9).

	Example	Trip to Work	Midday Trip	Midday Trip	Trip Home
Time you left	10 30 (AM) PM	__:__ AM PM	__:__ AM PM	__:__ AM PM	__:__ AM PM
	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd
Purpose	4 1 __	_____	___ ___ ___	___ ___ ___	___ ___ ___
Means of Travel	3 3 __	_____	___ ___ ___	___ ___ ___	___ ___ ___
Destination	9 2 __	_____	___ ___ ___	___ ___ ___	___ ___ ___
And then: to work	1. (1) 1.	1. 1. 1.	1. 1. 1.	1. 1. 1.	1. 1. 1.
to next stop	(2) 2. 2.	2. 2. 2.	2. 2. 2.	2. 2. 2.	2. 2. 2.
Arrival time	12:00				
Length of Trip	10 miles	___ miles	___ miles	___ miles	___ miles

WASHINGTON METROPOLITAN AREA TRAVEL SURVEY

This survey is part of a continuing effort, approved by the Washington Metropolitan Area Transit Authority, to plan for the transportation needs of employees within the Washington Region. We would appreciate your help in this effort by filling out this questionaire. The information obtained from this survey is completely confidential and will only be documented in summary form. Please complete this questionaire and drop it in any mailbox. No postage is required. If you have further questions about this survey, please contact Joan Jenkins, JHK & Associates, at (703) 370-2411.

THANK YOU FOR YOUR TIME AND COOPERATION.

One person may fill in the responses for all persons 16 years of age or older who are currently living in the household:

	Person 1	Person 2	Person 3
1. Date for reporting information - please use a weekday.	/ /89	/ /89	/ /89
2. Sex 1. Male 2. Female Enter one code number for each person.	_____	_____	_____
3. Age 1. 16-25 2. 26-35 3. 36-45 4. 46-55 5. 56-65 6. over 65_Enter code number.	_____	_____	_____
4. Does this person work outside this residence? 1. Yes, Full-time 2. Yes, Part-time 3. No Enter a code(s) number for each person.	_____	_____	_____
5. Does this person have a current drivers License? 1. Yes 2. No Enter one code number for each person.	_____	_____	_____

6. Including yourself, how many people live in your household?

Total number of people	____
Number under 16 years of age	____
How many work full time?	____
How many work part time?	____

7. How many autos, pickups, vans and motorcycles are available for use by members of your household? _____

TRIP MAKING CHARACTERISTICS

We would like to find out about all the trips you made to and from your building today. For each trip write in the corresponding code numbers from the lists below for Purpose of Trip and Means of Travel and Destination of Trip.

1. Work related
2. Personal business
3. Meal or snack
4. Shopping
5. Educational
6. Recreational
7. Other (specify)

1. Drove a car
2. Rode in a car
3. Metrorail and walk
4. Metrorail and drive
5. Metrorail and bus
6. Bus only
7. Walk
8. Bicycle
9. Other (specify)

1. Within half a mile
2. District of Columbia
3. Fairfax County
4. Arlington
5. Alexandria
6. Falls Church
7. Fairfax City
8. Prince Georges County
9. Bethesda
10. Silver Spring
11. Rockville
12. Elsewhere in Montgomery Co.
13. Elsewhere in Maryland
14. Elsewhere in Virginia
15. Other (specify)

The example indicates a midday trip made to the District of Columbia by Metrorail for the purpose of shopping with a stop over in Bethesda.

PERSON 1	**Example**	Trip to Work	Midday Trip	Midday Trip	Trip Home
Time you left	__:__ AM PM	__:__ AM PM	__:__ AM PM	__:__ AM PM	__:__ AM PM
	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd
Purpose	_____	_____	___ ___ ___	___ ___ ___	___ ___ ___
Means of Travel	_____	_____	___ ___ ___	___ ___ ___	___ ___ ___
Destination	_____	_____	___ ___ ___	___ ___ ___	___ ___ ___
And then:					
to work	1. 1. 1.	1. 1. 1.	1. 1. 1.	1. 1. 1.	1. 1. 1.
to next stop	2. 2. 2.	2. 2. 2.	2. 2. 2.	2. 2. 2.	2. 2. 2.
Arrival time					
Length of Trip	___ miles	___ miles	___ miles	___ miles	___ miles

