SPECIAL TRAFFIC GENERATOR STUDY

1973-1975

BY THE

STATE DEPARTMENT OF HIGHWAYS
AND PUBLIC TRANSPORTATION

TRANSPORTATION PLANNING DIVISION

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SPECIAL TRAFFIC GENERATOR STUDY

INTRODUCTION

The Transportation Planning Division of the Texas State Department of Highways and Public Transportation has recently completed the preliminary analysis of an extensive traffic generation study undertaken from September of 1973 through May of 1975. Travel data from 318 individual generators, classified by urban area[1], relative density, and generator type (including residential, commercial, industrial and others) provides the basis for the results of this analysis.

Although the original intent of the special generator study was basically to quantify trip rates for various types of generators, it became increasingly evident during preliminary data analysis that the extreme diversity of generated trips would preclude any simple rate structure. Consequently, several sections of this report are devoted to the examination of the interrelationship of travel variables which affect trip generation.

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[1]All traffic generators sampled were within twenty urban areas exceeding population of 50,000 in the State of Texas.

Special Generator Study Objectives

Previous research relating to the accuracy of trip end estimates obtained from traditional home interview (disaggregate) surveys has demonstrated that an extremely large variance of estimates may be expected when using traditional sampling rates to estimate either the mean trips per dwelling for a zone or the zonal trip ends. Interpreting these variances in terms of expected statistical error ranges at the 80 and 90 percent probability levels demonstrates the disturbingly large magnitude of these expected error ranges.[2]

Based largely on the findings of this type of research, the Transportation Planning Division has discontinued using the traditional home interview surveys and has begun to employ special surveys specifically directed at monitoring trip generation trends, updating urban travel parameters, and investigating areas which exhibit unique or unusual trip generation characteristics. With this intent, the special traffic generator study is an attempt to quantify trip production and trip attraction rates for many diverse traffic generators in order to provide specific person trip, auto-driver trip, and commercial vehicle trip generation for various residential, commercial, industrial, educational, cultural, and special traffic generators within each study area in Texas.

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[2]Texas Transportation Institute, Texas Highway Department, Accuracy of Trip End Estimates From The Home Interview Survey, 167-7, August, 1973.

Detailed examination of this extensive array of urban travel data, has subsequently provided the means to adjust outdated (Pre 1970 Origin-Destination Survey) trip generation data prior to the level review updates for each urban study area. Specifically, this information establishes a basis to;(1) reconcile trip production and attraction rates to reflect current travel characteristics in each urban area for 1975 planning reviews; (2) estimate travel volumes generated by a specific land use and the resulting impact upon nearby existing or planned facilities; and (3) quantify the trips generated by unique (one of a kind) traffic generators.

Special Generator Selection And Analysis

A total of 318 traffic generators from twenty urban areas in Texas were selected for trip generation analysis. Numerous residential, commercial retail/services, commercial banking, commercial office, commercial airport, medical, recreational, educational, government military, and government post offices sites, representing a diverse multi-density stratified sample were investigated for their trip generating properties. A summary of the specific number and types of generators selected and monitored is indicated below:

Generator Description	Quantity Selected
Residential	100
Commercial (Retail/Services)	66
Industrial	86
Medical (Hospital/Clinic)	16
Schools	19
Airports	12
Business Offices	3
Others	16
TOTAL	318

Meticulous preparations were necessary to locate, select, research and monitor appropriate traffic generators that would provide accurate, homogenous generation data, unbiased by through traffic and undiluted by disassociated activities. Further considerations dictated by limited manpower and/or fiscal limitations included the selection of generators based on the applicability of mechanical, rather than manual counting techniques. However, a few generators which exhibited desirable characteristics were manually counted despite of the difficulty and expense involved.

The procedural methodology and associated considerations relating to the actual selection and analysis of traffic generators are summarized as follows:

1. Generator Site Location - Preliminary information concerning the location and nature of major generators was provided by the local urban transportation study office. After initial feasibility checks and scouting (by light plane or helicopter where possible) each generator site was carefully examined for all traffic access points and sketched for further analysis.
2. Generator Selection - Basic selection criteria were predicated on the overall desirability and countability of the generator measured in terms of; (1) the degree of contribution towards obtaining a diversified, well stratified sample from each urban area; (2) the applicability of hourly count or cumulative count machines

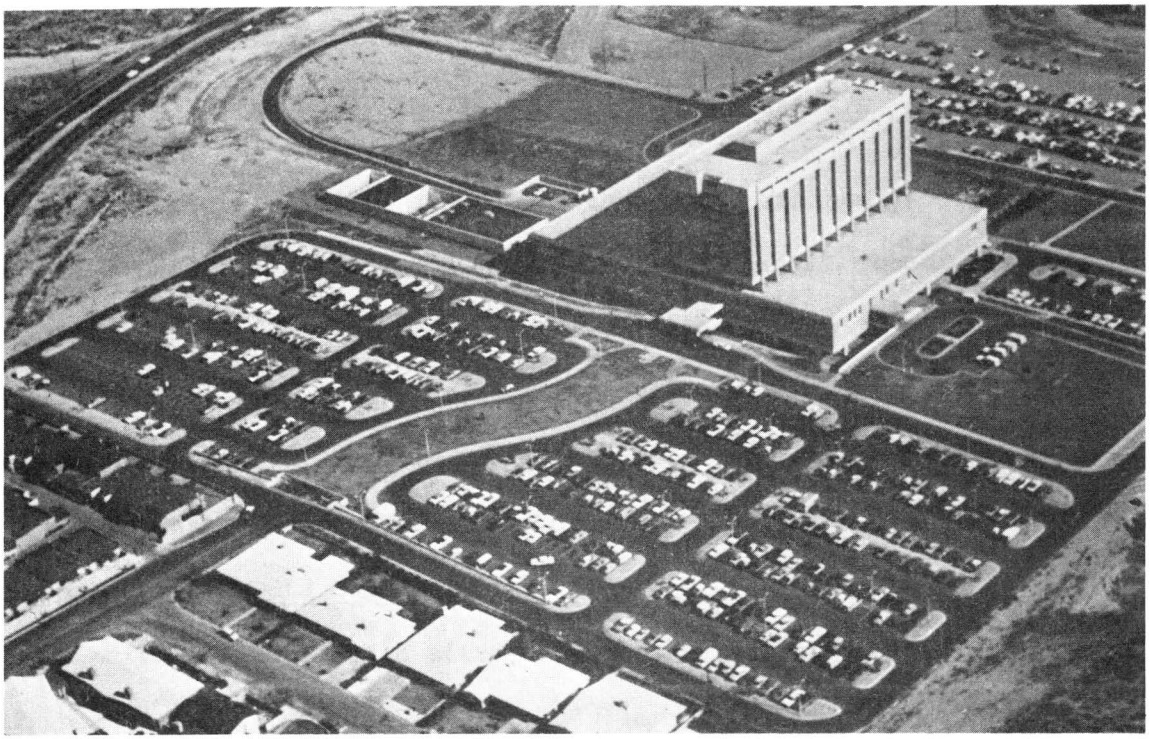
to facilitate 24-hour counts; and (3) the alleviation of ubiquitous traffic count dilution resulting from the presence of incongruous land use; through traffic flow (not generated at the site), and extraneous construction traffic.

3. Travel Variable Research - Travel variables associated with each type of generator were examined for their quantitative impact upon trip generation. The variables, including various characteristics such as dwelling unit density, vacancy rates, family income, employment, school enrollment, airline flights, hospital capacity, etc. were obtained through on-site surveys. Sample survey forms for generator variables are shown in Appendix A.

   Because their significance varies by generator type, appropriate variables are studied in greater detail by each generator section.

4. Generator Monitoring - Actual counting of the vehicle and person traffic produced by or attracted to each generator was conducted during the normal hours of operation at each site. Manual, as well as machine counts (when feasible) of peak and off-peak vehicle trips (with corresponding occupancy)

for passenger cars, commercial vehicles, buses, bicycles and motorcycles were made. In order to insure the proper placement of manual recorders and machines, a diagram of each generator was constructed from aerial photographs or on-site sketches. A typical example appears in Figure 1. Additional samples of counting forms and 24-hour tabulation are shown in Appendix B.



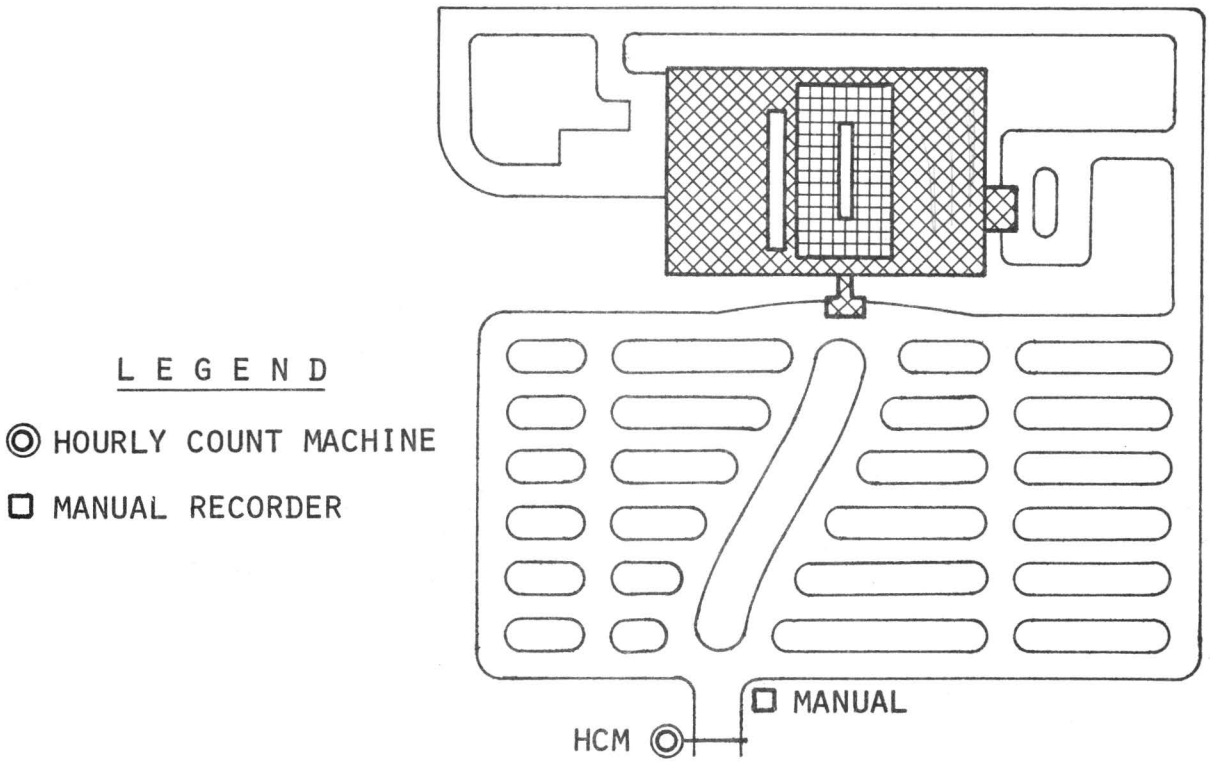


FIGURE 1: TYPICAL SPECIAL GENERATOR COUNT DIAGRAM

RESIDENTIAL TRAFFIC GENERATION ANALYSIS

Of 318 special traffic generators that were examined, 100 were residential areas. These included 68 single family neighborhoods (12,836 dwellings), 14 mobile home parks (1,444 dwellings), and 18 multi-family complexes (3,801 dwellings). None of the areas selected included those with mixed residential land use or with a significant amount of construction in progress.

Basic Residential Data Collection

As noted earlier, while attempting to select sites without through traffic dilution, some bias was probably introduced into the sample because the areas were necessarily isolated. This was particularly true of the single family residential areas selected because they were characteristically part of new subdivisions.

Although no individual interviews were conducted in conjunction with the examination of the traffic generated at each single family, mobile home, or multi-family residential site, some supplemental information (in addition to actual traffic and dwelling unit counts) was gathered. Specifically, for those areas examined that were included in the 1970 U.S. Census Block Data reports, family income data, average D.U. value and family size were aggregated by residential site. Average family income was estimated (based on a subjective analysis of observed D.U.value) for those areas that were not included in the 1970 census data.

Generation Rate Development

The development of simple vehicle and person trip rates (per dwelling unit) generated by each of the residential sites[3] selected from 19 urban areas is reflected in Table 1. Travel data summarized for individual residential generation sites includes location, density type, relative location (urban, suburban, or rural) as well as trip data for autos, commercial vehicles, buses, other modes and pedestrians. Auto and pickup (P.U.) driver trips are combined due to the extensive use of this type of vehicle as a second (or third) car. Other mode trips refers primarily to bicycle and motorcycle trips. Bus and bus passenger trips indicated in Table 1 are only those that were actually counted during the manual count periods and as such may be of questionable validity.

The type of information presented in Table 1 (beginning on page 12) can be most effectively utilized by the transportation analyst who is familiar enough with those residential areas counted to apply the trip data to analagous residential areas. However, without this first hand knowledge, it is still possible to develop simple generation rates which can be used to estimate the impact of new residential development upon transportation facilities.

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[3]Although the confidentiality of trip generation data collected from private businesses is guaranteed, it is not necessary to restrict the release of aggregated residential information.

One very elementary development of the residential trip rates is indicated in Table 2. In the absence of more detailed information such as average family income or family size, this summary could be used to reasonably estimate the number of trips that a proposed residential subdivision would generate.

Residential Trip Generation

Average Trips Per D.U.
(Table 2)

Housing Type	Areas Counted	Dwelling Units	Veh. Trips Per D.U.	Std. Dev.	Person Trips Per D.U.	Std. Dev.
Single Family	64	11,916	10.4	3.0	16.8	5.3
Urban	33	4,839	12.7	2.4	20.3	4.8
Suburban	21	5,000	9.4	2.1	14.7	3.5
Rural	10	2,077	7.6	2.5	13.0	5.2
Resort	4	920	5.4	0.6	7.8	1.1
Multi-Family	18	3,801	6.5	1.6	8.8	3.2
Mobile Home Parks	14	1,444	7.5	2.8	12.0	5.1

It can be noted that the trip rates for the "Resort" areas is significantly lower than for other classes of residential development. This is caused by the relatively high vacancy rates that are found on any week day during the school year. No detailed study of housing occupancy was conducted at the time the counts were made.

Vehicle and person trip generations (from Table 1) for single family residential areas, mobile home parks, and multi-family units are graphically represented in Figures 2, 3 and 4 by scatter diagram. Each indicates

RESIDENTIAL TRIP GENERATION

Vehicle And Person Trip Rates By Location And Density

Table 1

Residential Sites By Urban Area And Dwelling Unit Type	City Or Community Location	U-Urban S-Sub. R-Rural	No. Of Occ. D.U.'s	VEHICLE TRIPS					
				Auto And P.U. Driver Trips		Commercial Truck Trips		Bus Trips	Other Mode Trips
				Trips	Trips/D.U.	Trips	Trips/D.U.		
Midland-Odessa									
Single Family D.U.'s									
Hillmont	Odessa	R	81	642	7.9	44	.543	24	0
Atwood & Hammett	Odessa	R	77	576	7.5	32	.415	16	12
Multi-Family D.U.'s									
Thornwood Apts.	Midland	U	109	626	5.7	30	.275	0	32
Golden Crest Apts.	Odessa	U	116	730	6.3	4	.035	0	0
Airline Mobile D.U.'s	Odessa	R	146	842	5.8	14	.096	8	4
SABCUTS									
Single Family D.U.'s									
Indian Creek	San Antonio	R	810	4842	6.0	372	.459	8	588
East Houston	San Antonio	U	77	868	11.3	28	.364	0	16
Pearsall	San Antonio	R	428	2364	5.5	84	.196	12	134
Babcock	San Antonio	U	79	894	11.3	12	.152	8	20
Wurzback	San Antonio	U	213	2120	10.0	160	.751	6	88
Nacogdoches	San Antonio	U	114	1164	10.2	54	.474	10	32
Multi-Family D.U.'s									
Goliad Apts.	San Antonio	U	101	754	7.4	18	.178	4	24
El Paso									
Single Family D.U.'s									
Delta	El Paso	U	324	4394	13.6	26	.080	0	360
Palomino	El Paso	S	166	1186	7.1	6	.036	12	22
East Ridge	El Paso	U	98	1558	15.9	32	.326	0	24
Multi-Family D.U.'s									
Hill/Kinghill Apts.	El Paso	U	333	1920	5.7	34	.102	0	16
Waco									
Single Family D.U.'s									
Bolling	Bellmead	S	345	3344	9.7	136	.394	0	360
Orchard	Waco	S	276	2536	9.2	54	.196	0	150
Wooded Acres	Waco	U	60	862	14.4	36	.600	0	70
Hillcrest	Waco	U	71	940	13.2	32	.451	0	32
Bryan-College Station									
Single Family D.U.'s									
Wellington	Bryan	U	199	2536	12.7	46	.231	0	0
Munson	College Sta.	U	237	1928	8.1	16	.068	0	214
Tyler									
Single Family D.U.'s									
Ponderosa	Tyler	S	29	236	8.1	0	.000	0	0
Multi-Family D.U.'s									
Sherwood Forest Apts.	Tyler	S	129	1282	9.9	20	.155	0	28
Village East Apts.	Tyler	S	152	1212	8.0	4	.026	4	10
Rustic Mobile D.U.'s	Tyler	U	79	744	9.4	8	.101	8	8

RESIDENTIAL TRIP GENERATION

Vehicle And Person Trip Rates By Location And Density

Table 1

Total Vehicle Trips		Auto Occ.	PERSON TRIPS							
			Auto and P.U. Driver and Passenger Trips		Comm. Tr. Driver & Pass. Trips	Bus Pass.	Other Mode Trips	Pedes-trian	Total Person Trips	
Trips	Trips/D.U.		Trips	Trips/D.U.					Trips	Trips/D.U.
710	8.8	2.0	1298	16.0	60	360	0	0	1718	21.2
636	8.3	1.7	986	12.8	48	304	12	0	1350	17.5
688	6.3	1.4	904	8.3	42	0	32	0	978	9.0
734	6.3	1.2	898	7.7	8	0	0	0	906	7.8
868	5.9	1.5	1250	8.6	14	192	4	0	1460	10.0
5810	7.2	1.4	6980	8.6	566	196	588	924	9254	11.4
912	11.8	1.6	1390	18.1	28	0	16	92	1526	19.8
2594	6.1	1.4	3326	7.8	84	180	134	112	3836	9.0
934	11.8	1.6	1444	18.3	12	180	20	2	1658	21.0
2374	11.1	1.6	3346	15.7	170	130	88	90	3824	18.0
1260	11.1	1.8	2040	17.9	70	94	32	4	2240	19.6
800	7.9	1.7	1282	12.7	26	42	24	24	1398	13.8
4528	14.0	1.7	7546	23.3	26	0	108	620	8300	25.6
1226	7.4	1.6	1894	11.4	6	102	22	0	2024	12.2
1614	16.5	1.5	2382	24.3	80	0	24	40	2526	25.8
1970	5.9	1.3	2514	7.5	46	0	16	0	2576	7.7
3840	11.1	1.6	5338	15.5	222	0	360	352	6272	18.2
2740	9.9	1.6	4024	14.6	78	0	150	26	4278	15.5
968	16.1	1.4	1240	20.7	40	0	70	0	1350	22.5
1004	14.1	1.6	1502	21.2	42	0	32	0	1576	22.2
2582	13.0	1.8	4508	22.7	46	0	0	354	4908	24.7
2158	9.1	1.5	2928	12.4	16	0	214	18	3176	13.4
236	8.1	1.5	364	12.6	0	0	0	0	364	12.6
1330	10.3	1.4	1768	13.7	20	0	28	6	1822	14.1
1230	8.1	1.6	1954	12.9	8	34	10	4	2010	13.2
768	9.7	1.5	1100	13.9	8	52	8	0	1168	14.8

RESIDENTIAL TRIP GENERATION

Vehicle And Person Trip Rates By Location And Density

Table 1 Continued

Residential Sites By Urban Area And Dwelling Unit Type	City Or Community Location	U-Urban S-Sub. R-Rural	No. of Occ. D.U.'s	VEHICLE TRIPS					
				Auto And P.U. Driver Trips		Commercial Truck Trips		Bus Trips	Other Mode Trips
				Trips	Trips/D.U.	Trips	Trips/D.U.		
Sherman-Denison									
Single Family D.U.'s									
Cuffs	Denison	U	63	704	11.2	0	.000	0	8
Main	Denison	U	516	4524	8.8	266	.516	6	8
Constitution	Sherman	S	112	1052	9.4	22	.196	0	10
Hidden Valley	Sherman	U	78	892	11.4	0	.000	8	0
Multi-Family D.U.'s									
Camelot Apts.	Sherman	U	76	590	7.8	6	.079	4	0
Butterfield Mobile D.U.'s	Sherman	R	25	310	12.4	40	1.600	4	6
Amarillo									
Single Family D.U.'s									
Western/Cherry	Amarillo	R	237	2052	8.7	96	.405	0	202
Village Mobile D.U.'s	Amarillo	U	86	650	7.6	14	.163	0	16
Lubbock									
Single Family D.U.'s									
Quirt/2nd	Lubbock	U	44	692	15.7	12	.273	0	30
Camelot Mobile D.U.'s	Lubbock	S	220	1854	8.4	32	.145	4	20
Killeen-Temple									
Single Family D.U.'s									
Fowler	Temple	U	47	682	14.5	6	.128	0	28
Thirty-Forth	Temple	U	61	774	12.7	36	.590	0	248
Avenue B	Belton	U	21	346	16.5	0	.000	0	70
Upshaw	Temple	U	117	1664	14.2	10	.086	0	0
Forest	Belton	U	94	1248	13.3	0	.000	0	0
Janis	Killeen	U	86	1002	11.7	32	.372	8	30
Big Valley	Copperas	R	34	424	12.5	4	.117	12	16
Hickory	Temple	S	233	2920	12.5	0	.000	0	0
Multi-Family D.U.'s									
Granada Apts.	Temple	U	116	822	7.1	0	.000	0	0
Brookside Apts.	Killeen	U	100	802	8.0	56	.560	0	0
Century Plaza	Killeen	U	250	1692	6.8	0	.000	0	48
Rural/Resort D.U.'s									
Woodland Resort	Lake Belton	R	78	358	4.6	16	.205	0	6
Mack's Mobile D.U.'s	Nolanville	R	55	340	6.2	14	.254	0	16
Twin Oaks Mobile D.U.'s	Nolanville	R	36	242	6.7	0	.000	0	16
Chapparal Mobile D.U.'s	Killeen	R	155	1542	9.9	28	.181	0	136

RESIDENTIAL TRIP GENERATION

Vehicle And Person Trip Rates By Location And Density

Table 1 Continued

Total Vehicle Trips		Auto Occ.	PERSON TRIPS							
			Auto and P.U. Driver and Passenger Trips		Comm. Tr. Driver & Pass. Trips	Bus Pass.	Other Mode Trips	Pedes-trians	Total Person Trips	
Trips	Trips/D.U.		Trips	Trips/D.U.					Trips	Trips/D.U.
712	11.3	1.6	1110	17.6	0	0	8	0	1118	17.7
4804	9.3	1.5	6730	13.0	346	66	8	54	7204	14.0
1084	9.7	1.4	1468	13.1	32	0	10	8	1518	13.6
900	11.5	1.4	1224	15.7	0	162	0	0	1386	17.8
600	7.9	1.4	804	10.6	6	36	0	6	852	11.2
360	14.4	1.7	532	21.3	78	34	6	0	650	26.0
2350	9.9	1.7	3548	15.0	120	0	202	574	4444	18.8
680	7.9	1.8	1166	13.6	22	0	16	2	1206	14.0
734	16.7	1.6	1122	25.5	18	0	30	128	1298	29.5
1910	8.7	1.4	2578	11.7	32	52	20	0	2682	12.2
716	15.2	1.4	984	20.9	6	0	28	28	1046	22.3
1058	17.3	1.5	1168	19.1	36	0	238	306	1758	28.8
416	19.8	1.9	646	30.8	0	0	70	58	774	36.9
1674	14.3	1.4	2370	20.3	10	0	0	10	2390	20.4
1248	13.3	1.3	1600	17.0	0	0	0	0	1600	17.0
1072	12.5	1.4	1440	16.7	38	160	30	20	1688	19.6
456	13.4	1.5	652	19.2	4	152	16	0	824	24.2
2920	12.5	1.6	4526	19.4	0	0	0	0	4526	19.4
822	7.1	1.1	876	7.6	0	0	0	0	876	7.6
876	8.8	1.6	1248	12.5	56	0	18	38	1360	13.6
1740	7.0	1.3	2230	8.9	0	0	48	30	2308	9.2
380	4.9	1.5	544	7.0	16	0	6	16	582	7.5
370	6.7	1.5	502	9.1	14	0	16	26	558	10.1
258	7.2	1.3	312	8.7	0	0	16	92	420	11.7
1706	11.0	1.7	2634	17.0	28	0	136	110	2908	18.8

RESIDENTIAL TRIP GENERATION

Vehicle And Person Trip Rates By Location And Density

Table 1 Continued

Residential Sites By Urban Area And Dwelling Unit Type	City Or Community Location	U-Urban S-Sub. R-Rural	No. Of Occ. D.U.'s	Vehicle Trips					
				Auto And P.U.Driver Trips		Commercial Truck Trips		Bus Trips	Other Mode Trips
				Trips	Trips/D.U.	Trips	Trips/D.U.		
McAllen-Pharr									
Single Family D.U!s									
Main Floodway	McAllen	R	279	1558	5.6	114	.409	28	10
North Main	McAllen	U	364	4684	12.9	236	.648	0	502
Whitewing	McAllen	U	37	560	15.1	28	.757	0	46
Laredo									
Single Family D.U!s									
Retana Village	Laredo	U	157	1764	11.2	64	.407	4	200
Delmar	Laredo	S	111	1776	16.0	16	.144	0	42
Casa Norte Mobile D.U!s	Laredo	U	73	724	9.9	6	.082	4	4
Corpus Christi									
Single Family D.U!s									
South Bay	Corpus	S	74	612	8.3	10	.135	20	6
Multi-Family D.U!s									
C.C. Villa Apts.	Corpus	S	188	1200	6.4	12	.064	0	42
Gateway Mobile D.U!s		U	110	608	5.5	18	.164	0	18
Austin									
Single Family D.U!s									
Springdale	Austin	U	125	1840	14.7	96	.768	0	0
Rundberg	Austin	S	190	1664	8.8	2	.011	0	32
Battlebend Springs	Austin	S	650	4816	7.4	72	.111	60	112
Rutheford	Austin	S	160	1442	9.0	16	.100	0	2
Multi-Family D.U!s									
Las Colinas	Austin	S	43	258	6.0	46	1.070	0	0
North Castle Apts.	Austin	S	136	938	6.9	24	.177	0	20
Runnymede Apts.	Austin	S	202	1580	7.8	8	.040	4	36
Santa Maria Apts.	Austin	S	192	1924	10.0	8	.042	24	48
Lucksinger Mobile D.U!s	Austin	S	50	458	9.2	18	.360	0	4
Abilene									
Single Family D.U!s									
Post Oak	Abilene	S	174	1628	9.4	64	.367	6	0
Northway/Fair	Abilene	U	101	1580	15.6	54	.534	18	0
Lytle Shore	Abilene	S	109	1230	11.3	0	.000	0	0
Wichita Falls									
Single Family D.U!s									
Fairway	Wich.Falls	S	97	1028	10.6	84	.866	4	14
Beverly	Wich.Falls	U	103	1212	11.8	80	.777	0	14
Tanglewood	Wich.Falls	U	65	878	13.5	52	.800	8	18
City View Mobile D.U!s	Wich.Falls	U	101	740	7.3	30	.297	0	14
Lake/Resort D.U!s									
Royal	Wich.Falls	S	48	296	6.2	6	.125	4	0

RESIDENTIAL TRIP GENERATION

Vehicle And Person Trip Rates By Location And Density

Table 1 Continued

Total Vehicle Trips		Auto Occ.	Person Trips							
			Auto and P.U. Driver and Passenger Trips		Comm. Tr. Driver & Pass. Trips	Bus Pass.	Other Mode Trips	Pedes-trian	Total Person Trips	
Trips	Trips/D.U.		Trips	Trips/D.U.					Trips	Trips/D.U.
1710	6.1	2.2	3356	12.0	114	304	10	144	3928	14.1
5422	14.	1.5	7064	19.4	294	0	502	330	8190	22.5
634	17.1	1.6	918	24.8	32	0	46	44	1040	28.1
2032	12.9	1.6	2878	18.3	64	80	200	168	3390	21.6
1834	16.5	1.5	2612	23.5	30	0	42	142	2826	25.5
738	10.1	1.5	1076	14.7	6	36	4	6	1128	15.5
648	8.8	1.4	866	11.7	16	110	6	0	998	13.5
1254	6.7	1.4	1682	8.9	18	0	42	0	1742	9.3
644	5.9	1.4	868	7.9	18	0	18	26	930	8.5
1936	15.5	1.2	2248	18.0	96	0	0	0	2344	18.8
1698	8.9	1.6	2702	14.2	2	0	32	162	2898	15.3
5060	7.8	1.5	7308	11.2	74	210	112	22	7726	11.9
1460	9.1	1.5	2222	13.9	16	0	2	0	2240	14.0
304	7.1	1.4	370	8.6	56	0	0	0	426	9.9
982	7.2	1.2	1118	8.2	48	0	20	4	1190	8.8
1628	8.1	1.4	2144	10.6	8	160	36	44	2392	11.8
2004	10.4	1.7	3252	16.9	8	48	48	76	3432	17.9
480	9.6	1.6	710	14.2	18	0	4	8	740	14.8
1698	9.8	1.4	2268	13.0	64	6	0	238	2576	14.8
1652	16.4	1.6	2584	25.6	82	304	0	0	2970	29.4
1230	11.3	1.3	1592	14.6	0	0	0	0	1592	14.6
1130	11.6	1.5	1542	15.9	86	26	14	22	1690	17.4
1306	12.7	1.4	1704	16.5	96	0	14	32	1846	17.9
956	14.7	1.5	1326	20.4	56	84	18	6	1490	22.9
784	7.8	1.7	1230	12.2	30	0	14	6	1280	12.7
306	6.4	1.3	380	7.9	8	44	0	0	432	9.0

RESIDENTIAL TRIP GENERATION

Vehicle And Person Trip Rates By Location And Density

Table 1 Continued

Residential Sites By Urban Area And Dwelling Unit Type	City Or Community Location	U-Urban S-Sub. R-Rural	No. of Occ. D.U.'s	VEHICLE TRIPS					
				Auto & P.U. Driver Trips		Commercial Truck Trips		Bus Trips	Other Mode Trips
				Trips	Trips/D.U.	Trips	Trips/D.U.		
Texarkana									
Single Family D.U!s									
F.M. 2516	Texarkana	R	43	506	11.8	0	.000	0	18
Kennedy	Texarkana	U	58	798	13.8	2	.034	0	8
Multi-Family D.U!s									
Spanish Trace Apts.	Texarkana	U	92	834	9.1	0	.000	0	26
Dallas-Fort Worth									
Single Family D,U!s									
Bluffcreek	Dallas	U	213	2352	11.0	10	.047	16	100
Adshire	Dallas	U	189	2700	14.3	60	.317	4	20
Trailwood	Euless	S	144	1610	11.2	6	.047	12	50
Lake/Resort D.U!s									
Skeet-Richardson	Eagle Mt.	R	100	548	5.5	4	.040	8	4
Multi-Family D.U!s									
Spanish Gate Apts.	Ft.Worth	U	95	504	5.3	0	.000	0	2
K-Mar Mobile D.U!s	Ft.Worth	U	111	460	4.1	0	.000	0	0
Houston-Galveston									
Single Family D.U!s									
Kingspoint/Mango	Houston	U	494	5066	10.3	0	.000	0	266
Memorial Hills	Westfield	S	238	2540	10.7	26	.109	32	70
Daily Ashford	Houston	U	241	3032	12.6	0		0	42
Fondren Park	Houston	S	920	6608	7.2	62	.067	16	426
Lake Jackson	L.Jackson	R	45	482	10.7	0	.000	12	26
Sunset Ridge	Conroe	S	158	1562	9.9	46	.291	0	0
Mt. Belview	Baytown	R	43	388	9.0	0	.000	12	26
Baytown	Baytown	S	182	1896	10.4	58	.319	8	38
Deerpark	Deerpark	U	93	1106	11.9	116	1.247	0	0
Gruss	Houston	S	166	1064	6.4	66	.397	16	64
Hardy	Westfield	S	466	3964	8.5	116	.249	20	20
Lake/Resort D.U!s									
Briar Village	Houston	S	694	3612	5.2	80	.115	8	18
Multi-Family D.U!s									
Westpoint Apts.	Houston	U	1282	6046	4.7	12	.009	0	66
Mt. Houston Mobile D.U!s	Houston	S	197	694	3.5	36	.183	12	40

RESIDENTIAL TRIP GENERAITON

Vehicle And Person Trip Rates By Location And Density

Table 1 Continued

Total Vehicle Trips		Auto Occ.	PERSON TRIPS							
			Auto and P.U. Driver and Passenger Trips		Comm. Tr. Driver & Pass. Trips	Bus Pass.	Other Mode Trips	Pedes-trians	Total Person Trips	
Trips	Trips/D.U.		Trips	Trips/D.U.					Trips	Trips/D.U.
524	12.2	1.5	760	17.7	0	0	18	18	796	18.5
808	13.9	1.6	1278	22.0	2	0	8	54	1342	23.1
860	9.3	1.6	1302	14.1	0	0	26	0	1328	14.4
2470	11.6	1.7	3968	18.6	10	304	100	104	4486	21.1
2784	14.7	1.5	4154	22.0	60	54	20	92	4380	23.2
1678	11.7	1.6	2564	17.8	12	156	50	0	2782	19.3
564	5.6	1.5	810	8.1	4	158	4	0	976	9.8
506	5.3	1.4	682	7.2	0	0	2	16	700	7.4
460	4.1	1.4	640	5.8	0	0	0	10	650	5.9
5332	10.8	1.6	7894	16.0	0	0	266	0	8160	16.5
2668	11.2	1.6	4026	16.9	34	756	70	14	4900	20.6
3074	12.8	1.7	5230	21.7	0	0	42	14	5286	21.9
7112	7.7	1.4	9326	10.1	80	338	426	0	10170	11.1
520	11.6	1.8	890	19.8	0	214	26	0	1130	25.1
1608	10.2	1.3	2022	12.8	46	0	0	0	2068	13.1
426	9.9	1.6	612	14.2	0	210	26	0	888	20.7
2000	11.0	1.6	3072	16.9	98	48	38	0	3256	17.9
1222	13.1	1.6	1774	19.1	146	0	0	0	1920	20.6
1210	7.3	1.6	1694	10.2	80	388	64	84	2310	13.9
4120	8.8	1.5	6012	12.9	152	340	20	0	6524	14.0
3718	5.4	1.4	5044	7.3	134	18	18	0	5214	7.5
6124	4.8	1.2	7136	5.6	12	0	66	78	7292	5.7
782	4.0	1.8	1224	6.2	60	176	40	0	1500	7.6

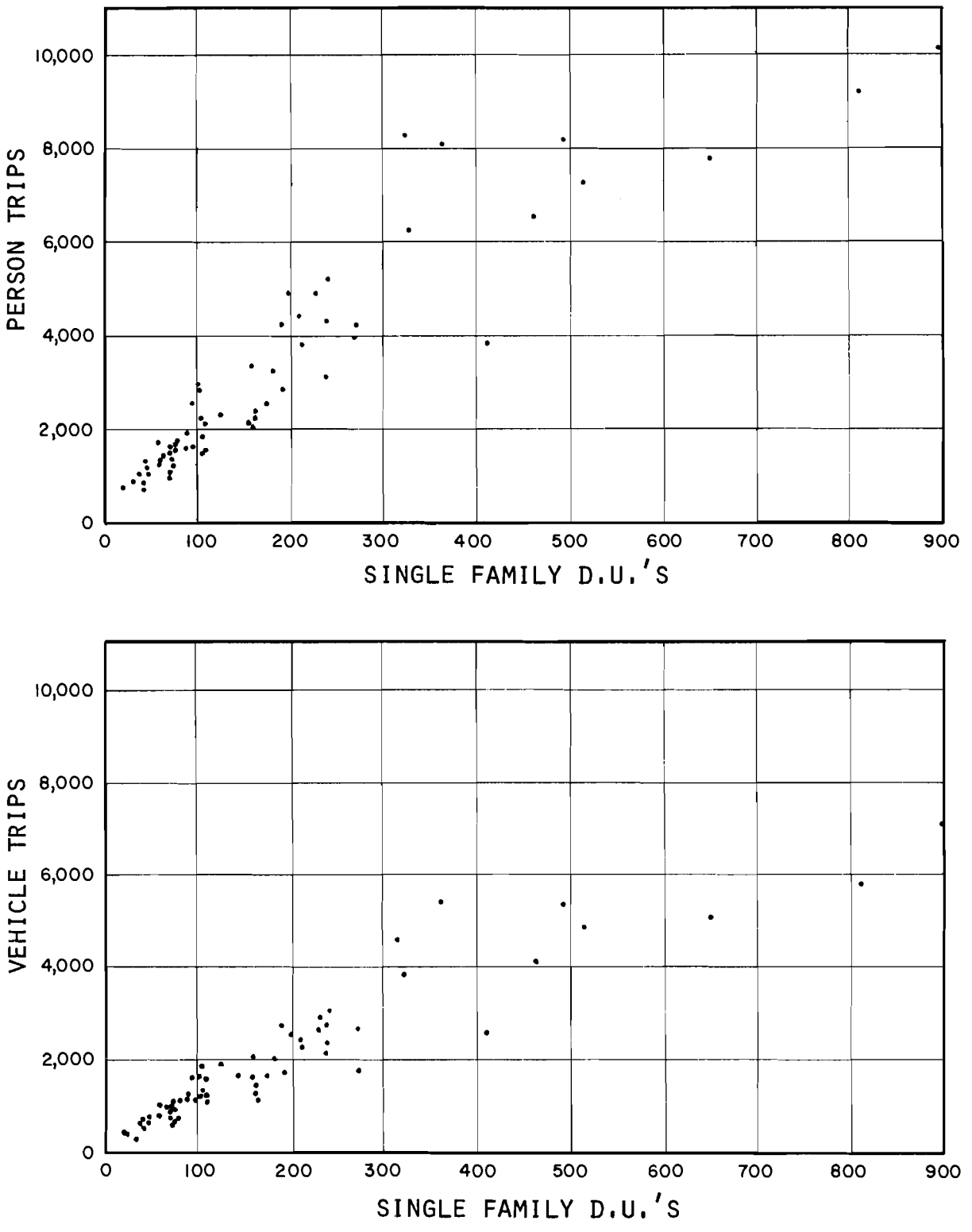


FIGURE 2: PERSON TRIPS AND VEHICLE TRIPS GENERATED BY THE NUMBER OF SINGLE FAMILY D.U.'S.

