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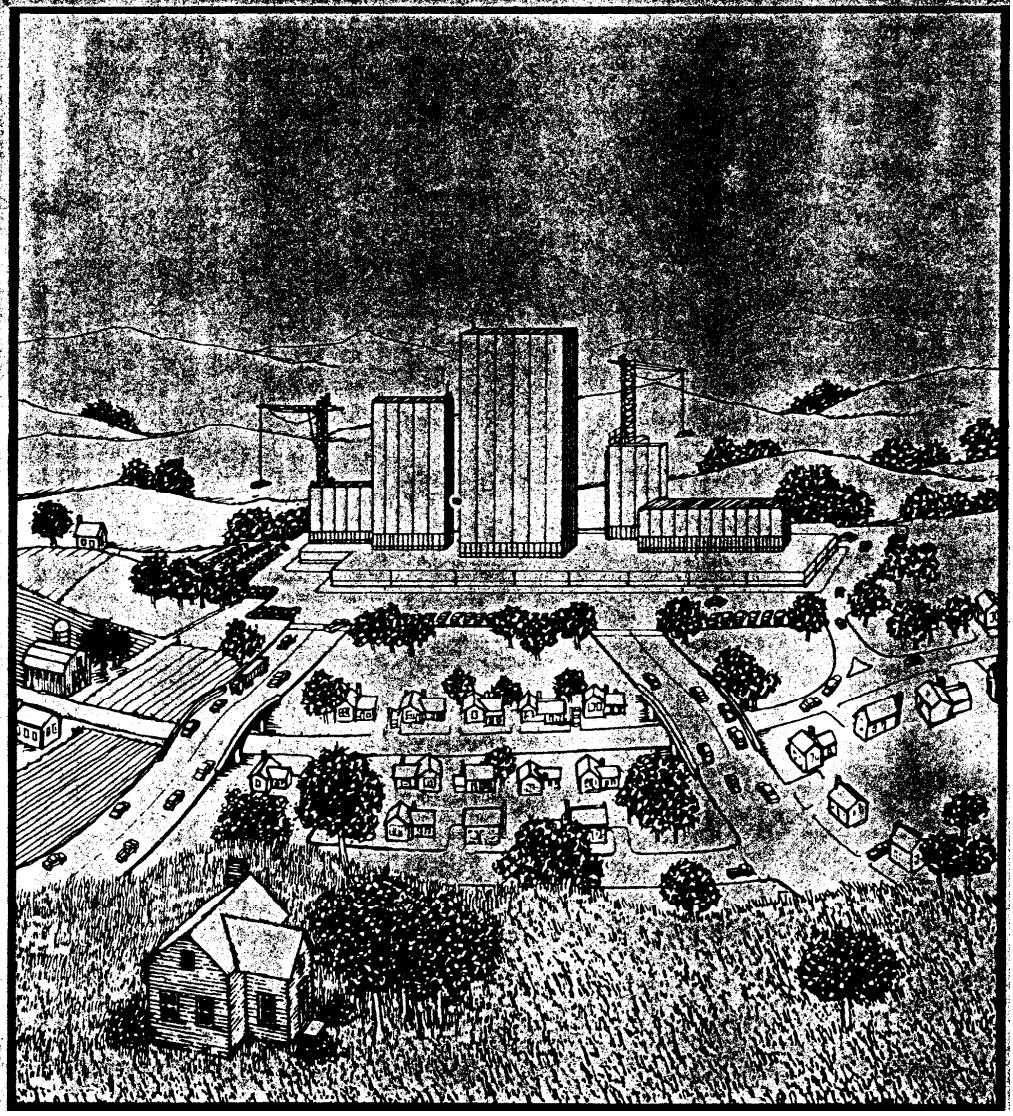
Development and Application of Trip Generation Rates

Final Report
January 1985



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16. Abstract

The study regarding the analysis and use of existing trip generation rates resulted in two reports:

* "Site Impact Traffic Evaluation (S.I.T.E.) Handbook"
  This report documents the site access study process in detail. As noted in the report, the trip generation estimation procedure is a critical step in the seven phase site access study. Four case studies are presented that demonstrate the use of trip generation rates and analyze the sensitivity of site related traffic to trip rates, trip distribution patterns and other key variables.

* "Development and Application of Trip Generation Rates"
  This report presents an overview of the data sources on trip generation rates. Updated trip generation rates are presented along with factors for adjusting trip rates due to variations in residential characteristics. The use of trip rates is described.

While each of the two reports is an independent document, they complement each other, and the user would benefit from reading both reports.

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I. INTRODUCTION

Local agencies are continually facing the need to address the physical condition and service capabilities of the streets and highways in their jurisdictions. Recently this concern has turned to the rapidly developing suburbs of metropolitan areas and the access needs of new development. Related to this are the issues of zoning variances and joint public/private funding for highway improvements to support these developments. Regional planning agencies are being called on more frequently to provide technical assistance and service to sub-regional areas and local jurisdictions. Local cities and counties face the need for accurate technical procedures to analyze 'the potential impacts of new development.

This publication and its companion document, the 'Site Impact Traffic Evaluation (S.I.T.E.) Handbook". provide guidance on site access analysis procedures. This report presents updated 'trip generation rates along with factors for adjusting trip rates due to variations in residential characteristics The use of trip rates is also described. The S.I.T.E. Handbook presents a seven phased site access study process including a trip generation rate development procedure (50). Four case studies are presented that demonstrate the use of trip generation rates and also analyze the sensitivity of site-related traffic to trip rates, trip distribution patterns and other key variables. Additional and related publications include:

- The ITE trip rates publication: 'Trip Generation - An Informational Report", Third Edition, 1982 (45)
- "Using the ITE Trip Generation Report" prepared by Carl Buttke for ITE, July 1984 (5)
- NCHRP Report 187 "Quick Response Urban Travel Estimation Techniques and Transferable Parameters: User's Guide" 1978. (83)

These publications should be collectively used for guidance and not relied upon' as the sole source of information for trip rate information in site access analyses. Where local data and procedures are available, they should be used if the analyst considers them to be more accurate.

OVERVIEW

There are many methods for collecting trip generation rates, ranging from driveway (ground) vehicular counts to regional home interview surveys. Driveway vehicular counts of traffic

entering and leaving development sites have been collected for many land uses. Manual counts or automatic traffic recorders are used to collect traffic data on driveways during peak hours of adjacent street traffic and/or the generator and sometimes over a twenty-four hour period. The traffic data for the cordoned site along with the background information on each site (such as dwelling units, gross floor area, number of employees and acres of land) are utilized to estimate vehicle trip rates per dwelling unit (or other independent variable). Most of these ground count based rates are compiled in such documents as the Institute of Transportation Engineers (ITE) "Trip Generation - An Informational Report" (45) and numerous locally developed documents. These rates, when applied to future land uses, result in an estimate of future daily and peak hour trips. Regional home interview surveys are not covered in this report. They provide information at the individual household level and are generally used to model trip generation relationships with various socioeconomic factors and land use characteristics. These trip generation relationships are generally used for long range comprehensive planning.

Several concerns have been raised regarding existing trip generation rate data:

- Variability among trip generation rate sources and geographic locations as well as differences between these rates and other national data sources, such as the 1977 Nationwide Personal Transportation Survey (NPTS).
- Effects of older data (collected in the 1960's) included in the more current trip generation rates.
- Lack of detailed guidelines on the use of existing trip generation rate data.

This publication provides guidance on the use of trip generation rates in light of these concerns. In addition three related issues are also addressed:

- The effect of socioeconomic variables on residential trip generation rates.
- Reduced external trips generated by multi-use centers (i.e. a percentage of the trips generated by a multi-use center are internal and remain on site).
- Capture rates for "pass-by" traffic (i.e. trips attracted to the development from traffic normally passing-by the site).

This technical concern for trip rate accuracy has emerged coincidentally with increased emphasis on site access studies. To illustrate this emerging issue, the FHWA has completed a

study to: 1) investigate the existing uses of private funds for highway improvements 2) evaluate the mechanisms-used to obtain private funding and, 3) to recommend improvements for which private funding may be used (52).

A key issue in the technical process is trip generation rates and their subsequent role in the estimation of traffic impact and needed road improvements. Since trip rates are so important to local zoning regulations it is essential-for the success of this new concept of private/public cost sharing to have accurate trip rate information. In most areas the ITE Trip Generation Report is considered the reference manual on trip generation. Accurate trip rates will enhance the application and accuracy of the quick response techniques and significantly aid site access analyses in the United States -- and also facilitate equitable cost sharing negotiations between public and private interests.

The findings of this study have implications for the public and private sectors in achieving cost effective roadway improvements. The trip rates and their adjustment factors developed in this study can be used to:

- conduct site access studies including the estimation of traffic generated by either a single use! multi-use or planned unit development.
- forecast daily and peak hour traffic volumes for the geometric design of traffic circulation and access plans.
- evaluate on-site alternative land use development conditions to optimize or minimize the traffic impact on the adjacent highway network.
- aid in the determination of the private developer's share in local transportation improvements.
- estimate daily and peak hour trip rates and traffic flows for transportation corridor and sub-area analyses.

The S.I.T.E. Handbook presents details on the uses of trip generation rates (50).

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II. ANALYSES OF TRIP RATE DATA

DATA SOURCES

The major data source for the trip rates presented in this report was the ITE data base. An extensive literature review was conducted, and agency contacts were made to identify trip generation data that were collected since the latest update of the ITE trip rates publication.(45) This search resulted in the identification of over 500 references. Approximately seventy of these references included relevant trip generation data. Accordingly, it was decided to augment the ITE data base with the new data collected. All new data collected were checked against the existing ITE data base to avoid duplication of data sources. The data sources that were not duplicative of the ITE data base are presented in Table 1. It should be noted that NCHRP Report 187, Table I (83), incorporates ITE trip rate data as well as other sources. The other sources in NCHRP 187 were neither described in the NCHRP Report nor available through the Transportation Research Board. Therefore, NCHRP 187 trip rate data could not be included in the data base for this report.

Because of concerns about travel habits changing due to the energy crisis, analyses comparing older data (pre-1973) and the newer data (post-1973) were performed. Based on statistical tests such as t-test and f-ratios, it was concluded that there were no significant differences between the mean trip rates of older data (pre-1973) and the newer data (post-1973) for all land uses analyzed. (See Appendix B for a detailed analysis.) In some cases, the mean trip rates appeared to be different but due to a large standard deviation, the statistical tests indicated no significant difference. Accordingly, all data regardless of age were used to develop the updated trip rates. Data on land uses not included in ITE were collected and analyzed. These land uses include high technology office buildings, townhouse office buildings, bowling alleys, department stores, drug stores, beauty salons, dry cleaners and printing shops. Some of these land uses have limited sample sizes and the trip rates are not included in this report.

UPDATING TRIP RATES

Trip generation rates for non-residential uses were estimated for each of the three variables: location, auto occupancy and transit usage. Location was categorized as urban, suburban and rural. Data on location were generally available for industrial parks, hotels, hospitals, office buildings, and shopping centers in the range of 100,000 to 499,999 square feet of gross leasable area (GLA).

TABLE 1
DATA SOURCES

SOURCE	SURVEY TYPE	REFERENCE [1]
Prince George's County, Maryland	Driveway	47
Maryland-National Capital Park and Planning Commission	Driveway	48
East-West Gateway Coordinating Council	Driveway	29
Anne Arundel County, Maryland	Driveway	90
Palm Beach County, Florida	Driveway	51,53
Virginia Department of Highway & Transportation	Driveway	80
Connecticut DOT	Home Interview	21
Southeast Michigan COG	Home Interview	79
Metropolitan Transportation Commission	Home Interview	54
Maryland DOT	Driveway	58
California DOT	Driveway	11
San Diego Association of Governments	Driveway/ Home Interview	20,43,74
Delaware DOT	Driveway	27
Kellerco Data Files	Driveway	49
New Hampshire Department of Public Works and Highways	Driveway	64
West Virginia DOT	Driveway	94
Chicago	Driveway/ Home Interview	16,17
Cincinnati, Ohio	Home Interview	14
Richmond, Virginia	Driveway/ Home Interview	70
Washington COG	Driveway	63
Virginia Highway and Transportation Research Council	Driveway	92,93
Fairfax County, Virginia	Driveway	89
Baltimore Disaggregate Data Set	Home Interview	31

[1] See list of references at the end of the Report

Auto occupancy data were available for manufacturing land use only. However, the sample size was not adequate for any statistical tests.

Transit availability data for industrial/manufacturing uses and shopping centers in the range of 100,000 to 499,999 square feet of GLA were included in the data base. The summary of mean daily trip rates with and without transit availability are presented in Table 2. For the industrial park, the mean daily, trip rates for sites not served by transit were higher than sites served by transit. This is contrary to what is generally expected; however, data were not available to determine the reasons for this anomaly. T-tests were carried out to determine if a significant difference existed between the mean trip rates of sites with and without transit available. In all cases the statistical tests showed that the means are not significantly different. It should be noted that although. the means are intuitively different, the high standard deviations result in the finding of no statistical differences.

The results of the updating analyses are presented in the next Chapter along with the use of the updated trip fates.