PERSON 2	Trip to Work	Midday Trip	Midday Trip	Trip Home
Time you left	__:__ AM PM	__:__ AM PM	__:__ AM PM	__:__ AM PM
	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd
Purpose	_____	___ ___ ___	___ ___ ___	___ ___ ___
Means of Travel	_____	___ ___ ___	___ ___ ___	___ ___ ___
Destination	_____	___ ___ ___	___ ___ ___	___ ___ ___
And then:				
to work	1. 1. 1.	1. 1. 1.	1. 1. 1.	1. 1. 1.
to next stop	2. 2. 2.	2. 2. 2.	2. 2. 2.	2. 2. 2.
Arrival time				

PERSON 3	Trip to Work	Midday Trip	Midday Trip	Trip Home
Time you left	__:__ AM PM	__:__ AM PM	__:__ AM PM	__:__ AM PM
	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd	Stop 1st 2nd 3rd
Purpose	_____	___ ___ ___	___ ___ ___	___ ___ ___
Means of Travel	_____	___ ___ ___	___ ___ ___	___ ___ ___
Destination	_____	___ ___ ___	___ ___ ___	___ ___ ___
And then:				
to work	1. 1. 1.	1. 1. 1.	1. 1. 1.	1. 1. 1.
to next stop	2. 2. 2.	2. 2. 2.	2. 2. 2.	2. 2. 2.
Arrival time				

8. Do you agree, disagree, or have no opinion with respect to the following statements? (circle one)

People should be encouraged to use transit. — 1. Agree 2. Disagree 3. No opinion

Schedule information for transit services is readily available. — 1. Agree 2. Disagree 3. No opinion

Metrorail is clean and reliable. — 1. Agree 2. Disagree 3. No opinion

Metrobus is clean and reliable. — 1. Agree 2. Disagree 3. No opinion

(Please seal here)

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

Business Reply Mail
First Class Permit No. 8224 Alexandria, VA

Postage Will Be Paid By Addressee

Washington Metropolitan Area Travel Survey
4660 Kenmore Ave., Suite 1200
Alexandria, VA 22304

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

Visitor Survey for Office Sites

Excuse me, I am conducting a travel survey for the Washington Metropolitan Area Transit Authority. Could I ask you a few brief questions?

Site Name: _____ Location of Interview: _____ **Begin Time:** _____ **End Time:** _____

Observer: _____ **Weather:** _____ **Date:** _____

Do you agree, disagree or have no opinion with respect to the following statements?

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Arrival Time	Do you work in this building? 1. Employee 2. Visitor 3. Eating 4. Banking 5. Courier 6. Health Club 7. Other If employee – Finished	How did you get to this building? Auto: 1. Driver 2. Passenger 3. Drop off 4. Walk 5. Metrorail 6. Bus 7. Taxi 8. Other	Auto drivers only: How many people came in your car including yourself?	Did you have a car available for your trip to the office? 1. Yes 2. No	Where was your last stop before coming here? City, building name or nearest intersection	Was this 1. An office 2. Your home 3. Friend's home 4. Store 5. Bank 6. Restaurant 7. School 8.Pickup/drop-off 9. Hotel 10. Medical 11. Health club 12. Other	How far is that from here? (miles)	Would you have driven by this office building if you did not stop? 1. Yes 2. No	What time do you expect to leave?	Where will your next stop be after leaving here? City, building name or nearest intersection	Is this 1. An office 2. Your home 3. Friend's home 4. Store 5. Bank 6. Restaurant 7. School 8.Pickup/drop-off 9. Hotel 10. Medical 11. Health club 12. Other	How will you be getting there? Auto: 1. Driver 2. Passenger 3. Dropoff 4. Walk 5. Metrorail 6. Bus 7. Taxi 8. Other	How far is that from here? (miles)	People should be encouraged to use transit. 1. Agree 2. Disagree 3. No opinion	Schedule information is readily available for public transit. 1. Agree 2. Disagree 3. No opinion	Metrorail is clean and reliable. 1. Agree 2. Disagree 3. No opinion	Metrobus clean an reliable. 1. Agree 2. Disag 3. No op

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

Pedestrian Survey for Retail Sites

Excuse me, I am conducting a travel survey for the Washington Metropolitan Area Transit Authority. Could I ask you a few brief questions?