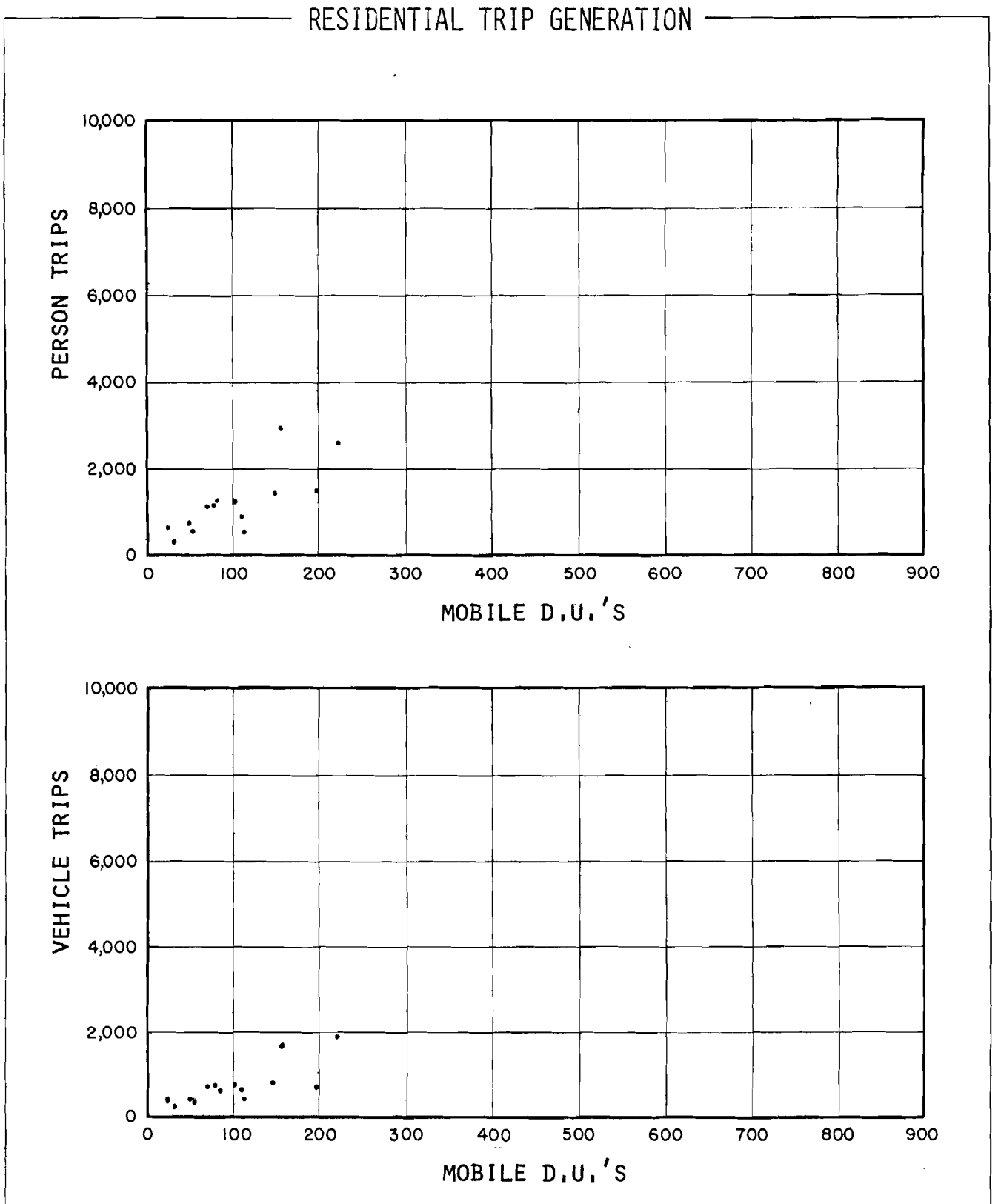


FIGURE 3: PERSON TRIPS AND VEHICLE TRIPS GENERATED BY THE NUMBER OF MOBILE HOMES.

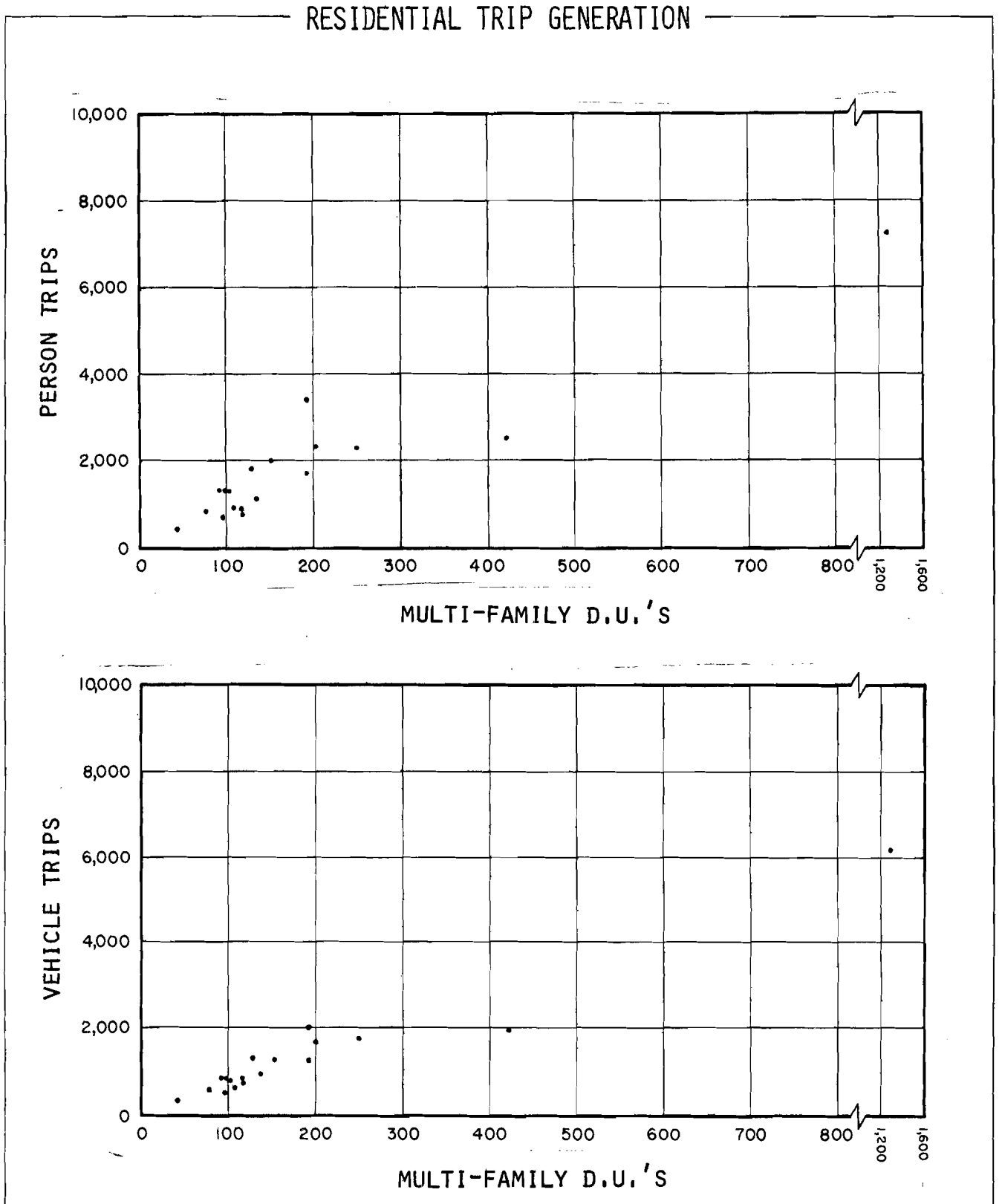


FIGURE 4: PERSON TRIPS AND VEHICLE TRIPS GENERATED BY THE NUMBER OF MULTI-FAMILY D.U.'S.

the results of plotting the observed person and vehicle trips with the number of dwelling units within each area. The resulting configuration of data observations tends to indicate a direct straight-line relationship for all those areas with fewer then 200 dwelling units and a dimenishing rate of increasing trips for those areas with greater numbers of dwellings.

Multi-Variable Stratification

Although the primary emphasis of this analysis was directed towards determining the reliability of forecasting trips with limited dwelling unit data, it is possible to attain greater accuracy in trip end estimation through the examination of additional variables. Several of these which affect residential trip generation include income, auto-ownership, the size of the metropolitan area in which the home is located, and density characteristics measured in terms of relative location (urban, suburban and rural).

The initial application of this type of variable stratification to the trip generaiton data is shown in Figure 5. Residential person and vehicle trips per D.U. are plotted with respect to the average cost of the dwelling unit which was obtained from 1970 U.S. Census block statistics. The resulting configuration of scatter points suggests that the same correlation between trips and family income revealed by traditional origin-destination studies is also present between trips and average dwelling unit cost.

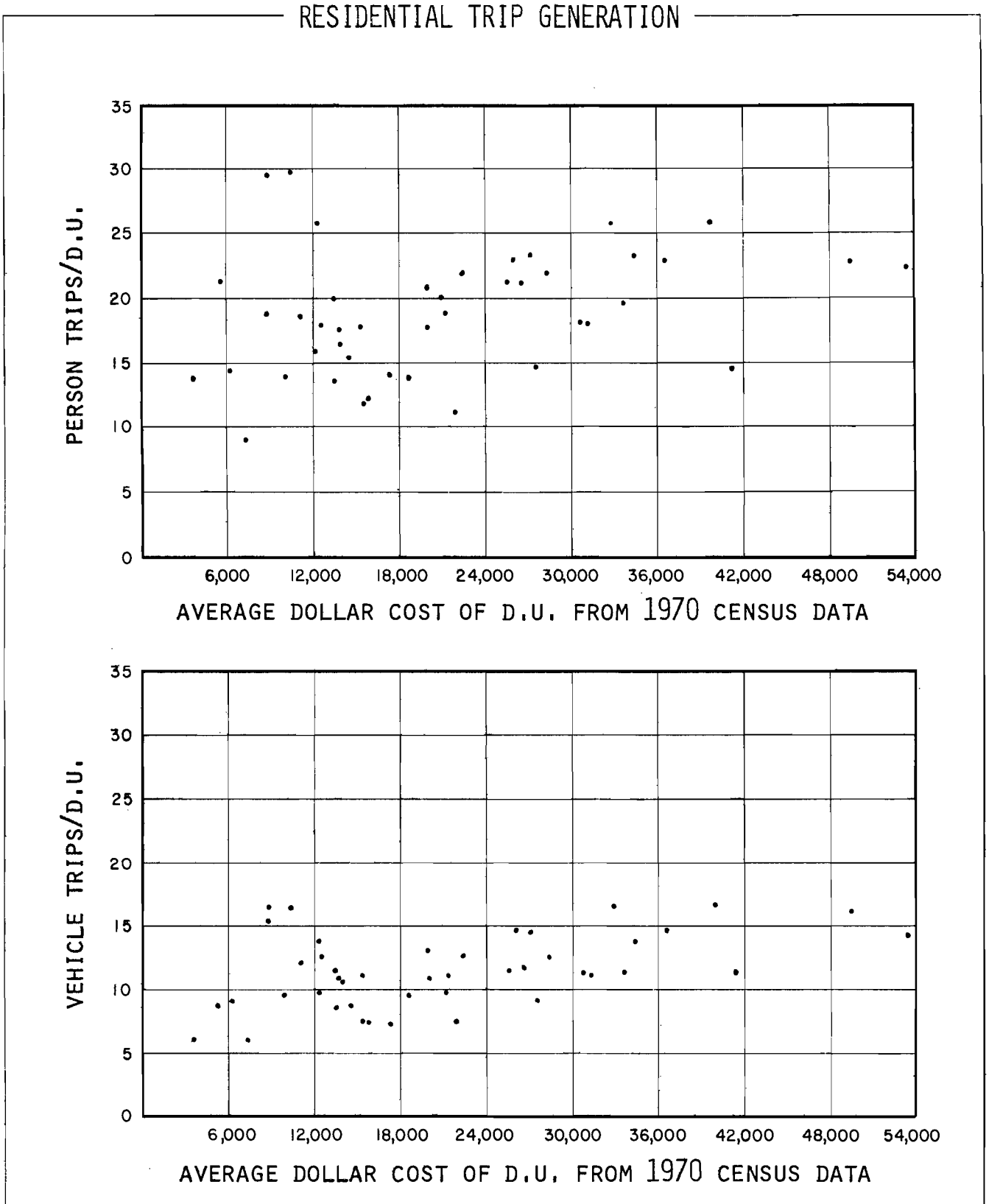


FIGURE 5: PERSON TRIPS/D.U. AND VEHICLE TRIPS/D.U. BY THE AVERAGE COST OF THE D.U. TAKEN FROM 1970 U.S. CENSUS DATA.

The graphs tend to indicate a declining impact of dwelling unit cost upon the trip rate after the value of the dwelling exceeds $30,000. The trip rate remains relatively constant for all higher dollar values. The considerable variance of data points around a "line of best fit" may be caused to some degree by dwelling unit values which are not always a direct indication of family incomes and trip making characteristics.

Table 3 shown below, summarizes by income group the average vehicle and person trip rates taken from the single family residential samples (lowest and highest rates are also indicated).

Residential Trip Rates And Ranges
By Income Group
(Table 3)

Income Groups	Vehicle Trips/D.U.			Person Trips/D.U.		
	Mean	High	Low	Mean	High	Low
Low	10.5	16.7	6.0	17.7	29.7	9.0
Medium	11.6	19.0	6.5	20.8	25.5	11.1
High	13.3	26.4	11.4	22.5	25.7	14.3

Additional stratification of the residential trip rates was accomplished through the introduction of population density (average persons per D.U.) into the analysis. Again, only those areas counted that were included in the block data statistics for the 1970 census were examined. The resulting scatter diagrams for both vehicle and person trips are indicated in Figure 6. The rather wide scatter pattern is probably caused

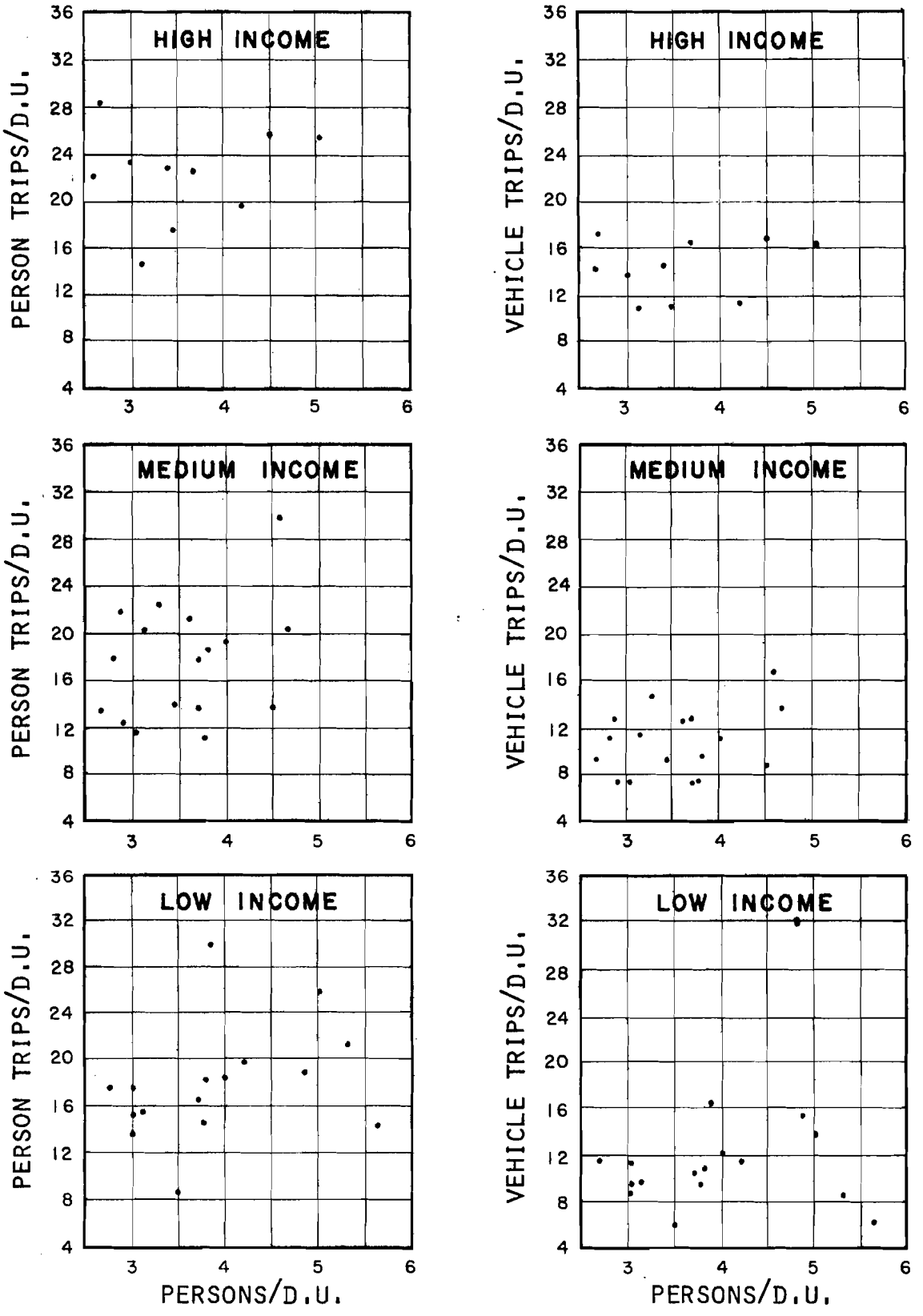


FIGURE 6: PERSON AND VEHICLE TRIPS/D.U. BY INCOME GROUP AND PERSONS PER D.U. FOR SINGLE FAMILY RESIDENTIAL AREAS.

by a combination of the income estimation process (income basically derived from D.U. cost from census) and possible changes in the number of persons per dwelling unit between 1970 and the date of the actual count. It is also recognized that the ages of the family members can cause considerable variations in the trip rate. The use of these graphs as a viable trip generation forecasting tool is questionable.

Additional scatter diagrams comprising Figure 7 indicate the relationship between residential trip rates and residential density classified as either urban or suburban development. Some dependence upon this variable is suggested as well as further indications of a reduced trip rate for larger neighborhoods caused by an increased quantity of unknown intra-neighborhood trips.

Residential dwelling observations were further sub-classified into urban,suburban, rural, and resort areas. Urban was defined as those developments within the "core" of the urbanized area and therefore close to central activity centers. Suburban included those areas located in the fringes of the city and are characterized as having easy access to some activity centers, primarily for convenience shopping. Rural, while within the urban area limits were classified as those areas usually separated from the city by a considerable distance and were not close to any significant activity center. Resort areas were defined as those built primarily near recreational activity areas (mostly lake resorts) and were generally considered "second homes".

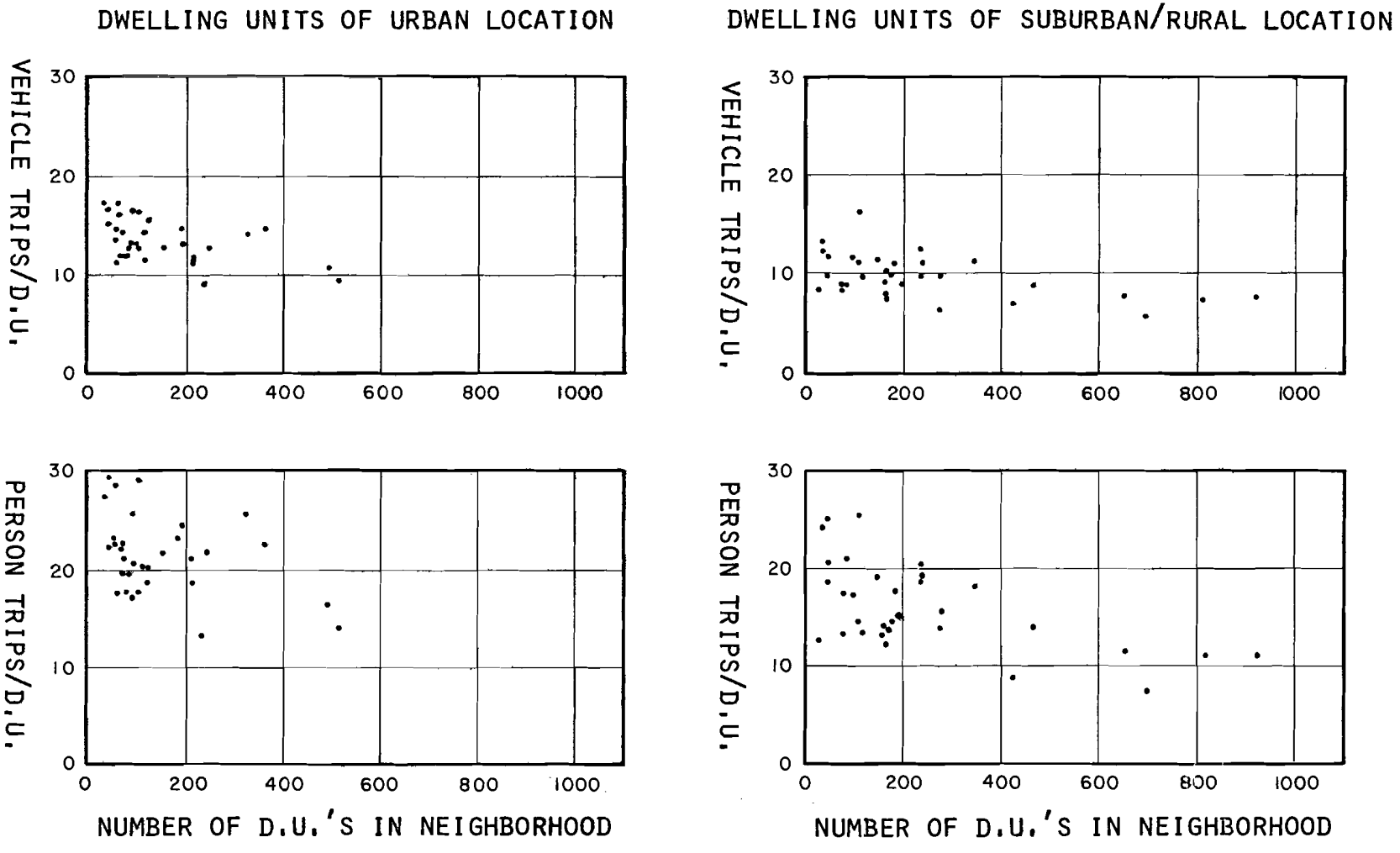


FIGURE 7: PERSON AND VEHICLE TRIPS/D.U. BY NEIGHBORHOOD SIZE AND URBAN OR SUBURBAN/RURAL LOCATION FOR SINGLE FAMILY RESIDENTIAL AREAS.

Although stratification of the trip rates by these sub-classifications failed to produce a satisfactory relationship when plotted by income or the number of dwellings in the area, the resulting trip rate averages for these four groups (Table 4) appear reasonable.

Residential Trip Rates
By Residential Density
(Table 4)

Density Classification	Vehicle Trips/D.U.	Person Trips/D.U.	Person Trips Per Vehicle Trip Ratio
Urban	12.7	20.3	1.6
Suburban	9.4	14.7	1.6
Rural	7.6	13.6	1.8
Resort	5.4	7.8	1.5

Conclusions

In order to facilitate the application of the residential trip generation data from this report, several important considerations should be summarized.

1. Substantial fluctuation of trip rates (reflected by the wide scatter of data points) is sometimes greater than statistically desired. This does not however, necessarily invalidate the basic variable relationships which can be displayed by constructing either "lines of best fit" or by applying the averages shown in the tables. The analyst should remember that these data

points represent "selected" areas which might prove biased if compared to the results of traditional origin-destination surveys which are based on a representative sample of all dwelling units within a given area. It must also be remembered that because individual data observations represent only one 24-hour week day count, some weekly or seasonal variation can be expected.

2. Although the development of the trip generation relationships is based on aggregate data (average income, persons per D.U., etc.) which caused some of the data fluctuations, it is doubtful that many residential forecasts (which are also usually aggregated) would provide any significant increase in level of precision over the generation models.
3. Since the complete residential analysis files for all neighborhoods observed are located in Austin, the Transportation Planning Divison will be pleased to aid in the development of both trip rates and anticipated travel for any applicable urban area where this data is required. However, the accuracy of the forecasted trip making and the resulting travel impacts is highly dependent upon the amount of residential information provided for a proposed development.

COMMERCIAL TRAFFIC GENERATION ANALYSIS

Analyses of the trip generation characteristics of commercial retail centers and commercial offices were conducted through the examination of 66 shopping areas from 19 urban areas within the State of Texas. These included many diverse sizes and configurations ranging from one freestanding store to centers comprised of 135 stores adjacent to offices, banks, automotive service centers, etc. Consequently, to facilitate the analysis of homogenous commercial activity each shopping center was further stratified by type as follows:

1. Regional Shopping Centers have at least 30 stores, 35 or more acres, 200,000 or more square feet, at least one major department store, and serve a regional area. There were 18 of these centers surveyed.
2. Neighborhood Shopping Centers have from 1 to 30 stores, 5 to 25 acres, and 10,000 to 200,000 square feet. They may contain junior department, variety, specialty and/or grocery stores, and serve a neighborhood area. Neighborhood centers were also classified by; (1) neighborhood with offices; (2) neighborhood without offices; and (3) strip development shopping centers. There were 38 neighborhood shopping centers counted during the study.

3. Discount Department Stores are usually large free-standing discount centers located on 1 to 15 acre tracts. Some include grocery, auto service, and garden departments.

Basic Commercial Data Collection

The selection of commercial retail and commercial office sites for trip generation analysis was limited to those sites with adequate off-street parking and no through traffic. Hourly count and 24-hour machines were used when feasible while manual recorders were stationed at a minimum at one entrance per generator for 10 to 16 hours in order to develop accurate vehicle occupancy counts. In addition to the traffic counts collected, supplementary information including number of employees, square footage of floor space, total acreage, number of parking spaces, and number of stores was obtained from interviews with commercial proprietors.

Special consideration was given to the scheduling of commercial travel monitoring because of the pronounced seasonal and daily variations of the shopping trips. An example of this type of fluctuation is indicated in Figure 8; a time series analysis whereby vehicles entering a selected shopping center were plotted by month and day of week. The results indicate that commercial traffic displays its largest variations during weekends, inclement weather and the month of December.