TABLE 2
DAILY TRIP RATES AS A FUNCTION
OF TRANSIT AVAILABILITY

LAND USE	Served By Transit			Not Served by Transit			Degrees of Freedom	t-Value		
	No. of Obs.	Mean Trip Rates	Std. Dev.	No. of Obs.	Mean Trips Rates	Std. Dev.		Computed 't'	Tables 2-tailed test t.975	t.995
130 Industrial Park	7	9.20	4.21	10	7.06	4.30	15	0.959	2.131	2.947
140 Manufacturing	11	3.07	1.82	42	6.60	7.96	51	-1.433	-2.010	-2.680
150 Warehousing	4	3.13	1.26	6	4.42	1.64	8	-1.190	-2.306	-3.355
822-825 Shopping Ctr.	7	58.87	15.27	5	76.65	20.43	10	-1.574	-2.228	-3.169

III. TRIP GENERATION RATES

This chapter presents the results of the trip generation analyses as the updated Table I of NCHRP Report 187 (83). The updated trip rates are presented in Table 3.

For each land use, the following data are included:

- Corresponding ITE land use code(s)
- The weighted mean daily trip rates for one or more independent variables, such as dwelling units, acres, employees and square-feet of gross floor area
- The minimum daily trip rate in the sample data
- The maximum daily trip rate in the sample data
- The standard deviation about the mean trip rate
- The standard error of mean which is estimated as (standard deviation)/(square root of number in sample)
- The weighted mean trip rates for the AM and PM peak hour of the adjacent street traffic. The directional distribution of trips is also presented
- The weighted mean trip rate for the peak one hour of the generator is included along with the directional distribution of trips
- Additional adjustment factors are provided for residential use characteristics such as household size, vehicle ownership and residential density. These adjustment factors are presented in Table 3a. it should be noted that the adjustment factors for residential characteristics are to be added (or subtracted) from the daily trip rates. The application of these factors is described in a later section.

USE OF TRIP RATES

The trip generation rates presented in Table 3 should be used with care, If local data are available for a similar site. then the local data should be used. Table 3 can be used to estimate the amount of traffic that may be generated by a specific land use or site. Appropriate adjustment factors for residential characteristics may be applied. Further adjustments due to increased ridesharing or proximity to transit may be applied using other techniques such as the office trip generation rate analysis technique, described in the SITE.Handbook, (50) and/or Using The ITE Trip Generation Report (5). This reference (5) describes the uses of trip generation rates including methodologies for adjusting trip rates for Transportation Systems Management (TSM) actions such as ridesharing, etc. The following sections briefly describe the use of trip rates presented in Table 3.

TABLE 3

LAND USE GENERATOR DESCRIPTION & ITE CODE	UNITS	VEHICLE TRIPS PER DAY TO & FROM LAND USE (Rate/Unit as noted) MEAN	MIN	MAX	STATISTICS STD DEV.	STD ERROR# OF MEAN	OBS. IN SAMPLE
PORTS & TERMINALS(000)							
Water Ports	BOSBER	171.52	38.60	338.57	112.98	42.70	7
010	ACRE	11.95	4.95	19.47	5.45	2.06	71
Air Ports	CFL/DY	70.85	51.33	78.44	13.59	7.85	3
020	FLT/DY	3.05	0.96	31.38	8.83	2.66	11
	EMP	21.45	11.55	284.29	102.29	38.66	7
	ACRE	4.77	0.99	24.89	8.25	2.49	11
Comm Airport	CFL/DY	122.21	99.50	138.74	22.55	13.02	3
021	FLT/DY	8.34	1.62	122.97	60.71	35.05	3
	EMP	15.39	14.11	22.94	6.25	4.42	2
	ACRE	11.48	9.13	16.22	3.63	2.10	3
Gen Avi Airport	FLT/DY	2.50	*	*	NA	NA	*
022	EMP	6.50	*	*	NA	NA	*
	ACRE	3.60	*	*	NA	NA	*
Truck Terminals	1K SF	9.86	NA	NA	NA	NA	1
030	EMP	6.99	4.22	47.29	30.45	21.53	2
	ACRE	81.86	66.20	100.08	23.96	16.94	2
INDUSTRIAL(100)							
Gen Lght Indus	1K SF	6.98	1.58	16.88	4.44	1.05	18
110	EMP	4.50	1.53	10.42	2.12	0.49	19
	ACRE	76.03	5.21	159.38	43.90	10.07	19
Gen Heavy Indus	1K SF	1.50	0.58	1.84	0.69	0.40	3
120	EMP	2.05	0.75	11.05	4.99	2.50	4
	ACRE	15.62	1.66	55.13	24.71	12.36	4
Indus Park	1K SF	7.00	0.91	36.97	7.71	1.12	47
130	EMP	3.59	1.37	8.80	1.92	0.29	45
	ACRE	62.82	13.87	1272.63	209.24	32.68	41
Manufact	1K SF	3.85	0.50	52.05	6.90	0.89	60
140	EMP	2.09	0.60	6.66	1.21	0.16	60
	ACRE	38.88	2.54	396.00	69.43	9.28	56
Warehouse	1K SF	4.88	1.51	17.00	3.76	0.97	15
150	EMP	3.89	1.47	15.71	3.74	0.97	15
	ACRE	56.08	20.23	255.80	59.64	15.94	14

LEGEND FOR UNITS:

1K SF	1,000 SQ. FT. GFA	CFL/DY	COMMERCIAL FLIGHT PER DAY
ACRE	ACRE	CIVEMP	CIVILIAN EMPLOYEE
BED	HOSPITAL BED	DEFEMP	DEFENSE FORCES EMPLOYEE
BOSBER	BOAT-OR SHIP BERTH	DU	DWELLING UNIT

TRIP GENERATION RATES

LAND USE GENERATOR		VEHICLE TRIP RATES IN PEAK HOUR								
		AM			PM			PEAK HOUR OF GENERATOR		
DESCRIPTION & ITE CODE	UNITS	IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL
PORTS & TERMINALS(000)										
Water Ports 010	BOSBER	*	*	*	*	*	*	*	*	*
	ACRE	*	*	*	*	*	*	*	*	*
Air Ports 020	CFL/DY	2.86	1.95	4.81	4.16	4.42	8.58	3.33	3.33	6.66
	FLT/DY	0.17	0.13	0.30	0.22	0.23	0.45	0.25	0.25	0.50
	EMP	1.32	1.03	2.35	1.69	1.81	3.50	0.98	0.98	1.96
	ACRE	0.23	0.18	0.41	0.30	0.31	0.61	0.31	0.31	0.62
Comm Airport 021	CFL/DY	3.57	2.86	6.43	3.72	3.17	6.89	4.26	4.98	9.24
	FLT/DY	0.24	0.20	0.44	0.25	0.22	0.47	0.29	0.34	0.63
	EMP	0.45	0.37	0.82	0.44	0.36	0.80	0.54	0.67	1.21
	ACRE	0.33	0.27	0.60	0.35	0.30	0.65	0.40	0.47	0.87
Gen Avi Airport 022	FLT/DY	*	*	0.30	*	*	0.26	*	*	0.39
	EMP	*	*	0.77	*	*	0.68	*	*	1.02
	ACRE	*	*	0.43	*	*	0.38	*	*	0.57
Truck Terminals 030	1K SF	0.36	0.54	0.90	0.35	0.47	0.82	0.36	0.54	0.90
	EMP	0.27	0.39	0.66	0.26	0.29	0.55	0.27	0.39	0.66
	ACRE	3.12	4.62	7.74	3.05	3.41	6.46	3.12	4.62	7.74
INDUSTRIAL(100)										
Gen Lght Indus 110	1K SF	0.82	0.13	0.95	0.19	0.69	0.88	0.35	0.66	1.01
	EMP	0.45	0.07	0.52	0.10	0.37	0.47	0.53	0.08	0.61
	ACRE	7.51	1.35	8.86	1.80	6.12	7.92	7.63	2.63	10.26
Gen Heavy Indus 120	1K SF	*	*	0.51	*	*	0.19	*	*	0.69
	EMP	*	*	0.51	*	*	0.89	*	*	0.89
	ACRE	*	*	1.98	*	*	2.16	*	*	6.41
Indus Park 130	1K SF	0.71	0.22	0.93	0.24	0.75	0.99	0.24	0.75	0.99
	EMP	0.42	0.15	0.57	0.14	0.38	0.52	0.42	0.15	0.57
	ACRE	7.79	2.45	10.24	8.26	2.65	10.91	8.26	2.65	10.91
Manufact 140	1K SF	*	*	0.78	0.43	0.32	0.75	0.52	0.26	0.78
	EMP	*	*	0.43	0.22	0.17	0.39	0.17	0.29	0.46
	ACRE	*	*	7.35	4.78	3.50	8.28	6.10	3.05	9.15
Warehouse 150	1K SF	*	*	0.66	0.62	1.01	1.63	2.19	2.69	4.88
	EMP	*	*	0.50	0.49	0.79	1.28	0.61	0.76	1.37
	ACRE	*	*	9.56	7.07	11.70	18.77	9.01	11.01	20.02

Vehicle Trips Per...

EMP	EMPLOYEE	ROOM	HOTEL/MOTEL ROOM
FLT/DY	FLIGHT PER DAY	SEAT	RESTAURANT SEAT
PRKSPC	PARKING SPACE	STDNT	STUDENT
PUMP	GAS(OR DIESEL) PUMP	STN	GAS(OR DIESEL) STATION

TABLE 3 , continued

LAND USE GENERATOR	VEHICLE TRIPS PER DAY TO & FROM LAND USE (Rate/Unit as noted)				STATISTICS		
DESCRIPTION & ITE CODE	UNITS	MEAN	MIN	MAX	STD DEV.	STD ERROR OF MEAN	# OBS. IN SAMPLE
RESIDENTIAL(200)							
S-F Det Hous	DU	10.03	4.31	21.90	2.37	0.13	313
210	ACRE	26.18	1.82	275.19	31.15	2.82	122
Urban	DU	11.28					
	ACRE	29.45					
Suburban	DU	9.06					
	ACRE	23.64					
Rural	DU	9.73					
	ACRE	25.40					
Apartment	DU	6.11	0.54	12.34	1.92	0.17	122
220	ACRE	23.79	1.82	361.83	67.98	8.37	66
Urban	DU	6.87					
	ACRE	26.76					
Suburban	DU	5.52					
	ACRE	21.48					
Rural	DU	5.93					
	ACRE	23.08					
Condomin	DU	5.40	0.57	11.79	2.28	0.31	55
230	ACRE	68.04	14.81	337.66	74.29	17.04	19
Urban	DU	6.08					
	ACRE	76.55					
Suburban	DU	4.88					
	ACRE	61.44					
Mobile Home	DU	4.78	2.29	7.60	1.44	0.28	26
240	ACRE	9.13	15.86	85.89	17.19	3.19	29
Retire Comm	DU	3.30	2.80	9.90	NA	NA	3
250							
Plan Unit Dev	DU	7.49	5.23	14.38	2.62	0.70	14
270	ACRE	46.78	41.85	50.80	4.24	2.12	4
(Suburban)							

LEGEND FOR UNITS:

1K SF	1,000 SQ. FT. GFA	CFL/DY	COMMERCIAL FLIGHT PER DAY
ACRE	ACRE	CIVEMP	CIVILIAN EMPLOYEE
BED	HOSPITAL BED	DEFEMP	DEFENSE FORCES EMPLOYEE
BOSBER	BOAT OR SHIP BERTH	DU	DWELLING UNIT

TRIP GENERATION RATES

LAND USE GENERATOR		VEHICLE TRIP RATES IN PEAK HOUR								
		AM			PM			PEAK HOUR OF GENERATOR		
DESCRIPTION & ITE CODE	UNITS	IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL
RESIDENTIAL(200)										
S-F Det Hous	DU	0.21	0.54	0.75	0.64	0.36	1.00	0.64	0.36	1.00
210	ACRE	0.61	1.50	2.11	1.70	1.03	2.73	1.70	1.03	2.73
Urban	DU	0.24	0.61	0.84	0.72	0.41	1.13	0.72	0.41	1.13
	ACRE	0.69	1.69	2.37	1.91	1.16	3.07	1.91	1.16	3.07
Suburban	DU	0.19	0.49	0.68	0.58	0.33	0.90	0.58	0.33	0.90
	ACRE	0.55	1.35	1.91	1.54	0.93	2.47	1.54	0.93	2.47
Rural	DU	0.20	0.52	0.73	0.62	0.35	0.97	0.62	0.35	0.97
	ACRE	0.59	1.46	2.05	1.65	1.00	2.65	1.65	1.00	2.65
Apartment	DU	0.09	0.46	0.55	0.49	0.22	0.71	0.49	0.22	0.71
220	ACRE	0.36	0.90	1.26	1.40	0.81	2.21	1.40	0.81	2.21
Urban	DU	0.10	0.52	0.62	0.55	0.25	0.80	0.55	0.25	0.80
	ACRE	0.41	1.01	1.42	1.58	0.91	2.49	1.58	0.91	2.49
Suburban	DU	0.08	0.42	0.50	0.44	0.20	0.64	0.44	0.20	0.64
	ACRE	0.33	0.81	1.14	1.26	0.73	2.00	1.26	0.73	2.00
Rural	DU	0.09	0.45	0.53	0.48	0.21	0.69	0.48	0.21	0.69
	ACRE	0.35	0.87	1.22	1.36	0.79	2.14	1.36	0.79	2.14
Condomin	DU	0.07	0.37	0.44	0.36	0.18	0.54	0.36	0.18	0.54
230	ACRE	0.76	4.50	5.26	4.41	2.16	6.57	4.66	2.52	7.18
Urban	DU	0.08	0.42	0.50	0.41	0.20	0.61	0.41	0.20	0.61
	ACRE	0.86	5.06	5.92	4.96	2.43	7.39	5.24	2.84	8.08
Suburban	DU	0.06	0.33	0.40	0.33	0.16	0.49	0.33	0.16	0.49
	ACRE	0.69	4.06	4.75	3.98	1.95	5.93	4.21	2.28	6.48
Mobile Home	DU	0.05	0.37	0.42	0.38	0.19	0.57	0.38	0.19	0.57
240	ACRE	0.59	3.03	3.62	3.10	1.81	4.91	3.23	1.81	5.04
Retire Comm	DU	*	*	0.40	*	*	0.40	*	*	*
250										
Plan Unit Dev	DU	0.13	0.43	0.56	0.46	0.24	0.70	0.46	0.26	0.72
270	ACRE	0.67	2.21	2.88	2.66	1.39	4.05	2.64	1.49	4.13
(Suburban)										

Vehicle Trips Per...