Site Name: _____ Location of Interview: _____ Begin Time: _____ End Time: _____

Observer: _____ Weather: _____ Date: _____

Do you agree, disagree or have no opinion with respect to the following statements?

(1) Arrival Time	(2) Are you: 1. Shopping 2. Eating 3. Business 4. Employee 5. Banking 6. Other	(3) What is your home zip code?	(4) How did you get to ____ Auto: 1. Driver 2. Passenger 3. Drop off 4. Walk 5. Metrorail 6. Bus 7. Taxi 8. Other	(5) Did you have a car available for your trip? 1. Yes 2. No	(6) How many people came in your group?	(7) Where was your last stop before coming here? City, name of building or nearest intersection	(8) Was this 1. An office 2. Your home 3. Friend's home 4. Store 5. Bank 6. Restaurant 7. School 8.Pickup/drop-off 9. Hotel 10. Medical 11. Health club 12. Other	(9) How far is that from here? (miles)	(10) What time do you expect to leave?	(11) Where will your next stop be after leaving here? City, building name or nearest intersection	(12) Is this 1. An office 2. Your home 3. Friend's home 4. Store 5. Bank 6. Restaurant 7. School 8.Pickup/drop-off 9. Hotel 10. Medical 11. Health club 12. Other	(13) How will you be getting there? Auto: 1. Driver 2. Passenger 3. Dropoff 4. Walk 5. Metrorail 6. Bus 7. Taxi 8. Other	(14) How far is that from here? (miles)	(15) People should be encouraged to use transit. 1. Agree 2. Disagree 3. No opinion	(16) Schedule information is readily available for public transit. 1. Agree 2. Disagree 3. No opinion	(17) Metrorail is clean and reliable. 1. Agree 2. Disagree 3. No opinion	(18) Metrobus clean an reliable. 1. Agree 2. Disagr 3. No op

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

Survey for Hotel Sites

Excuse me, I am conducting a travel survey for the Washington Metropolitan Area Transit Authority. Could I ask you a few brief questions?

Site Name: _____ **Location of Interview:** _____ **Begin Time:** _____ **End Time:** _____

Observer: _____ **Weather:** _____ **Date:** _____

Do you agree, disagree or have no opinion with respect the following statements?

(1) Arrival Time	(2) Are you 1. An employee 2. An overnight guest 3. Attending Mtg./Conf. 4. Both 2&3 5. Going to restaurant-lounge 6. Other	(3) Have you been outside this hotel earlier TODAY? 1. Yes 2. No - Go to Question 7	(4) What time did you get here? How many people in your group?	(5) How did you get here? 1. Own car 2. Rental car 3. Walked 4. Metrorail 5. Bus 6. Taxi/limo 7. Hotel shuttle 8. Other	If person used Metrorail or bus: (6) Did you have a car available for your trip to the hotel?	All: (7) Where were you coming from? City, building name or nearest intersection What was the purpose of your trip? 1. Work related 2. Shopping 3. Sightseeing 4. Other	(8) Will you be going outside this hotel later today? 1. Yes 2. No - Go to Question 12	(9) What time do you expect to leave? How many people will be in your group?	(10) Where will you be going? City, Building name or nearest intersection What was the purpose of your trip? 1. Work related 2. Shopping 3. Sightseeing 4. Other	(11) How will you be getting there? 1. Own car 2. Rental car 3. Walked 4. Metrorail 5. Bus 6. Taxi/limo 7. Hotel Shuttle 8. Other	(12) People should be encouraged to use transit. 1. Agree 2. Disagree 3. No opinion	(13) Schedule information is readily available for public transit. 1. Agree 2. Disagree 3. No opinion	(14) Metrorail is clean and reliable. 1. Agree 2. Disagree 3. No opinion	(15) Metrobus is clean and reliable. 1. Agree 2. Disagree 3. No opinion