COMMERCIAL TRIP GENERATION

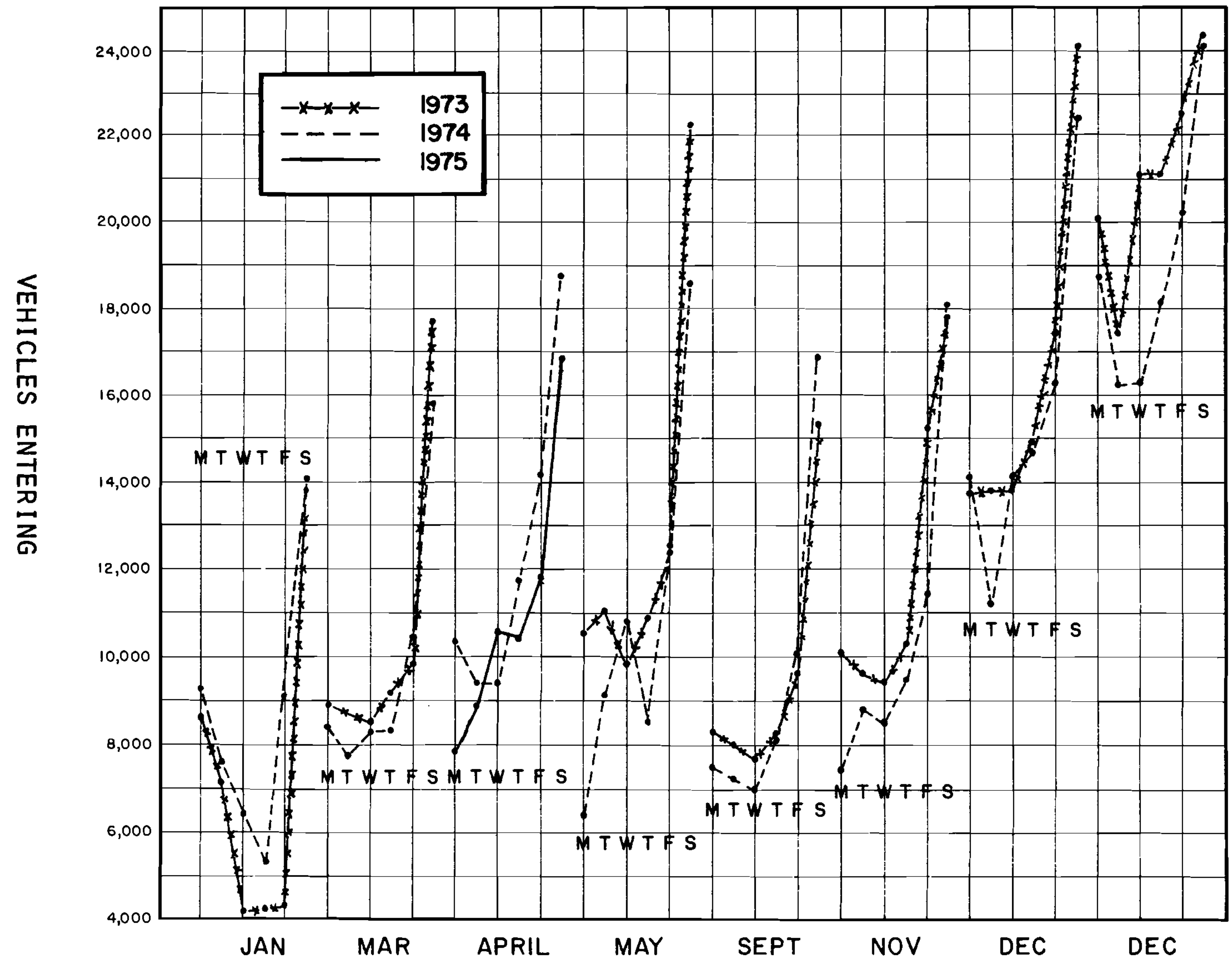


FIGURE 8: COMMERCIAL TRIP FLUCTUATION BY DAY AND MONTH

COMMERCIAL TRIP GENERATION

Regional Shopping Centers

Table 5

Urban Area Location	Employment	Gross Acreage	Building Square Footage	Number of Stores	Parking Spaces	Employees per Store	Total Vehicle Trips	Vehicle Trips per Employee
Jefferson-Orange Co.	500	20.0	248,683	55	2,042	9	14,392	28.8
San Antonio	1,000	55.0	750,000	116	5,050	9	27,704	27.7
Wichita Falls	482	52.5	270,777	35	4,000	14	11,538	23.9
Austin	1,000	56.9	720,000	84	4,900	12	23,708	23.7
Austin	900	36.0	400,000	36	2,500	25	20,742	23.0
Bryan-College Station	327	35.9	436,300	30	2,022	11	7,524	23.0
Dallas-Fort Worth	1,800	94.0	1,300,000	135	8,000	9	38,478	21.4
Dallas-Fort Worth	1,000	99.0	1,100,000	132	7,000	8	20,240	20.2
Amarillo	708	34.6	722,153	33	2,600	21	13,952	19.7
San Antonio	1,030	53.9	488,300	50	4,010	21	20,068	19.4
Midland-Odessa	612	36.2	418,478	45	2,590	14	11,420	18.7
McAllen-Pharr	436	41.5	450,300	31	2,500	14	7,538	17.3
Corpus Christi	407	47.3	177,000	3	2,000	136	6,752	16.6
Houston-Galveston	2,546	77.0	1,400,000	58	6,000	44	41,340	16.2
Fort Worth	2,107	85.0	708,147	115	4,977	18	25,590	12.1
Sherman-Denison	900	42.0	446,166	68	2,990	13	11,144	12.4
Corpus Christi	1,200	44.9	622,897	73	3,618	16	13,376	11.1
El Paso	1,430	55.4	1,100,000	60	5,000	24	14,748	10.3

COMMERCIAL TRIP GENERATION

Regional Shopping Centers

Table 5 Continued

Vehicle Trips per Acre	Vehicle Trips per 100 Sq Ft	Vehicle Trips per Store	Vehicle Trips per Parking	Total Person Trips	Person Trips per Employee	Person Trips per Acre	Person Trips per 100 Sq Ft	Person Trips per Store	Person Trips per Parking
719.6	5.8	261.7	7.0	22,130	44.3	1,160.5	8.9	402.4	10.8
503.8	3.7	238.8	5.5	43,350	43.4	788.2	5.8	373.7	8.6
219.8	4.3	329.7	2.9	16,636	34.5	316.9	6.1	475.3	4.2
416.7	3.3	282.2	4.8	36,784	36.8	646.6	5.0	437.9	7.5
576.2	5.2	576.2	8.3	32,002	35.6	888.9	8.0	888.9	12.8
209.6	1.7	250.8	3.7	10,694	32.7	297.9	2.5	356.5	5.3
409.3	3.0	285.0	4.8	52,682	29.3	560.4	4.1	390.2	6.6
204.4	1.8	153.3	2.9	36,976	37.0	373.5	3.4	280.1	5.3
403.2	1.9	422.8	5.4	22,108	31.2	639.2	3.1	669.9	8.5
372.3	4.1	401.4	5.0	32,316	31.3	609.7	6.6	646.3	8.1
315.5	2.7	253.8	4.4	20,962	34.3	579.1	5.0	465.8	8.1
181.6	1.7	243.2	3.0	13,456	30.9	324.2	3.0	434.1	5.4
142.7	3.8	2,250.7	3.4	10,368	25.5	219.2	5.9	3,456.0	5.2
536.9	3.0	712.8	6.9	57,092	22.4	741.5	4.1	984.3	9.5
301.1	3.6	222.5	5.1	41,482	19.7	488.0	5.9	360.7	8.3
265.3	2.5	163.9	3.7	17,080	19.0	406.7	3.8	251.2	5.7
297.9	2.1	183.2	3.7	23,434	19.5	521.9	3.7	321.0	6.5
266.2	1.3	246.0	3.0	25,898	18.1	467.5	2.4	431.6	5.2

COMMERCIAL TRIP GENERAITON

Neighborhood Shopping Centers (With Offices)

Table 6

Urban Area Location	Employment	Gross Acreage	Building Square Footage	Number of Stores	Parking Spaces	Employees per Store	Total Vehicle Trips	Vehicle Trips per Employee
Abilene	17	8.7	114,928	7	135	2	1,064	62.6
Houston-Galveston	139	6.5	62,300	12	450	12	6,926	49.8
Waco	153	2.4	27,927	15	130	10	7,306	47.8
Odessa	74	6.7	73,000	10	612	7	3,394	45.9
McAllen-Pharr	125	3.3	52,500	9	211	14	5,562	44.5
McAllen-Pharr	208	7.6	123,400	25	500	8	8,136	39.1
Bryan-College Sta.	113	6.0	66,208	14	459	8	3,852	34.1
Houston-Galveston	99	1.8	50,000	12	212	8	3,738	37.8
Houston-Galveston	212	10.0	117,400	21	490	10	6,320	29.8
Odessa	145	7.6	90,675	19	580	8	3,990	27.5
Houston-Galveston	144	7.5	95,175	15	357	10	3,918	27.2
Houston-Galveston	192	3.1	110,000	10	400	19	2,020	10.5
Waco	116	3.7	20,166	18	135	6	924	8.0

COMMERCIAL TRIP GENERATION

Neighborhood Shopping Centers (With Offices)

Table 6 Continued

Vehicle Trips per Acre	Vehicle Trips per 100 Sq Ft	Vehicle Trips per Store	Vehicle Trips per Parking	Total Person Trips	Person Trips per Employee	Person Trips per Acre	Person Trips per 100 Sq Ft	Person Trips per Store	Person Trips per Parking
122.3	0.9	152.0	7.9	1,548	91.1	177.9	1.4	221.1	11.5
1,065.5	11.1	577.2	15.4	9,752	70.2	1,500.3	15.7	812.7	21.7
3,044.2	26.2	487.1	56.2	10,594	69.2	4,414.2	37.9	706.3	81.5
506.6	4.7	339.4	5.5	5,150	69.6	768.7	7.1	515.0	8.4
1,685.5	10.6	618.0	26.4	10,194	81.6	3,089.0	19.4	1,132.7	48.3
1,070.5	6.6	325.4	16.3	12,586	60.5	1,656.1	10.2	503.4	25.2
642.0	5.8	275.4	8.4	5,826	51.6	971.0	8.8	416.1	12.7
2,076.7	7.5	311.5	17.6	5,822	58.8	3,324.4	11.6	485.2	27.5
632.0	5.4	301.0	12.9	9,398	44.3	939.8	8.0	447.5	19.2
525.0	4.4	210.0	6.9	5,988	41.0	781.3	6.6	315.2	10.3
522.4	4.1	261.2	11.0	6,270	43.5	836.0	6.6	418.0	17.6
651.6	1.8	202.0	5.1	2,740	14.3	883.9	2.5	274.0	6.9
249.7	4.6	51.3	6.8	1,374	11.8	371.4	6.8	76.3	10.2

COMMERCIAL TRIP GENERATION

Neighborhood Shopping Centers (Without Offices)

Table 7

Urban Area Location	Employment	Gross Acreage	Building Square Footage	Number of Stores	Parking Spaces	Employees Per Store	Total Vehicle Trips	Vehicle Trips per Employee
Waco	125	13.9	142,475	21	1,255	6	9,228	73.8
Waco	112	9.0	81,296	18	820	6	8,232	73.5
El Paso	30	9.0	35,000	2	350	15	2,070	69.0
Temple	122	29.0	197,000	24	320	5	8,412	69.0
Waco	85	11.0	113,980	21	1,016	4	5,626	66.2
Abilene	58	6.2	79,496	8	128	7	3,710	64.0
Waco	34	3.1	34,003	3	183	11	1,996	58.7
Temple	31	2.0	15,000	1	109	31	1,794	57.8
Lubbock	135	9.0	75,005	10	320	14	7,706	57.1
Bryan-College Sta.	211	10.8	121,400	6	646	35	11,719	55.5
Abilene	146	12.9	143,385	23	645	6	7,306	50.0
Sherman-Denison	36	2.2	30,000	22	86	2	1,742	48.4
Texarkana	120	12.0	125,000	14	911	9	5,752	47.9
Sherman-Denison	65	8.9	63,128	13	418	5	2,572	39.6
Houston-Galveston	215	12.0	100,000	22	800	10	7,580	35.3

COMMERCIAL TRIP GENERATION

Neighborhood Shopping Centers (Without Offices)

Table 7 Continued

Vehicle Trips per Acre	Vehicle Trips per 100 Sq Ft	Vehicle Trips per Store	Vehicle Trips per Parking	Total Person Trips	Person Trips per Employee	Person Trips per Acre	Person Trips per 100 Sq Ft	Person Trips per Store	Person Trips per Parking
663.9	6.5	439.4	7.4	14,836	118.7	1,067.3	10.4	706.5	11.8
914.7	10.1	457.3	10.0	12,882	115.0	1,431.3	15.8	715.7	15.7
230.0	5.9	1,035.0	5.9	3,244	108.1	360.4	9.3	1,622.0	9.3
290.1	4.3	350.5	26.3	13,216	108.3	455.7	6.7	550.7	41.3
511.5	4.9	267.9	5.5	8,266	97.3	751.5	7.3	393.6	8.1
598.4	4.7	463.8	30.0	5,714	98.5	929.1	7.2	714.3	44.6
643.9	5.9	665.3	10.9	3,250	95.6	1,048.4	9.6	1,083.3	17.8
897.0	11.9	1,794.0	16.5	3,086	99.5	1,543.0	20.6	3,086.0	28.3
856.2	10.3	770.6	24.1	11,102	82.2	1,233.6	14.8	1,110.2	34.7
1,085.0	9.7	1,953.0	18.1	17,598	83.4	1,629.4	14.5	2,933.0	27.2
566.4	5.1	317.7	11.3	10,366	71.0	803.6	7.2	450.7	16.1
791.4	5.8	79.2	20.3	2,610	72.5	1,186.4	8.7	118.6	30.3
479.3	4.6	410.9	6.3	10,498	87.5	874.8	8.4	749.9	11.5
289.0	4.1	197.9	6.2	3,718	57.2	309.8	5.9	286.0	8.9
631.7	7.6	344.5	9.5	11,108	51.7	925.7	11.1	504.9	13.9

COMMERCIAL TRIP GENERATION

Neighborhood Shopping Centers (Strip Development)

Table 8

Urban Area Location	Employment	Gross Acreage	Building Square Footage	Number of Stores	Parking Spaces	Employees per Store	Total Vehicle Trips	Vehicle Trips per Employee
Amarillo	97	4.3	95,774	14	255	7	2,946	30.4
Houston-Galveston	125	6.2	63,000	14	417	9	3,668	29.3
Wichita Falls	212	4.2	78,712	14	300	15	6,080	28.7
Lubbock	180	10.0	116,029	2	800	90	4,488	24.9
Abilene	110	4.2	148,795	22	106	5	2,700	24.5
Houston-Galveston	176	11.3	126,183	33	700	5	4,234	24.1
Amarillo	71	1.4	21,000	10	150	7	1,604	22.6
Wichita Falls	165	2.2	58,260	5	281	33	3,692	22.4
Austin	225	6.6	106,383	12	280	19	5,000	22.2
Austin	34	1.2	14,500	10	80	3	618	18.2

COMMERCIAL TRIP GENERATION

Discount Department Stores

Table 9

Lubbock	85	9.7	72,000	1	450	85	4,730	55.7
Tyler	110	5.0	53,830	1	250	110	5,332	48.5
Houston-Galveston	150	12.0	100,000	1	680	150	6,934	46.2
Abilene	50	5.0	100,000	3	260	17	2,196	43.9
Laredo	90	5.0	40,625	1	376	90	3,182	35.4
Wichita Falls	191	14.5	142,808	3	1,011	64	5,798	30.4
Laredo	100	14.6	93,000	1	978	100	2,888	28.9
Odessa	150	5.1	88,000	1	576	150	4,340	28.9
McAllen-Pharr	274	5.2	227,100	1	453	274	7,230	26.4
Temple	135	3.0	64,000	1	105	135	2,358	17.5

COMMERCIAL TRIP GENERATION

Neighborhood Shopping Centers (Strip Development)

Table 8 Continued

Vehicle Trips per Acre	Vehicle Trips per 100 Sq Ft	Vehicle Trips per Store	Vehicle Trips per Parking	Total Person Trips	Person Trips per Employee	Person Trips per Acre	Person Trips per 100 Sq Ft	Person Trips per Store	Person Trips per Parking
685.1	3.1	210.4	11.6	3,960	40.8	920.9	4.1	282.9	15.5
591.6	5.8	262.0	8.8	5,598	44.8	902.9	8.9	399.9	13.4
1,447.6	7.7	434.3	20.3	10,058	47.4	2,394.8	12.8	718.4	33.5
448.8	3.9	2,244.0	5.6	6,978	38.8	697.8	6.0	3,489.0	8.7
642.9	1.8	122.7	25.5	3,764	34.2	896.2	2.5	171.1	35.5
374.7	3.4	128.3	6.0	6,166	35.0	545.7	4.9	186.9	8.8
1,145.7	7.6	160.4	10.7	2,220	31.3	1,585.7	10.6	222.0	14.8
1,678.2	6.3	738.4	13.1	5,452	33.0	2,478.1	9.4	1,090.4	19.4
756.2	4.7	416.7	17.9	6,834	30.4	1,035.5	6.4	569.5	24.4
515.0	4.3	61.8	7.7	806	23.7	671.2	5.6	80.6	10.1

COMMERCIAL TRIP GENERATION

Discount Department Stores

Table 9 Continued

487.6	6.6	4,730.0	10.5	7,520	88.5	775.3	10.4	752.0	16.7
1,066.4	9.9	5,332.0	21.3	8,108	74.4	1,636.0	15.2	8,180.0	32.7
577.8	6.9	6,934.0	10.2	9,882	65.9	823.5	9.9	9,882.0	14.5
439.2	2.2	732.0	8.5	3,594	71.9	718.8	3.6	1,198.2	13.8
636.4	7.8	3,182.0	8.5	5,742	63.8	1,148.4	14.1	5,742.0	15.3
399.9	4.1	1,932.7	5.7	10,606	55.5	731.4	7.4	3,535.0	10.5
197.8	3.1	2,888.0	3.0	5,984	59.8	409.9	6.4	5,984.0	6.1
851.0	4.9	4,340.0	7.5	7,014	46.8	1,375.3	8.0	7,014.0	12.2
1,390.4	3.2	7,230.0	16.0	13,322	48.6	2,561.9	5.9	13,322.0	29.4
786.0	3.7	2,358.0	22.5	3,888	28.8	1,296.0	6.1	3,888.0	37.0

Generation Rate Development

The development of vehicle and person trip rates for regional shopping centers (Table 5), neighborhood shopping centers with offices (Table 6), neighborhood shopping centers without offices (Table 7), neighborhood strip development (Table 8) and discount department stores (Table 9) is based on the physical characteristics from each type of commercial center. To maintain confidentiality, each center is identified only by its urban location.

Although each commercial activity center was carefully categorized by size and type, the resulting trip generation rate calculations reveal a rather disturbing magnitude of fluctuations within each commercial category. This is indicative of the fact that several unknown or intangible variables (such as general popularity or store variety) can significantly affect the number of trips generated at a commercial center. A more precise measure of commercial trip rate variation (for trips per employee and acre) by each commercial type, appears in Table 10 on page 53.

Commercial vehicle and person trip generations for regional, neighborhood, and discount centers, are graphically represented through a series of scatter diagrams comprising Figures 9 through 18. Counted vehicle and person trips entering or leaving each commercial site are plotted for the number of employees, gross acreage, square footage, number of stores, and number of parking spaces which characterize that center.

Although the graphs exhibit quite noticeable commercial trip fluctuations for all independent variables, the basic generation trends are still discernable. The similarities among the various scatter diagrams probably

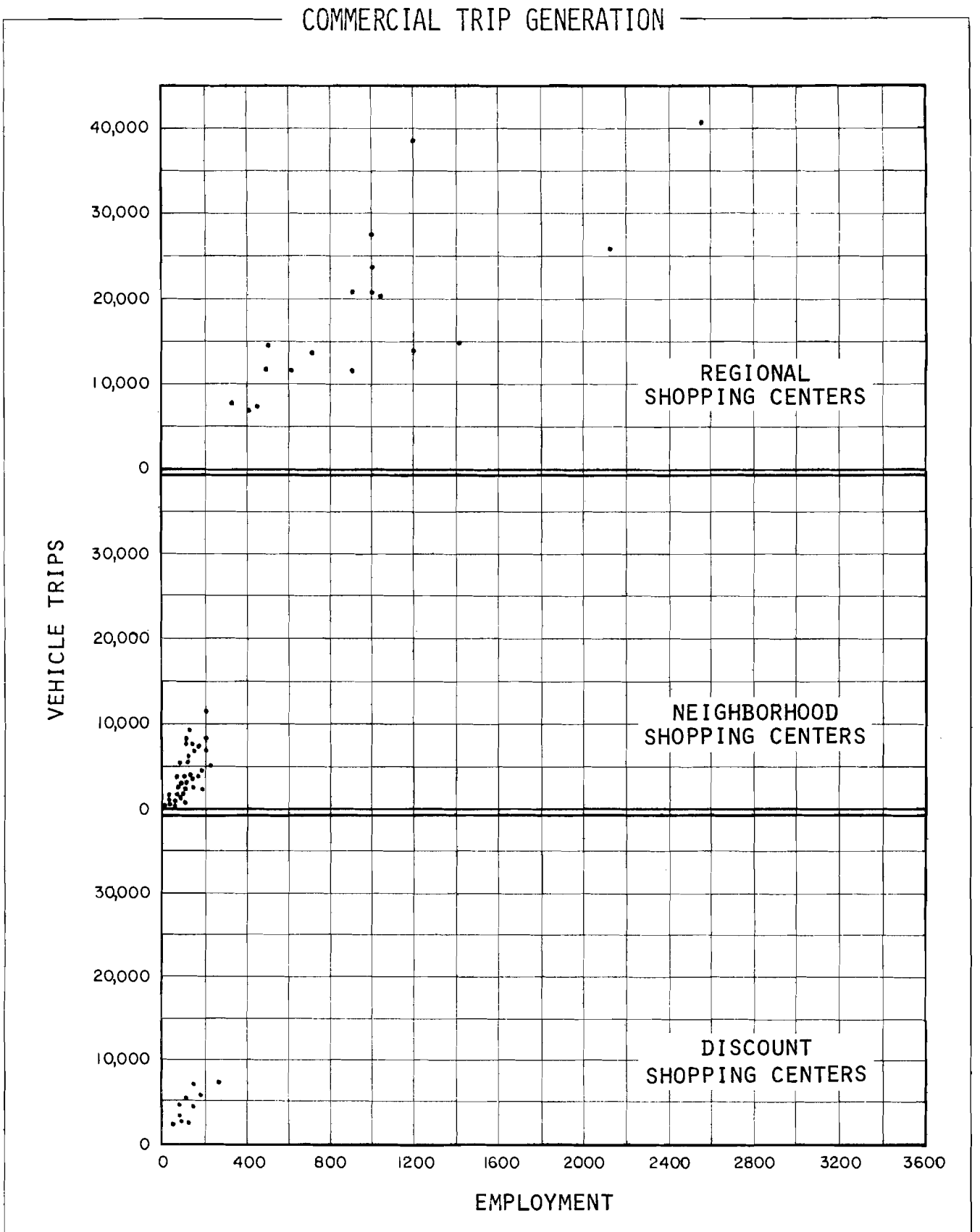


FIGURE 9: VEHICLE TRIPS GENERATED BY EMPLOYMENT FOR REGIONAL, NEIGHBORHOOD, AND DISCOUNT SHOPPING CENTERS.

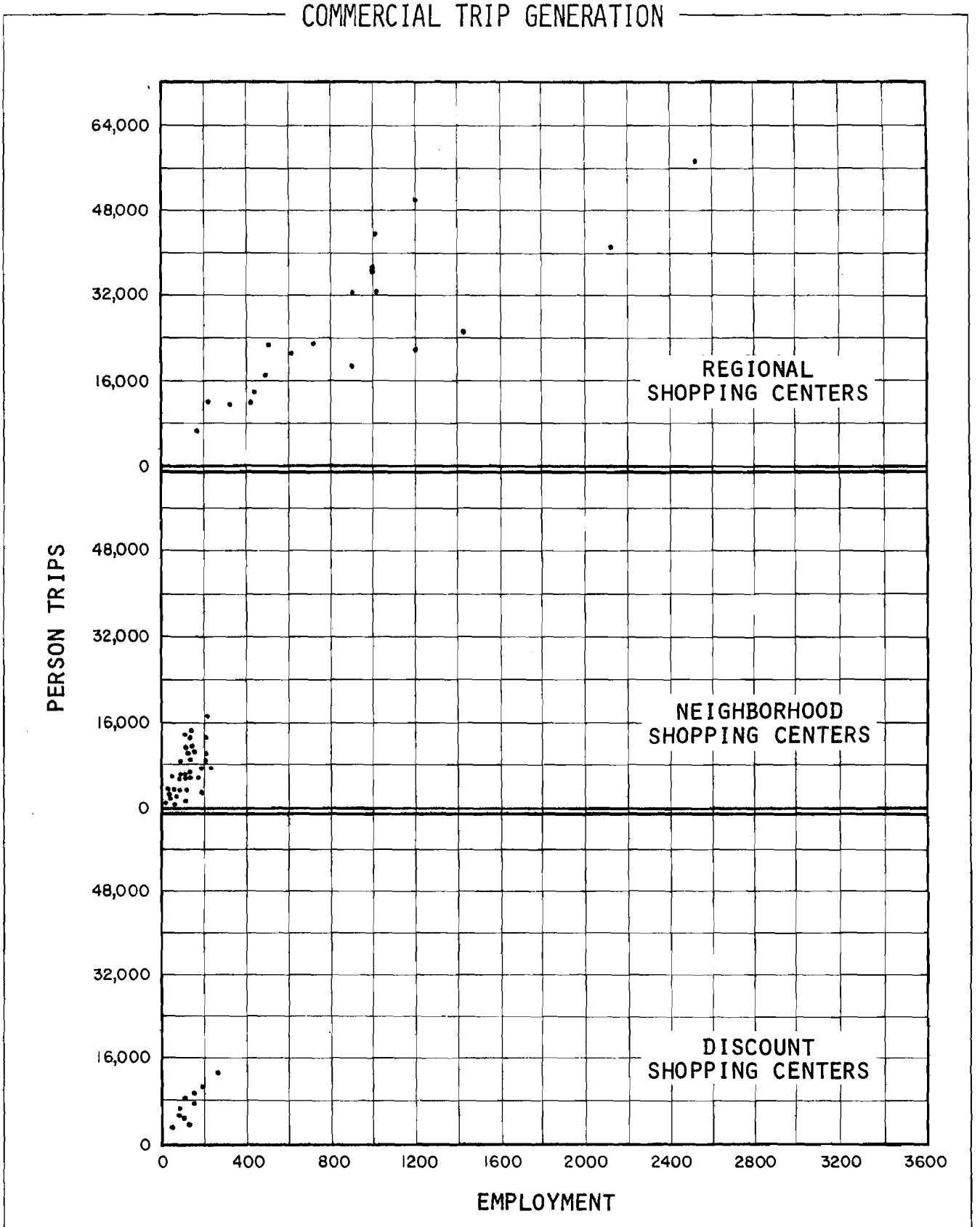


FIGURE 10: PERSON TRIPS GENERATED BY EMPLOYMENT FOR REGIONAL, NEIGHBORHOOD, AND DISCOUNT SHOPPING CENTERS.

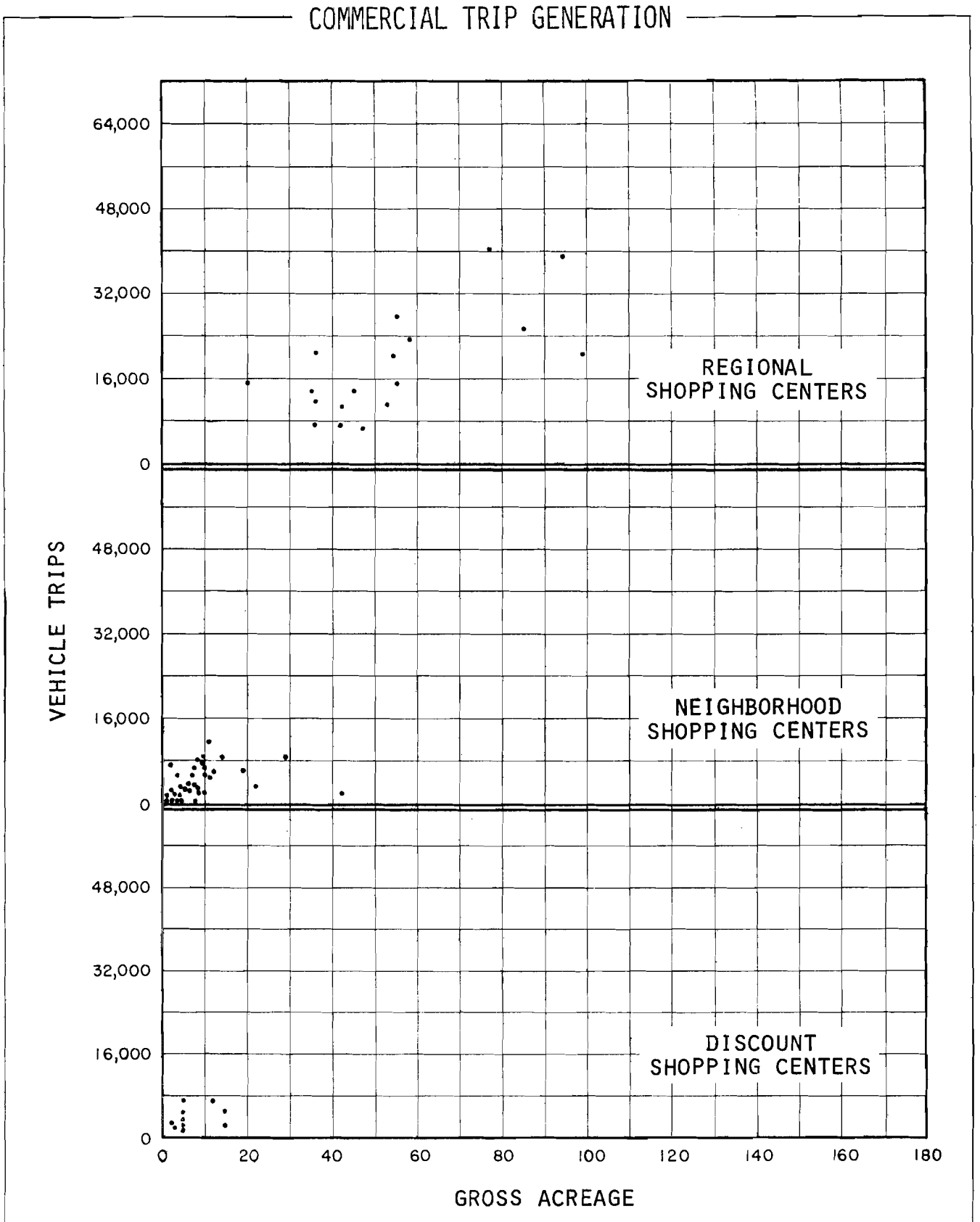


FIGURE 11: VEHICLE TRIPS GENERATED BY GROSS ACREAGE FOR REGIONAL, NEIGHBORHOOD, AND DISCOUNT SHOPPING CENTERS.

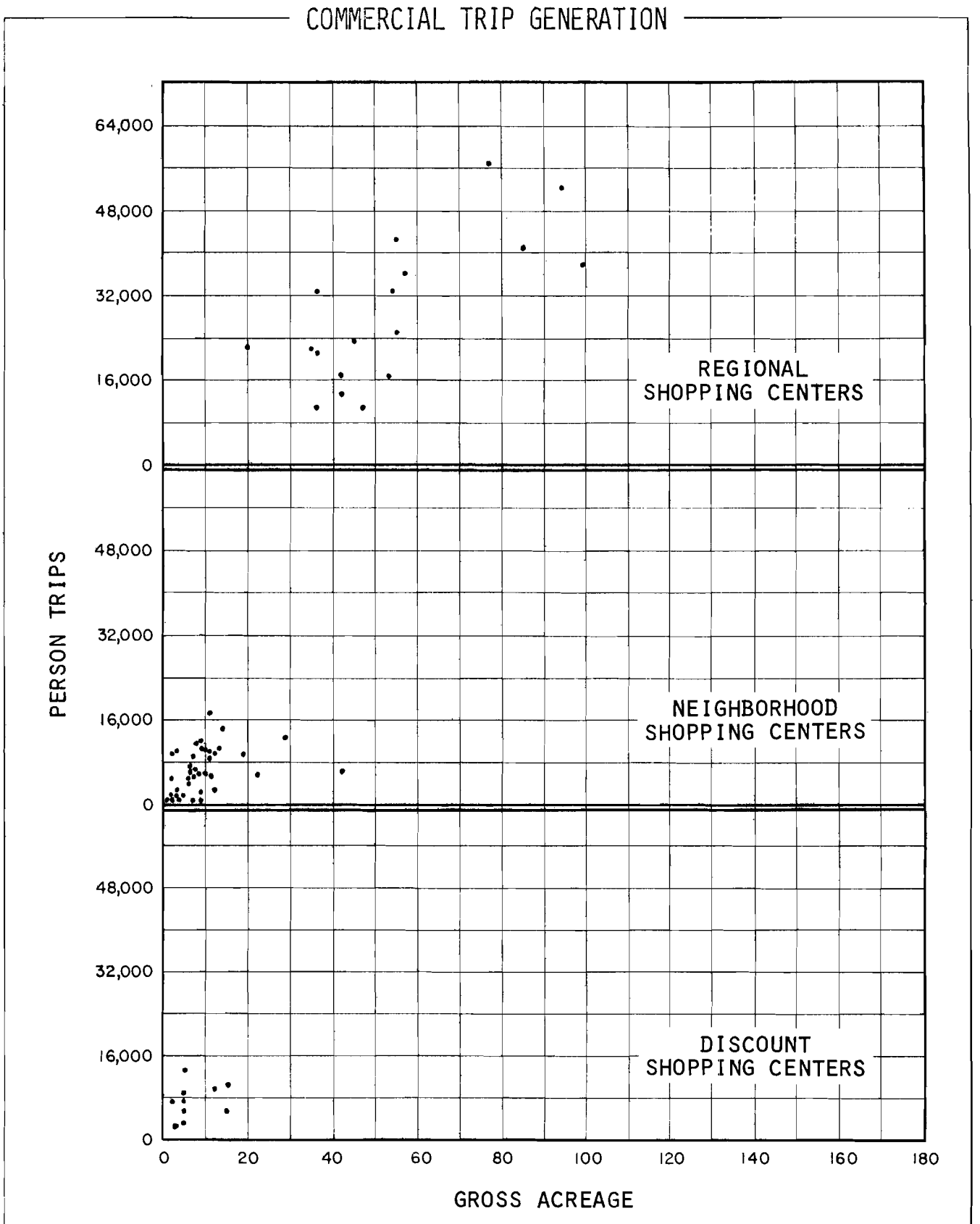


FIGURE 12: PERSON TRIPS GENERATED BY GROSS ACREAGE FOR REGIONAL, NEIGHBORHOOD, AND DISCOUNT SHOPPING CENTERS.