EMP	EMPLOYEE	ROOM	HOTEL/MOTEL ROOM
FLT/DY	FLIGHT PER DAY	SEAT	RESTAURANT SEAT
PRKSPC	PARKING SPACE	STDNT	STUDENT
PUMP	GAS(OR DIESEL) PUMP	STN	GAS(OR DIESEL) STATION

TABLE 3 , continued

LAND USE GENERATOR		VEHICLE TRIPS PER DAY TO & FROM LAND USE (Rate/Unit as noted)	STATISTICS				
DESCRIPTION & ITE CODE	UNITS	# OBS. STD ERROR OF MEAN	IN MIN	MAX	STD DEV.	MEAN	SAMPLE
LODGING(300)							
Hotel	ROOM	8.70	5.31	9.58	1.58	0.60	7
310	EMP	14.34	8.85	24.47	6.13	2.74	5
	ACRE	1430.19	755.38	1663.55	395.72	197.86	4
Urban	ROOM	8.68					
	EMP	14.31					
	ACRE	1427.33					
Suburban	ROOM	9.34					
EMP	15.39						
	ACRE	534.59					
Motel	ROOM	6.13	4.17	10.04	2.54	0.90	8
320	EMP	12.81	7.20	41.00	10.69	3.38	10
	ACRE	180.71	38.41	364.44	106.57	32.13	11
Resort Hotel	ROOM	18.40	7.11	52.41	14.33	5.07	8
330	EMP	10.27	NA	NA	NA	NA	1
	ACRE	237.96	33.42	1811.11	568.51	201.00	8
RECREATION(400)							
Parks	PRKSPC	7.81	2.93	24.28	6.74	2.25	9
410	EMP	96.17	42.35	183.62	59.56	29.78	4
	ACRE	30.37	2.99	214.55	62.22	16.07	15
City Parks	PRKSPC	6.50	1.91	12.55	5.51	3.18	3
411	EMP	51.10	47.06	66.67	9.97	5.76	3
	ACRE	3.66	1.04	129.83	55.36	24.76	5
County Parks	PRKSPC	2.18	0.42	21.00	5.58	1.61	12
412	EMP	26.46	23.33	183.33	50.32	13.96	13
	ACRE	5.09	0.17	81.24	21.12	5.12	17
State Parks	PRKSPC	1.15	0.40	3.13	0.97	0.34	8
413	EMP	60.20	21.93	183.33	67.14	20.24	11
	ACRE	0.69	0.05	16.67	6.51	1.81	13
Marinas	BOSBER	2.96	1.91	0.4	2.33	0.70	11
420	EMP	251.47	231.50	276.67	24.13	12.06	4
	ACRE	20.92	10.32	75.45	32.64	18.84	3
Golf Course	PRKSPC	5.32	1.75	16.39	3.47	0.87	16
430	EMP	20.63	10.90	75.00	18.27	5.07	13
	ACRE	6.91	2.33	22.78	4.42	0.94	22

LEGEND FOR UNITS:

1K SF	1,000 SQ. FT. GFA	CFL/DY	COMMERCIAL FLIGHT PER DAY
ACRE	ACRE	CIVEMP	CIVILIAN EMPLOYEE
BED	HOSPITAL BED	DEFEMP	DEFENSE FORCES EMPLOYEE
BOSBER	BOAT OR SHIP BERTH	DU	DWELLING UNIT

TRIP GENERATION RATES

LAND USE GENERATOR		VEHICLE TRIP RATES IN PEAK HOUR								
		AM			PM			PEAK HOUR OF GENERATOR		
DESCRIPTION & ITE CODE	UNITS	IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL
LODGING(300)										
Hotel 310	ROOM	0.44	0.26	0.70	0.36	0.31	0.67	0.56	0.35	0.91
	EMP	0.40	0.29	0.69	0.36	0.27	0.63	0.52	0.45	0.97
	ACRE	7.05	4.90	11.95	47.31	46.42	93.73	65.28	54.57	119.85
Urban	ROOM	0.44	0.26	0.70	0.36	0.31	0.67	0.56	0.35	0.91
	EMP	0.40	0.29	0.69	0.36	0.27	0.63	0.52	0.45	0.97
	ACRE	7.04	4.89	11.93	47.22	46.33	93.54	65.15	54.46	119.61
Suburban	ROOM	0.47	0.28	0.75	0.39	0.33	0.72	0.60	0.38	0.98
	EMP	0.43	0.31	0.74	0.39	0.29	0.68	0.56	0.48	1.04
	ACRE	7.56	5.26	12.82	50.76	49.81	100.57	70.05	58.55	128.60
Motel 320	ROOM	0.32	0.20	0.52	0.27	0.27	0.54	0.41	0.24	0.65
	EMP	0.51	0.31	0.82	0.30	0.30	0.60	0.69	0.42	1.11
	ACRE	12.03	7.32	19.35	6.39	6.39	12.78	11.03	6.45	17.48
Resort Hotel 330	ROOM	*	*	0.24	*	*	0.50	*	*	0.57
	EMP	*	*	0.34	*	*	0.73	*	*	0.82
	ACRE	*	*	16.72	*	*	35.63	*	*	40.18
RECREATION(400)										
Parks 410	PRKSPC	*	*	*	*	*	*	*	*	*
	EMP	*	*	*	*	*	*	*	*	*
	ACRE	*	*	*	*	*	*	*	*	*
City Parks 411	PRKSPC	*	*	0.43	*	*	0.60	*	*	1.00
	EMP	*	*	2.32	*	*	3.21	*	*	5.37
	ACRE	*	*	2.43	*	*	3.37	*	*	5.63
County Parks 412	PRKSPC	*	*	*	*	*	0.22	*	*	*
	EMP	*	*	*	*	*	2.17	*	*	*
	ACRE	*	*	*	*	*	7.50	*	*	*
State Parks 413	PRKSPC	*	*	*	*	*	*	*	*	*
	EMP	*	*	2.35	*	*	4.60	*	*	5.45
	ACRE	*	*	0.64	*	*	0.06	*	*	1.49
Marinas 420	BOSBER	*	*	0.09	*	*	0.17	*	*	0.20
	EMP	*	*	9.75	*	*	18.00	*	*	31.75
	ACRE	*	*	*	*	*	*	*	*	*
Golf Course 430	PRKSPC	0.22	0.06	0.28	0.13	0.20	0.33	*	*	*
	EMP	*	*	*	*	*	*	*	*	*
	ACRE	0.21	0.06	0.27	0.12	0.27	0.39	*	*	*

Vehicle Trips Per...

EMP	EMPLOYEE	ROOM	HOTEL/MOTEL ROOM
FLT/DY	FLIGHT PER DAY	SEAT	RESTAURANT SEAT
PRKSPC	PARKING SPACE	STDNT	STUDENT
PUMP	GAS(OR DIESEL) PUMP	STN	GAS(OR DIESEL) STATION

TABLE 3continued

LAND USE GENERATOR	VEHICLE TRIPS PER DAY TO & FROM LAND USE (Rate/Unit as noted)				STATISTICS		
DESCRIPTION & ITE CODE	UNITS	MEAN	MIN	MAX	STD DEV.	STD ERROR OF MEAN	# OBS. IN SAMPLE
INSTITUTIONS(500)							
Military Base	EMP	1.80			NA	NA	
501	DEFEMP	2.20			NA	NA	
	CIVEMP	7.10			NA	NA	
Day Care Cen	STDNT	4.98	4.10	7.10	1.22	0.55	5
511	1K SF	79.14	57.20	125.10	26.40	11.81	5
(Suburban)	EMP	33.20	25.60	50.40	12.73	5.70	5
Elem School	STDNT	1.02	0.45	1.82	0.35	0.06	40
520	EMP	13.10	4.47	26.37	5.28	0.84	40
	ACRE	33.69	3.72	123.80	28.41	4.49	40
High School	STDNT	1.38	0.71	2.49	0.52	0.10	27
530	EMP	16.79	4.28	32.87	6.52	1.26	27
	ACRE	23.81	1.02	103.20	26.71	5.97	20
Jr Comm Coll	STDNT	1.58	0.94	27.52	5.65	1.23	21
540	EMP	10.06	NA	NA	NA	NA	1
	ACRE	11.90	NA	NA	NA	NA	1
Universit	STDNT	2.41	1.40	3.89	0.92	0.37	6
550	EMP	14.35	NA	NA	NA	NA	1
	ACRE	107.28	NA	NA	NA	NA	1
Libraries	EMP	49.51	36.80	81.91	19.65	9.83	4
590	ACRE	343.78	221.65	909.00	296.91	148.46	4
MEDICAL(600)							
Hospital	BED	11.84	3.00	32.83	7.46	1.49	25
610	EMP	5.03	2.17	11.11	2.35	0.49	23
	ACRE	167.73	24.07	1012.50	229.97	51.42	20
Urban	BED	13.08					
	EMP	5.56					
	ACRE	185.34					
Suburban	BED	11.21					
	EMP	4.76					
	ACRE	158.86					
Nurs Home	BED	2.60	1.88	3.97	0.57	0.13	18
620	EMP	4.03	2.53	9.69	1.99	0.47	18
Clinics	BED	15.96	NA	NA	NA	NA	1
630	EMP	5.89	NA	NA	NA	NA	1
	ACRE	91.19	NA	NA	NA	NA	1

LEGEND FOR UNITS:

1K SF	1,000 SQ. FT. GFA	CFL/DY	COMMERCIAL FLIGHT PER DAY
ACRE	ACRE	CIVEMP	CIVILIAN EMPLOYEE
BED	HOSPITAL BED	DEFEMP	DEFENSE FORCES EMPLOYEE
BOSBER	BOAT OR SHIP BERTH	DU	DWELLING UNIT

TRIP GENERATION RATES

LAND USE GENERATOR		VEHICLE TRIP RATES IN PEAK HOUR								
		AM			PM			PEAK HOUR OF GENERATOR		
DESCRIPTION & ITE CODE	UNITS	IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL
INSTITUTIONS(500)										
Military Base 501	EMP	*	*	*	*	*	*	*	*	*
	DEFEMP	*	*	*	*	*	*	*	*	*
	CIVEMP	*	*	*	*	*	*	*	*	*
Day Care Cen 511 (Suburban)	STDNT	0.53	0.41	0.94	0.44	0.47	0.91	0.59	0.46	1.05
	1K SF	8.38	6.47	14.85	6.94	7.45	14.40	9.36	7.32	15.68
	EMP	3.52	2.71	6.23	2.91	3.13	6.04	3.93	3.07	6.60
Elem School 520	STDNT	0.12	0.07	0.19	*	*	0.03	0.12	0.07	0.19
	EMP	1.86	1.08	2.94	*	*	0.28	2.34	1.05	3.39
	ACRE	10.71	6.24	16.95	*	*	1.60	5.96	2.75	8.71
High School 530	STDNT	0.23	0.10	0.33	0.07	0.14	0.21	0.23	0.10	0.33
	EMP	1.47	0.64	2.11	0.28	0.55	0.83	2.64	0.94	3.58
	ACRE	6.01	2.61	8.62	1.13	2.25	3.38	8.70	3.09	11.79
Jr Comm Coll 540	STDNT	0.16	0.02	0.18	0.05	0.07	0.12	0.16	0.02	0.18
	EMP	*	*	*	*	*	*	*	*	1.73
	ACRE	*	*	*	*	*	*	*	*	2.04
Universit 550	STDNT	*	*	*	*	*	*	*	*	*
	EMP	*	*	*	*	*	*	*	*	1.77
	ACRE	*	*	*	*	*	*	*	*	13.20
Libraries 590	EMP	*	*	1.00	*	*	4.44	3.57	3.17	6.74
	ACRE	*	*	11.56	*	*	51.33	24.70	22.13	46.83
MEDICAL(600)										
Hospital 610	BED	0.72	0.29	1.01	0.38	0.79	1.17	0.44	0.92	1.36
	EMP	0.17	0.08	0.25	0.10	0.19	0.29	0.23	0.34	0.57
	ACRE	7.67	3.50	11.17	3.70	10.02	13.72	5.21	9.13	14.34
Urban	BED	0.80	0.32	1.12	0.42	0.87	1.29	0.49	1.02	1.50
	EMP	0.19	0.09	0.28	0.11	0.21	0.32	0.25	0.38	0.63
	ACRE	8.48	3.87	12.34	4.09	11.07	15.16	5.76	10.09	15.85
Suburban	BED	0.68	0.27	0.96	0.36	0.75	1.11	0.42	0.87	1.29
	EMP	0.16	0.08	0.24	0.09	0.18	0.27	0.22	0.32	0.54
	ACRE	7.26	3.31	10.58	3.50	9.49	12.99	4.93	8.65	13.58
Nurs Home 620	BED	*	*	*	0.05	0.16	0.21	0.17	0.19	0.36
	EMP	*	*	*	*	*	*	*	*	0.44
Clinics 630	BED	*	*	*	*	*	*	*	*	*
	EMP	0.30	0.15	0.45	0.46	0.66	1.12	0.65	0.65	1.30
	ACRE	*	*	*	*	*	*	*	*	*

Vehicle Trips Per...

EMP	EMPLOYEE	ROOM	HOTEL/MOTEL ROOM
FLT/DY	FLIGHT PER DAY	SEAT	RESTAURANT SEAT
PRKSPC	PARKING SPACE	STDNT	STUDENT
PUMP	GAS(OR DIESEL) PUMP	STN	GAS(OR DIESEL) STATION

TABLE 3, continued

LAND USE GENERATOR	VEHICLE TRIPS PER DAY TO & FROM LAND USE (Rate/Unit as noted)	STATISTICS					
DESCRIPTION & ITE CODE	UNITS	MEAN	MIN	MAX	STD DEV.	STD ERROR OF MEAN	# OBS. IN SAMPLE
OFFICE(700)							
Gen Off Bldg	1K SF	12.43	3.60	28.80	6.03	0.95	39
710	EMP	3.54	2.42	6.22	1.16	0.24	23
	ACRE	250.64	50.75	299.70	1580.16	116.03	25
Urban	1K SF	10.33					
	EMP	2.94					
	ACRE	208.28					
Suburban	1K SF	14.81					
	EMP	4.22					
	ACRE	298.64					
Med Off Bldg	1K SF	39.83	38.68	42.55	2.74	1.94	2
720	EMP	12.20	NA	NA	NA	NA	1
	ACRE	6666.67	NA	NA	NA	NA	1
Urban	1K SF	33.10					
	EMP	10.14					
	ACRE	5540.00					
Suburban	1K SF	47.46					
	EMP	14.54					
	ACRE	7943.34					
Gov Off Bldg	1K SF	67.72	NA	NA	NA	NA	1
730	EMP	11.95	NA	NA	NA	NA	1
	ACRE	66.25	NA	NA	NA	NA	1
Urban	1K SF	56.28					
	EMP	9.93					
	ACRE	55.05					
Suburban	1K SF	80.69					
	EMP	14.24					
	ACRE	78.94					
Civic Center	1K SF	25.00	NA	NA	NA	NA	1
740	EMP	6.09	NA	NA	NA	NA	1
Off Parks	1K SF	20.65	9.40	30.30	11.68	6.74	3
750	EMP	3.33	2.92	3.53	0.32	0.19	3
	ACRE	276.38	153.68	340.87	93.86	54.19	3
Urban	1K SF	17.16					
	EMP	2.77					
	ACRE	229.67					
Suburban	K SF	24.60					
	EMP	3.97					
	ACRE	329.31					

LEGEND FOR UNITS:

1K SF	1,000 SQ. FT. GFA	CFL/DY	COMMERCIAL FLIGHT PER DAY
ACRE	ACRE	CIVEMP	CIVILIAN EMPLOYEE
BED	HOSPITAL BED	DEFEMP	DEFENSE FORCES EMPLOYEE
BOSBER	BOAT OR SHIP BERTH	DU	DWELLING UNIT

TRIP GENERATION RATES

LAND USE GENERATOR	VEHICLE TRIP RATES IN PEAK HOUR								
		AM			PM			PEAK HOUR OF GENERATOR	
DESCRIPTION & ITE CODE	UNITS	IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL
OFFICE(700)										
Gen Off Bldg 710	1K SF	1.76	0.22	1.98	0.31	1.62	1.93	1.76	0.22	1.98
	EMP	0.43	0.05	0.48	0.08	0.38	0.46	0.43	0.05	0.48
	ACRE	19.46	2.61	22.07	4.41	17.21	21.62	18.46	2.61	22.07
Urban	1K SF	1.46	0.18	1.65	0.26	1.35	1.60	1.46	0.18	1.65
	EMP	0.36	0.04	0.40	0.07	0.32	0.38	0.36	0.04	0.40
	ACRE	16.17	2.17	18.34	3.66	14.30	17.97	15.34	2.17	18.34
Suburban	1K SF	2.10	0.26	2.36	0.37	1.93	2.30	2.10	0.26	2.36
	EMP	0.51	0.06	0.57	0.10	0.45	0.55	0.51	0.06	0.57
	ACRE	23.19	3.11	26.30	5.25	20.51	25.76	22.00	3.11	26.30
Med Off Bldg 720	1K SF	0.64	0.21	0.85	0.89	3.05	3.94	2.55	1.65	4.20
	EMP	0.18	0.06	0.24	0.58	0.99	1.57	0.58	0.99	1.57
	ACRE	100.00	33.33	133.33	316.67	540.00	856.67	543.33	540.00	1083.33
Urban	1K SF	0.53	0.17	0.71	0.74	2.53	3.27	2.12	1.37	3.49
	EMP	0.15	0.05	0.20	0.48	0.82	1.30	0.48	0.82	1.30
	ACRE	83.10	27.70	110.80	263.15	448.74	711.89	451.51	448.74	900.25
Suburban	1K SF	0.76	0.25	1.01	1.06	3.63	4.69	3.04	1.97	5.00
	EMP	0.21	0.07	0.29	0.69	1.18	1.87	0.69	1.18	1.87
	ACRE	119.15	39.71	158.86	377.31	643.41	1020.72	647.38	643.41	1290.79
Gov Off Bldg 730	1K SF	4.83	0.95	5.78	*	*	*	8.06	2.78	10.84
	EMP	0.85	0.17	1.02	*	*	*	1.42	0.49	1.91
	ACRE	4.80	0.85	5.65	*	*	*	7.88	2.72	10.60
Urban	1K SF	4.01	0.79	4.80	0.00	0.00	0.00	6.70	2.31	9.01
	EMP	0.71	0.14	0.85	0.00	0.00	0.00	1.18	0.41	1.59
	ACRE	3.99	0.71	4.70	0.00	0.00	0.00	6.55	2.26	8.81
Suburban	1K SF	5.75	1.13	6.89	0.00	0.00	0.00	9.60	3.31	12.92
	EMP	1.01	0.20	1.22	0.00	0.00	0.00	1.69	0.58	2.28
	ACRE	5.72	1.01	6.73	0.00	0.00	0.00	9.39	3.24	12.63
Civic Center 740	1K SF	2.00	0.25	2.25	0.89	1.97	2.86	0.89	1.97	2.86
	EMP	0.49	0.06	0.55	0.22	0.48	0.70	0.22	0.48	0.70
Off Parks 750	1K SF	2.30	0.34	2.64	0.40	1.96	2.36	2.30	0.34	2.64
	EMP	0.55	0.08	0.63	0.09	0.45	0.54	0.55	0.08	0.63
	ACRE	45.83	6.78	52.61	7.57	37.12	44.69	45.83	6.78	52.61
Urban	1K SF	1.91	0.28	2.19	0.33	1.63	1.96	1.91	0.28	2.19
	EMP	0.46	0.07	0.52	0.07	0.37	0.45	0.46	0.07	0.52
	ACRE	38.08	5.63	43.72	6.29	30.85	37.14	38.08	5.63	43.72
Suburban	1K SF	2.74	0.41	3.15	0.48	2.34	2.81	2.74	0.41	3.15
	EMP	0.66	0.10	0.75	0.11	0.54	0.64	0.66	0.10	0.75
	ACRE	54.61	8.08	62.68	9.02	44.23	53.25	54.61	8.08	62.68

Vehicle Trips Per...

EMP	EMPLOYEE	ROOM	HOTEL/MOTEL ROOM
FLT/DY	FLIGHT PER DAY	SEAT	RESTAURANT SEAT
PRKSPC	PARKING SPACE	STDNT	STUDENT
PUMP	GAS(OR DIESEL) PUMP	STN	GAS(OR DIESEL) STATION

TABLE 3 , continued

LAND USE GENERATOR	VEHICLE TRIPS PER DAY TO & FROM LAND USE (Rate/Unit as noted)	STATISTICS					
DESCRIPTION & ITE CODE	UNITS	MEAN	MIN	MAX	STD DEV.	STD ERROR OF MEAN	# OBS. IN SAMPLE
Research Cen	1K SF	5.34	1.78	12.98	4.02	1.42	8
760	EMP	2.37	0.96	5.33	1.29	0.43	9
	ACRE	57.25	15.61	1323.08	525.95	214.72	6
Urban	1K SF	4.44					
	EMP	1.97					
	ACRE	47.57					
Suburban	1K SF	6.36					
	EMP	2.82					
	ACRE	68.21					
Hi-Tech Off Bldg	1K SF	7.28	4.08	8.71	2.18	1.26	3
770	EMP	2.76	2.39	3.27	0.47	0.27	3
Urban	1K SF	6.05					
	EMP	2.29					
Suburban	1K SF	8.67					
	EMP	3.29					
Twnhs Off Bldg	1K SF	23.47	19.06	24.78	4.94	2.85	3
780							
Urban	1K SF	19.50					
Suburban	1K SF	27.96					
RETAIL(800)							
Disc Shop Ctr	1K SF	70.13	25.53	106.88	27.83	10.52	7
815	EMP	32.53	28.08	35.46	3.10	1.38	5
	ACRE	456.31	127.64	480.63	302.57	135.31	5
Shp Ctr(1000k sf)	1K SF	29.59	11.99	72.82	16.13	3.80	18
827,828	EMP	12.50	6.14	42.41	14.60	5.16	8
	ACRE	268.31	62.17	1259.74	1376.87	125.62	9

LEGEND FOR UNITS:

1K SF	1,000 SQ. FT. GFA	CFL/DY	COMMERCIAL FLIGHT PER DAY
ACRE	ACRE	CIVEMP	CIVILIAN EMPLOYEE
BED	HOSPITAL BED	DEFEMP	DEFENSE FORCES EMPLOYEE
BOSBER	BOAT OR SHIP BERTH	DU	DWELLING UNIT

TRIP GENERATION RATES

LAND USE GENERATOR		VEHICLE TRIP RATES IN PEAK HOUR								
		AM			PM			PEAK HOUR OF GENERATOR		
DESCRIPTION & ITE CODE	UNITS	IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL
Research Cen	1K SF	1.11	0.10	1.21	0.12	0.81	0.93	2.28	0.21	2.49
760	EMP	0.45	0.03	0.48	0.43	0.03	0.46	0.03	0.55	0.58
	ACRE	21.58	1.13	22.71	1.27	20.18	21.45	21.58	1.13	22.71
Urban	1K SF	0.92	0.08	1.01	0.10	0.67	0.77	1.89	0.17	2.07
	EMP	0.37	0.02	0.40	0.36	0.02	0.38	0.02	0.46	0.48
	ACRE	17.93	0.94	18.87	1.06	16.77	17.82	17.93	0.94	18.87
Suburban	1K SF	1.32	0.12	1.44	0.14	0.97	1.11	2.72	0.25	2.97
	EMP	0.54	0.04	0.57	0.51	0.04	0.55	0.04	0.66	0.69
	ACRE	25.71	1.35	27.06	1.51	24.04	25.56	25.71	1.35	27.06
Hi-Tech Off Bldg	1K SF	1.39	0.10	1.49	0.08	1.27	1.35	1.39	0.10	1.49
770	EMP	0.53	0.04	0.57	0.03	0.48	0.51	0.53	0.04	0.57
Urban	1K SF	1.16	0.08	1.24	0.07	1.06	1.12	1.16	0.08	1.24
	EMP	0.44	0.03	0.47	0.02	0.40	0.42	0.44	0.03	0.47
Suburban	1K SF	1.66	0.12	1.78	0.10	1.51	1.61	1.66	0.12	1.78
	EMP	0.63	0.05	0.68	0.04	0.57	0.61	0.63	0.05	0.68
Twnhs Off Bldg	1K SF	2.22	0.49	2.71	0.66	1.54	2.20	2.22	0.49	2.71
780										
Urban	1K SF	1.84	0.41	2.25	0.55	1.28	1.83	1.84	0.41	2.25
Suburban	1K SF	2.65	0.58	3.23	0.79	1.83	2.62	2.65	0.58	3.23
RETAIL(800)										
Disc Shop Ctr	1K SF	*	*	0.51	*	*	4.43	*	*	6.97
815	EMP	*	*	0.37	*	*	3.17	*	*	4.54
	ACRE	*	*	5.27	*	*	45.70	*	*	63.73
Shp Ctr(<100k sf)	1K SF	1.50	1.33	2.83	4.89	5.08	9.97	5.72	5.69	11.41
820,821	EMP	0.72	0.66	1.38	2.28	2.42	4.70	2.42	2.28	4.70
	ACRE	13.48	12.47	25.95	46.01	50.00	96.01	46.01	50.00	96.01
Sh Ctr(100k.500k)	1K SF	0.89	0.53	1.42	2.59	2.65	5.24	2.35	3.05	5.40
822,823,824,825	EMP	0.45	0.33	0.78	1.58	1.55	3.13	1.58	1.55	3.13
	ACRE	6.55	5.14	11.69	25.57	25.57	51.14	25.57	25.57	51.14
Sh Cr(500k.1000k)	1K SF	0.47	0.22	0.69	1.61	1.59	3.20	1.93	1.87	3.80
826	EMP	0.21	0.12	0.33	0.81	0.80	1.61	0.91	0.89	1.80
	ACRE	5.83	3.27	9.10	19.92	19.47	39.39	24.87	24.40	49.27
Sh Ctr(>1000k sf)	1K SF	0.47	0.16	0.63	1.17	1.42	2.59	1.59	1.54	3.13
827,828	EMP	0.10	0.03	0.13	0.30	0.34	0.64	0.40	0.32	0.72
	ACRE	3.35	0.92	4.27	9.57	10.93	20.50	12.79	10.33	23.12

Vehicle Trips Per...