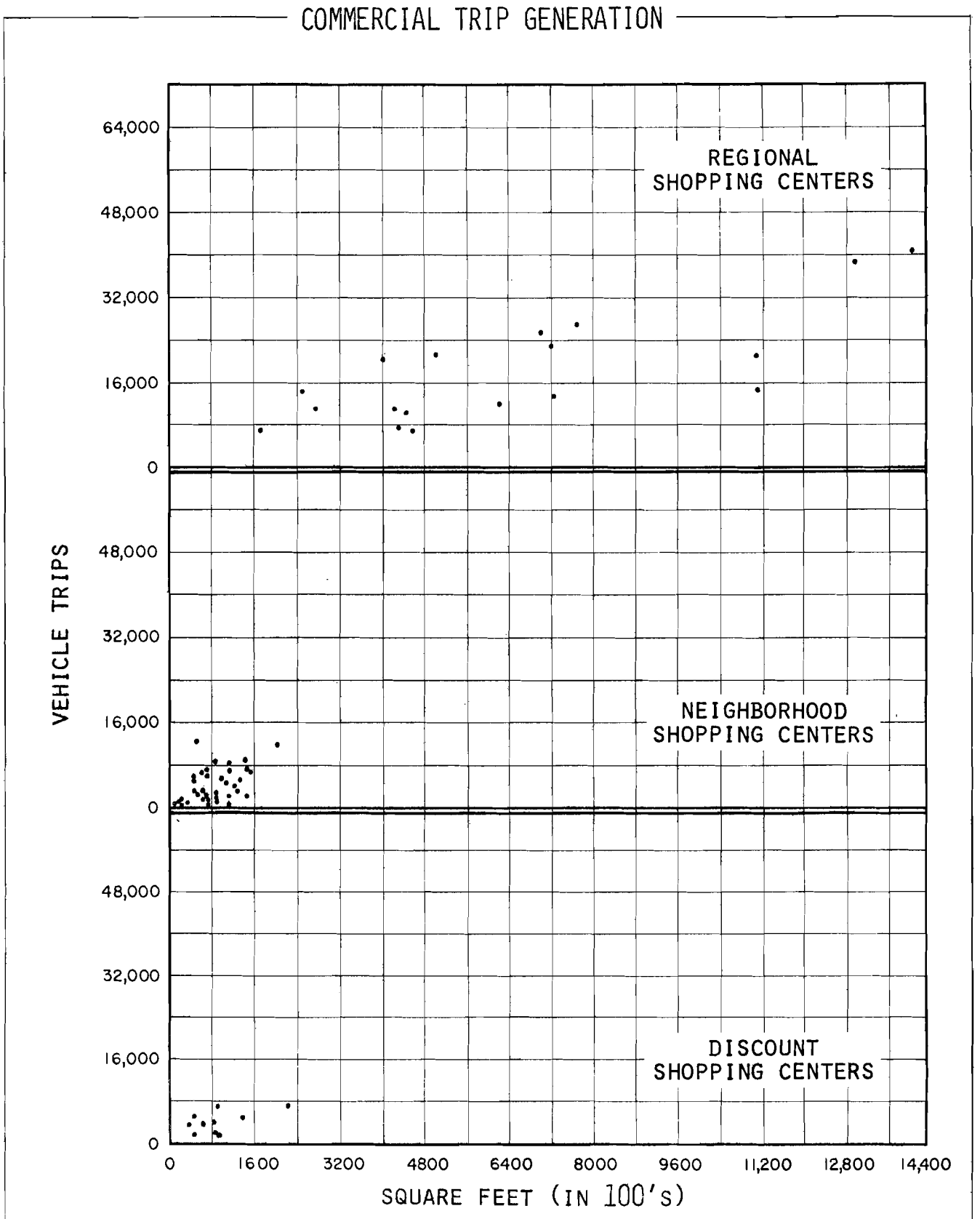


FIGURE 13: VEHICLE TRIPS GENERATED BY SQUARE FOOTAGE FOR REGIONAL, NEIGHBORHOOD, AND DISCOUNT SHOPPING CENTER.

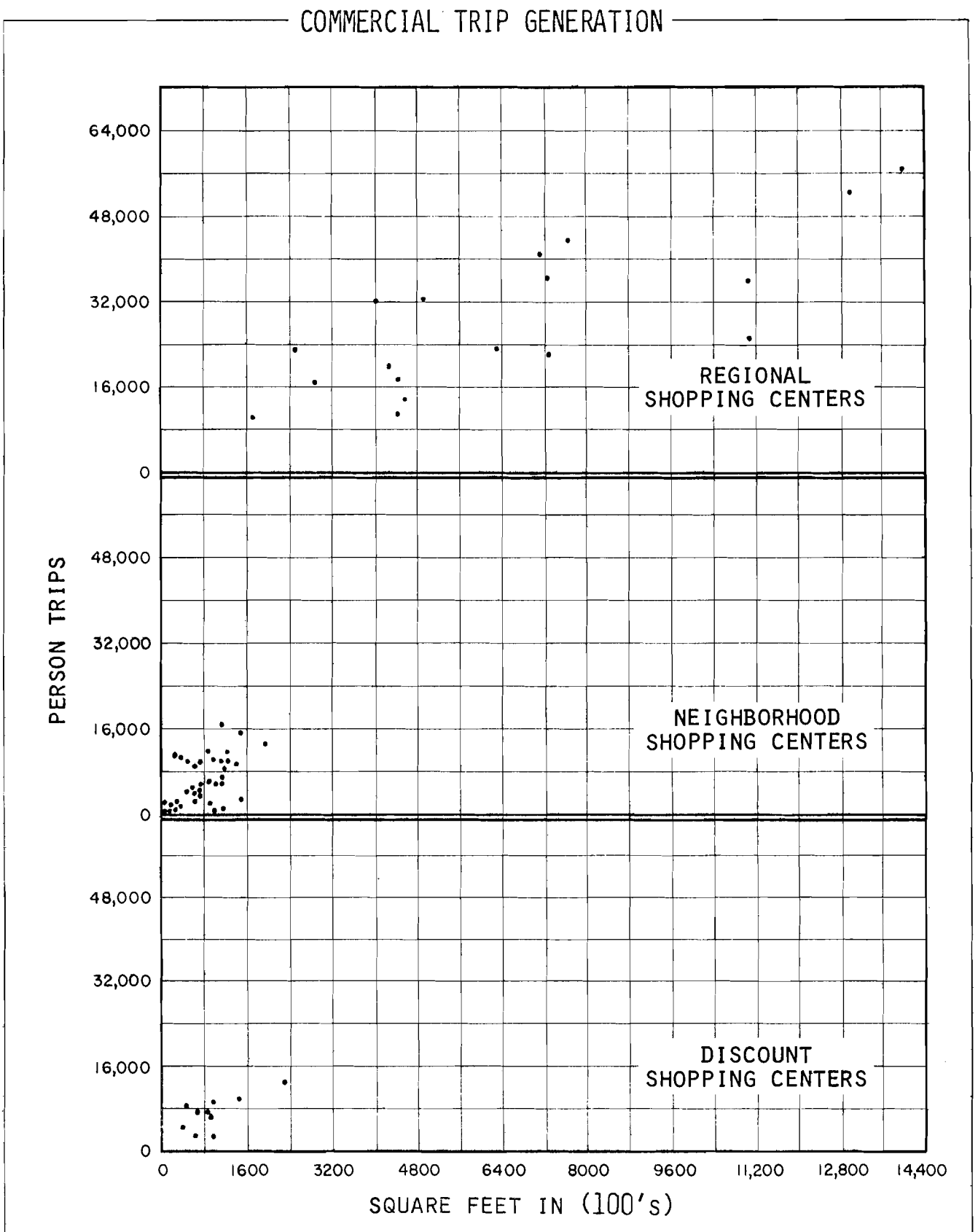


FIGURE 14: PERSON TRIPS GENERATED BY SQUARE FOOTAGE FOR REGIONAL, NEIGHBORHOOD, AND DISCOUNT SHOPPING CENTER.

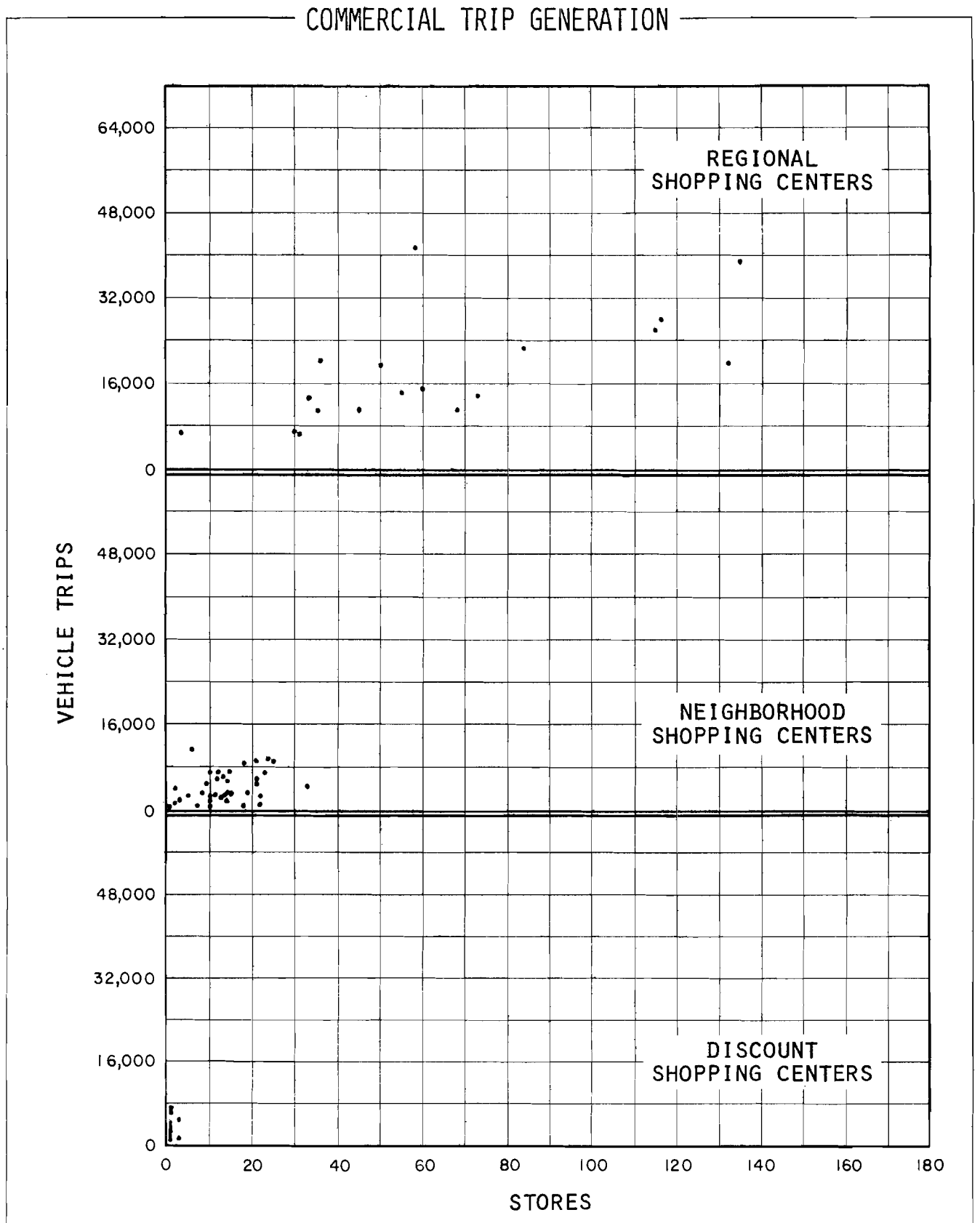


FIGURE 15: VEHICLE TRIPS GENERATED BY NUMBER OF STORES FOR REGIONAL, NEIGHBORHOOD, AND DISCOUNT SHOPPING CENTERS.

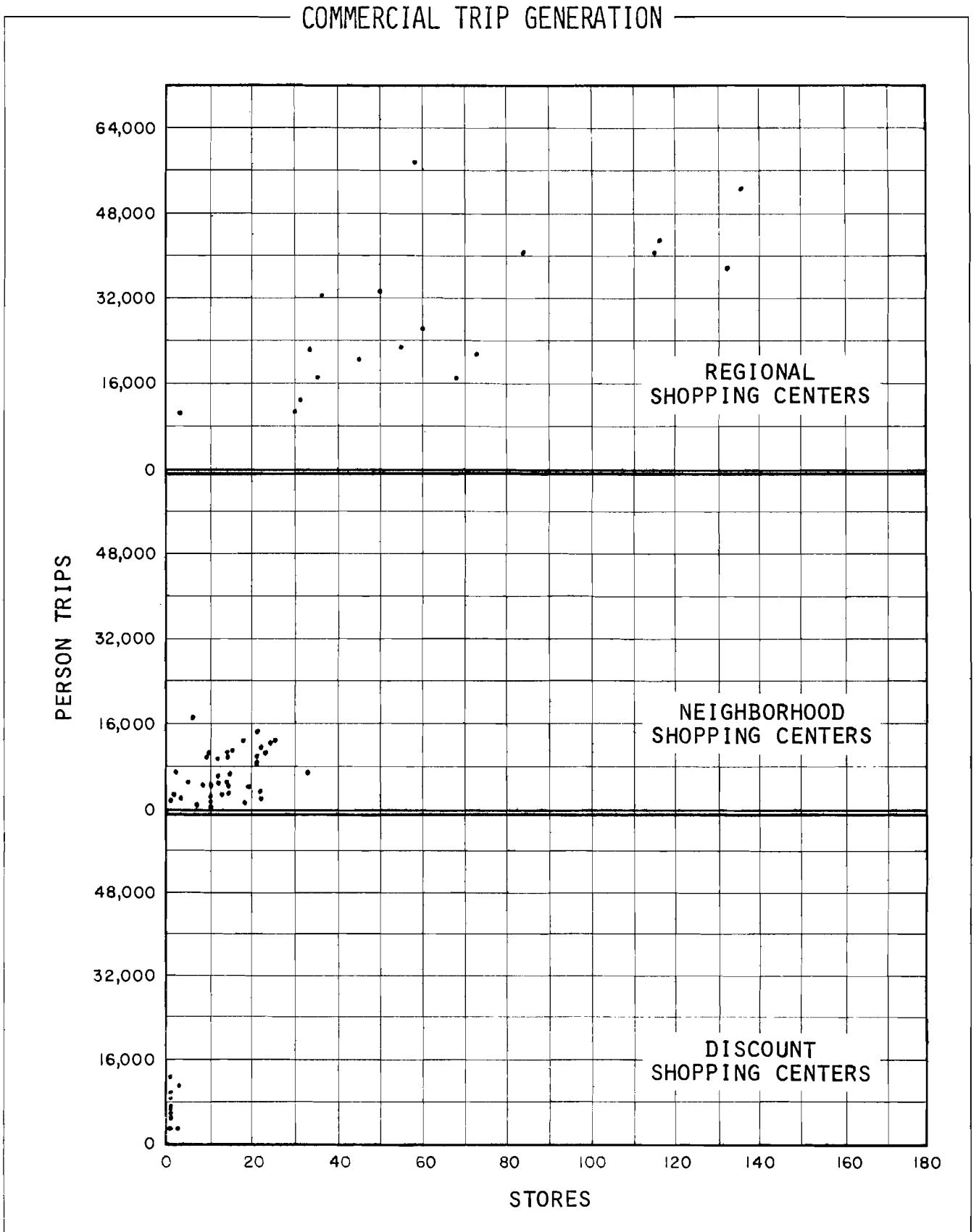


FIGURE 16: PERSON TRIPS GENERATED BY NUMBER OF STORES FOR REGIONAL, NEIGHBORHOOD, AND DISCOUNT SHOPPING CENTERS.

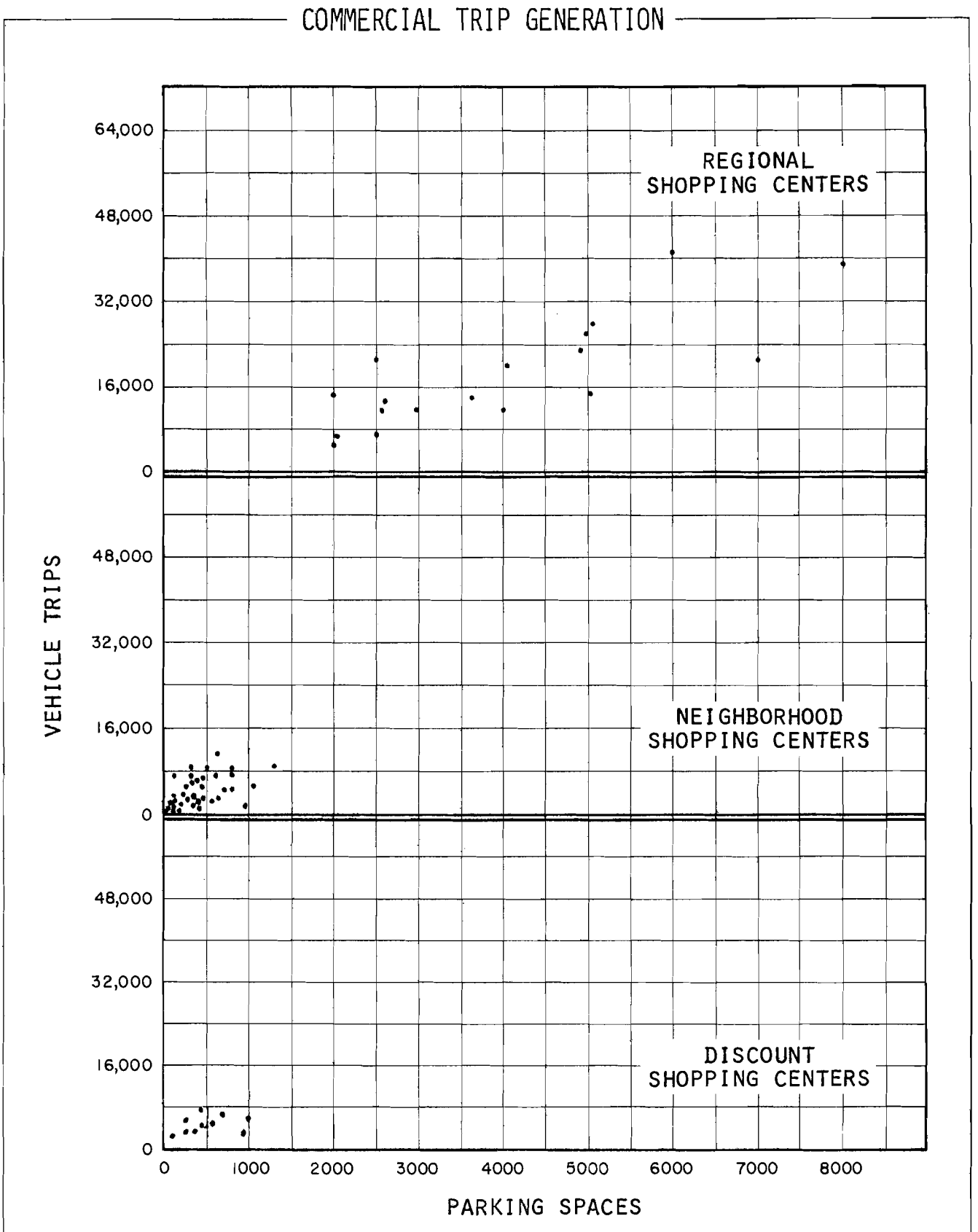


FIGURE 17: VEHICLE TRIPS GENERATED BY NUMBER OF PARKING SPACES FOR REGIONAL, NEIGHBORHOOD, AND DISCOUNT SHOPPING CENTERS.

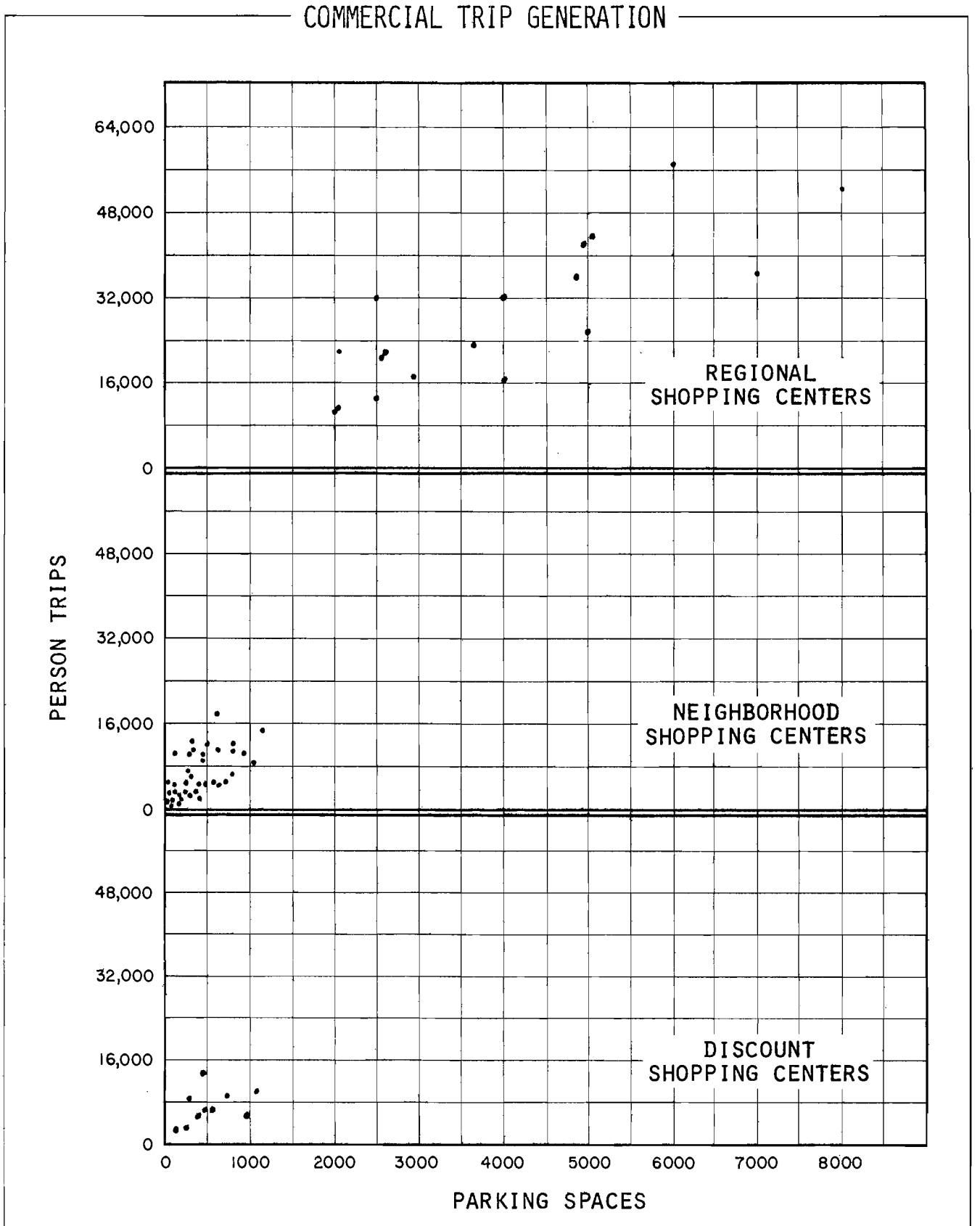


FIGURE 18: PERSON TRIPS GENERATED BY NUMBER OF PARKING SPACES FOR REGIONAL, NEIGHBORHOOD, AND DISCOUNT SHOPPING CENTERS.

results from a high degree of inter-correlation among commercial employment, acreage, square footage, stores, and parking spaces. Consequently, the application of any one of these dependent relationships in forecasting commercial vehicle or person trips would provide about the same level of accuracy.

Commercial Trip Generation
Average Trips Per Employee and Acre
(Table 10)

Commercial Center Type	Areas Counted	Veh. Trips Per Emp.	Std. Dev.	Person Trips Per Emp.	Std. Dev.	Veh. Trips Per Acre	Std. Dev.	Person Trips Per Acre	Std. Dev.
Regional	18	18.0	5.4	28.0	8.1	341.5	154.8	533.0	235.6
Neighborhood									
With Offices	13	32.9	15.4	50.2	23.6	763.0	828.1	1,164.8	1,286.3
W/O Offices	15	56.0	11.8	86.2	20.1	565.9	249.5	870.8	402.5
Strip Dev.	10	25.1	3.8	37.2	7.1	678.9	443.6	1,004.6	703.5
Discount	10	35.5	11.9	56.7	16.7	591.2	351.6	957.4	619.8

Multi-Variable Stratification

Additional analyses of the variables affecting commercial trip generation included an examination of the relationships between individual vehicle trip rates (trips per employee, trips per acre, etc.) and their respective independent variables. Specifically, vehicle trips per employee vs. employment, trips per acre vs. gross acreage, trips per 100 square feet vs. square footage, trips per store vs. number of stores and

trips per parking space vs. number of parking spaces are reflected by a series of scatter diagrams comprising Figures 19-23. As expected, each graph indicates that commercial trip rates are inversely proportional to the size of the shopping area measured in terms of employment, acreage, etc.

Multi-dimensional regression of the functional relationships between commercial trips and shopping center characteristics was individually applied to regional, neighborhood, and discount shopping data. This technique, whereby selected independent variables are allowed to enter the regression equations based on their contribution to accuracy, was executed via the standard Bio Med stepwise multiple regression analysis package. Similar to the computational procedure of simple regression, the process yields a multiple regression equation with the following general form:

$$Y = a + b_1x_1 + b_2x_2 \ldots + b_n x_n.$$

The results indicate that for all three commercial center types, employment and parking spaces are the two most reliable independent variables for establishing regression equations which will adequately quantify commercial shopping trips. The subsequent introduction of acreage, square footage and number of stores into the equations failed to significantly increase the accuracy of prediction. Specific equations from the multiple regression analysis are indicated in Table 11.

Commercial Trip Generation
Multiple Regression
(Table 11)

Commercial Center Type	Dependent Variable (Y)	Regression Equation	Correlation Coefficient (R)	Determination Coefficient (R^2)
Regional	Person Trips	= 3121.5 + 6.4 *Parking	.8234	.6780
		= 1132.7 + 10.6 *Employment + 4.3 *Parking	.8948	.8008
	Vehicle Trips	= 664.2 + 4.4 *Parking	.7912	.6261
		= -754.5 + 7.5 *Employment + 2.9 *Parking	.8638	.7461
Neighbor-hood	Person Trips	= 263.1 + 39.0 *Employment	.9236	.8530
		= 295.5 + 37.8 *Employment + 0.6 *Parking	.9247	.8552
	Vehicle Trips	= 42.8 + 24.8 *Employment	.9593	.9202
		= 31.9 + 24.3 *Employment + 0.2 *Parking	.9597	.9210
Discount	Person Trips	= 2234.9 + 40.0 *Employment	.8356	.6982
		= 1493.6 + 37.4 *Employment + 2.1 *Employment	.8596	.7389
	Vehicle Trips	= 1697.7 + 21.0 *Employment	.7309	.5342
		= 1419.1 + 20.0 *Employment + 0.8 *Parking	.7418	.5502