EMP	EMPLOYEE	ROOM	HOTEL/MOTEL ROOM
FLT/DY	FLIGHT PER DAY	SEAT	RESTAURANT SEAT
PRKSPC	PARKING SPACE	STDNT	STUDENT
PUMP	GAS(OR DIESEL) PUMP	STN	GAS(OR DIESEL) STATION

TABLE 3 , continued

LAND USE GENERATOR	VEHICLE TRIPS PER DAY TO & FROM LAND USE (Rate/Unit as noted)	STATISTICS					
DESCRIPTION & ITE CODE	# OBS. STD UNITS	OF MEAN	IN MIN	MAX	STD ERROR DEV.	MEAN	SAMPLE
Qual StDwn Rest	SEAT	2.95	1.77	5.50	1.16	0.32	13
831	1K SF	97.27	48.56	139.33	30.81	8.54	13
	EMP	14.53	9.16	29.98	5.93	1.65	13
	ACRE	478.44	223.21	806.32	1201.42	60.73	11
Fast Food Restau	SEAT	22.25	8.88	35.78	8.21	2.28	13
833	1K SF	685.61	284.00	359.50	280.14	77.70	13
	EMP	54.78	28.40	90.63	22.05	6.37	12
	ACRE	2985.22	2772.22	3298.57	268.22	154.86	3
New Car Sales	1K SF	47.52	15.45	79.00	36.15	20.87	3
841	EMP	24.04	10.82	38.55	13.94	8.05	3
	ACRE	385.57	162.25	526.67	1206.84	119.42	3
Service Stations	PUMP	*	*	*	NA	NA	*
844	STN	*	*	*	NA	NA	*
Food Store	1K SF	*	*	*	NA	NA	*
850	ACRE	*	*	*	NA	NA	*
Conv Market	1K SF	756.44	396.00	1438.00	334.23	118.17	8
851	EMP	275.07	158.40	359.50	24.02	67.95	8
	ACRE	289.70	221.33	419.50	74.37	33.26	5
SERVICES(900)							
Walk-in-Bank	1K SF	169.00	NA	NA	NA	NA	1
911	EMP	44.47	NA	NA	NA	NA	1
	ACRE	1056.25	NA	NA	NA	NA	1
Drive-in-Bank	1K SF	291.11	134.67	1520.00	1391.06	117.91	11
912	EMP	79.79	31.85	380.00	101.75	30.68	11
	ACRE	849.30	414.00	1647.50	1545.77	272.88	4
Walk-in Sv & Ln	1K SF	61.00	NA	NA	NA	NA	1
913	EMP	30.50	NA	NA	NA	NA	1
	ACRE	261.42	NA	NA	NA	NA	1
Drive-in Sv & Ln	1K SF	74.17	NA	NA	NA	NA	1
914	EMP	49.44	NA	NA	NA	NA	1
	ACRE	1483.33	NA	NA	NA	NA	1

LEGEND FOR UNITS:

1K SF	1,000 SQ. PT. GFA	CFL/DY	COMMERCIAL FLIGHT PER DAY
ACRE	ACRE	CIVEMP	CIVILIAN EMPLOYEE
BED	HOSPITAL BED	DEFEMP	DEFENSE FORCES EMPLOYEE
BOSBER	BOAT OR SHIP BERTH	DU	DWELLING UNIT

TRIP GENERATION RATES

LAND USE GENERATOR		VEHICLE TRIP RATES IN PEAK HOUR								
		AM			PM			PEAK HOUR OF GENERATOR		
DESCRIPTION & ITE CODE	UNITS	IN	OUT	TOTAL	IN	OUT	TOTAL	IN	OUT	TOTAL
Qual StDwn Rest 831	SEAT	*	*	0.03	0.14	0.06	0.20	0.16	0.11	0.27
	1K SF	*	*	0.94	4.57	1.57	6.14	5.95	4.40	10.35
	EMP	*	*	0.13	0.68	0.26	0.94	0.76	0.72	1.48
	ACRE	*	*	5.08	25.89	9.67	35.56	28.94	26.93	55.87
Fast Food Restau 833	SEAT	0.30	0.25	0.55	0.65	0.55	1.20	1.59	1.65	3.24
	1K SF	8.18	6.82	15.00	21.84	19.28	41.12	58.95	58.27	117.22
	EMP	0.52	0.44	0.96	1.68	1.54	3.22	3.97	4.28	8.25
	ACRE	4.02	3.37	7.39	100.49	89.73	190.22	172.90	189.75	362.65
New Car Sales 841	1K SF	2.12	1.76	3.88	1.26	2.82	4.58	*	*	*
	EMP	1.08	0.90	1.98	0.34	0.69	1.03	*	*	*
	ACRE	16.42	13.58	30.00	15.93	25.50	41.43	22.27	24.09	46.36
Service Stations 844	PUMP	*	*	10.76	*	*	14.36	*	*	17.24
	STN	*	*	74.00	*	*	98.75	*	*	118.50
Food Store 850	1K SF	0.38	0.16	0.54	4.54	4.28	8.82	3.47	3.64	7.11
	ACRE	9.86	4.20	14.06	92.12	86.06	178.18	92.12	86.06	178.18
Conv Market 851	1K SF	32.65	32.29	64.94	25.77	25.09	50.86	32.65	32.29	64.94
	EMP	11.87	11.74	23.61	9.25	9.01	18.26	11.69	12.63	24.32
	ACRE	42.73	42.27	85.00	11.94	11.63	23.57	*	*	*
SERVICES(900)										
Walk-in-Bank 911	1K SF	*	*	4.40	8.34	8.34	16.68	17.01	17.99	35.80
	EMP	*	*	1.16	3.16	3.16	6.32	4.47	4.93	9.40
	ACRE	*	*	27.50	231.67	231.67	963.33	255.00	255.00	510.00
Drive-in-Bank 912	1K SF	3.71	3.23	6.94	15.30	15.85	31.15	20.47	19.75	40.22
	EMP	0.96	0.84	1.80	3.92	4.16	8.08	5.86	5.65	11.47
	ACRE	24.17	2.71	26.88	96.24	104.17	200.41	96.24	104.17	200.41
Walk-in Sv & Ln 913	1K SF	*	*	1.33	*	*	5.33	*	*	9.67
	EMP	*	*	0.67	*	*	2.67	*	*	4.83
	ACRE	*	*	5.71	*	*	22.86	*	*	41.43
Drive-in Sv & Ln 914	1K SF	*	*	1.00	*	*	6.83	*	*	9.67
	EMP	*	*	0.67	*	*	4.56	*	*	6.44
	ACRE	*	*	20.00	*	*	136.67	*	*	193.33

Vehicle Trips Per...

EMP	EMPLOYEE	ROOM	HOTEL/MOTEL ROOM
FLT/DY	FLIGHT PER DAY	SEAT	RESTAURANT SEAT
PRKSPC	PARKING SPACE	STDNT	STUDENT
PUMP	GAS(OR DIESEL) PUMP	STN	GAS(OR DIESEL) STATION

Applicable Uses of Trip Rates

The most common use of trip rates is for site access studies. A site access study describes how traffic generated by either new land use(s) or replacement land use(s) will be served by an existing or future road network (50). The analyses allow for the effect of site generated traffic to be compared with the traffic on the adjacent road network. The site access study is being used more and more as a basis for establishing a developer's share of roadway improvements and therefore trip rates play a critical role in the process.

Many local jurisdictions are using trip rates as the basis for assessments in local transportation improvement districts. The design hour volumes in the vicinity of sites can be forecast using Table 3 trip rates for design of the roadway improvements. Alternative land use scenarios can be tested as part of site access studies, to determine the optimization land density and mix with respect to traffic flow. In some cases, a reverse analysis can be conducted to determine the density and mix of land uses that can be accommodated by a given roadway network (50).

In addition to site access studies, Table 3 can also be used for corridor and sub-area analyses (84). Quick response techniques, both manual and micro-computer, for transportation modelling have been developed that can use peak hour or daily trip rates from Table 3 (6, 83). Some techniques utilize highway networks in the trip distribution/assignment procedure. In these cases the trip rate data for residential uses is converted into trip productions and trip attractions as in the four step Urban Transportation Planning process.

Selection of Trip Rates

The weighted mean daily vehicle trip rates along with the minimum and maximum trip rates measured in the sample are included in Table 3. The weighted mean trip rates are presented for the peak hours (AM, PM and peak hour of generator). The weighted mean trip rates are recommended for use by planners. The standard deviation is provided for a measure of how the individual trip rates in the sample are spread out from the mean, A large standard deviation indicates that the individual trip rates are distant from the mean trip rate. The standard error of mean helps to determine the potential degree of discrepancy between the sample mean and the usually unknown population mean. Deviations from the mean trip rates may be dependent on the values of unknown variables such as the extent of ridesharing, proximity to transit, or parking costs.

The selection of the appropriate time period of analysis is related to the peak generation periods of the subject site and the adjacent street traffic characteristics (5). In general, the time periods selected should result in the maximum impact of the site generated traffic on the adjacent street traffic. In most cases, the trip rates for the AM and PM peak hours of the adjacent street traffic would be utilized for conducting the site access studies and estimating roadway needs. Some sites such as shopping centers have a considerable impact during the PM peak hour of the adjacent street system, but may have an even greater impact during the evening hours or on Saturdays. Therefore, in such cases the generator may have to be analyzed for all three time periods (PM peak hour e.g. 5-6 PM Friday; evening peak hour e.g. 7-8 PM Friday; Saturday peak hour e.g. 1 to 2 PM Saturday) to determine the design requirements and the impact on the adjacent street traffic flow (5).

Selection of Independent Variable

Trip rates for land use generators in Table 3 are presented for more than one independent variable. In each case, the recommended independent variable is listed first. This independent variable is recommended based on the sample size, the general data availability and the correlation between trips and the independent variable.

Selection of the independent variable is critical for determining the total trips generated. Consider for example, an office building while the number of employees is an excellent indicator of trip rates. This information is generally not available. Further more, the number of employees may change over time due to new tenants or change in tenant mix. Therefore, gross building area is listed as the first choice in Table 3. The S.I.T.E. Handbook presents a discussion on the office trip generation rate including the square feet per employee typically found in office buildings. The other independent variable presented in Table 3 is acres. This information is generally available. Due to the variations in floor area ratio or buildable area, correlation between trips and acres is not as good as that between trips and employees or gross building area.

In some cases (generally, in the planning stage), only the parcel size is known. In these cases, common land use densities can be used to determine an estimate of the independent variable with a higher correlation trip rates. For industrial uses, employee densities per acre of land and trip rates per employee may be utilized. For shopping centers and office buildings,

building density can be estimated from parcel size using the Floor Area Ratio, and the trip rate per 1000 gross square feet can be utilized. For residential uses, the applicable zoning code can be used to determine the number of dwelling units per acre of land. Table 4 presents some land use densities (5).

Application of Adjustment Factors

Adjustment factors for residential characteristics (household size, vehicle ownership and density) are presented in Table 3a. The adjustment factors are to be added (or subtracted) from the daily trip rates with dwelling units as the independent variable. Furthermore, any combination of adjustment factors may be applied. If specific residential characteristic data are unavailable, then the mean trip rate should be utilized. The. application of adjustment factors to peak hour trip rates, requires the computation of the ratio of the daily adjusted trip rate to daily mean trip rate. The procedure is illustrated in Table 5.

TABLE 3a
ADJUSTMENT FACTORS FOR RESIDENTIAL CHARACTERISTICS

TABLE 3a
ADJUSTMENT FACTORS FOR RESIDENTIAL CHARACTERISTICS

Land Use Generator Description and ITE Code	Mean Daily Trip Rate Per Dwelling Unit	Adjustment Factors[1]								
		Household Size			Vehicle Ownership			Density (D.U./Acre)		
210. Single Family Detached	10.03	1-2	2-3	>3	0-1	1-2	>2	0-3	3-5	>5
		-3.4	-1.8	0.0	-1.5	0.0	+2.9	0.0	0.0	-0.1
220. Apartments	6.11	1-2	2-3	>3	0-1	1-2	>2	0-15	15-25	>25
		-1.0	+0.9	+2.8	-0.3	+0.2	+1.3	-0.2	0.0	+0.4
230. Condominiums	5.40	1-2	2-3	>3	0-1	1-2	>2	NA	NA	NA
		-0.07	+0.04	+0.15	-1.7	0.0	+3.6			

(1) Adjustment factors to be added (or subtracted) from the mean daily trip rate per dwelling unit.

TABLE 4
TYPICAL LAND-USE DENSITIES

Land Use	Density
110 General Light Industrial	16.4 employees per acre 1.7 employees per T.G.S.F.
120 General Heavy Industrial	7.6 employees per acre 1.6 employees per T.G.S.F.
130 Industrial Park	18.0 employees per acre 2.0 employees per T.G.S.F.
140 Manufacturing	18.5 employees per acre 1.9 employees per T.G.S.F.
150 Warehouse	14.0 employees per acre 1.25 employees per T.G.S.F.
711 General Office, Under 100 T.G.S.F	4.7 employees per T.G.S.F.
712 General Office, 100-199.9 T.G.S.F.	4.2 employees per T.G.S.F.
713 General Officer Over 200 T.G.S.F.	3.1 employees per T.G.S.F.
720 Medical Office Building	3.7 employees per T.G.S.F.
770 High Tech Electronics	40-100 employees per acre
814-828 Retail Center	10-14 T.G.L.S.F. per acre

NOTE: T.G.S.F. = thousand gross square feet;
T.G.L.S.F. = thousand gross leasable square feet.

SOURCE: Reference (5)
Reported with permission from ITE.

TABLE 5
APPLICATION OF ADJUSTMENT FACTORS

PROBLEM:
Determine daily and PM peak hour trip rates per dwelling unit for a proposed single family detached housing development located in a suburban area.

Residential density	= 3.5 d.u./acre
Average household size	= 2.5 persons
Average vehicle ownership per household	= 2.5

SOLUTION:
Mean Daily Trip Rate
Refer to Table 3 for trip rates by land use type
Land use generator "single family detached" (210).
Daily trip rate/d.u. in the suburban area = 10.03

Adjustment Factors for Mean Daily Trip Rate
Refer to Table 3a for adjustment factors due to residential characteristics.

Household Size (2.5)	= 1.8
Vehicle Ownership (2.5)	= + 2.9
Density (3.5 d.u./acre)	= 0.0
Current time adjustment factor	= + 1.1

Adjusted daily trip rate = 10.03 + 1.1 = 11.13 trips/d.u.

PM Peak Hour Trip Rate
Adjustment factor for PM peak hour adjusted daily trip rate for suburban location = 11.13/10.03 = 1.11
mean daily trip rate for suburban location

The AM peak hour trip rates. if desired, should also be factored by this adjustment factor.

Refer to Table 3. Land Use 210. for PM Peak Hour Inbound/Outbound/Total vehicle trip rates.

PM peak hour trip rates/d.u.

In	= 0.64 x 1.11 = 0.71 trips/d.u
Out	= 0.36 x 1.11 = 0.40 trips/d.u.
Total	= 1.00 x 1.11 = 1.11 trips/d.u.

IV. OTHER FACTORS AFFECTING TRIP RATES

The previous chapter presented updated trip rates for a wide range of land uses; including the development and application of adjustment factors for residential use.

In addition to the application of the trip rate process to individual land uses, there are two other conditions which require trip rate adjustments.

- Multi-use developments (MUD) which consist of a complimentary mix of land uses but for which individual land use trip rates cannot be simply added without adjustment.
- Development located along major travel corridors where current pass-by traffic will be 'captured' by the new land use. A straightforward application of Table 3 will make the trips rates too high.

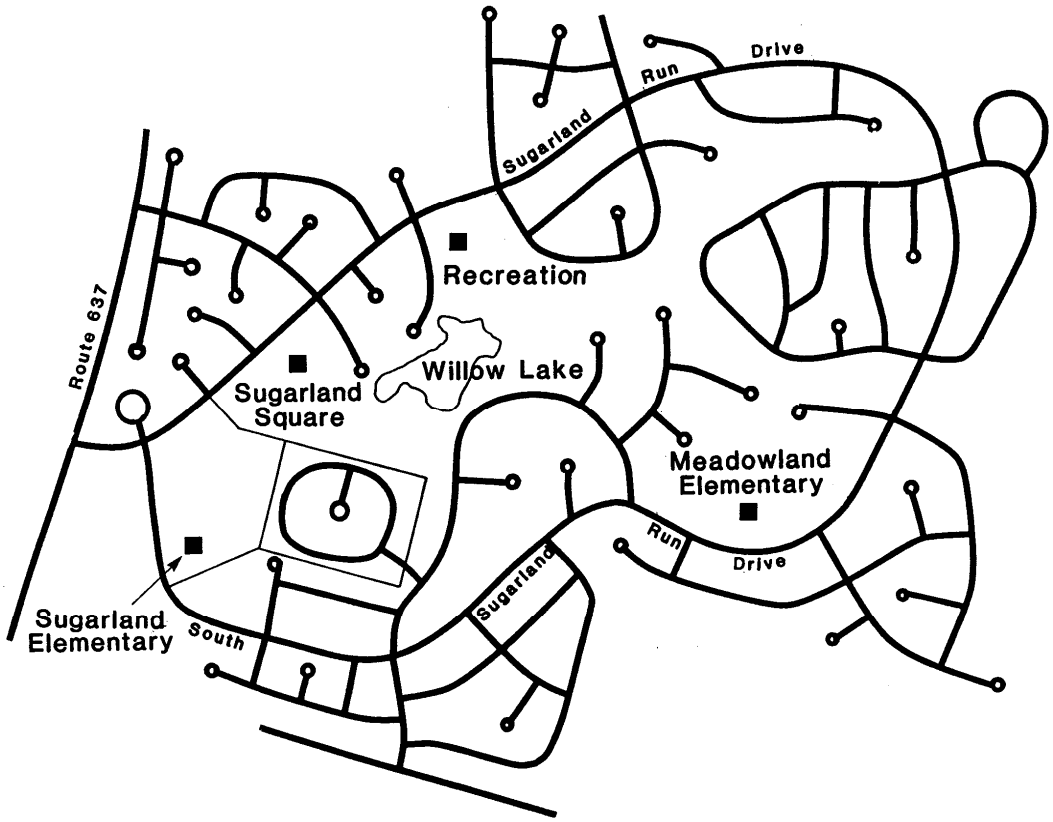
MULTI-USE DEVELOPMENT

A Multi-Use Development (MUD) may be described as a concentration of compatible land uses which are physically integrated by means of internal pedestrian or roadway network system. The multi-use development was initially a concept of private developers who were aware of its market potential. They were also influenced by public planning agencies which became aware of the need to encourage Planned Unit Development (PUD). A PUD is usually defined as a variety of land use types with a predominance of residential development. A PUD by definition is different from a multi-use development (MUD) which consists of more retail and office uses Because MUD/PUD land use components tend to complement each other, it reduces the need for persons to make vehicular trips beyond the development. The composition of a MUD/PUD determines the amount of interaction among its land use components. The trips on the roadway network, external to the development, vary depending on the mix of land uses within the development. Two studies on PUDs have been conducted recently (70,92). Both PUDs were located in suburban areas.

One PUD consisted of a total of 2,330 residential units including 1,138 single family detached units, 1000 townhouses and 192 garden apartments. (See Figure 1). Also included is the PUD were the following land uses:

- two elementary schools
- a middle school
- a day care center

FIGURE 1
NORTHERN VIRGINIA PUD



- 9,000 square feet of retail area with a convenience store, beauty salon, florist, dry cleaner, a restaurant and a bank.
- six pump self-service gas stations fire and rescue station
- community center with a swimming pool

Based on the ground count data for this PUD, it was estimated that approximately 28 percent of the residential trips occur within the development as internal trips. This leaves only 72 percent of the trips generated by the residential units within the PUD impact the external roadway network.

Another study analyzed external trips generated by uses in a PUD (located in Richmond, Virginia) utilizing home interview surveys, roadside origin-destination surveys, ground counts and turning movement counts (70). This PUD, illustrated in Figure 1. contains approximately 2300 occupied dwelling units. A vast majority are single family detached units with some multi-family townhouse type units. There are two primary areas of commercial development. The following land uses are located in the Richmond PUD:

- 85,000 gross square feet of primary commercial center with a grocery store, a drive-in savings and loan, a convenience food mart, a drug store, several small offices and a variety of small-shops
- 16,600 gross square feet of medical center a small computer store
- 63,000 square feet of business park
- recreational facilities including a golf courser tennis courts, swimming facilities and several lakeside recreational facilities

Table 6 presents an estimate of the number of external trips generated by residential and commercial uses in the PUD. The percentage of external trips varies between 30 percent and 65 percent depending on the use and time period considered. The residential uses resulted in 50 percent daily external trips; however, these percentages may vary depending on the quantity of commercial use in the PUD. A development with little or no commercial use may be 10 percent higher, whereas, a development with more commercial use may be 5 percent lower (70). More data are necessary to verify these estimates.

Figure 3 presents relationships between percentage of internal trips and the composition of a PUD based on one study (70). Curve A relates the percentage of internal home-based work trips to a ratio between office area (in gross square feet) and the number of residential units.

FIGURE 2
RICHMOND, VIRGINIA PUD

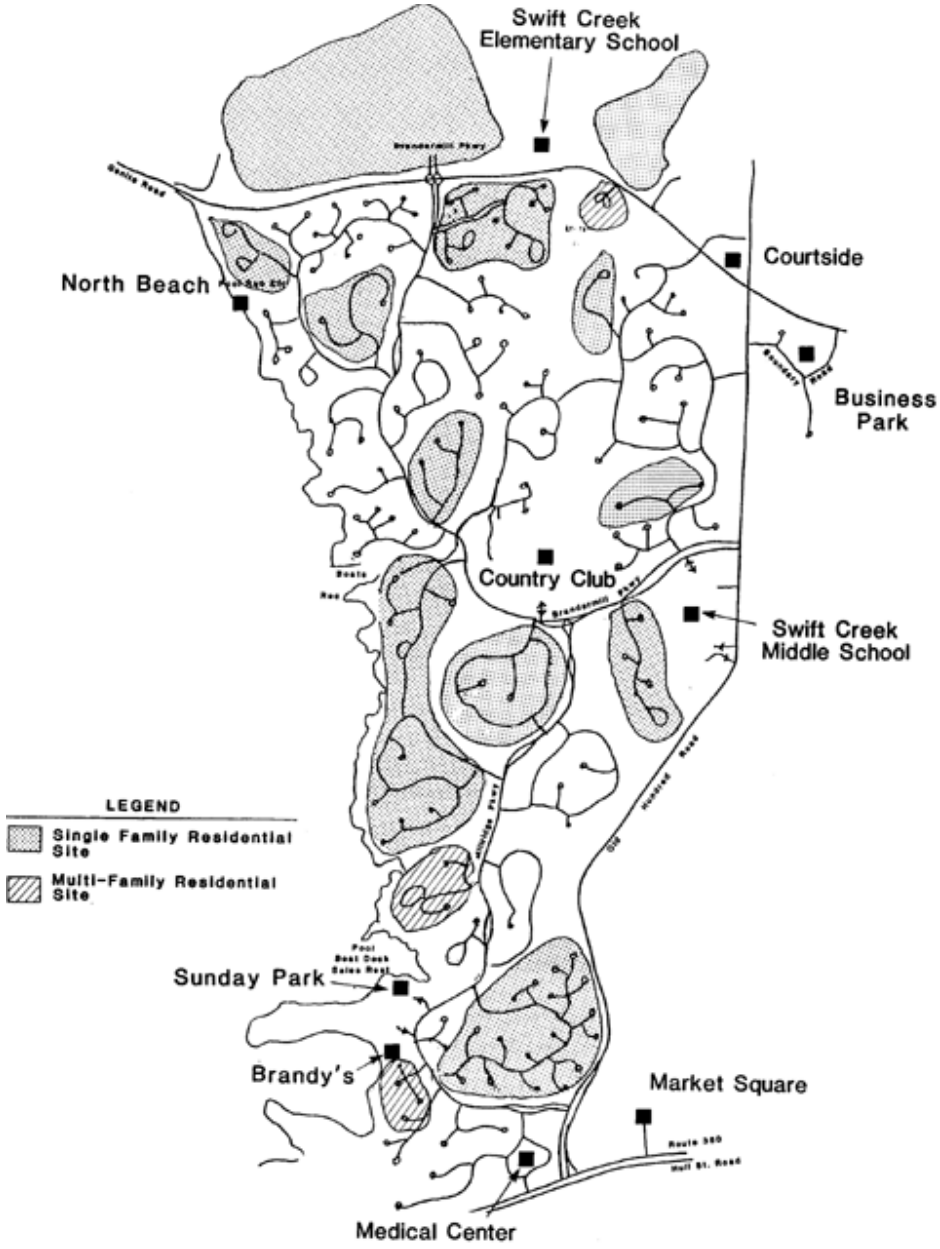


TABLE 6 :
EXTERNAL TRIPS GENERATED BY USES IN A PUD

	INBOUND					OUTBOUND				
	Trip Rate	Units or 1,000 s.f.	No. Trips	% External	No. Ext. Trips	Trip Rate	Units or 1,000 s.f.	No. Trips	% External	No. Ext. Trips
AM Peak Hour[1]										
Residential										
Single F.	.15	2,120	320	35[2]	110	.63	2,120	1,340	65[2]	870
Multi-F.	.10	180	20	35[2]	10	.40	180	70	65[2]	50
Office[3]	.71	80.0	60	50	30	.32	80.0	30	50	10
Shopping Ctr.	1.6	82.6	130	35	50	1.4	82.6	120	45	50
Medical Ofc.	0	14.0	-	-	0	0	14.0	-	-	0
Restaurant	0	4.4	-	-	0	0	4.4	-	-	0
School[6]	.12	2,400	290	50[3]	140	.08	2,400	190	50[3]	100
Total Trips			820	41	340			1,750	62	1,080
PM Peak Hour[1]										
Residential										
Single F.	.61	2,120	1,290	50[2]	650	.37	2,120	780	40[2]	310
Multi-F.	.36	180	60	50[2]	30	.19	180	30	40[2]	10
Office[3]	.55	80.0	40	50	20	1.3	80.0	100	50	50
Shopping Ctr.	3.1	82.6	260	45	120	3.7	82.6	310	35	110
Medical Ofc.	.80	14.0	10	55	5	1.9	14.0	30	45	10
Restaurant	3.4	4.4	15	30	5	2.0	4.4	10	30	5
Total Trip			1,675	50	830			1,260	39	495
Daily			Total 2-Way							
Residential										
Single F.	10.1	2,120	21,400	50[2]	10,700					
Multi-F.	6.5	180	1,170	50[2]	590					
Office[3] [7]	19.5	80.0	1,560	50	780					
Shopping Ctr.	71.0	82.6	5,860	40	2,340					
Medical Ofc.	25.1	14.0	350	65	230					
Restaurant	[4]	4.4	130	30	40					
School[6]	[4]	2,400	3,200	50	1,600					
Total Trips			33,340	48	16,230					

(1) Rates are for street peak hours (7-8 AM and 4-6 PM). Peak hours of generator closely coincide with peak hours of adjacent street traffic.