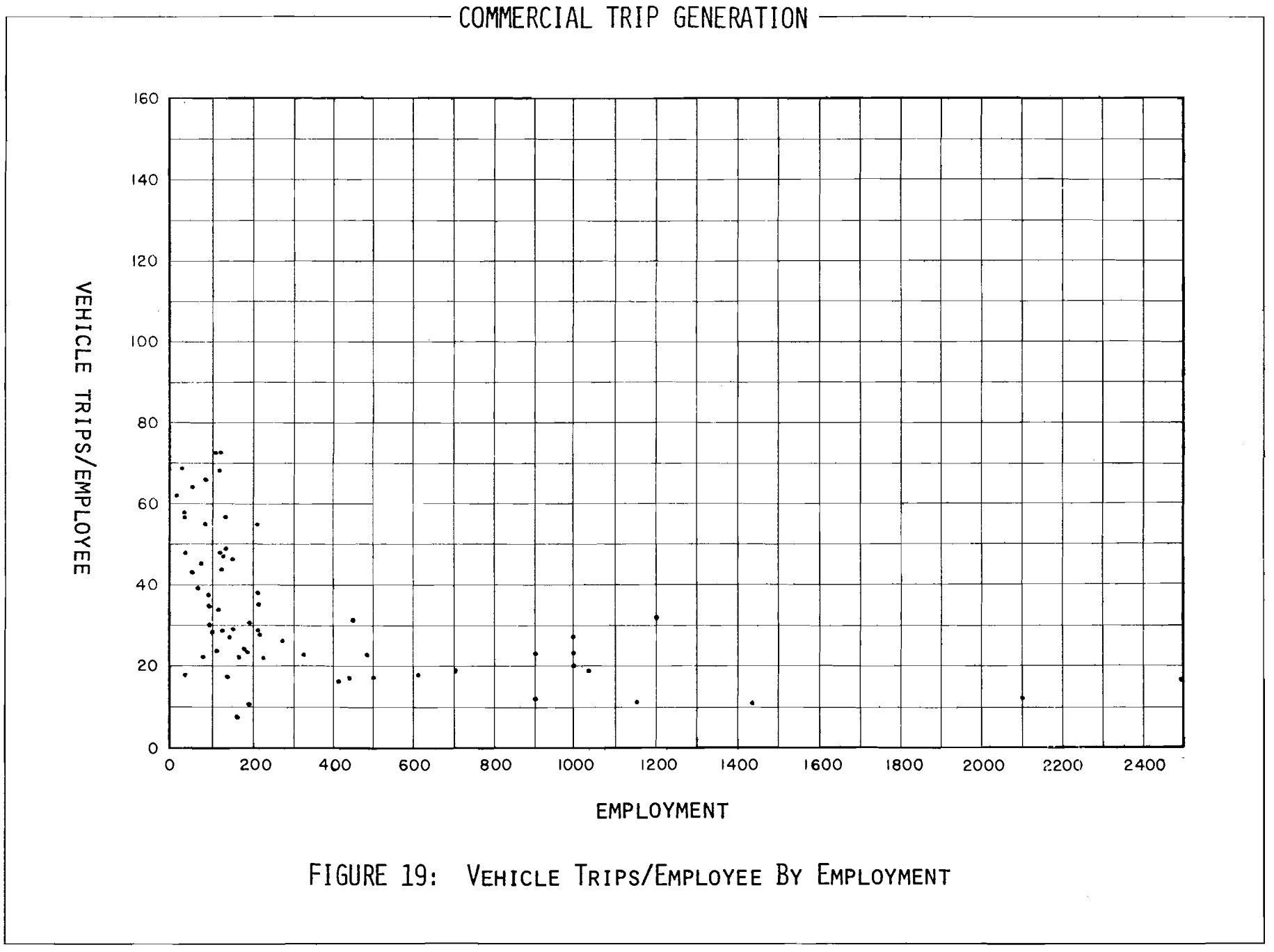


FIGURE 19: VEHICLE TRIPS/EMPLOYEE BY EMPLOYMENT

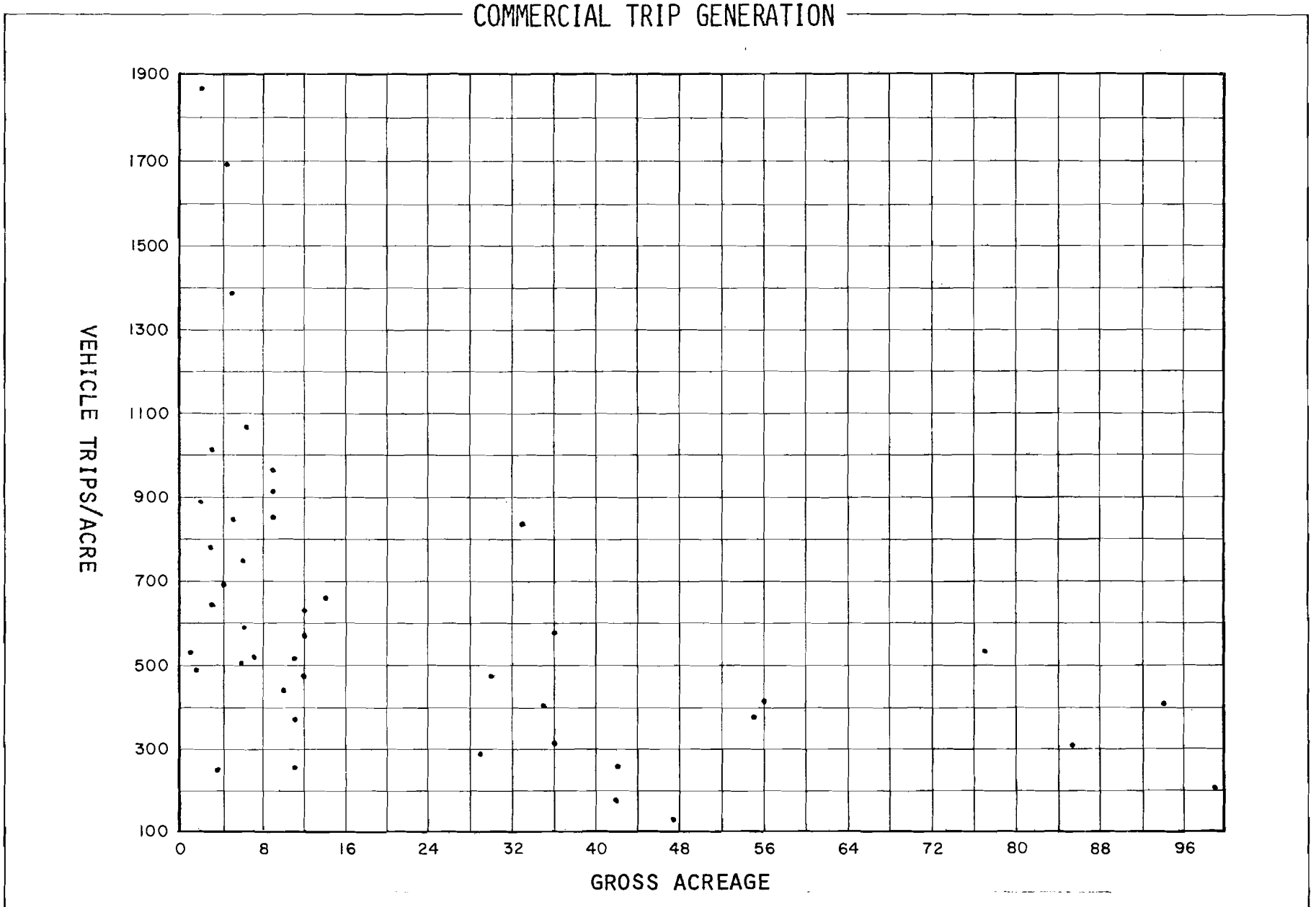


FIGURE 20: VEHICLE TRIPS/ACRE BY NUMBER OF ACRES IN CENTER

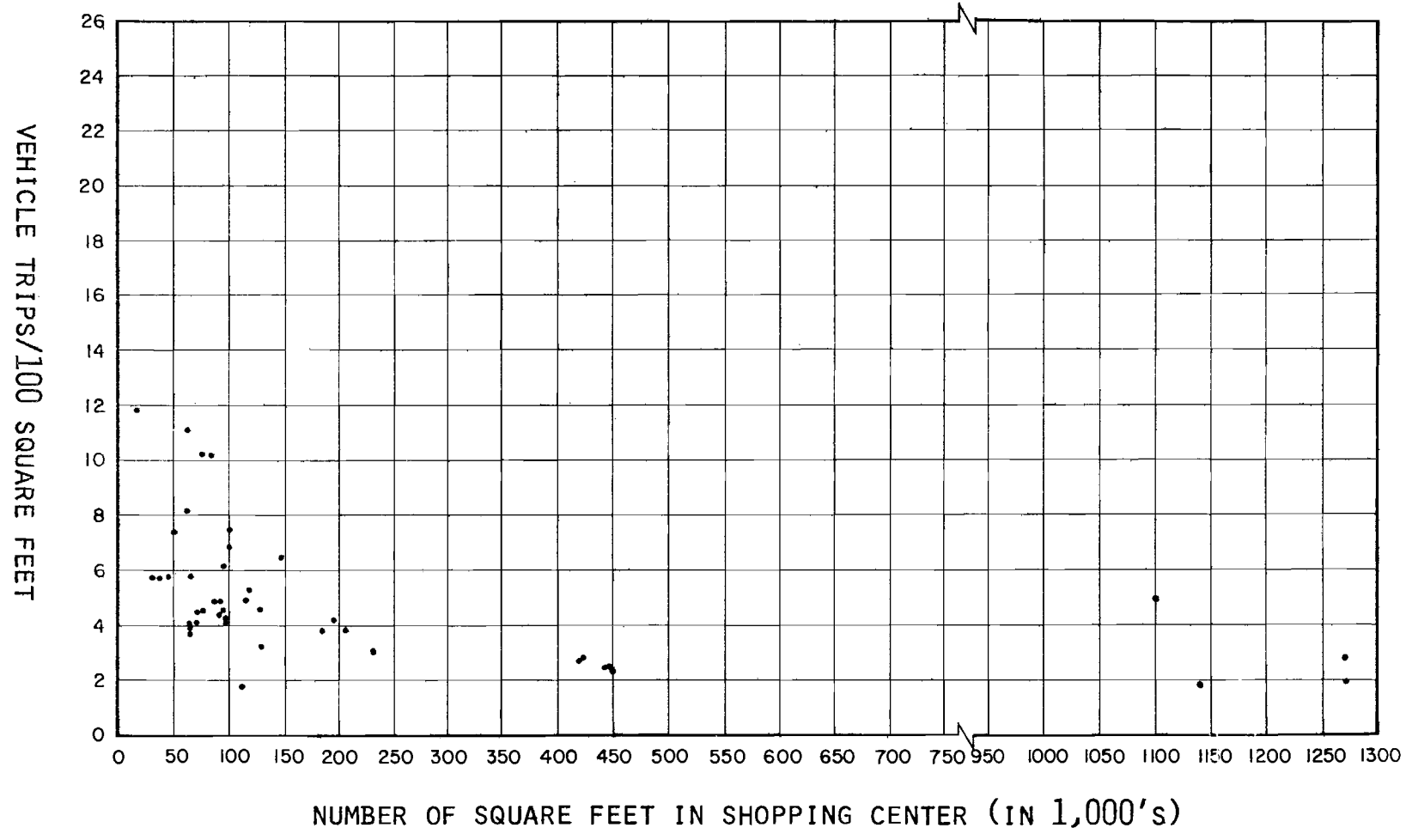


FIGURE 21: VEHICLE TRIPS/100 SQUARE FEET BY NUMBER OF SQUARE FEET IN CENTER

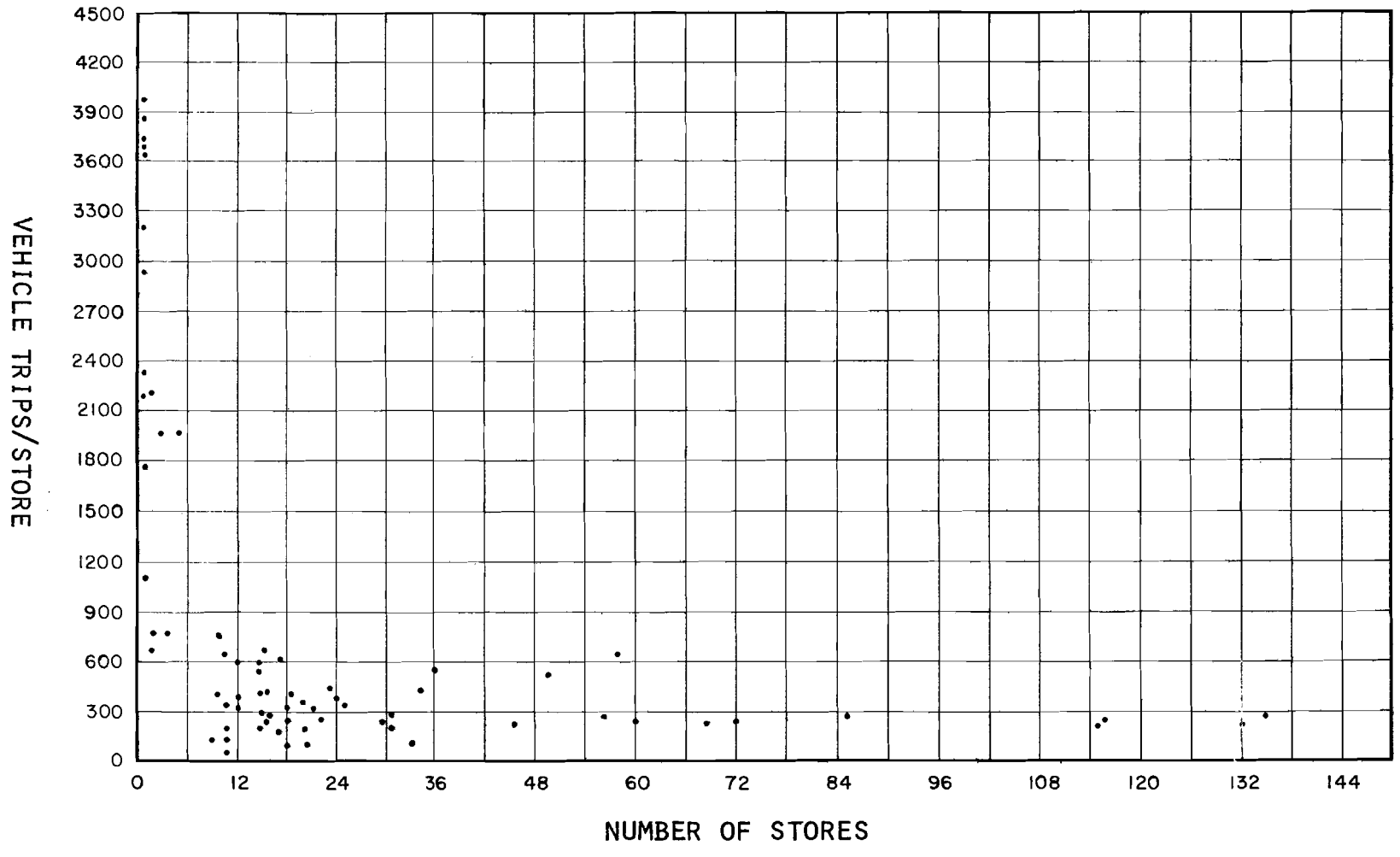


FIGURE 22: VEHICLE TRIPS/STORE BY NUMBER OF STORES IN CENTER

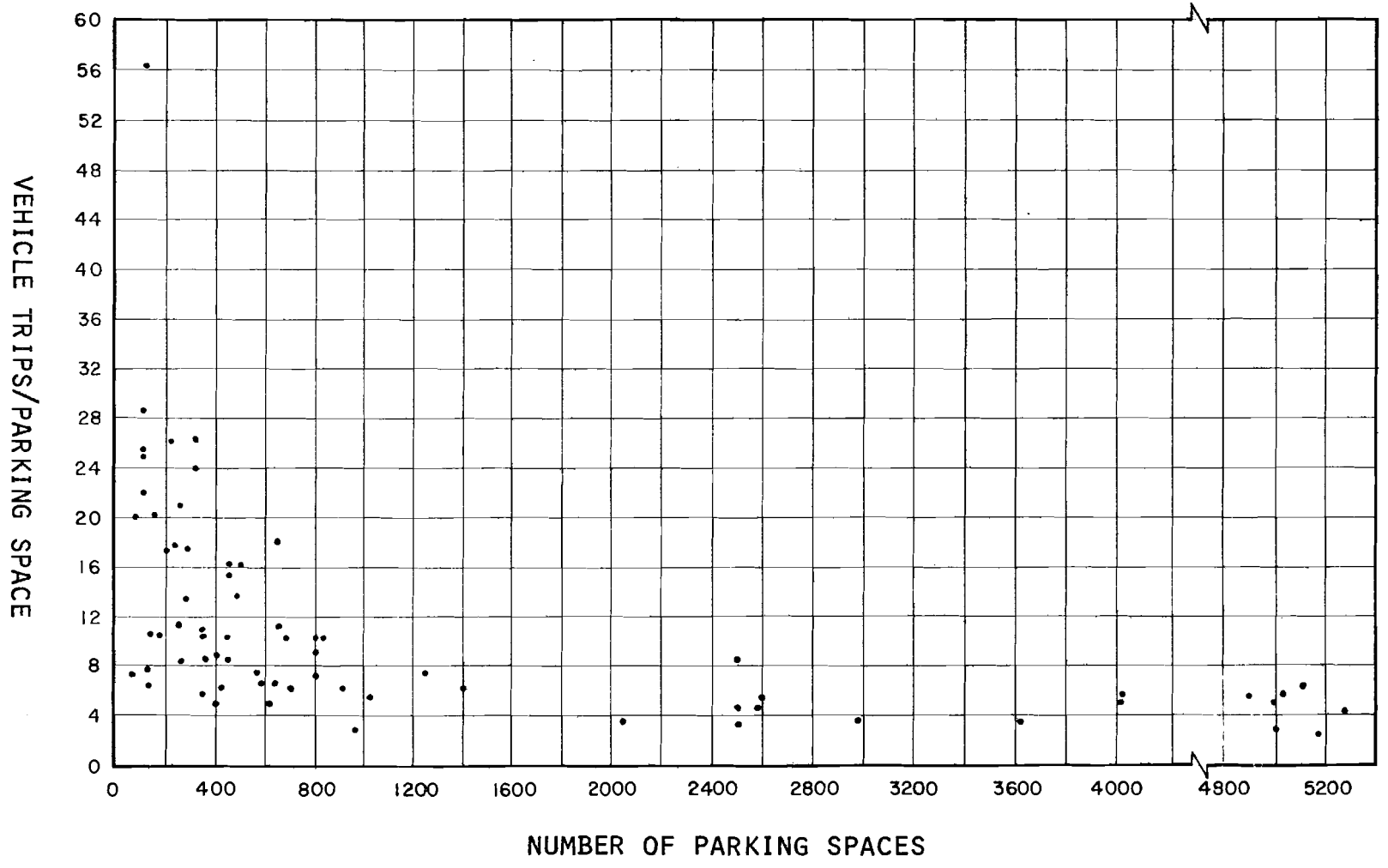


FIGURE 23: VEHICLE TRIPS/PARKING SPACE BY NUMBER OF PARKING SPACE

Conclusions

In order to facilitate the application of commercial trip generation data from this report, several important considerations should be summarized.

1. Commercial shopping trip generation is significantly affected by pronounced seasonal and daily variation, inclement weather and special promotional sales. Trip rates tend to be higher on weekends and in December.
2. A rather disturbing magnitude of trip rate fluctuation remains evident within commercial center groups which were stratified by size and center type.
3. The high degree of inter-correlation among independent variables which affect commercial trip generation makes possible the selection of employment, acreage, square footage, number of stores, or number of parking spaces as an approximately equal basis for forecasting trips. However, according to the stepwise multiple regression analysis, the independent variables of commercial employment and number of parking spaces yield the greatest accuracy in forecasting commercial trips.

INDUSTRIAL TRAFFIC GENERATION ANALYSIS

Analyses of the trip generation characteristics of industrial shipping and manufacturing concerns were conducted through the examination of 86 industrial sites from 19 urban areas within the State of Texas. Because of inherent trip generation characteristics whereby industrial trip rates fluctuate dramatically among industry types (although work trip rates remain relatively consistant) each generator was categorized by the following functions:

Rubber Product Mfg.
Clothing Product Mfg.
Electronic Instrument Mfg.
Heavy Equipment and Machinery
Paper Product Mfg. and Printing
Warehousing
Steel and Pipe Mfg.
Oil Well Machine Shop and Service
Shipping/Port Industries
Electric Power Generation
Food Product Processing
Chemical Processing
Cement Product Mfg.
Mixed Light Industries (Industrial Parks)

Basic Industrial Data Collection

In addition to the examination of the industrial functions at each site, further analysis of variables affecting trip generation was conducted. The type of information gathered included number of employees by shift, gross acreage, number of acres of open space or storage, square feet of floor space, acres of parking, work shift scheduling, and seasonal information.

Generation Rate Development

The development of vehicle and person trip rates for each of the fifteen industrial categories by employment, square footage and acreage is indicated in Table 12 (beginning on page 66). To maintain confidentiality, each industrial site is identified only by its function.

The resulting trip generation rate calculations reveal a high degree of rate fluctuation between, as well as within the industrial classifications. Consequently, from a statistical point of view, it seems rather ambitious to develop specific trip generation rates for individual industrial sites. However, in the absence of additional site characteristics, the application of an average generation rate is the only alternative. A more precise measure of industrial trip rate variation (for trips per employee and acre) by each industrial category appears in Table 13.

Industrial vehicle and person trip generations are graphically represented through several scatter diagrams comprising Figures 24, 25 and 26. Counted vehicle and person trips entering or leaving each industrial site are plotted for the number of employees, gross acreage and square footage which characterize that site.

INDUSTRIAL TRIP GENERATION

Average Trips By Employment And Acreage
(Table 13)

Industrial Category	Areas Counted	Vehicle Trips Per Employee	Standard Dev.	Person Trips Per Employee	Standard Dev.	Vehicle Trips Per Acre	Standard Dev.	Person Trips Per Acre	Standard Dev.
Rubber Pro.	5	1.9	0.53	2.4	0.75	5.7	24.1	7.0	28.2
Clothing Pro.	7	1.7	0.44	2.7	0.34	36.6	30.1	57.6	49.2
Electronic	14	2.3	0.63	2.8	0.68	14.1	44.3	17.4	53.5
Heavy Equip.	6	3.1	0.87	4.2	1.06	20.7	19.5	28.2	29.6
Paper Pro.	3	3.2	0.55	3.7	0.35	1.5	15.7	1.8	20.7
Warehousing	1	3.1	--	3.4	--	28.1	--	30.6	--
Steel & Pipe	7	2.5	0.38	3.0	0.59	6.7	25.5	8.0	33.1
Oil Wells Ser.	2	4.3	0.35	5.7	0.78	67.4	35.6	88.9	50.3
Shipping/Port	2	3.4	0.92	4.5	1.34	14.3	8.7	18.7	11.7
Electric Pwr.	1	3.5	--	4.2	--	2.5	--	3.0	--
Food Pro.	6	3.4	0.88	4.0	1.05	15.2	40.8	17.7	52.8
Chemical Pro.	18	3.4	1.61	5.4	1.86	5.0	26.5	7.9	30.2
Cement Pro.	2	6.7	1.41	7.5	1.34	2.2	1.7	2.5	1.7
Mixed Ind.	12	3.6	1.13	4.4	1.30	12.4	37.2	15.3	45.7

INDUSTRIAL TRIP GENERATION

Vehicle and Person Trip Rates by Industrial Category

Table 12

Industrial Category	Employment	Gross Acreage	Usable Acreage	Building Square Footage	Auto And Pickup Trips	Total Vehicle Trips	Vehicle Trips per Employee
Rubber Product Manufacturing	1,405	44.5	--	1,200,000	2,344	2,550	1.8
	367	880.0	94.0	298,705	932	1,050	2.9
	571	115.0	--	--	790	870	1.5
	243	192.3	--	225,450	536	536	2.2
	1,300	78.0	--	1,200,000	2,322	2,438	1.9
Clothing Product Manufacturing	201	45.0	--	137,200	512	564	2.8
	850	26.0	--	520,000	1,718	1,828	2.2
	1,000	145.0	--	728,000	2,066	2,174	2.2
	507	11.5	--	94,114	974	996	2.0
	950	20.0	--	123,000	1,636	1,648	1.7
	4,300	116.0	--	1,300,000	5,682	5,914	1.4
	519	21.9	--	96,500	906	964	1.9
Electronic Instrument Manufacturing	1,800	400.0	40.0	642,000	4,954	5,150	2.9
	1,000	400.0	15.0	210,000	2,232	2,338	2.3
	300	77.7	--	600,000	542	592	2.0
	1,520	74.7	14.0	150,000	2,622	2,638	1.7
	290	20.0	--	40,000	384	418	1.4
	850	25.7	--	168,000	1,858	1,890	2.2
	920	20.0	--	239,000	2,958	3,014	3.3
	1,100	45.0	--	500,000	2,312	2,434	2.2
	1,800	740.0	--	340,000	3,266	3,348	1.9
	200	210.0	--	103,500	526	550	2.8
	500	16.4	--	173,840	1,822	1,854	3.7
	1,620	125.0	--	100,000	3,022	3,146	1.9

INDUSTRIAL TRIP GENERATION

Vehicle and Person Trip Rates by Industrial Category

Table 12 Continued

Vehicle Trips per Acre	Vehicle Trips per Usable Acre	Vehicle Trips per 100 Sq Ft	Vehicle Occupancy Rate	Total Person Trips	Person Trips per Employee	Person Trips per Acre	Person Trips per Usable Acre	Person Trips per 100 Sq Ft
57.3	--	0.213	1.2	2,968	2.1	66.7	--	0.248
1.2	11.2	0.352	1.3	1,386	3.8	1.6	14.7	0.464
7.6	--	--	1.3	1,100	1.9	9.6	--	--
2.8	--	0.238	1.2	634	2.6	3.3	--	0.281
31.3	--	0.203	1.2	3,046	2.3	39.1	--	0.254
12.5	--	0.411	1.2	690	3.4	15.3	--	0.503
70.3	--	0.352	1.3	2,328	2.7	89.5	--	0.447
15.0	--	0.299	1.3	2,916	2.9	20.1	--	0.400
86.6	--	1.058	1.5	1,524	3.0	132.5	--	1.620
82.4	--	1.340	1.7	2,838	3.0	141.9	--	2.307
51.0	--	0.455	1.7	10,184	2.4	87.8	--	0.783
44.0	--	0.999	1.8	1,720	3.3	78.5	--	1.782
12.9	128.8	0.803	1.1	5,468	3.0	13.7	136.7	0.852
5.8	156.0	1.113	1.1	2,606	2.6	6.5	173.7	1.241
7.6	--	0.099	1.3	778	2.6	10.0	--	0.130
35.3	188.4	1.759	1.4	3,720	2.5	49.8	265.7	2.480
20.9	--	1.045	1.2	490	1.7	24.5	--	1.225
73.5	--	1.125	1.4	2,582	3.0	100.5	--	1.536
150.7	--	1.261	1.2	3,570	3.9	178.5	--	1.494
54.1	--	0.487	1.2	2,902	2.6	64.5	--	0.580
4.5	--	0.985	1.3	4,244	2.4	5.7	--	1.248
2.6	--	0.531	1.1	630	3.2	3.0	--	0.609
113.1	--	1.067	1.2	2,246	4.5	137.0	--	1.292
25.2	--	0.315	1.3	4,078	2.5	32.6	--	0.408

INDUSTRIAL TRIP GENERATION

Vehicle and Person Trip Rates by Industrial Category

Table 12 Continued

Industrial Category	Employment	Gross Acreage	Usable Acreage	Building Square Footage	Auto And Pickup Trips	Total Vehicle Trips	Vehicle Trips per Employee
Electronic Instrument Manufacturing (Cont.)	465	20.0	--	400,000	1,072	1,160	2.5
	2,055	150.0	--	786,000	4,074	4,332	2.1
Heavy Equipment and Machinery	497	38.7	--	500,000	1,862	2,076	4.2
	700	42.5	--	300,000	1,560	1,740	2.5
	530	105.2	--	248,000	1,454	1,568	3.0
	325	112.0	--	135,000	908	922	2.8
	11	12.0	--	8,000	42	52	4.7
	65	10.0	--	80,000	170	204	3.1
Paper Product Manufacturing and Printing	171	19.7	--	104,000	502	514	3.0
	330	1,200.0	56.0	244,218	768	1,156	3.5
	76	6.0	--	78,000	160	180	2.4
Warehousing	200	22.0	--	600,000	574	618	3.1
Steel and Pipe Manufacturing	80	45.0	--	37,200	198	238	3.0
	300	14.0	--	740,000	874	906	3.0
	243	60.0	--	217,800	660	790	3.3
	1,400	128.0	--	508,000	3,296	3,376	2.4
	1,075	475.0	--	1,437,480	2,262	2,358	2.2
	100	5.0	--	90,000	268	274	2.7
	735	747.0	--	7,710,000	1,744	1,898	2.6
Oil Well Machine Shop and Service	60	6.1	--	108,900	128	238	4.0
	165	8.3	--	81,369	722	742	4.5

INDUSTRIAL TRIP GENERATION

Vehicle and Person Trip Rates by Industrial Category

Table 12 Continued

Vehicle Trips per Acre	Vehicle Trips per Usable Acre	Vehicle Trips per 100 Sq Ft	Vehicle Occupancy Rate	Total Person Trips	Person Trips per Employee	Person Trips per Acre	Person Trips per Usable Acre	Person Trips per 100 Sq Ft
58.0	--	0.290	1.2	1,414	3.0	70.0	--	0.354
28.9	--	0.550	1.3	5,622	2.7	37.5	--	0.715
53.6	--	0.415	1.5	3,038	6.1	78.5	--	0.608
40.9	--	0.580	1.5	2,544	3.6	59.9	--	0.848
14.9	--	0.632	1.2	1,870	3.5	17.8	--	0.754
8.2	--	0.683	1.3	1,184	3.6	10.9	--	0.877
4.3	--	0.650	1.1	56	5.1	4.7	--	0.700
20.4	--	0.255	1.2	254	3.9	25.4	--	0.318
26.1	--	0.494	1.3	650	3.8	33.0	--	0.625
1.0	20.6	0.473	1.1	1,266	3.8	1.1	22.6	0.518
30.0	--	0.231	1.3	240	3.2	40.0	--	0.308
28.1	--	0.103	1.1	674	3.4	30.6	--	0.112
5.3	--	0.640	1.2	286	3.6	6.4	--	0.769
64.7	--	0.122	1.3	1,214	4.1	86.7	--	0.164
13.2	--	0.363	1.2	986	4.1	16.4	--	0.453
26.4	--	0.665	1.2	3,984	2.8	31.1	--	0.784
5.0	--	0.164	1.3	2,966	2.8	6.2	--	0.206
54.8	--	0.304	1.2	332	3.3	66.4	--	0.369
2.5	--	0.025	1.1	2,046	2.8	2.7	--	0.027
39.0	--	0.219	1.2	292	4.9	47.9	--	0.268
89.4	--	0.912	1.3	988	6.0	119.0	--	1.215

INDUSTRIAL TRIP GENERATION

Vehicle and Person Trip Rates by Industrial Category

Table 12 Continued

Industrial Category	Employment	Gross Acreage	Usable Acreage	Building Square Footage	Auto And Pickup Trips	Total Vehicle Trips	Vehicle Trips per Employee
Shipping/Port Industries	1,966	644.0	--	736,200	5,092	5,144	2.6
	3,500	674.0	--	1,636,190	10,518	13,678	3.9
Electric Power Generation	74	104.0	2.5	108,480	256	258	3.5
Food Product Processing	225	9.2	--	86,000	634	802	3.6
	175	185.0	--	541,760	354	414	2.4
	425	168.0	--	--	774	834	2.0
	271	10.0	--	200,000	802	874	3.2
	335	14.7	5.8	125,383	1,068	1,194	3.6
	729	96.3	15.1	425,685	3,028	3,238	4.4
Chemical Processing	200	142.2	--	--	646	684	3.4
	18	20.0	--	--	52	70	3.9
	2,179	1,050.0	100.0	--	7,454	7,872	3.6
	180	60.0	--	15,000	636	1,022	5.7
	2,064	1,377.0	--	--	6,528	6,540	3.2
	243	405.0	15.8	686,070	1,248	1,364	5.6
	468	96.0	43.0	125,000	1,258	1,302	2.8
	77	56.0	11.6	506,167	542	606	7.9
	122	5.0	--	58,800	394	462	3.8
	72	108.0	4.0	175,000	254	280	3.9
	428	395.4	4.8	209,900	962	982	2.3
	482	1,000.0	--	65,000	1,510	1,536	3.2
	42	32.2	--	32,825	140	146	3.5
	350	62.0	--	205,450	1,030	1,172	3.3
	75	5.8	--	31,200	464	478	6.4

INDUSTRIAL TRIP GENERATION

Vehicle and Person Trip Rates by Industrial Category

Table 12 Continued

Vehicle Trips per Acre	Vehicle Trips per Usable Acre	Vehicle Trips per 100 Sq Ft	Vehicle Occupancy Rate	Total Person Trips	Person Trips per Employee	Person Trips per Acre	Person Trips per Usable Acre	Person Trips per 100 Sq Ft
8.0	--	0.699	1.3	6,568	3.3	10.2	--	0.892
20.3	--	0.836	1.3	18,092	5.2	26.8	--	1.106
2.5	103.2	0.238	1.2	308	4.2	3.0	123.2	0.284
87.2	--	0.933	1.4	1,138	5.1	123.7	--	1.323
2.2	--	0.076	1.3	536	3.1	2.9	--	0.099
5.0	--	--	1.2	962	2.3	5.7	--	--
87.4	--	0.437	1.2	1,054	3.9	105.4	--	0.527
81.2	205.9	0.952	1.1	1,356	4.1	92.2	233.8	1.081
33.6	214.4	0.761	1.1	3,486	4.8	36.2	230.9	0.819
4.8	--	--	1.2	802	4.0	5.6	--	--
3.5	--	--	1.1	78	4.3	3.9	--	--
7.5	78.7	--	1.5	12,060	5.5	11.5	120.6	--
17.0	--	6.813	1.1	1,080	6.0	18.0	--	7.200
4.8	--	--	2.3	15,114	7.3	11.0	--	--
3.4	86.3	0.199	1.2	1,676	6.9	4.1	106.1	0.244
13.6	30.3	1.042	1.3	1,702	3.6	17.7	39.6	1.362
10.8	52.2	0.120	1.2	740	9.6	13.2	63.8	0.146
92.4	--	0.786	1.2	536	4.4	107.2	--	0.912
2.6	70.0	0.160	1.1	320	4.4	3.0	80.0	0.183
2.5	204.6	0.468	1.4	1,378	3.2	3.5	287.1	0.657
1.5	--	2.363	1.2	1,868	3.9	1.9	--	2.900
4.5	--	0.445	1.2	170	4.0	5.3	--	0.518
18.9	--	0.570	1.1	1,310	3.7	21.1	--	0.638
82.4	--	1.532	1.1	542	7.2	93.4	--	1.737

INDUSTRIAL TRIP GENERATION

Vehicle and Person Trip Rates by Industrial Category

Table 12 Continued

Industrial Category	Employment	Gross Acreage	Usable Acreage	Building Square Footage	Auto And Pickup Trips	Total Vehicle Trips	Vehicle Trips Per Employee
Chemical Processing (Cont.)	50	34.1	--	18,200	274	334	6.7
	662	412.0	--	--	1,320	1,350	2.0
	130	110.0	--	96,000	442	518	4.0
Cement Product Manufacturing	121	462.0	10.0	77,400	550	708	5.9
	91	184.0	8.0	340,000	482	718	7.9
Mixed Light Industries (Industrial Parks)	744	21.3	--	460,000	2,010	2,218	3.0
	425	54.0	--	236,500	1,314	1,468	3.5
	275	--	--	--	1,010	1,132	4.1
	553	1,043.5	--	110,019	1,914	1,946	3.5
	71	43.5	--	45,019	404	410	5.8
	373	27.8	--	371,000	1,124	1,418	3.8
	1,128	81.1	--	463,300	2,962	3,024	2.7
	517	28.5	--	500,000	2,558	3,070	5.9
	358	33.2	--	396,000	968	1,130	3.2
	1,952	599.6	--	724,200	4,840	4,892	2.5
	753	56.0	--	465,000	3,516	3,820	5.1
	40	11.5	--	35,000	148	156	3.9

INDUSTRIAL TRIP GENERATION

Vehicle and Person Trip Rates by Industrial Category

Table 12 Continued

Vehicle Trips per Acre	Vehicle Trips per Usable Acre	Vehicle Trips per 100 Sq Ft	Vehicle Occupancy Rate	Total Person Trips	Person Trips per Employee	Person Trips per Acre	Person Trips per Usable Acre	Person Trips per 100 Sq Ft
9.8	--	1.835	1.2	392	7.8	11.5	--	2.154
3.3	--	--	1.5	1,994	3.0	4.8	--	--
4.7	--	0.540	1.2	602	4.6	5.5	--	0.627
1.5	70.8	0.915	1.2	814	6.7	1.8	81.4	1.051
3.9	89.8	0.211	1.1	780	8.6	4.2	97.5	0.229
104.1	--	0.482	1.3	2,888	3.9	135.6	--	0.628
27.2	--	0.621	1.6	2,354	5.5	43.6	--	0.995
--	--	--	1.1	1,284	4.7	--	--	--
1.9	--	1.769	1.2	2,366	4.3	2.3	--	2.151
9.4	--	0.911	1.2	498	7.0	11.4	--	1.106
51.0	--	0.382	1.2	1,744	4.7	62.7	--	0.470
37.3	--	0.653	1.2	3,482	3.1	42.9	--	0.752
107.7	--	0.614	1.2	3,656	7.1	128.3	--	0.731
34.0	--	0.285	1.3	1,490	4.2	44.8	--	0.376
8.2	--	0.676	1.3	6,250	3.2	10.4	--	0.863
68.2	--	0.822	1.2	4,422	5.9	79.0	--	0.951
13.6	--	0.446	1.3	200	5.0	17.4	--	0.571

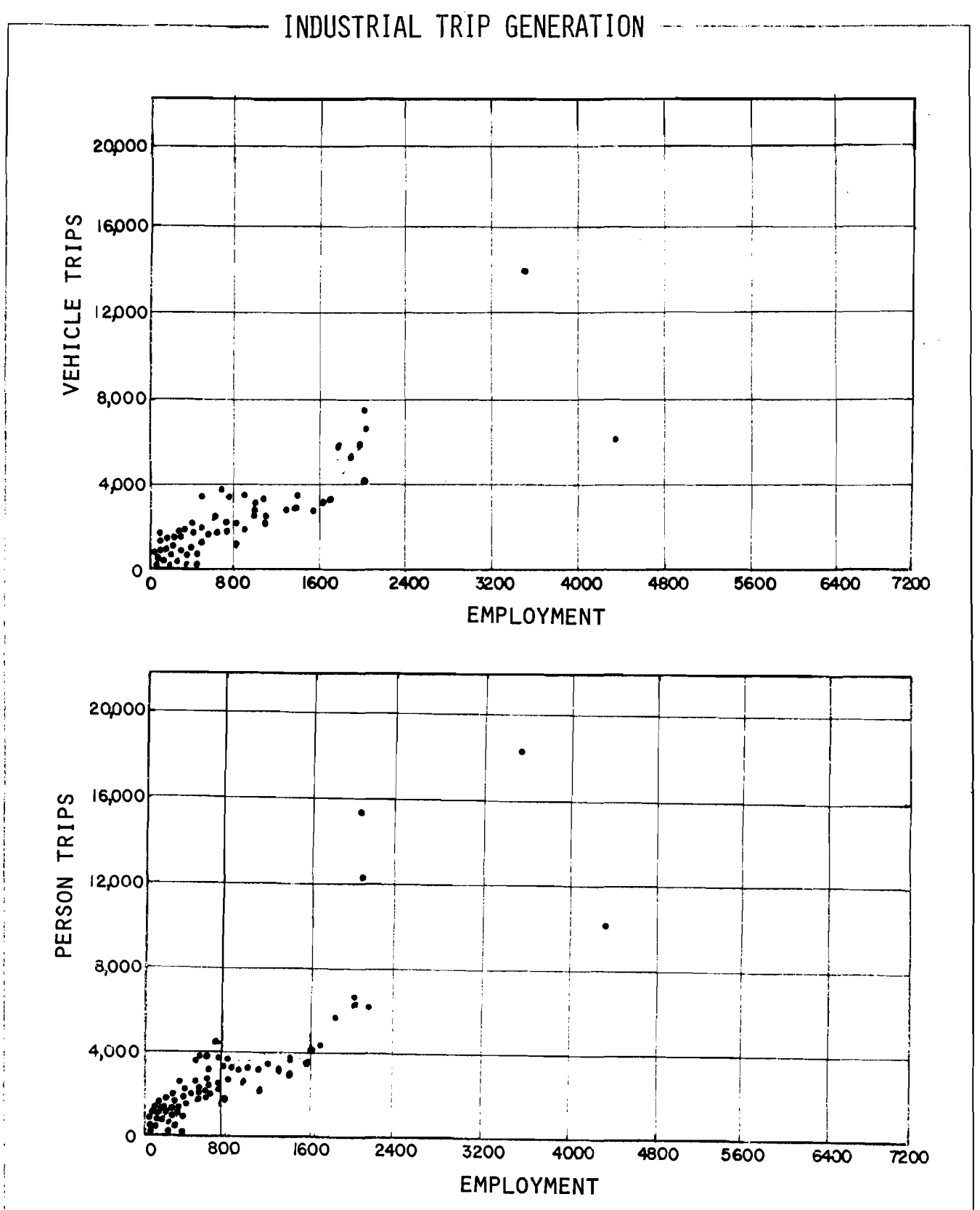
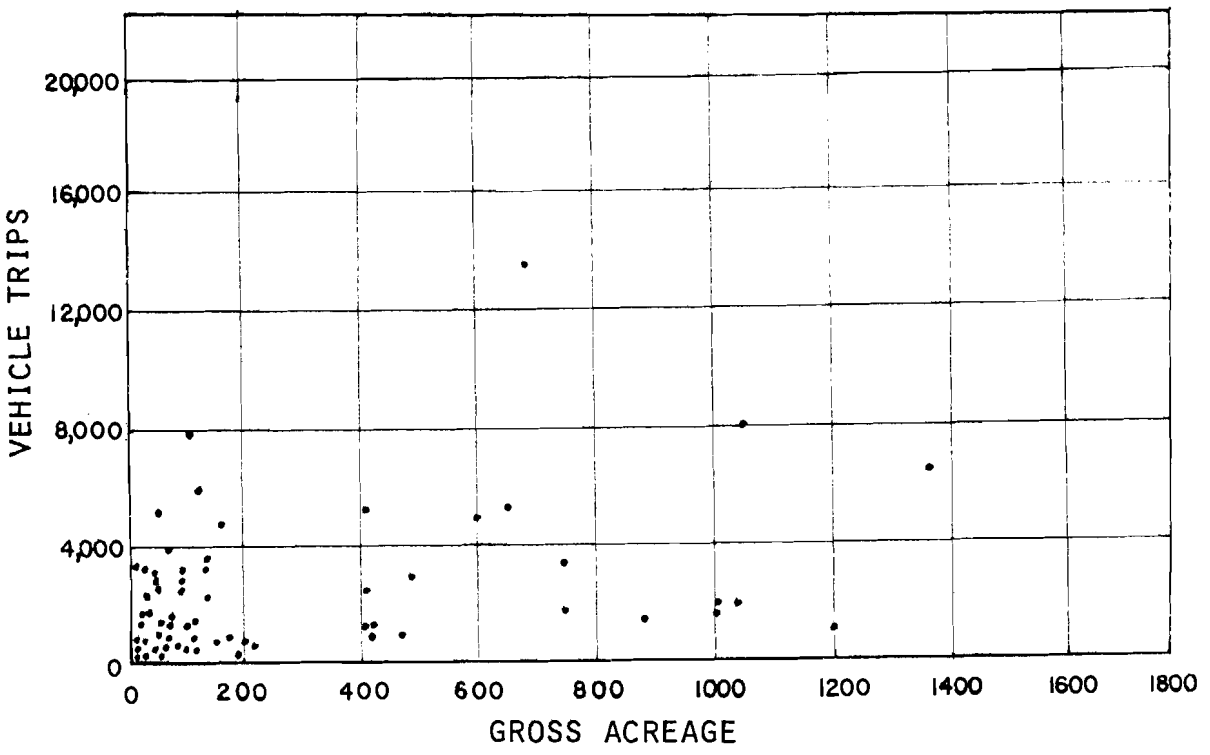


FIGURE 24: PERSON TRIPS AND VEHICLE TRIPS GENERATED BY INDUSTRIAL EMPLOYMENT.



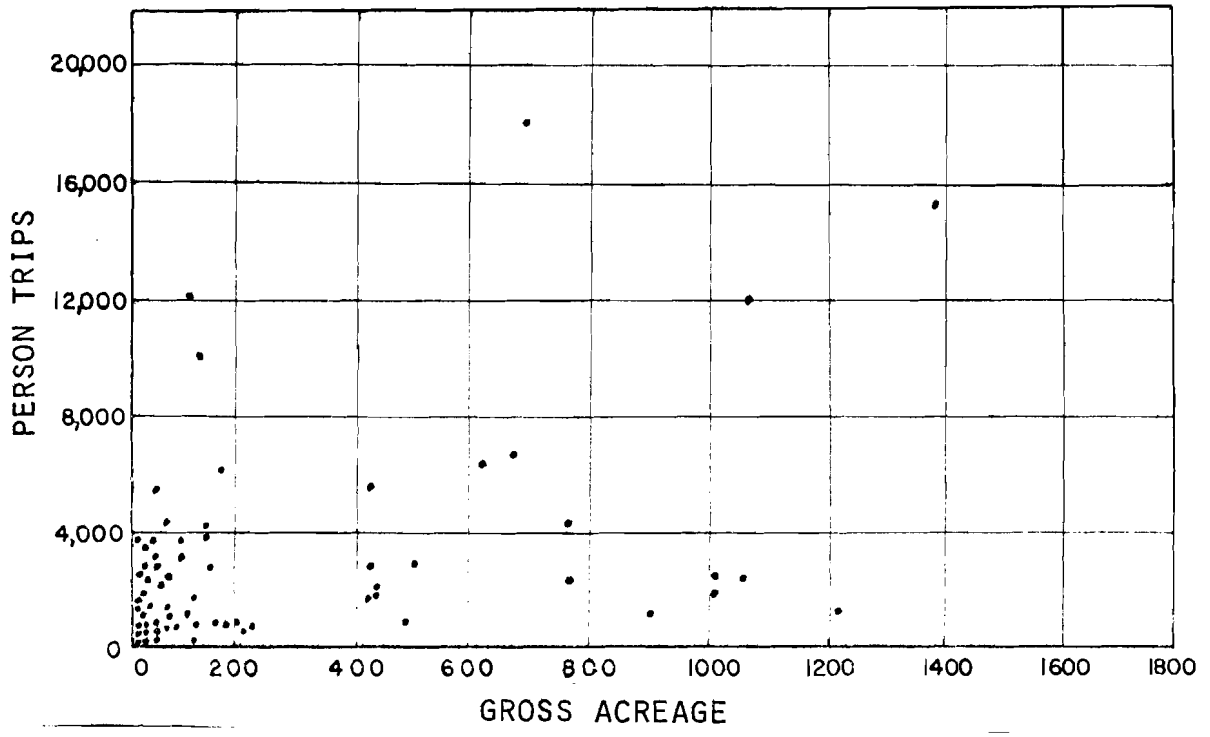
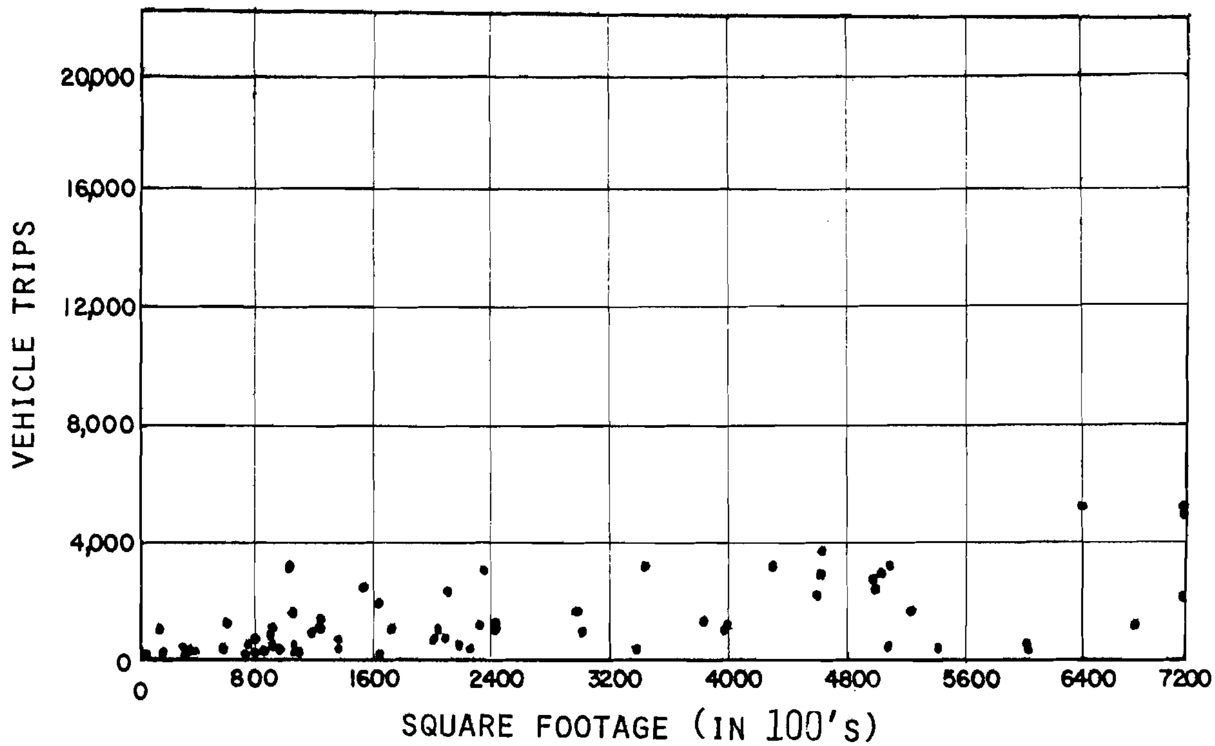


FIGURE 25: PERSON TRIPS AND VEHICLE TRIPS GENERATED BY INDUSTRIAL GROSS ACREAGE.

INDUSTRIAL TRIP GENERATION



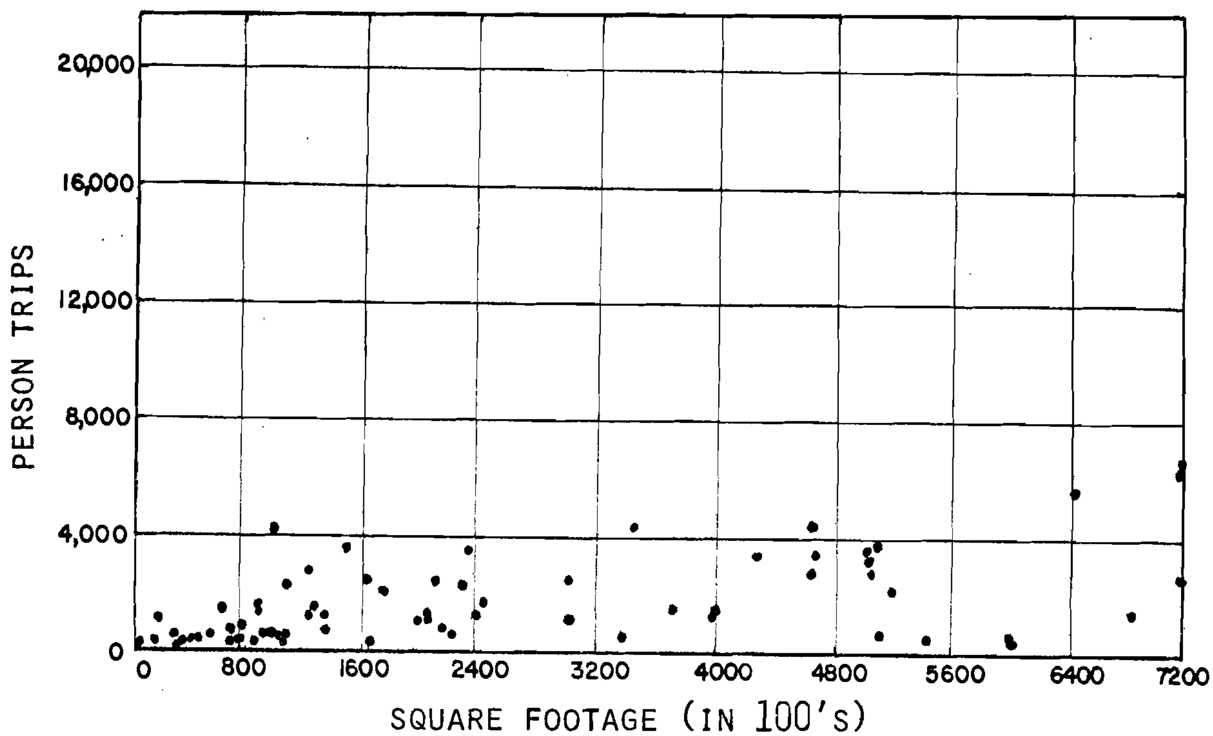


FIGURE 26: PERSON TRIPS AND VEHICLE TRIPS GENERATED BY INDUSTRIAL SQUARE FOOTAGE.

Although a distinct linear relationship exists between trip generated and number of employees (Figure 24) for the low order portion of the graph, the variable dependency tends to break down for those industries with more than 2,000 employees[4]. Further, there is little significant indication of positive correlation between trips generated and gross acreage reflected by Figure 25.

Multi-Variable Stratification

Further analyses of the variables affecting industrial trip generation included an examination of the relationships between trip rates (vehicle trips per employee and vehicle trips per 100 square feet) and the industrial functions of the generators. Although extreme rate fluctuation within each category is indicated by scatter diagrams comprising Figure 27 and 28, the distinction between the trip rates of the various industrial functions is mildly discernable. It is doubtful, however that these rates would be of significant value in the determination of industrial trips without additional site specific information.

Additional multi-variable relationships examined included vehicle trips per employee vs. employment (Figure 29), vehicle trips per acre vs. gross acreage (Figure 30), and vehicle trips per 100 square feet vs. building square footage (Figure 31). As expected, each graph indicates that industrial trip rates are inversely proportional to the size of the industrial

[4]Some of the wide dispersion may be attributable to the limited number of observations for this employee range.

INDUSTRIAL TRIP GENERATION

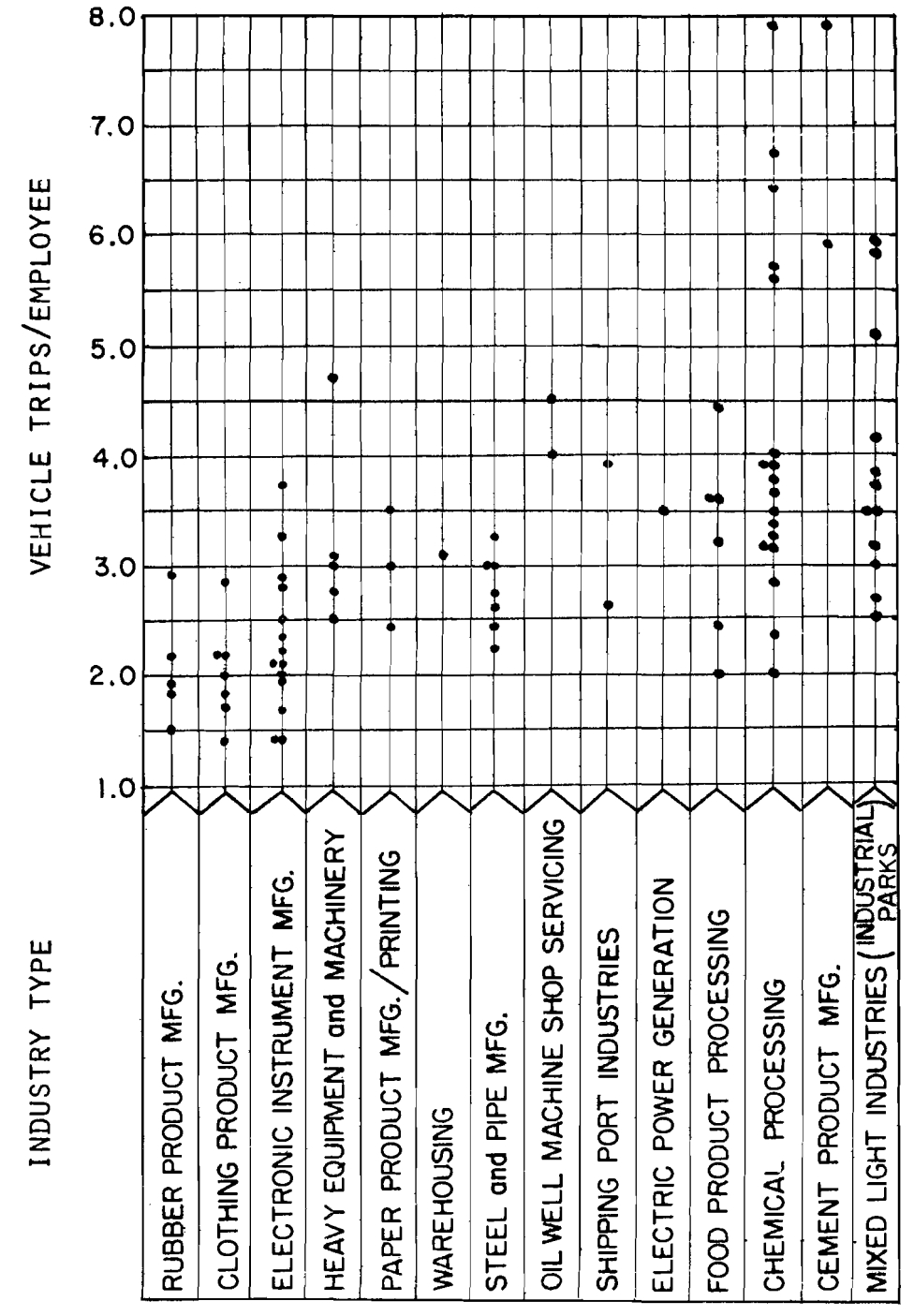


FIGURE 27: VEHICLE TRIPS/EMPLOYEE BY INDUSTRY TYPE.

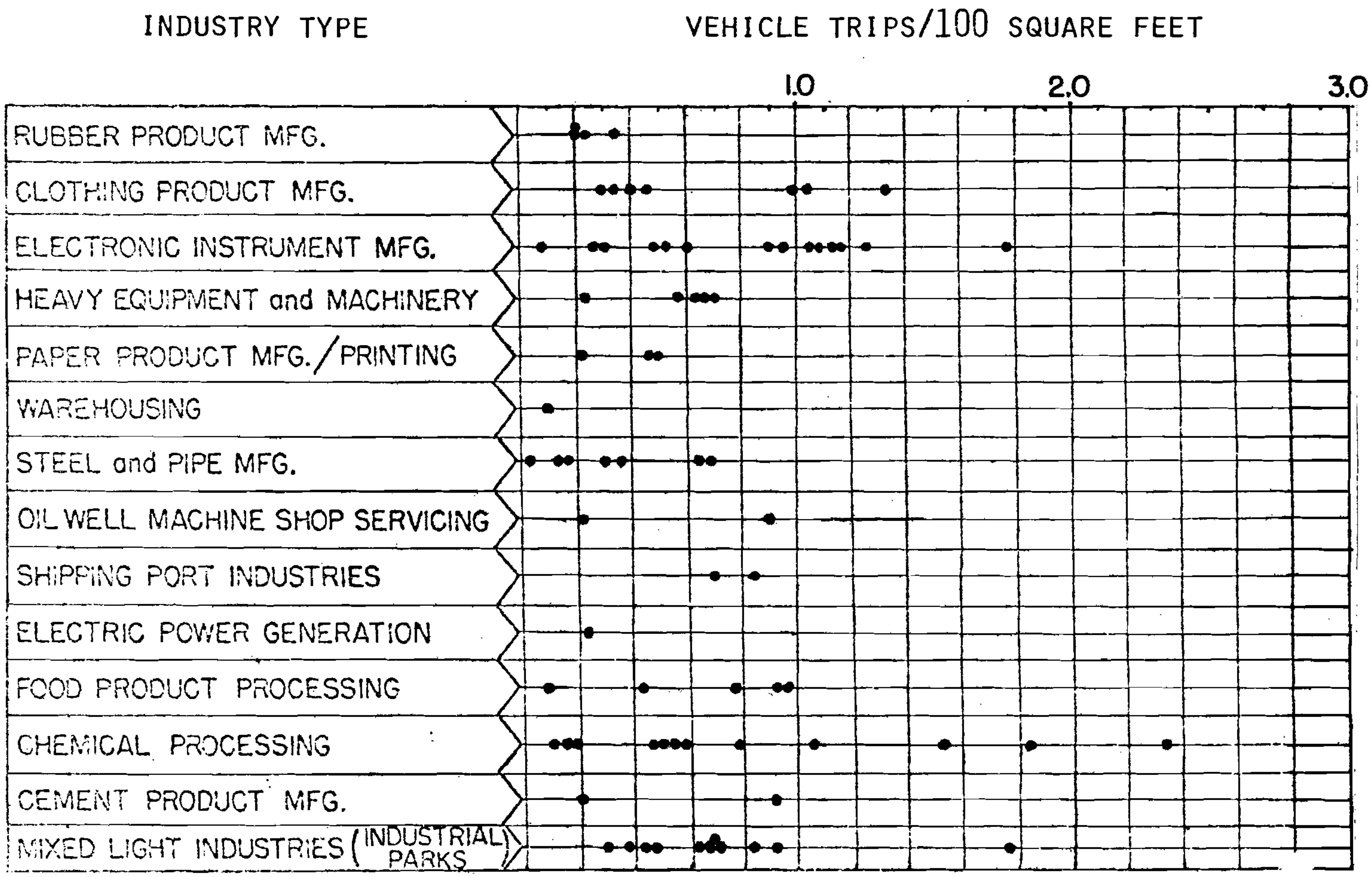


FIGURE 28: VEHICLE TRIPS/SQUARE FOOT BY INDUSTRY TYPE.

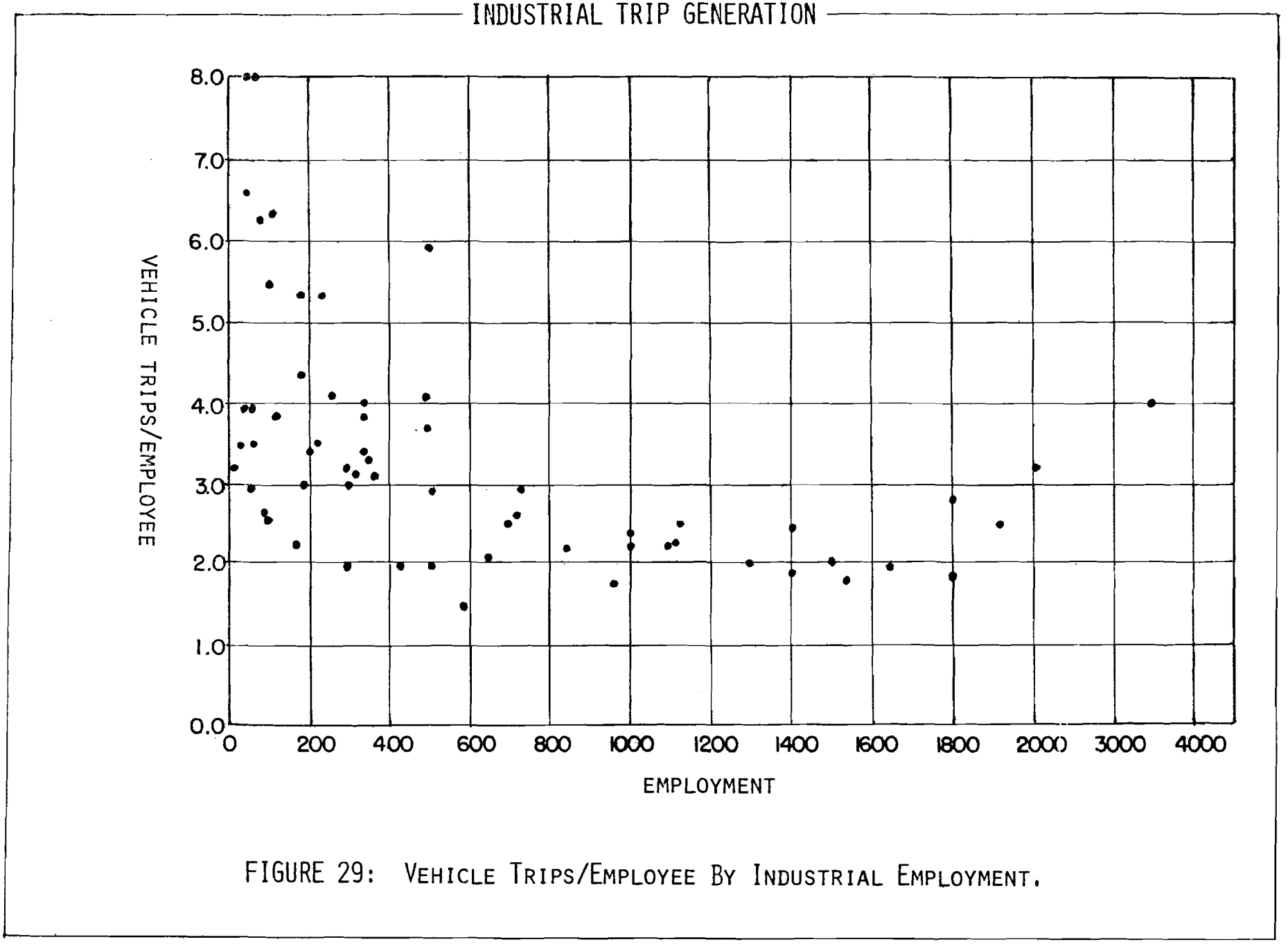


FIGURE 29: VEHICLE TRIPS/EMPLOYEE BY INDUSTRIAL EMPLOYMENT.

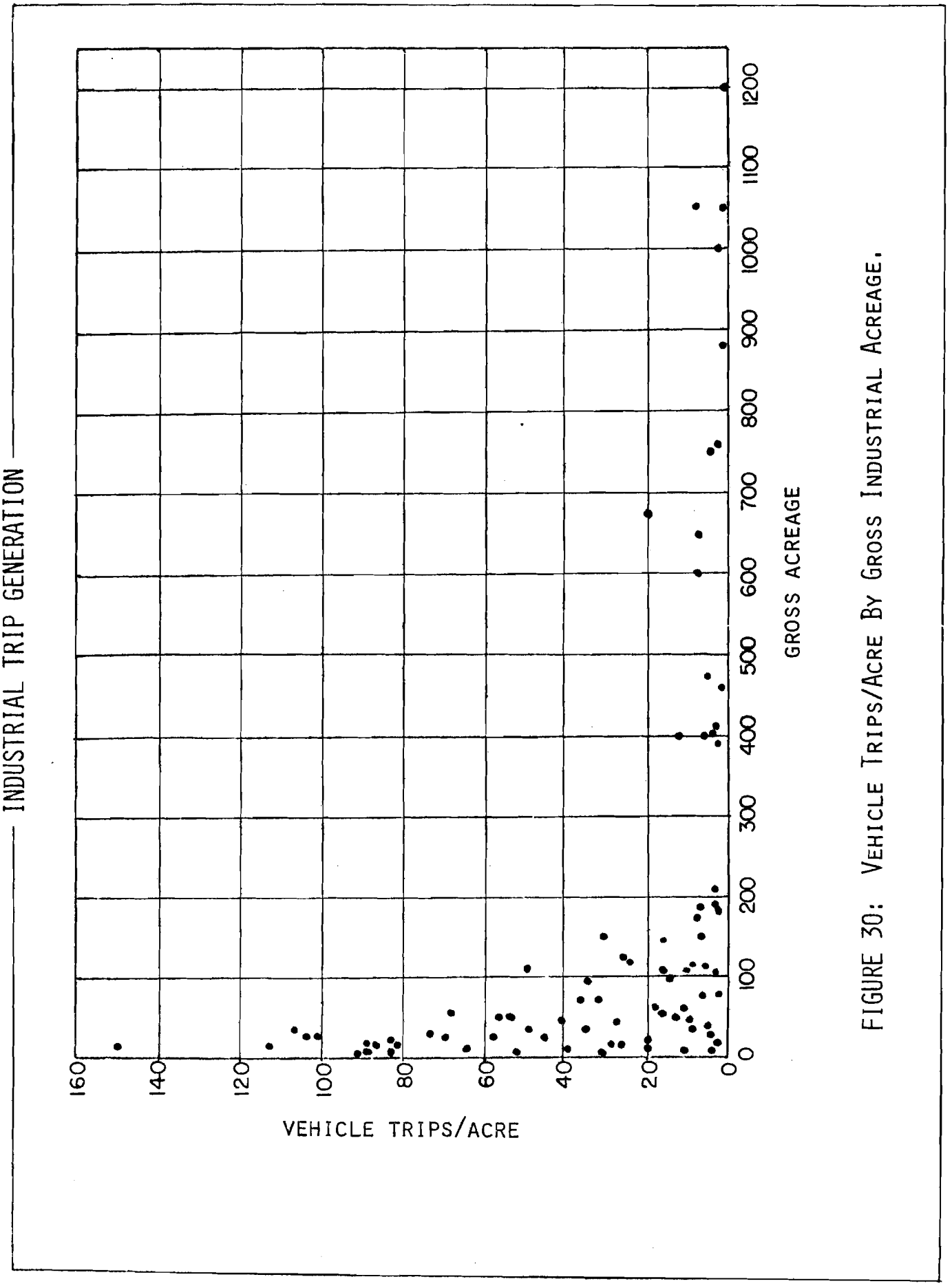


FIGURE 30: VEHICLE TRIPS/ACRE BY GROSS INDUSTRIAL ACREAGE.

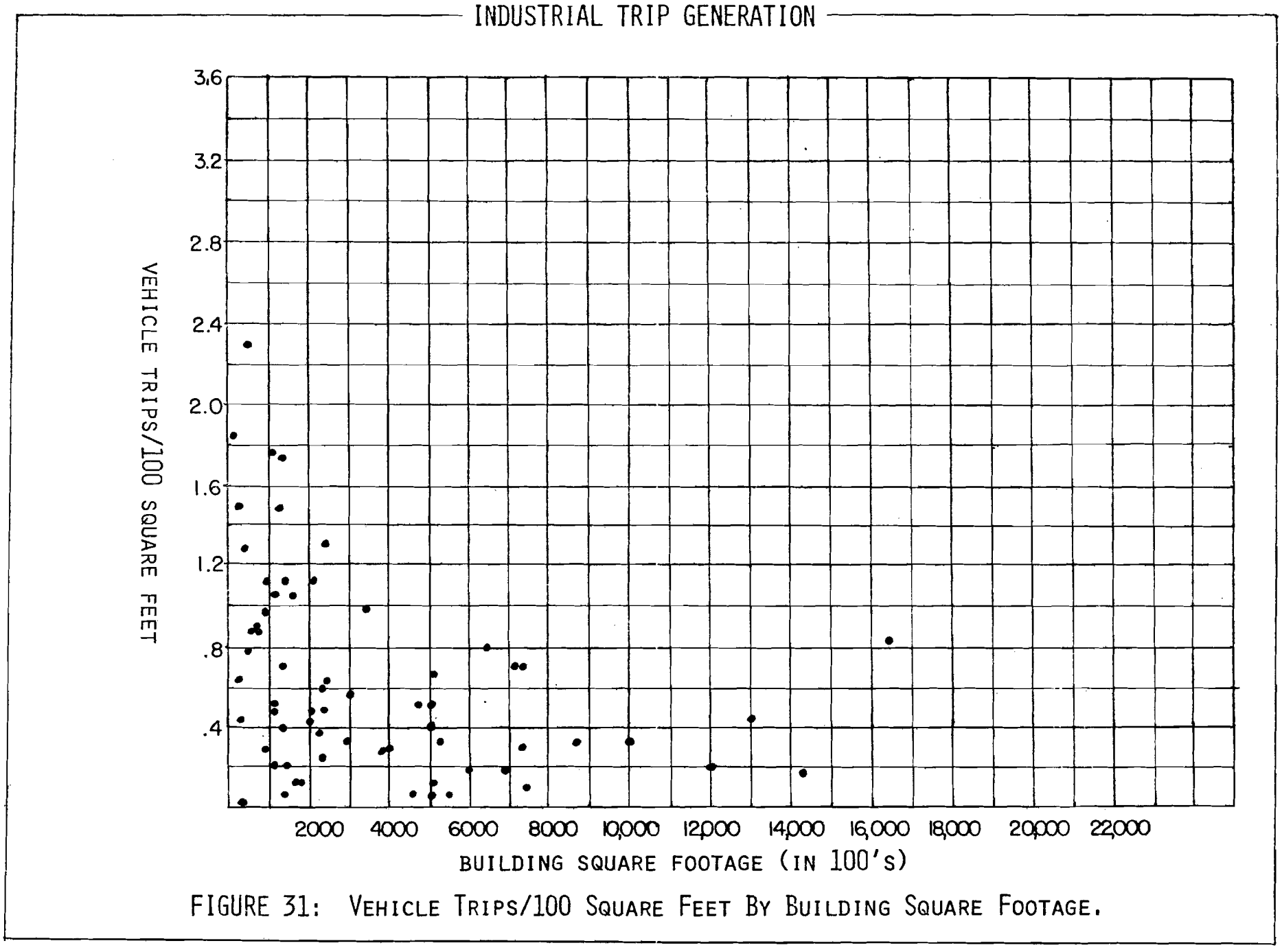


FIGURE 31: VEHICLE TRIPS/100 SQUARE FEET BY BUILDING SQUARE FOOTAGE.

site measured in terms of employment, acreage, and building size.

Multi-dimensional regression of the functional relationships between industrial trips and site characteristics were applied to the industrial observations via the standard stepwise multiple regression analysis package. The results indicate that employment used as an independent variable for describing industrial trips provides significantly better accuracy over gross acreage or building square footage. Only the simple regression equations are indicated in Table 14 because there was virtually no prediction accuracy gained through a multiple regression of industrial trips in terms of employment, gross acreage, and building square footage.

Industrial Trip Generation
Simple Regression
(Table 14)

Dependent Variable (Y)		Regression Equation	Coefficient Of Correlation (R)	Coefficient Of Determination (R^2)
Industrial Person Trips	=	65.1 + 3.5 * Employ.	.8769	.7689
Industrial Vehicle Trips	=	218.4 + 2.4 * Employ.	.8853	.7837

Conclusions

In order to facilitate the application of industrial trip generation data from this report, several important considerations should be summarized.

1. Assuming work trip rates remain relatively constant per industrial employee, the non-work trip rates resulting from daily operations fluctuate dramatically.
2. Little correlation between average trip rates and industrial function is evident along with the intense trip rate fluctuation found within each industrial category. This suggests that general knowledge of industrial type is of limited value in computing industrial trip generation unless more site - specific information is available.
3. The stepwise multiple regression of industrial person and vehicle trips in terms of employment, gross acreage and building square footage indicates that employment is the superior independent variable in forecasting industrial trips.

OTHER SPECIAL TRAFFIC GENERATION ANALYSIS

In addition to the analysis of the trip generating properties of residential, commercial, and industrial sites, some consideration was given to other special traffic generators. Inherent to virtually every urban area, these generators can usually be distinguished by their unique trip generation characteristics and significant (although sometimes sporadic or seasonal) impact upon traffic volumes.