(2) External percentages for residential development may vary depending on quantity of commercial use in PUD.

(3) Estimated based on student population and trip purpose data from residential survey.

(4) Not available. Number of daily trips was approximated for this use, based on ratio of peak to daily from other sources.

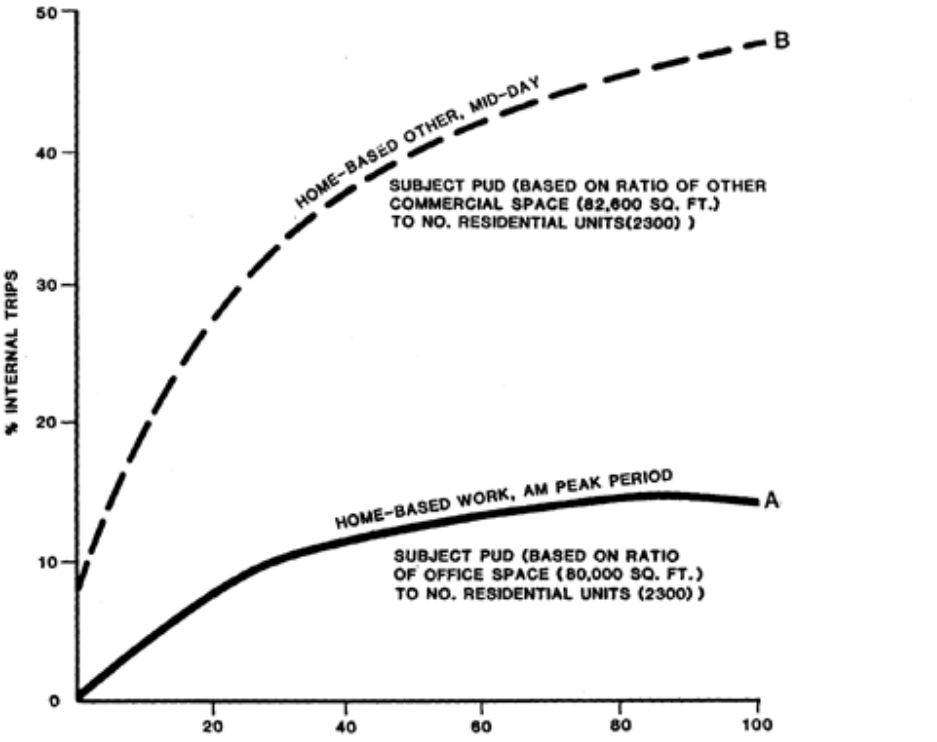
(5) Percent external for office based on employee surveys and does not include visitors.

(6) School trip rate based on no. students.

(7) Daily external % for non-residential uses based on weighted average of midday and peak period results

Source: Reference (70)

FIGURE 3
ILLUSTRATIVE RELATIONSHIP BETWEEN PERCENTAGES OF
INTERNAL TRIPS AND RATIO OF COMMERCIAL SPACE
TO NUMBER OF RESIDENTIAL UNITS



Ratio of Office Square Footage to Number of Residential Units (Sq. Ft./Unit)

Ratio of Commercial Square Footage to Number of Residential Units (Sq. Ft./Unit)

NOTE: Relationships are approximated based on one PUD data. More data necessary before relationships can be widely applied. These relationships should be reasonably applicable to PUDs not exceeding 3000 to 4000 residential units.

SOURCE: Reference (70)

Curve B relates internal home-based non work trips to a ratio of commercial area and the number of residential units. It should be noted that both curves are approximate, but should be generally applicable to PUDs not exceeding 3000 to 4000 residential units.

SITE DEVELOPMENT CAPTURE RATES FOR PASS-BY TRAFFIC

Site access studies generally assume that all trips to the new development are new trips which were not made prior to the development being completed. This is incorrect since a portion of the new trips are already being made to other similar and existing developments. In this case a route diversion occurs.

A second assumption for site access studies is that all of the trips are primary trips being made for a specific purpose; to return directly to their place of origin. Several land use generators such as shopping centers, drive-in (fast food) restaurants, service stations, convenience markets and other support services (banks, etc.), capture trips from the normal traffic passing-by the site. For many of these trips, the stop at the site is a secondary part of a linked trip such as from work to shopping center to home. in all of these cases, the driveway volumes at the site are higher than the actual amount of traffic added to the adjacent street system, since some of the site generated traffic was already counted in the adjacent street traffic. Table 7 presents the limited information available on the capture rates for pass-by traffic. In the case of shopping centers, the trip rates from Table 3 can be reduced by 25 percent (from Table 7) to determine the actual traffic to be added to the adjacent street network: the total driveway volumes as well as the traffic on the internal roadway network should be based on Table 3 rates without any reduction due to capture rates. Information on trips "diverted' from a nearby roadway based on one study are also presented in Table 7. The results in Table 7 should be used cautiously since they are based on a limited number of studies.

Since MUD or PUD developments may include various modes of travel, the user may also wish to refer to the ITE publication 'Using the ITE Trip Generation Report(s)" for methodologies for adjusting trip rates to reflect the use of alternative modes of transportation (5) .

TABLE 7
SITE DEVELOPED CAPTURE RATE FROM PASS-BY TRAFFIC

Land Use	PERCENT OF SITE TRAFFIC		
	Primary Trips [2]	From Pass-by Traffic	Diverted From Another Route [3]
820-828 Shopping Centers	35%	25%	40%
833 Fast Food Restaurant	45%	[1]	[1]
844 Service Station	26% [4]	58%	16% [4]
851 Convenience Market	[1]	45%	[1]

SOURCE: Reference (5), except as noted
Reprinted with permission from ITE.

[1] Not measured
[2] These are trips that were made for a-specific purpose and returned directly to their place of origin.
[3] These are trips in which the stop at the site land use is part of the current sequence of stops. This involves trip chaining of a series of trip times. Furthermore the stop requires a significant route diversion from the route that would be followed otherwise, if this particular stop were not made.
[4] Source: Reference (49)

An extensive literature review and data collection effort was carried out as part of the study. A detailed work plan was developed to analyze the data collected including the development of trip rate adjustment factors for site location availability of transit and vehicle occupancy. However, data on these factors were generally missing from the data base. In some cases where data was available, the sample size was not large enough to conduct statistical tests. Trip rates by location were developed for land uses with adequate samples. For residential uses, trip rate adjustment factors were developed for certain residential characteristics. In order to fill the data gaps, recommendations for further research are presented in Appendix C.

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APPENDIX A
LIST OF AGENCIES CONTACTED

1. Washington Council of Governments,
   Washington, D.C.

2. Southwestern Pennsylvania Regional Planning Commission
   Pittsburgh, Pennsylvania

3. Metropolitan Transportation Commission, San Francisco, California

4. Southeast Michigan Council of Governments, Detroit, Michigan

5. Ohio-Kentucky-Indiana Council of Governments, Cincinnati, Ohio

6. Chicago Area Transportation Study, Chicago, Illinois

7. CALTRANS, California

8. Maryland Department of Transportation

9. Connecticut Department of Transportation

10. Delaware Department of Transportation

11. Arizona Department of Transportation

12. Virginia Department of Highways and Transportation

13. San Diego Association of Governments

14. Virginia Highway and Transportation Research Council

15. Maryland National Capital Park and Planning Commission

16. District of Columbia Department of Public Works

17. Fairfax County, Virginia

18. Prince George's County, Maryland

19. Anne Arundel County., Maryland

20. Baltimore Regional Planning Commission

21. Transportation Research Board

22. Montgomery County, Maryland

23. Delaware Valley Regional Planning Commission

24. Metropolitan Government of Nashville and Davidson County, Tennessee

25. City of Pittsburgh, Pennsylvania

APPENDIX B
TRIP RATE ANALYSIS METHODOLOGY

DATA SOURCES

An extensive literature review was performed to identify relevant trip generation (rate) data. This literature review included direct contacts with state and local agencies, a TRIS computerized reference search, and review of U.S. Department of Transportation and University of Maryland library information. Initially, an extensive list of references pertaining to trip rates was developed. In addition, the TRIS computerized search revealed 497 references. The reference list was then screened for relevancy to this study and a selected number of references were obtained and reviewed. In addition to the library search, a number of state and local agencies responsible for transportation planning were contacted. The agencies contacted are shown in Appendix A. Several of these agencies were able to provide reports or data summaries pertaining to trip generation rates.

The data sources included data from home interview survey's as well as driveway counts collected within the last five years and represent the current socioeconomic conditions and the post 1973 energy crisis travel behavior.' The data sources on driveway counts included land uses such as single family and multi-family residential; high-technology, townhouse and general office buildings; industrial plants; shopping centers of different sizes; hotels; hospitals and clinics; fast food restaurants; and miscellaneous services such as banks, beauty salons, dry cleaners, and printing shops. Some sources include data for peak hours and daily trips, others include data for peak hours or daily trips. In most of the cases,, the location of the site within the Standard Metropolitan Statistical Area (SMSA) was identified. The home interview surveys provide travel data for all members of the household for a given day. For each trip made, travel data collected through home interviews generally include: type of vehicle, trip origin and destination vehicle occupancy, trip purpose and time of trip origin. In addition to the travel data, household data, such as location, number of persons in the household, number of licensed drivers, household income range, number of vehicles and type of housing structure are also collected. In this study, the home interview data was used to study the impact of residential characteristics on trip generation rates.

For residential uses, location data as well as residential characteristics (household size, vehicle ownership and density) data were available for several samples located in the suburban

areas. However, residential characteristics data for other locations (urban and rural) were generally not available. other residential characteristics, such as rent, value of dwelling, and number of workers in the household were generally not available in the ground count data base. These characteristics were available from home interview surveys such as from Detroit and Baltimore. Efforts to correlate ground count data from these cities to the home interview survey were not successful due to lack of ground count data for the matching locations.

METHODOLOGY

Trip rate analyses were also conducted on the following:

1) determining the effects of older data in the ITE data base;
2) residential trip rate analysis as a function of residential characteristics.

Effects of Older Data

Much of the data for the existing trip generation rates including the ITE data base date back to 1960. over the period of twenty years from 1960 to 1980 several changes have occurred that may have changed the vehicle trip rates. In 1973-74 a serious energy crisis occurred. This crisis resulted in severe shortfalls in gasoline as well as significant increases in gasoline prices. During the energy crisis period, the increase in transportation costs and the energy constraints resulted in a reduction in vehicular travel and changes in travel patterns such as increased ridesharing and trip chaining.

The ITE data base, augmented by the data collected in this study, was used to determine the effects of older data. The data base was split into two groups: (1) pre-1973; and (2) post-1973 based on the assumption that the 1973 energy crisis was the major reason for the changes in travel behavior and the associated changes in trip rates. Based on data availability, and the frequency of use of data, the following land uses were analyzed:

- Industrial/manufacturing - general light industrial, heavy industrial, industrial park, manufacturing and warehousing.
- Residential - single family, apartment (low-rise and high-rise) and planned unit developments.
- Hotel
- Hospital
- Offices - general, medical office building, office park and research center.

- Shopping Center - regional, community neighborhood and central area, and quality restaurant.
- Drive-in bank

Trip generation rates (simple arithmetic means) for pre-1973 and post-1973 groups were estimated using the Statistical Package for Social Sciences (SPSS) Version 9. The mean trip rates from the two groups were compared to determine significant .differences using student "T" test and "F" ratios. Analysis of Variance (ANOVA) was used to test significance of differences between group means. If the group means are not significantly different, then the pre-1973 data would be usable under today's conditions. If the test fails - that is, if the means are found to be significantly different, then the pre-1973 data would not represent the current travel behavior.

Table B-1 presents the results of the tests of significant differences between the pre-1973 and post-1973 data for selected land uses. For each land user the number of cases, mean daily trip rate and standard deviation are presented for the pre-1973 and post-1973 conditions. It should be noted that the mean trip rates are simple arithmetic means. The student "T" values, as computed, are presented along with the values from "T" tables for the 5 percent and 1 percent level of significance on the basis of a two-tailed test. It should be noted that for some land uses, sample sizes were not sufficient to perform meaningful T-tests. In all cases? based on the T-tests, it can be concluded that there is not significant difference between the two means at a 1 percent level of significance. On the basis of a two-tailed test at a 5 percent level of significance, the mean trip rates for all land uses, except apartments are not significantly different. For the apartments, since the differences between means are significant at the 5 percent level but not at the 1 percent level, it can be concluded that the means are probably different.

For some land uses, such as industrial parks and hospitals, the mean trip rates for the post-1973 data were intuitively different than the pre-1973 data. In these cases, the F-value was computed and compared with the tabular values for the F-distribution. A 5 percent significance level was selected for comparison with the computed values. If the computed F is larger than the value reported in the F table, the null hypothesis that the means are equal can be rejected. if it is smaller, the null hypothesis cannot be rejected. In all cases analyzed, the computed F value was smaller than the table value. The null hypothesis that the means are equal cannot be rejected. This analysis indicated that the trip rate means between the pre-1973 and post-1973 period were not significantly different.