Analyses of the trip generation characteristics of other special or unique generators were conducted through the examination of 59 special sites from 19 urban areas within the State of Texas. These included several from each of five categories as follows:

Educational Facilities

Airports

Health Institutions

Military Bases

Recreational Facilities

Educational Facilities

The 19 educational facilities examined included 3 elementary schools, 1 junior high school, 9 senior high schools, 5 small colleges/universities, and 1 state school. Each was counted during the full operational cycle to insure the collection of all student trips as well as those trips generated by the faculty/staff. Vehicle occupancy was obtained through manual counts of minimum six hour duration.

EDUCATIONAL TRIP GENERATION

Vehicle and Person Trip Rates

Table 15

School/Urban Location	Employment	Gross Acreage	Building Square Footage	Students Living On Campus	Total Students	Total Vehicle Trips	Vehicle Trips per Employee
Hunt Elem./Lubbock	27	9.0	30,000	--	342	240	8.9
Hays Elem./Odessa	36	12.9	--	--	420	326	9.1
Leon Heights Elem./Belton	23	--	--	--	333	574	25.0
John Hood Jr. High/Odessa	75	20.7	--	--	954	1,408	18.8
Killeen High/Killeen	170	--	--	--	2,409	4,848	28.5
Little Cypress High/Orange	73	60.0	16,300	--	858	1,852	25.4
Sherman High/Sherman	125	180.0	260,000	--	1,800	2,248	18.0
W. Oso High/Corpus Christi	58	76.7	198,700	--	667	1,334	23.0
Coronado High/El Paso	165	27.1	232,000	--	2,400	2,286	13.9
Grapevine High/Ft. Worth	93	--	--	--	889	2,118	22.8
Texarkana High/Texarkana	111	91.0	234,200	--	1,500	4,696	42.3
Lake Highlands High/Dallas	135	--	--	--	2,200	2,774	20.5
N. Mesquite High/Dallas	150	--	--	--	2,400	4,220	28.1
St. Marys Univ./San Antonio	474	137.0	700,000	482	3,564	7,740	16.3
Grayson Co. Coll./Sherman	250	180.0	254,888	96	3,854	4,444	17.8
Texas A&I/Corpus Christi	250	232.8	287,227	--	1,600	3,296	13.2
Tarrant Jr. Coll./Ft.Worth	430	160.0	458,372	--	7,345	14,370	33.4
Texas College/Tyler	100	60.0	167,319	300	500	1,354	13.5
Lubbock State School	685	120.0	260,800	630	630	1,336	2.0

EDUCATIONAL TRIP GENERATION

Vehicle and Person Trip Rates

Table 15 Continued

Vehicle Trips per Acre	Vehicle Trips per 100 Sq Ft	Vehicle Trips per Student	Vehicle Occupancy Rate	Total Person Trips	Person Trips per Employee	Person Trips per Acre	Person Trips per 100 Sq Ft	Person Trips per Student
26.6	0.8	0.7	3.9	928	34.4	103.1	3.1	2.7
25.3	--	0.8	3.9	1,282	35.6	99.4	--	3.1
--	--	1.7	2.8	1,584	68.9	--	--	4.8
68.0	--	1.5	2.7	3,866	51.5	186.8	--	4.1
--	--	2.0	2.8	13,332	78.4	--	--	5.5
30.9	11.4	2.2	1.9	3,472	47.6	57.9	21.3	4.0
12.5	0.9	1.2	2.5	5,594	44.8	31.1	2.2	3.1
17.4	0.7	2.0	2.6	3,514	60.6	45.8	1.8	5.3
84.4	1.0	1.0	2.7	6,184	37.5	228.2	2.7	2.6
--	--	2.4	2.1	4,444	47.8	--	--	5.0
51.6	2.0	3.1	1.6	7,390	66.6	81.2	3.2	4.9
--	--	1.3	1.5	4,160	30.8	--	--	1.9
--	--	1.8	2.0	8,516	56.8	--	--	3.5
56.5	1.1	2.2	1.3	9,850	20.8	71.9	1.4	2.8
24.7	1.7	1.2	1.3	5,768	23.1	32.0	2.3	1.5
14.2	1.1	2.1	1.2	3,936	15.7	16.9	1.4	2.5
89.8	3.1	2.0	1.2	17,598	40.9	110.0	3.8	2.4
22.6	0.8	2.7	1.8	2,430	24.3	40.5	1.5	4.9
11.1	0.5	2.1	1.5	1,938	2.8	16.2	0.7	3.1

Additional educational trip generation data collected included the number of faculty/staff employees, students, building square footage, gross acreage and where applicable the number of students living on campus. Table 15 indicates the resulting person trip and vehicle trip rates calculated for each facility examined.

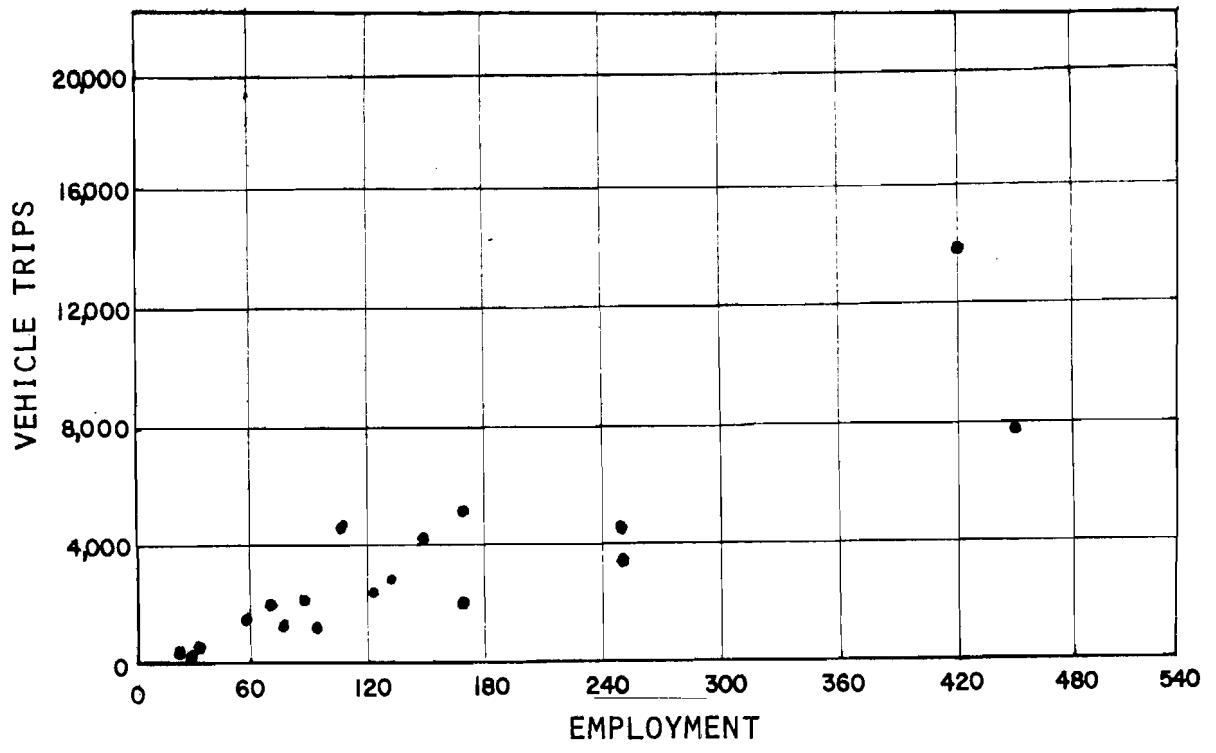
Vehicle trip rate variations among individual schools can be explained to some degree by the economic condition of the neighborhood served by the school as well as individual school policies with respect to student autos. Typically, there are significantly more student auto-driver and auto-passenger trips generated from higher income neighborhoods and more walk trips and bus passenger trips generated from economically depressed communities. In addition, some schools adopt policies towards student drivers which penalize (usually through restrictive parking) those who drive their autos to school.

Educational vehicle and person trip generations for elementary schools, junior high shcools, senior high schools, and small colleges are graphically represented by four scatter diagrams comprising Figures 32 and 33. Counted vehicle and person trips entering and/or leaving each school are plotted for the number of employees and number of students which characterize that school.

Airports

There were 11 municipal airports and 1 small private airfield examined for their trip generating characteristics. The air travel activity of the airports varied from 2 to 666 regularly scheduled flights per day according to

EDUCATIONAL TRIP GENERATION



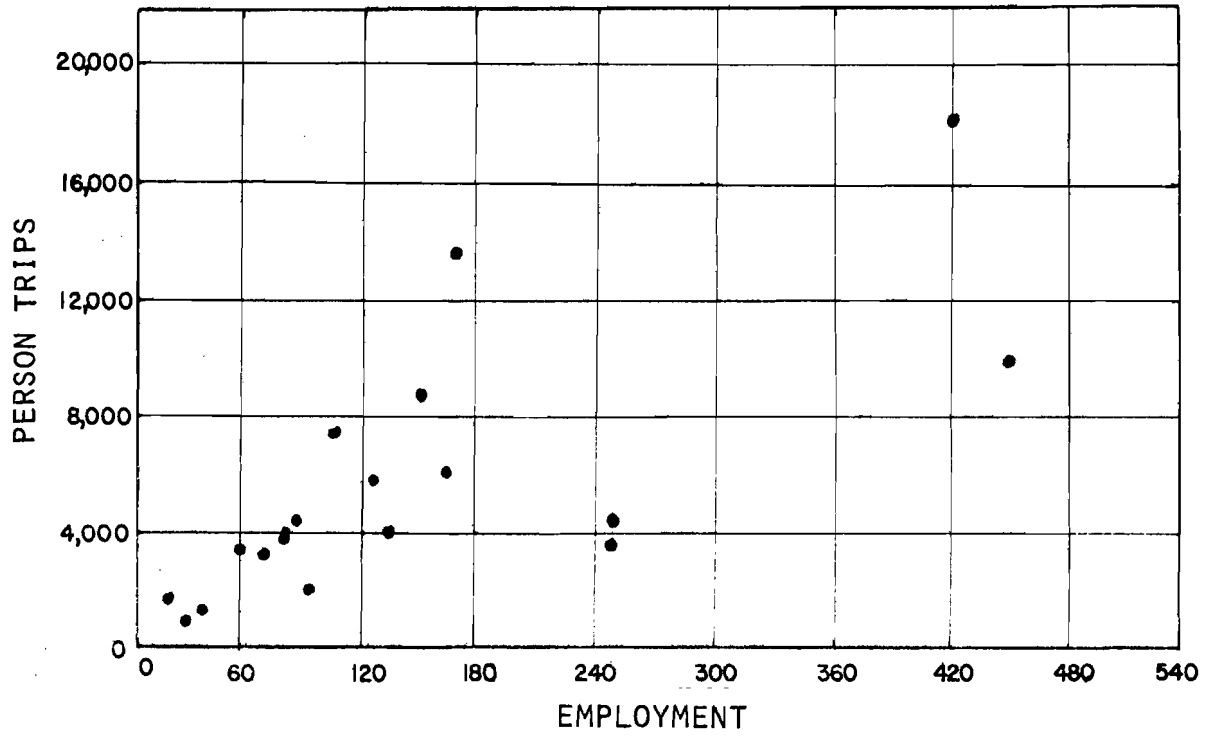
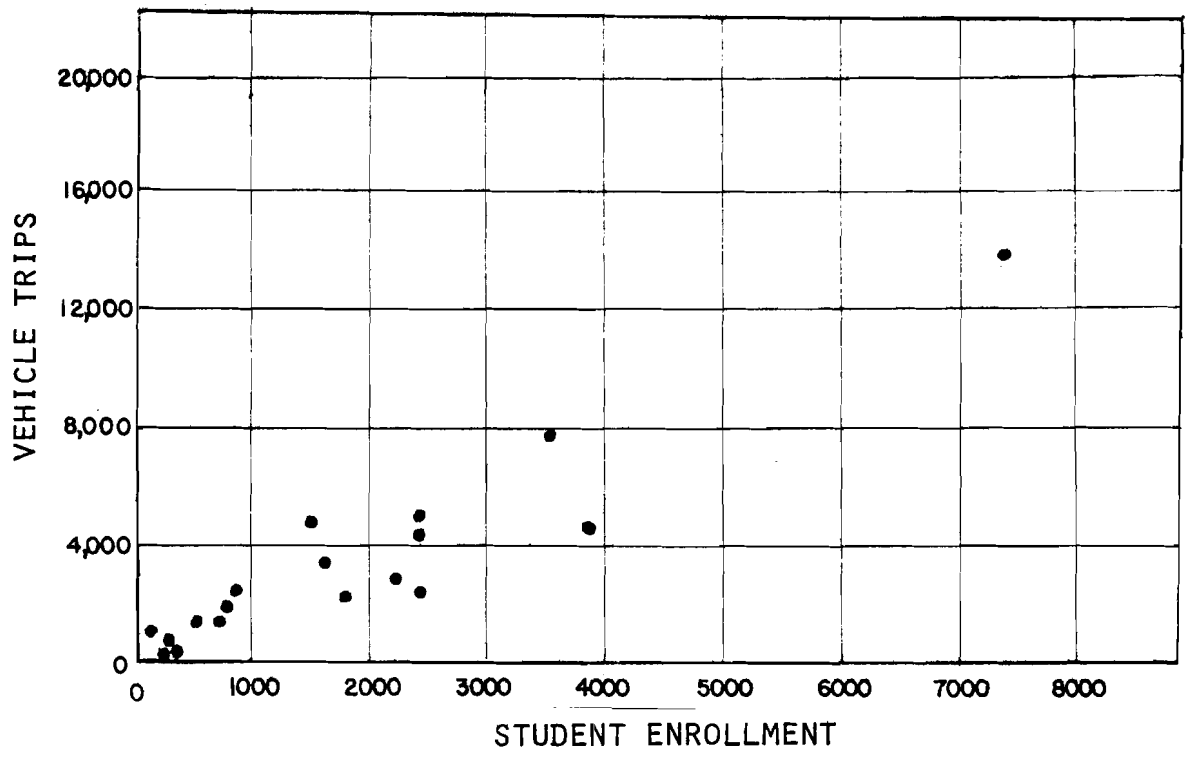


FIGURE 32: SCHOOL VEHICLE AND PERSON TRIPS GENERATED BY SCHOOL EMPLOYMENT.

EDUCATIONAL TRIP GENERATION



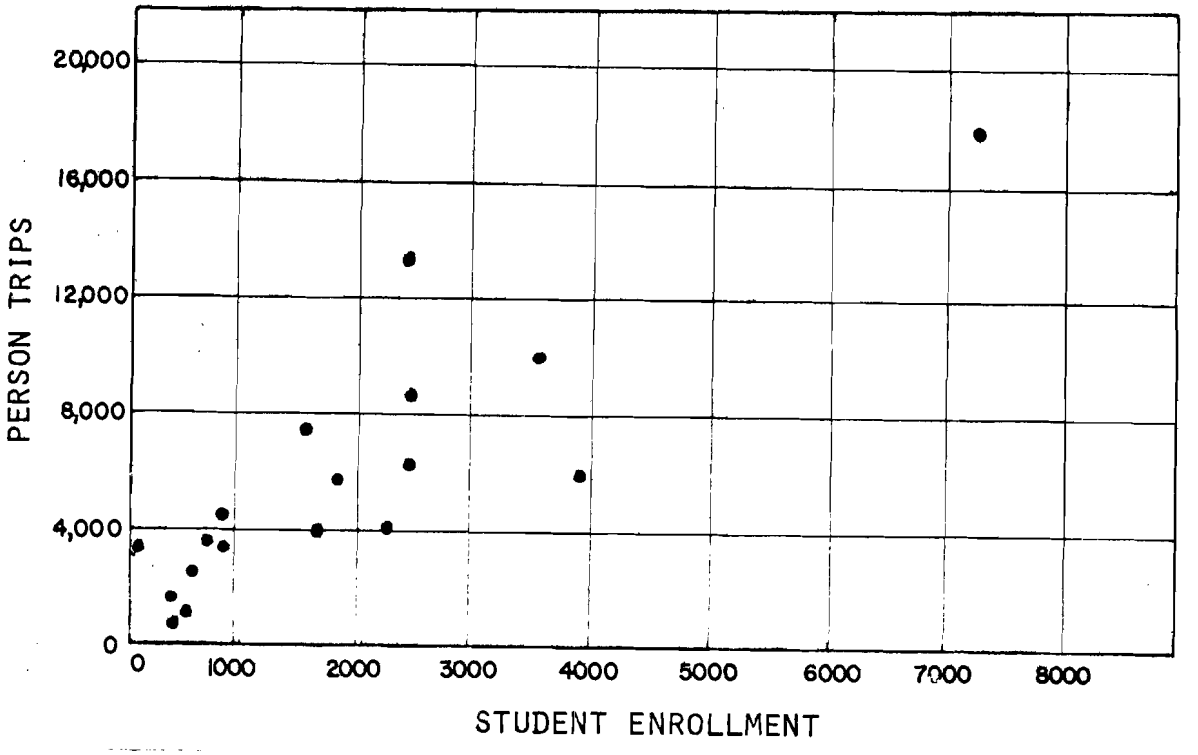


FIGURE 33: SCHOOL VEHICLE AND PERSON TRIPS GENERATED BY SCHOOL ENROLLMENT.

the size of the urban area each serves. Because of the extent of airport activity, complete 24-hour vehicle counts were made in conjunction with extended peak/off peak vehicle occupancy surveys.

Additional airport trip generation data collected included the number of employees, regularly scheduled flights per day, charter flights per day, deplaning passengers per day and gross acreage. Table 16 beginning on page 92 indicates the resulting person trip and vehicle trip rates calulated for each airport examined.

Airport Trip Generation
Multiple Regression
(Table 17)

Dependent Variable (Y)	Regression Equation	Coefficient Of Correlation (R)	Coefficient Of Correlation (R^2)
Person Trips	= 1422.0 + 4.7 * Deplaning Passengers	.9965	.9930
	= 1077.4 + 3.3 * Deplaning Passengers + 5.6 * Population in Thousands	.9979	.9959
Vehicle Trips	= 873.3 + 2.9 * Deplaning Passengers	.9957	.9914
	= 588.4 + 1.7 * Deplaning Passengers + 4.6 * Population in Thousands	.9983	.9966

AIRPORT/AIR TERMINAL TRIP GENERATION

Vehicle and Person Trip Rates

Table 16

Airport/Urban Area Location	Urban Area Population	Employment	Regularly Scheduled Flights/Day	Deplaning Passengers Per Day	Total Vehicle Trips	Vehicle Trips per Population
Municipal Airport/Austin	264,499	275	28	1,841	4,564	0.017
Easterwood Airport/Bryan-College Sta.	57,000	75	12	60	842	0.015
Amarillo Air Terminal/Amarillo	130,387	300	19	500	2,898	0.022
Tradewinds Airport/Amarillo	130,387	82	2	80	832	0.006
Municipal Airport/Abilene	92,193	133	6	108	1,072	0.012
Lubbock Air Terminal/Lubbock	150,135	206	30	567	3,442	0.023
Municipal Airport/Wichita Falls	97,564	86	11	170	1,176	0.012
Miller Int. Airport/McAllen-Pharr	91,143	55	5	192	1,604	0.018
Intercontinental Airport/HGRTS[1]	2,181,315	880	666	8,633	25,750	0.012
Jefferson Co. Airport/JORTS[2]	324,321	158	23	172	1,762	0.005
International Airport/Corpus Christi	212,820	300	38	487	2,582	0.012
Municipal Airport/Killeen-Temple	42,450	131	15	210	860	0.020

[1]HGRTS - Houston-Galveston Regional Transportation Study Area.

[2]JORTS - Jefferson-Orange County Regional Transportation Study Area.

AIRPORT/AIR TERMINAL TRIP GENERATION

Vehicle and Person Trip Rates

Table 16 Continued

Vehicle Trips per Employee	Vehicle Trips per Reg. Flight	Vehicle Trips per Passenger	Vehicle Occupancy Rate	Total Person Trips	Person Trips per Population	Person Trips per Employee	Person Trips per Reg. Flight	Person Trips per
16.6	163.0	2.5	1.8	8,064	0.030	29.3	288.0	4.4
11.2	70.2	14.0	1.3	1,116	0.020	14.8	93.0	18.6
9.7	152.5	5.8	1.8	5,090	0.039	17.0	267.9	10.2
10.1	416.0	10.4	1.4	1,126	0.009	13.7	563.0	14.1
8.1	178.7	9.9	1.8	1,902	0.021	14.3	317.0	17.6
16.7	114.7	6.1	1.6	5,512	0.037	26.8	183.7	9.7
13.7	106.9	6.9	1.7	1,950	0.020	22.7	177.3	11.5
29.2	320.8	8.4	1.7	2,756	0.030	50.1	551.0	14.4
29.3	38.7	3.0	1.6	41,896	0.019	47.6	62.9	4.9
11.2	76.6	10.2	1.5	2,576	0.007	16.3	112.0	15.0
8.6	67.9	5.3	1.5	3,806	0.018	12.7	100.2	7.8
6.6	57.3	4.1	1.5	1,260	0.030	9.6	84.0	6.0

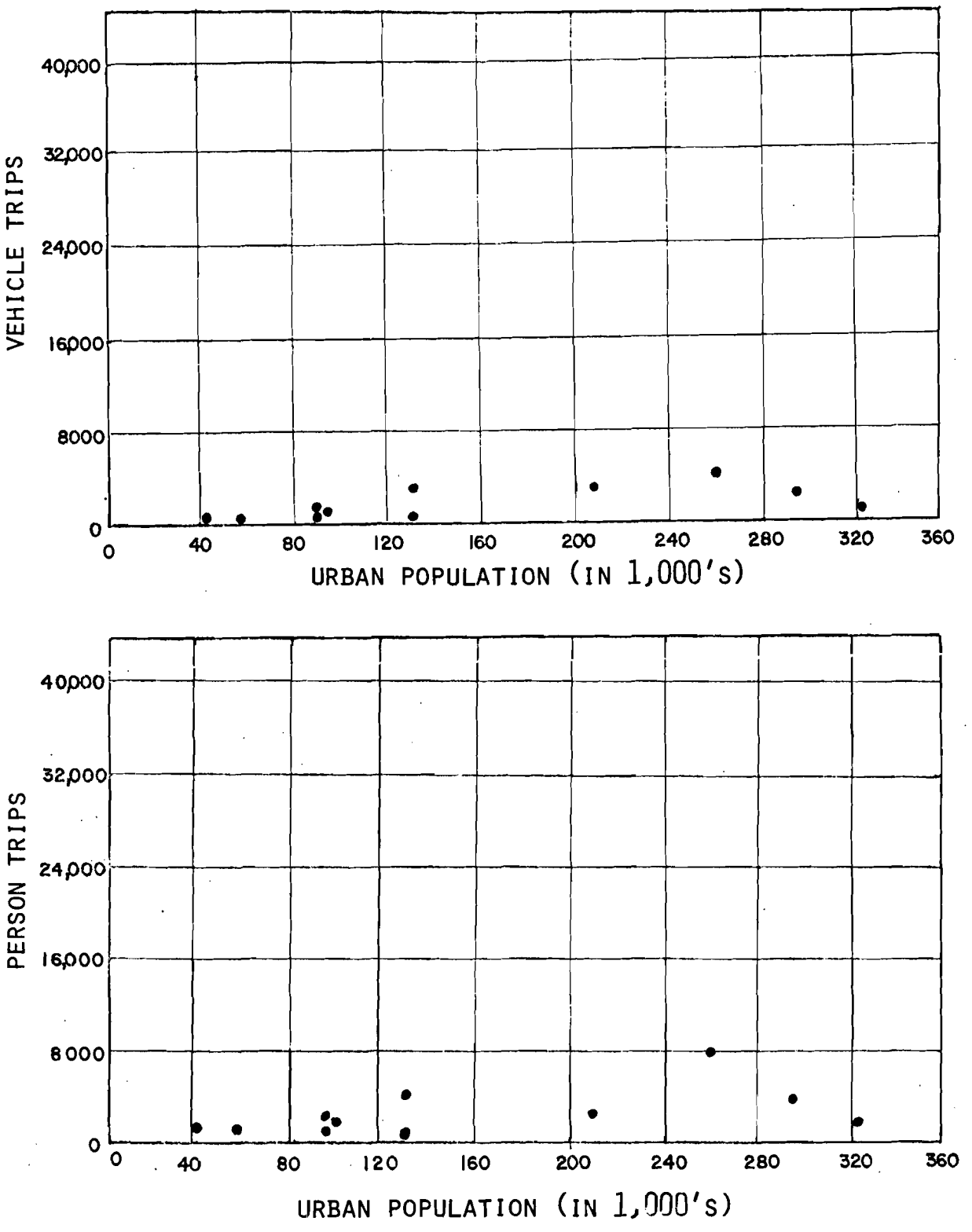


FIGURE 34: AIRPORT VEHICLE AND PERSON TRIPS GENERATED BY URBAN POPULATION.

AIRPORT TRIP GENERATION

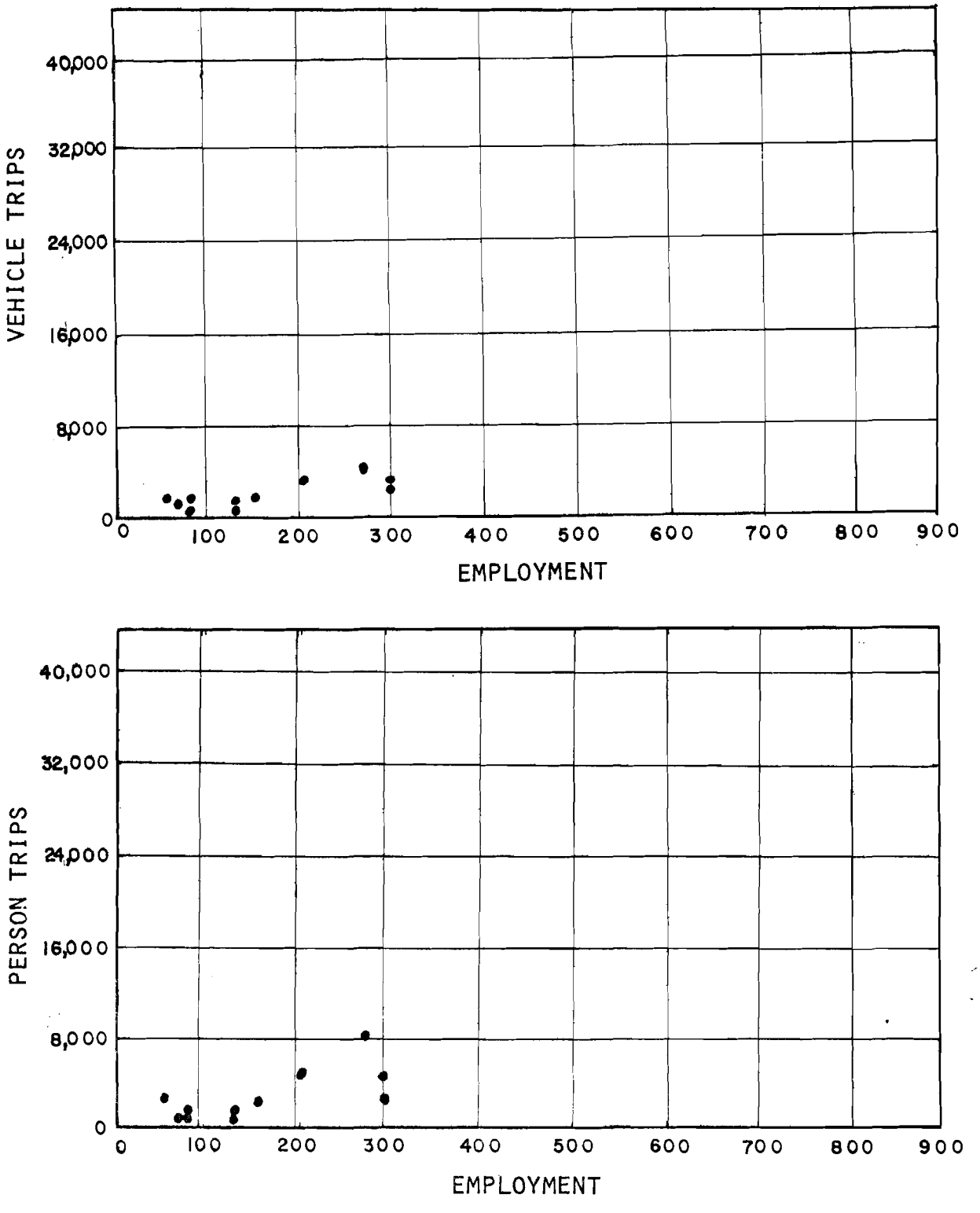


FIGURE 35: AIRPORT VEHICLE AND PERSON TRIPS GENERATED BY EMPLOYMENT.

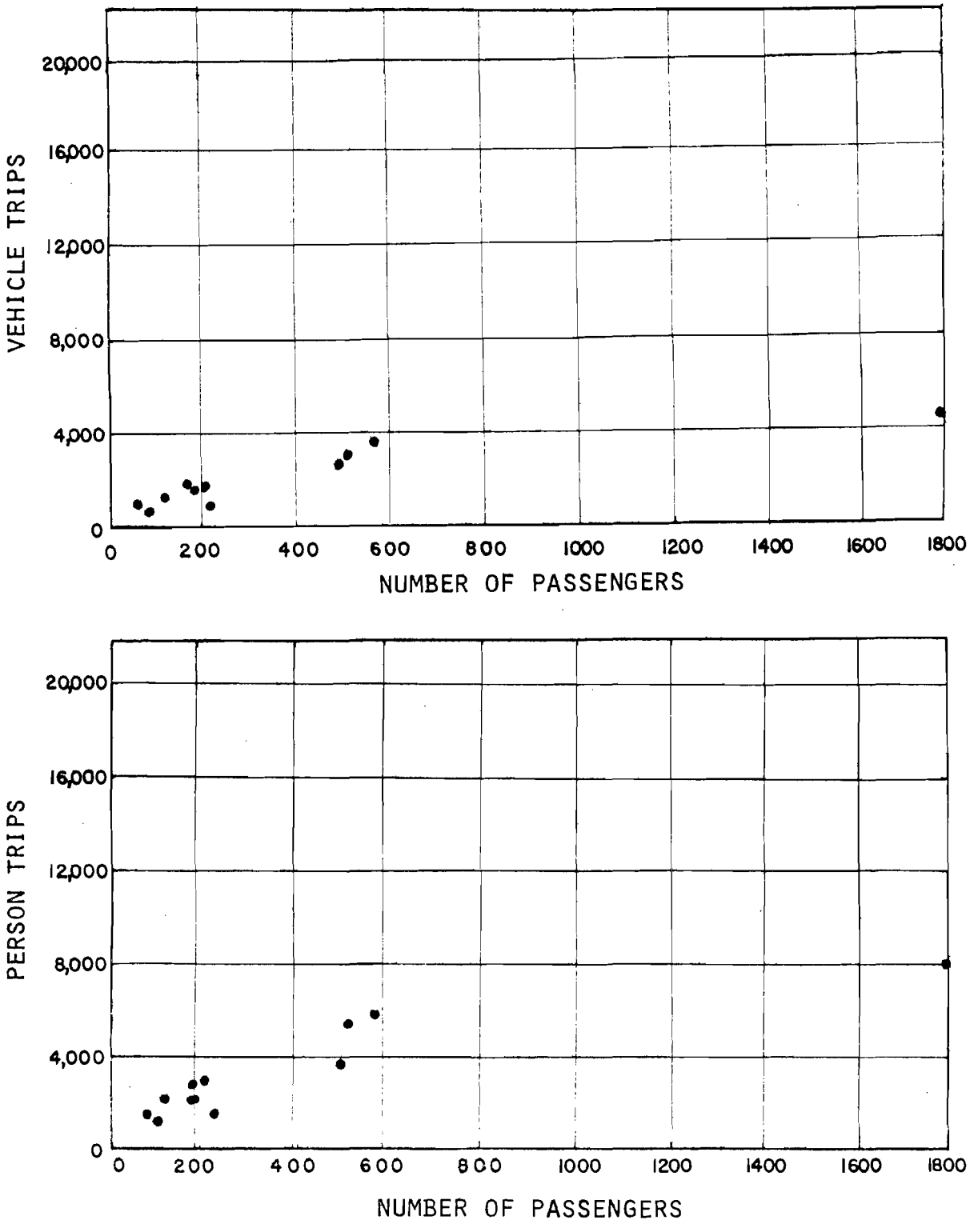


FIGURE 36: AIRPORT VEHICLE AND PERSON TRIPS GENERATED BY NUMBER OF PASSENGERS.