TABLE B-1
TEST OF SIGNIFICANT DIFFERENCES BETWEEN PRE-1973 AND POST-1973 DATA

ITE Code	Land Use	Pre-1973 No. of cases	Pre-1973 Mean	Pre-1973 Std. Dev.	Post 1973 No. of cases	Post 1973 Mean	Post 1973 Std. Dev.	Degrees of Freedom	Computed 't'	Tables 2-tailed test .05 level (t.975)	Tables 2-tailed test .01 level (t.995)	F - Value Computed	F - Value Table P(F)=0.05
110	General Light Industrial	13	7.62	5.04	5	7.07	2.71	16	.23	2.12	2.92	3.47	
120	General Heavy Industrial	3	1.37	.69	0	NA	NA	NA	NA	NA	NA	NA	
130	Industrial Park	37	8.80	6.55	10	13.26	10.70	45	-1.66	2.005	2.69	2.67	4.06
140	Manufacturing	54	5.96	7.23	1	2.65	.00	53	.45	NA	NA	NA	
150	Warehousing	15	5.38	3.76	0	NA	NA	NA	NA	NA	NA	NA	
210	Single-Family Detached Housing	269	10.32	2.44	43	9.84	1.87	310	1.23	1.96	2.576	1.70	
220	Apartment	107	6.53	2.07	12	5.30	1.42	117	2	1.98	2.61	2.13	
221	Low-Rise Apartment	3	5.21	.461	0	NA	NA	NA	NA	NA	NA	NA	
270	Planned Unit Development (Residential)	0	NA	NA	14	8.37	2.62	NA	NA	NA	NA	NA	
310	Hotel	2	8.61	1.37	5	8.51	1.81	5	.07	2.57	4.03	1.74	5.99
610	Hospital	11	24.65	12.52	7	18.29	9.34	16	1.15	2.12	2.92	--	4.49
710	General Office Building	19	14.4	6.04	21	17.56	5.75	38	-1.69	2.03	2.71	1.10	4.10
720	Medical Office Building	1	42.55	.00	1	38.69	.00	NA	NA	NA	NA	NA	
750	Office Park	3	16.84	11.68	0	NA	NA	NA	NA	NA	NA	NA	
760	Research Center	7	6.05	3.44	1	12.98	.00	6	-1.89	NA	NA	NA	
820-821	Shopping Center Under 100,000 sq.ft.	49	101.20	46.83	25	84.80	37.29	72	1.52	2.0	2.66	1.58	3.99
322-325	Shopping Center 100,000-499,999 Gr. sq.ft.	100	51.82	20.44	44	55.50	26.88	142	- .90	1.96	2.58	1.73	3.84
826	Shopping Center 500,000-999,999	38	34.69	10.47	26	34.91	12.81	62	- .08	2.0	2.56	1.50	
827-828	Shopping Center Over 1,000,00 sq.ft.	8	30.07	13.47	9	30.45	19.20	15	- .05	2.13	2.95	2.03	
831	Quality Restaurant	0	NA	NA	12	95.74	32.48	NA	NA	NA	NA	NA	
912	Drive-In Bank	0	NA	NA	11	393.74	391.06	NA	NA	NA	NA	NA	

NOTE: NA - Not Applicable

TABLE B-2
TEST OF SIGNIFICANT DIFFERENCES BY LOCATION BETWEEN PRE-1973
AND POST-1973 DATA

ITE Code	Land Use	Location	Pre-1973			Post 1973			Degrees of Freedom	Computed	Tables 2-tailed test		F - Value	
			No. of cases	Mean	Std. Dev.	No. of cases	Mean	Std. Dev.		Computed 't'	.05 level (t.975)	.01 level (t.995)	Computed	Table F(f)=0.05
110	General Light Industrial	Suburban Non CBD	9	7.86	5.01	4	3.19	3.72	11	1.55	2.20	3.11	1.81	6.04
		Interchange	1	5.79	NA	3	7.53	3.66	2	0.34	4.30	9.93		
210	Single Family Detached Housing	Urban Non CBD	32	11.58	1.99	2	10.55	.80	32	0.71	2.04	2.74		
		Suburban Non CBD	242	9.44	3.44	34	8.56	3.61	274	1.33	1.96	2.58		
		Suburban CBD	1	8.10	NA	1	10.76	NA	NA	NA	NA	NA		
		Rural	9	10.47	1.75	5	8.95	2.67	12	1.19	2.18	3.06		
220	Apartment	Urban Non CBD	10	7.75	1.50	1	2.00	NA	9	3.46	NA	NA		
		Suburban Non CBD	109	5.49	2.99	10	5.56	1.05	117	0.01	1.98	2.62		
710	General Office Building	Suburban Non CBD	12	10.75	9.33	17	9.09	9.11	27	0.46	2.05	2.77		
820-821	Shopping Center Under 100,000 sq. ft.	Suburban Non CBD	15	81.75	57.32	17	72.13	52.78	30	0.48	2.04	2.75	1.18	2.37
610	Hospital	Suburban Non CBD	5	13.19	14.02	8	9.02	11.98	11	0.53	2.20	3.106	1.37	4.12
831	Quality Restaurant	Suburban Non CBD	0	NA	NA	4	91.03	26.58	3	-2.63	NA	NA		
827-828	Shopping Center Over 1,000,000 sq. ft.	Suburban Non CBD	1	11.93	NA	8	30.99	20.45	7	-0.82	NA	NA		
826	Shopping Center 500,000-999,999 sq. ft.	Suburban Non CBD	1	33.49	NA	24	30.48	17.25	23	0.17	NA	NA		
822	100,000-499,999 sq. ft.	Suburban Non CBD	19	29.10	31.25	25	49.13	32.36	42	-2.02	2.02	2.70		
760	Research Center	Suburban Non CBD	2	6.77	3.54	5	2.60	5.81	5	0.08	2.57	4.03		

NOTE: NA - Not Applicable

Further tests were conducted for some land uses to verify the differences between the means based on location of the land use within an SMSA. The results are presented in Table B-2 in a similar format as Table B-1. T-tests and F-tests were conducted for each of the land uses listed. The results showed that the mean trip rates for the pre-1973 and post-1973 time periods were not significantly different by location within an SMSA.

These analyses showed that the mean-trip rates for the older data (pre-1973) were not significantly different than the newer data (post-1973). Therefore, it was decided to include the pre 1973 data in the updating of the trip generation rates.

Residential Analysis

The impact of residential characteristics on trip generation rates was estimated using the updated ITE data base, as well as the home interview survey data. The ITE data base includes residential characteristics such as household size, household income, residential density, vehicle ownership and location. A cross-classification analysis of the variables was carried out to determine the sample sizes in each cell. This analysis found that an insufficient number of observations existed to study the income data, as well as all locations other than suburban areas. Accordingly, a multiple regression analysis was conducted with daily vehicle trips per dwelling unit as the dependent variable and household size, vehicle ownership and residential density as the independent variables. Three residential land uses were analyzed: single family detached, apartments and condominiums. The results of the analyses are presented in Table B-3, along with associated statistics. As noted in the table, the correlation coefficients are greater than 0.9 in all cases. These regression relationships were utilized in developing trip rate adjustment factors for the three residential land uses.

In addition to the regression analysis, cross-classification of trip rate data from other sources was carried out. The Arizona Department of Transportation conducted a study on the value of dwellings as a residential characteristic of trip rates (2). The trip rate summary for three areas in the U.S. (Delaware, Wisconsin and Ohio) are presented in Table B-4. The weighted average trip rate for low value single family dwelling (less than $250,000 in 1976 dollars) is 9.96. The trip rates increase as the market value of the dwelling increases (11.09 for market values between $25,000 and $50,000 and 14.72 for market value over $50,000). A two-tailed T-test test indicated that the means were significantly different at the 5 percent level of significance.

TABLE B-3
MULTIPLE REGRESSION ANALYSIS
STATISTICS FOR RESIDENTIAL USES

SINGLE FAMILY RESIDENTIAL DETACHED

Multiple R	.98087	Analysis of Variance			
R Square	.96210		DF	Sum of Squares	Mean Square
Adjusted R Square	.96027	Regression	3	5577.62697	1859.20899
Standard Error	1.88251	Residual	62	219.71817	3.54384

F = 524.63098 Signif F = .0000

VARIABLES IN THE EQUATION

Dependent Variable - Trip Rate Per Dwelling Unit

Variable	B	SE B	BETA	T	SIG T
Household Size	1.55	.35206	.55420	4.043	.0001
Vehicle Ownership	2.93	.81953	.43579	3.333	.0015
Density	-0.14	.08642	-.00600	-.149	.8820

APARTMENTS

Multiple R	.96831	Analysis of Variance			
R Square	.93762		DF	Sum of Squares	Mean Square
Adjusted R Square	.93337	Regression	3	1929.41209	643.13736
Standard Error	1.70797	Residual	44	128.35441	2.91715

F = 220.46803 Signif F = .0000

VARIABLES IN THE EQUATION

Dependent Variable - Trip Rate Per Dwelling Unit

Variable	B	SE B	BETA	T	SIG T
Household Size	1.93	.68199	.64271	2.959	.0050
Density	0.03	.02292	.09882	1.207	.2339
Vehicle Ownership	1.10	1.16138	.24229	.991	.3269

CONDOMINIUMS

Multiple R	.96166	Analysis of Variance			
R. Square	.92478		DF	Sum of Squares	Mean Square
Adjusted R Square	.91762	Regression	2	848.74140	424.37070
Standard Error	1.81308	Residual	21	69.03272	3.28727

F = 129.09509 Signif F = .0000

VARIABLES IN THE EQUATION
Dependent Variable - Trip Rate Per Dwelling Unit

Variable	B	SE B	BETA	T	SIG T
Household size	3.86	.68371	.92105	5.643	.0000
Vehicle ownership	0.13	.47232	.04350	.267	.7924

TABLE B-4
TRIP RATES AS A FUNCTION OF MARKET VALUES
OF SINGLE FAMILY DETACHED
RESIDENTIAL DWELLINGS

	Low Value(1) (Mkt. Value < $25,000)		Medium Value(1) (Mkt. Value between, $25,000 & $50,000)		High Value (Mkt. Value > $50,000)	
	Trip Rate	No. of Dwellings	Trip Rate	No. of Dwellings	Trip Rate	No. of Dwellings
Delaware DOT	10.9	1700	11.6	770	13.8	304
Wisconsin DOT	8.5	1148	11.3	1198	16.0	256
Ohio Section ITE	10.1	506	10.2	715	14.3	12
Weighted Average	9.96	3354	11.09	2683	14.72	6,112
Computed Mean Trip Rate	9.96		11.09		14.72	
Standard Deviation	2.15		2.31		3.05	
No. of Studies	29		39		8	

(1) In 1976 dollars

The ITE data base does not include "value of dwelling unit". Therefore, a direct correlation between the data presented in Table B-4 and the ITE data base cannot be made. However, the trip rates can be used for correlating the two sources. The ITE data base correlates well with the low market value database. This would result in adjustment factors of 1.10 and 1.50 for medium value and high value dwelling units to be applied to the Table 3 trip rates of 10.03 trips per dwelling unit. It should be noted that the market values of dwelling units vary for locations within the region as well as by geographic areas of the country. Therefore, this adjustment factor should be applied based on low, medium and high values for the particular region rather than the dollar value.

Home interview trip rate survey data from Detroit, Baltimore and California were categorized by variables such as household size, vehicle ownership, location, and income (12, 31, 79). In the case of Detroit and Baltimore, no comparable data from the augmented ITE data file could be found to correlate the home interview surveys with the driveway counts. Trip rates based on driveway or ground counts data are more applicable to site specific studies including determination of roadway/intersection improvement needs. For regional or areawide studies, trip rates based on home interview (origin-destination) surveys are more applicable. The California DOT survey included summaries of vehicle trip rates by household size as well as vehicle ownership for single family and multi-family dwelling units. T-tests were conducted to determine the significance of difference of mean trip rates as a function of household size. The mean trip rates by household size were found to be significantly different for single family dwelling units but not for multifamily dwelling units.

APPENDIX C
RECOMMENDATIONS FOR FURTHER RESEARCH

The ITE Permanent Trip Generation Committee (6A-32) has collected extensive trip data since 1972. In those cases where the sources of data are known? it is recommended that the Committee request the sources to provide data on trip location of the sites within the SMSA. In addition new data collection efforts are recommended, primarily in urban areas, to develop trip rates by location for the appropriate land uses in Table 3. Another area needing additional ground counts relates to the residential uses in Baltimore and Detroit. As discussed in Appendix B, home interview data from these two sources are available, however, adequate ground count data are not available for correlation of the two sources.

The potential impact of new multi-use developments and planned unit developments on the adjacent roadway network was previously discussed on the basis of only two studies (70, 92). More research is needed in this area to validate/refine the study results. Information on capture rate of pass-by traffic is also very weak. More research is needed to identify the percentage of trips captured by a site from passing traffic as well as the traffic diverted from another route to the new development. The research on multi-use centers and capture rates from pass-by traffic would require origin-destination survey questionnaires of patrons visiting the potential site uses (shopping centers, restaurants banks, service stations, convenience markets and multi-use centers).

Certain land uses such as shopping centers, restaurants and banks exhibit significant daily and seasonal variations in trip rates. For many of these uses Friday trips are greater than the average weekday trips. Shopping centers exhibit seasonal peaks with January/February the lower seasonal months and November/December the peak seasonal months. In some cases, Fridays or seasonal trip rates should be used as the design or analysis period rather than the average weekday. More research is needed to develop this information.

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