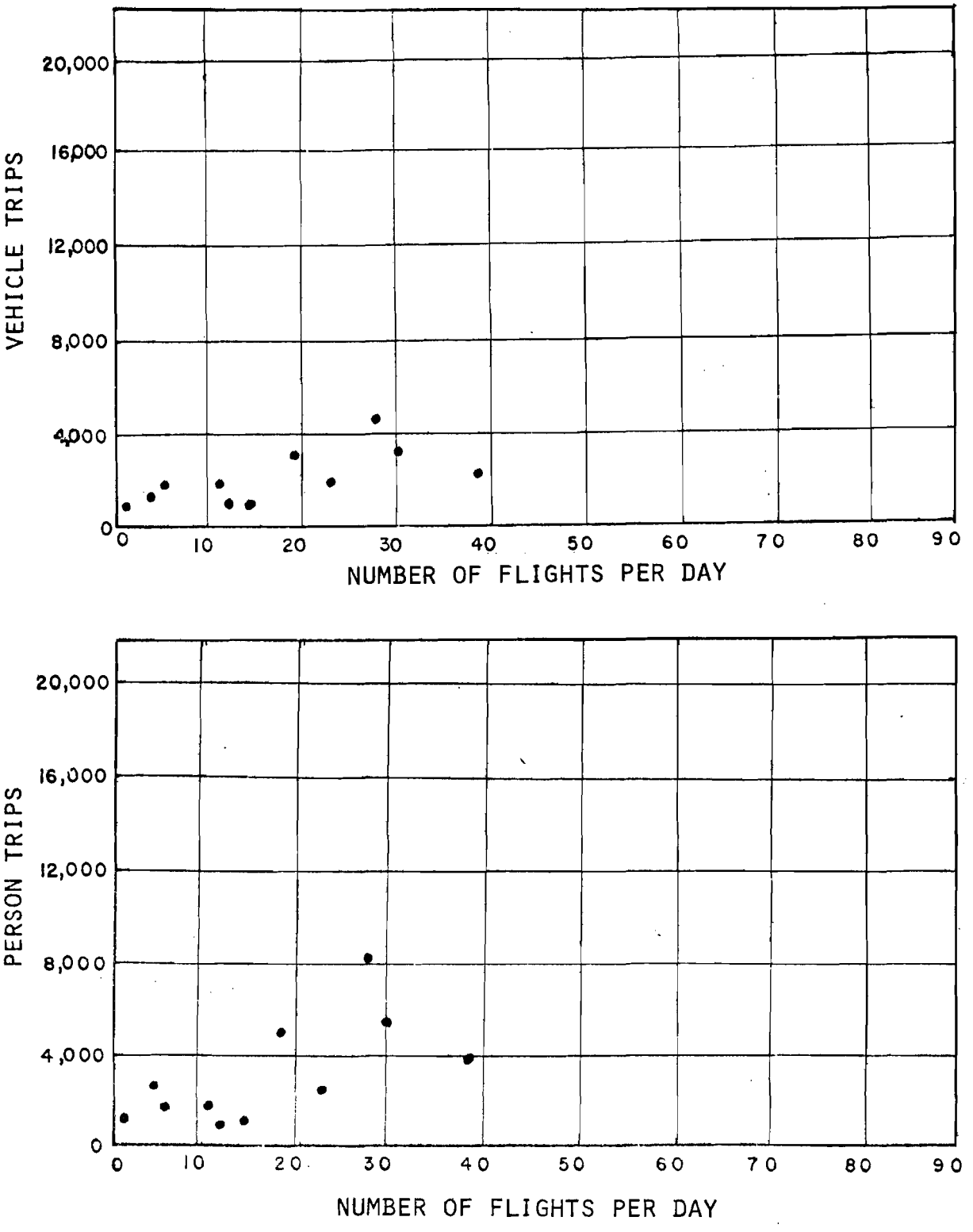


FIGURE 37: AIRPORT VEHICLE AND PERSON TRIPS GENERATED BY NUMBER OF REGULARLY SCHEDULED FLIGHTS PER DAY.

The relationships between the counted vehicle/person trip generations and the variables which characterize the airport activity level are graphically represented by a series of scatter diagrams comprising figures 34 through 37. Counted vehicle and person trips entering or leaving each airport are plotted by population of the urban area, employment, deplaning passengers and number of regularly scheduled flights per day.

A multi-dimensional regression of these variables reveals that an extremely strong correlation exists between airport trip generation and deplaning passengers per day. Table 17 on page 91 describes the resulting regression equations.

Health Institutions

The 16 health institutions examined included 8 general hospitals, 2 out-patient clinics, 4 Veterans Administration Hospitals, and 2 government mental hospitals. The hospital vehicle trip generations were counted by machine for the 24-hour work day with corresponding peak and off-peak vehicle occupancy counts.

Pertinent trip making data collected for each institution included employment, number of beds, square footage, gross acres, and parking spaces. Table 18 indicates the resulting person trip and vehicle trip rates calculated for each institution examined. The relationships between hospital person/vehicle trips and the corresponding employment and capacity (number of beds) are graphically represented by four scatter diagrams comprising Figures 38 and 39.

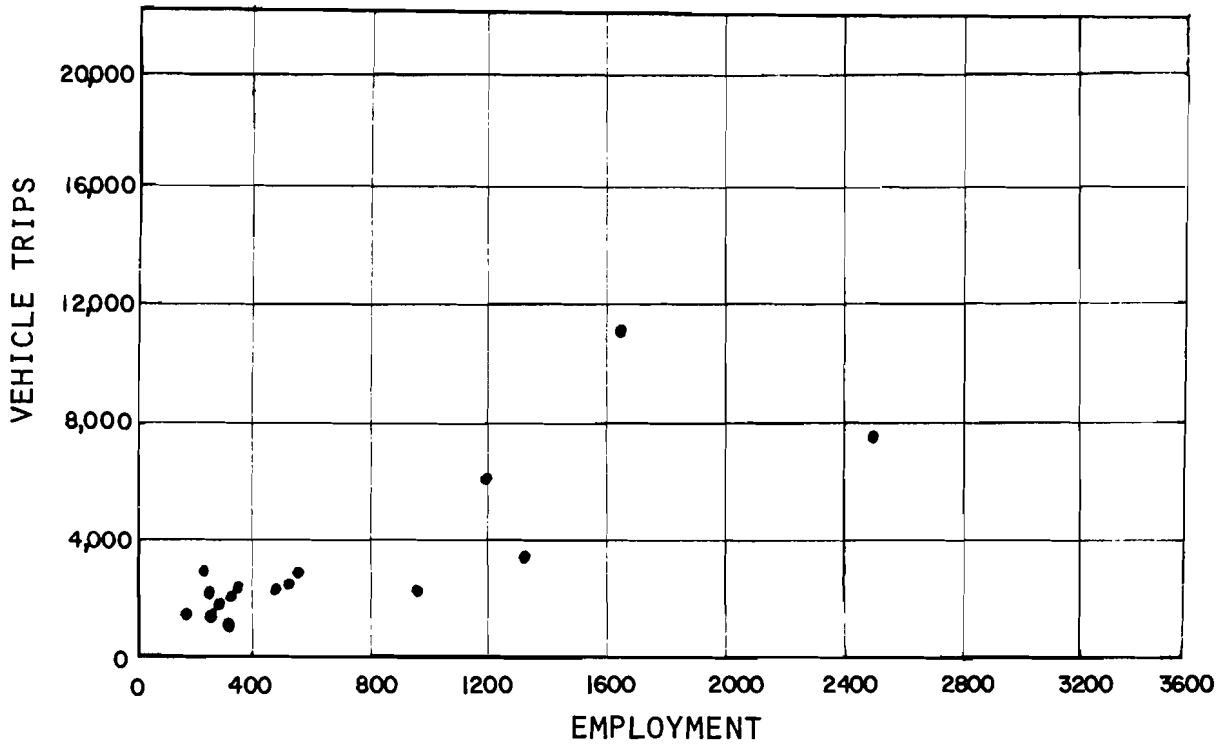
HEALTH INSTITUTION TRIP GENERATION

Vehicle and Person Trip Rate

Table 18

Medical Institution	Employment	Hospital Beds	Total Vehicle Trips	Vehicle Trips per Employee	Vehicle Trips per Bed	Vehicle Occupancy Rate	Total Person Trips	Person Trips per Employee	Person Trips per Bed
General Hospitals	325	189	2,038	6.3	10.8	1.5	2,984	9.2	15.8
	490	300	2,786	5.7	9.3	1.6	4,414	9.0	14.7
	440	143	2,264	5.1	16.8	1.3	3,020	6.9	22.4
	1,650	508	11,654	7.1	22.9	1.6	18,568	11.3	36.6
	226	100	2,026	9.0	20.3	1.4	2,862	12.7	28.6
	201	115	2,936	14.6	25.5	1.5	4,338	21.6	37.7
	333	99	1,864	5.6	22.7	1.4	2,662	8.0	32.5
	480	201	2,636	5.5	13.1	1.4	3,806	7.9	18.9
Vetern Admin. Hospitals	224	146	1,028	4.6	7.0	1.5	1,554	6.9	10.6
	1,308	1,100	3,340	2.6	3.0	1.5	4,882	3.7	4.4
	2,500	1,337	7,474	3.0	5.6	1.6	11,780	4.7	8.8
	1,195	1,120	6,260	5.2	5.6	1.4	8,494	7.1	7.6
Outpatient Clinics	242	--	1,974	8.2	--	1.5	3,380	14.0	--
	135	--	1,300	9.6	--	1.5	1,984	14.7	--
Government Mental Hospitals	925	1,300	2,182	2.4	1.7	1.3	2,728	2.9	2.1
	250	525	1,012	4.0	1.9	1.3	1,350	5.4	2.6

HOSPITAL TRIP GENERATION



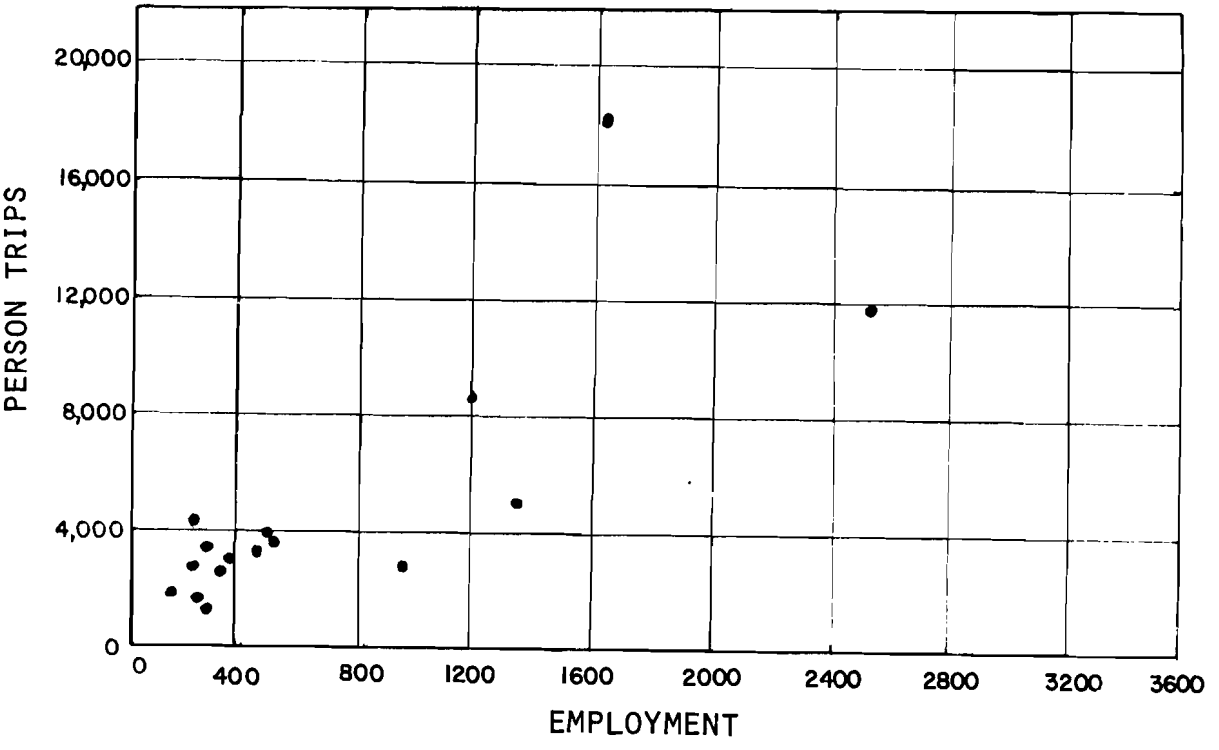
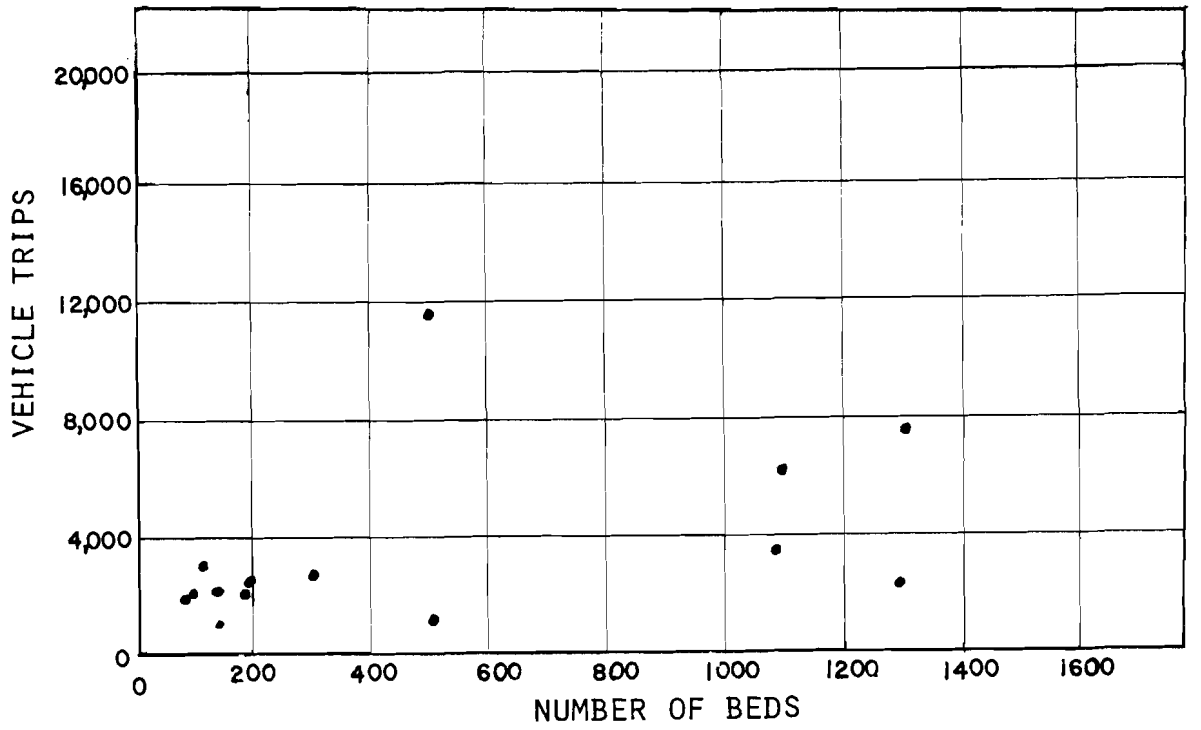


FIGURE 38: HOSPITAL VEHICLE AND PERSON TRIPS GENERATED BY EMPLOYMENT.



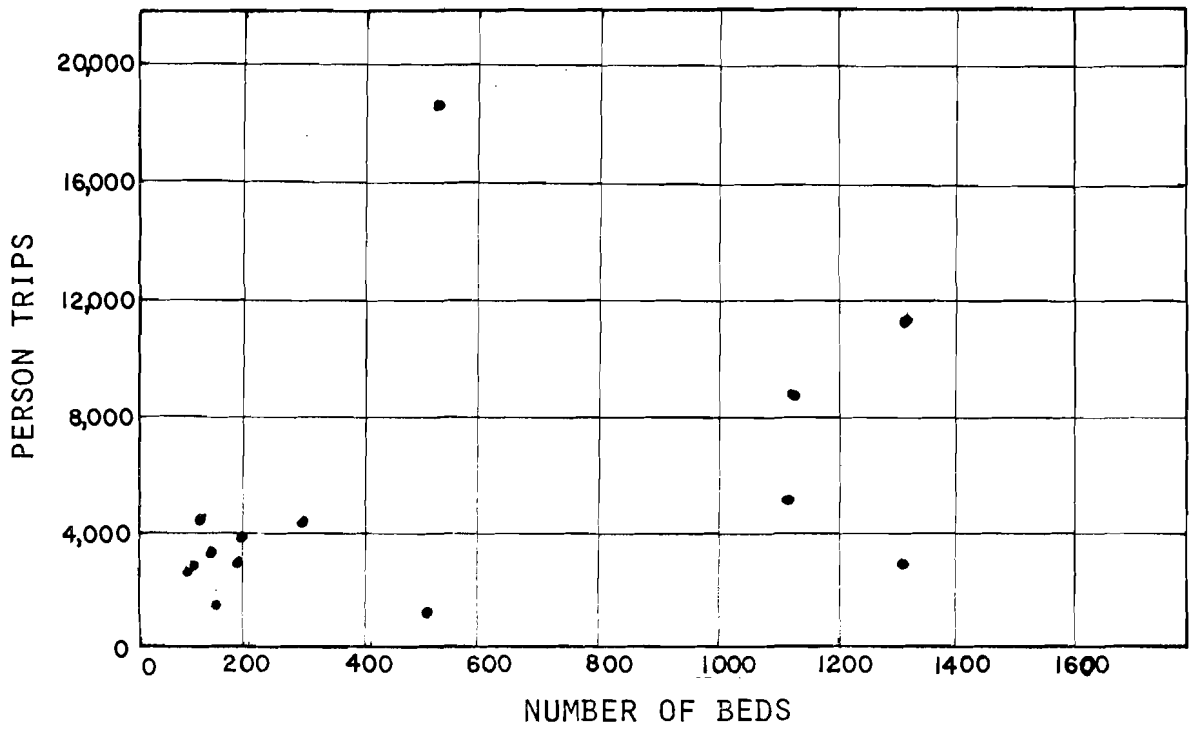


FIGURE 39: HOSPITAL VEHICLE AND PERSON TRIPS GENERATED BY NUMBER OF HOSPITAL BEDS.

Military Bases

The 4 military installations examined included 2 major air force bases, 1 major naval air station, and 1 field training base. Each was counted during the full 24-hour operational cycle by machine with corresponding manual vehicle occupancy counts.

Additional military related trip generation data collected included the number of employees, the number of military personnel residing on and off base, civilian personnel and gross acreage. Table 19 indicates the resulting person trip and vehicle trip rates calcualted for each installation examined. The generations are graphically represented in Figures 40 and 41 where person and vehicle trips are plotted by employment and acreage.

Recreation Facilities

There were 8 recreational facilities examined for their trip generating characteristics. These included 2 country clubs with golf courses and lake accessibility, 2 municipal golf courses, 1 private club with golf course, 1 zoological garden with adjoining park, 1 boat harbor with adjoining park and 1 public park with lake access. Each was counted during the hours of operation for both vehicle trips and vehicle occupancy.

Employment and gross acreage were the only variables available to base the recreation trip generations upon. The resulting vehicle and person trip rates for each facility are indicated in Table 20.

MILITARY TRIP GENERATION

Vehicle and Person Trip Rates

Table 19

Military Installation	Employment	Gross Acreage	Total Vehicle Trips	Vehicle Trips per Employee	Vehicle Trips per Acre	Vehicle Occupancy Rate	Total Person Trips	Person Trips per Employee	Person Trips per Acre
Bergstrom Air Force Base	5,965	3,000	20,560	3.4	6.9	1.5	30,780	5.2	10.3
Randolph Air Force Base	8,727	2,608	30,468	3.5	11.7	1.4	42,628	4.9	16.3
Medina Air Force Base	2,400	4,017	6,632	2.8	1.7	1.6	10,314	4.3	2.6
Corpus Christi Naval Air Sta.	8,658	2,000	20,408	2.4	10.2	1.4	28,054	3.2	14.0

RECREATIONAL TRIP GENERATION

Vehicle and Person Trip Rates

Table 20

Recreational Facility	Employment	Gross Acreage	Total Vehicle Trips	Vehicle Trips per Employee	Vehicle Trips per Acre	Vehicle Occupancy Rate	Total Person Trips	Person Trips per Employee	Person Trips per Acre
Country Club W/Golf Course	55	237	532	9.7	2.25	1.2	622	11.3	2.62
Country Club W/Golf Course	50	1,600	1,032	20.6	0.65	2.0	2,102	42.0	1.31
Municipal Golf Course	3	150	92	30.7	0.61	1.1	100	33.3	0.67
Municipal Golf Course	6	488	171	28.5	0.35	1.6	266	44.3	0.55
Res. Area Club W/Golf Course	22	150	926	42.1	6.17	1.7	1,540	70.0	10.27
Zoological Gardens	12	174	174	14.5	1.00	2.7	466	38.8	2.68
Park and Boat Marina	47	--	2,682	57.1	--	1.4	3,658	77.8	--
Park and Boat Marina	20	420	2,868	143.4	6.83	2.0	5,756	287.8	13.70

MILITARY TRIP GENERATION

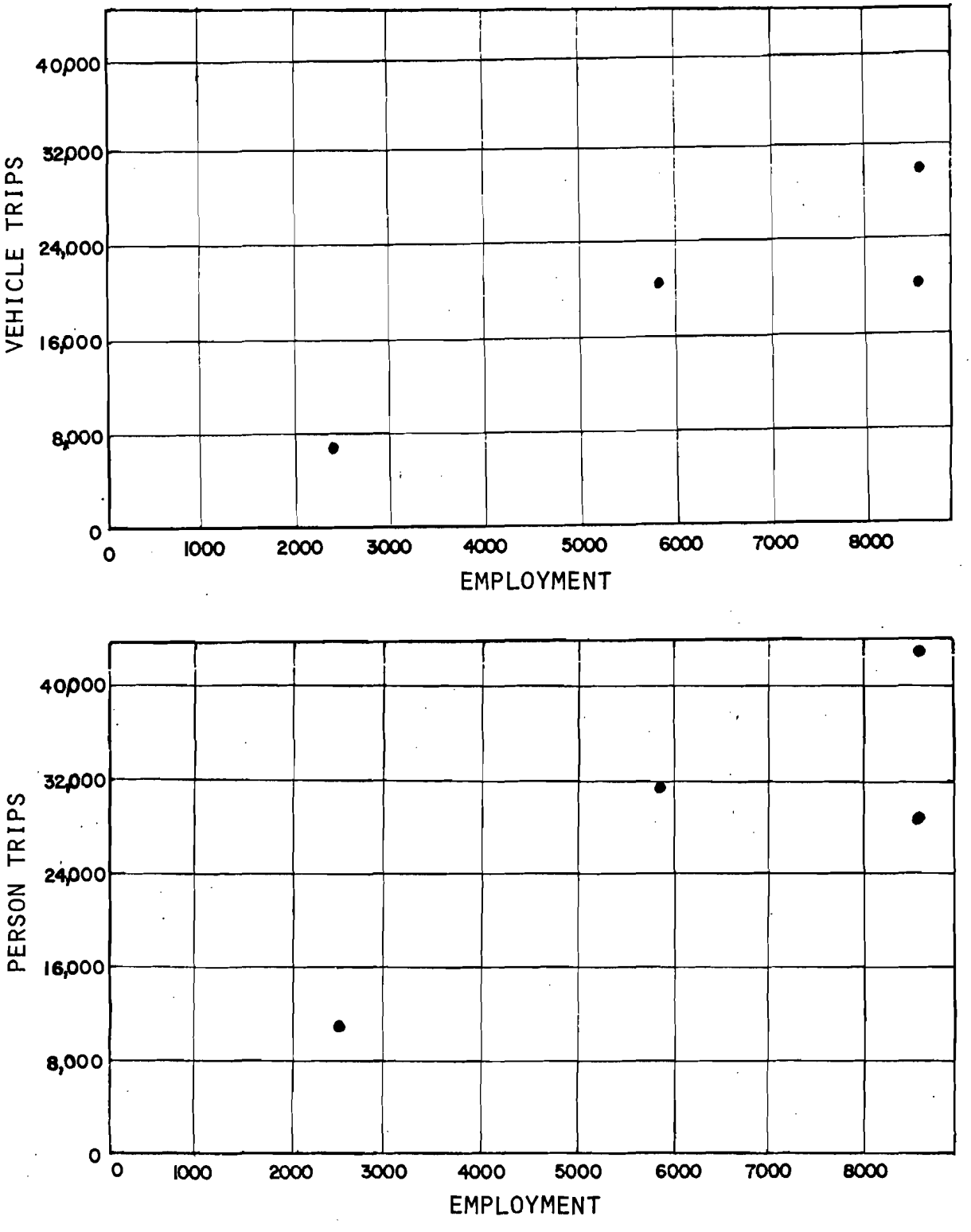
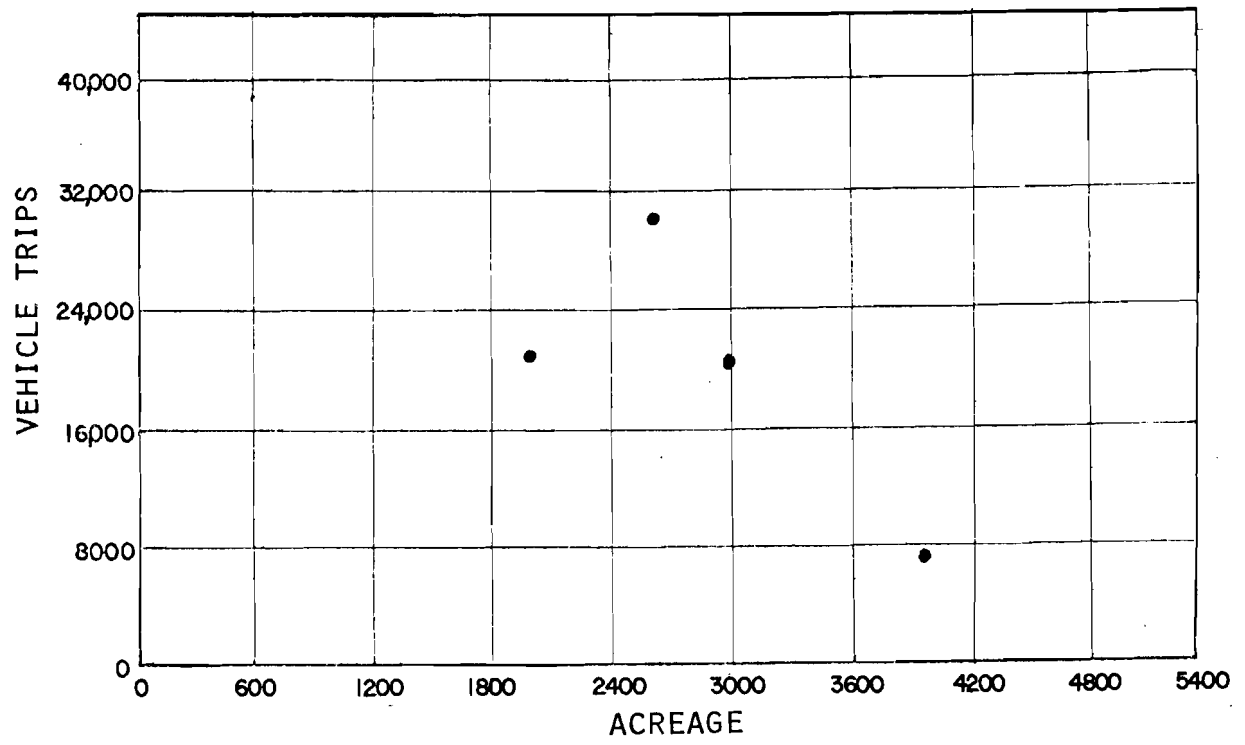


FIGURE 40: MILITARY VEHICLE AND PERSON TRIPS GENERATED BY EMPLOYMENT.



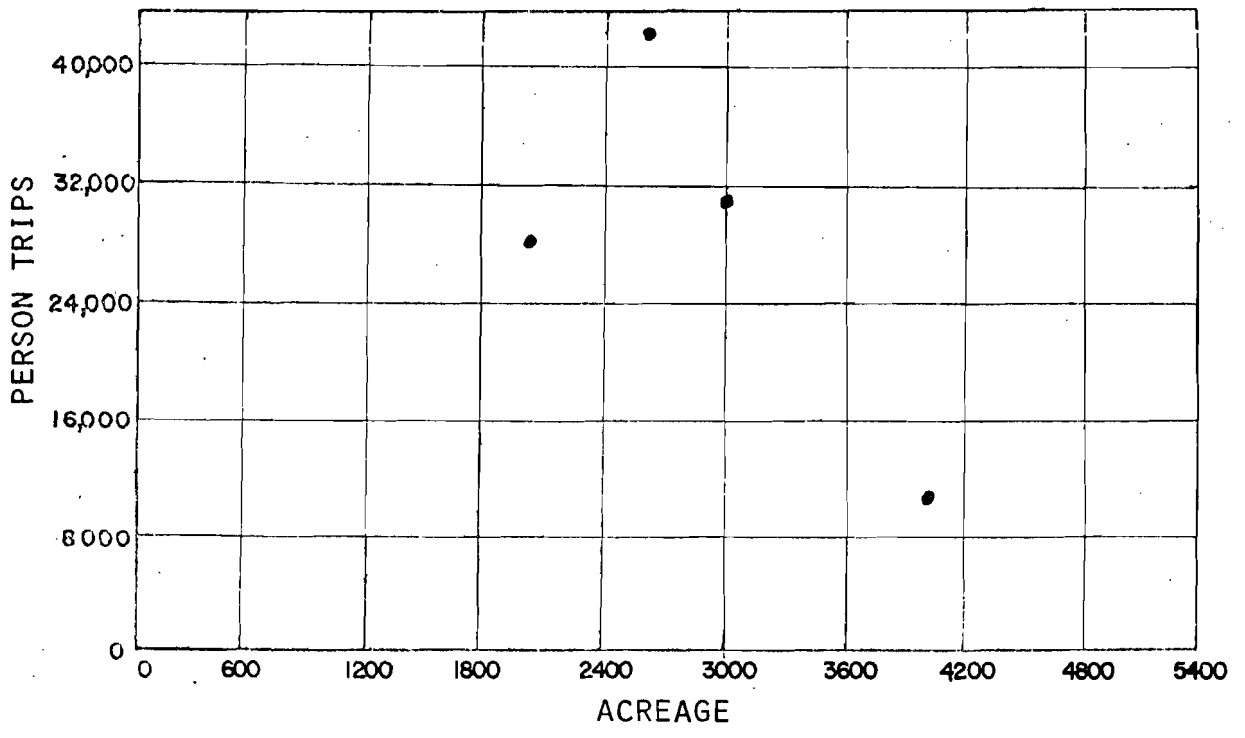


FIGURE 41: MILITARY VEHICLE AND PERSON TRIPS GENERATED BY ACREAGE.

Appendix A

Sample Generation Variable Survey Forms

Exhibit A-1

Special Generator
_____

_____ URBAN TRANSPORTATION STUDY

Census Tract _____ Serial Zone _____

Survey Zones _____

RESIDENTIAL AREAS

Name _____ City _____

Number of Single Family D/U _____

Number of Apartments _____ Occupancy Rate _____

Number of Mobile Homes _____

Number of Units Under Construction _____

Number of Units Obviously Vacant _____

Estimated Persons Per D/U _____

Estimated Family Income (High, Med., Low) _____

Remarks: _____

_____

_____

Exhibit A-2

Special Generator
_____

_____ URBAN TRANSPORTATION STUDY

Census Tract _____ Serial Zone _____

Survey Zones _____

OFFICE BUILDINGS

Name _____ Address _____

Total Number of Firms _____

Number of Employees _____

Number of Floors _____ Sq. Ft. _____

Surface Acres _____

Number of Firms Which Generate a Large Amount of HSW Trips, as Opposed to HSW Trips ____

_____

Total Acres _____

Unusual Activities _____

_____

Special Generator

Exhibit A-3

_____

_____ URBAN TRANSPORTATION STUDY

Census Tract _____ Serial Zone _____

Survey Zones _____

SHOPPING CENTERS

Name _____ Address _____

Number of Employees _____

Hours of Operation _____ To _____

Parking Lot Size and Number of Speces _____

Total Acres _____

Number of Stores _____

Names of Major Stores _____

_____

Floor Space (So. Ft.) _____

*Unusual Characteristics _____

_____

_____

*Businesses or activities not normally associated with shopping centers. (Movies, motels hotels, restaurants, service stations, skating rinks, parking lot across street, businesses with unusual hours, etc.)

Special Generator

Exhibit A-4

_____

_____ URBAN TRANSPORTATION STUDY

Census Tract _____ Serial Zone _____

Survey Zones _____

INDUSTRIAL AREAS

Name _____ Address _____

Number of Employees (by shift) _____

_____

Gross Acres _____

Floor Space (sq. ft.) _____

Acres of Open Space or Storage _____

Acres of Parking Area _____

Hours of Operation _____

Time of Shift Change _____

If Seasonal:

Months of Operation _____

_____

Product _____

Exhibit A-5

Special Generator
_____

_____ URBAN TRANSPORTATION STUDY

Census Tract _____ Serial Zone _____

Survey Zones _____

COLLEGES and UNIVERSITIES

Name _____ Address _____

Catagory _____

Number of Students _____

Number of Students Living On-Campus _____

Total Employees _____

Remarks _____

_____

_____

_____

Exhibit A-6

Special Generator
_____

_____ URBAN TRANSPORTATION STUDY

Census Tract _____ Serial Zone _____

Survey Zones _____

HOSPITALS

Name _____ Address _____

*Type _____

Number of Beds _____

Total Staff _____

Remarks _____

Total Acres _____

Floor Space (Sq. Ft.) _____

Time of Shift Change _____
*General, Veterans, Mental, Teaching, Nurses Training.

Exhibit A-7

Special Generator
_____

_____ URBAN TRANSPORTATION STUDY

Census Tract _____ Serial Zone _____

Survey Zones _____

AIRPORTS

Name _____ City _____

*Type _____

Number of Regularly Scheduled Flights Per Day _____

Number of Deplaning Passengers _____

Number of Lease or Charter Planes _____

Number of Employees _____

Area Population _____

Total Acres _____

Remarks _____

_____

*Municipal, Private

Exhibit A-8

Special Generator
_____

_____ URBAN TRANSPORTATION STUDY

Census Tract _____ Serial Zone _____

Survey Zones _____

MILITARY BASES

Name _____ City _____

Number of Military Personnel Residing on Base _____ Off Base _____

Number of Civilian Employees _____

Gross Acres _____

Remarks _____

_____

_____

Exhibit A-9

Special Generator
_____

_____ URBAN TRANSPORTATION STUDY

Census Tract _____ Serial Zone _____

Survey Zones _____

AMUSEMENT CENTERS

Name _____ Address _____

Gross Acres _____

Employment _____

Floor Space (Square Feet) _____

Hours of Operation _____

*General Attraction Features _____

Acres of Open Space _____

Parking Space _____

Seasonal _____

*Golf courses, country clubs, zoos, parks, amusement parks, etc.

Appendix B

Sample Counting/Tabulation Forms

Exhibit B-1

_____ URBAN TRANSPORTATION STUDY DATE _____ 197_

WEATHER _____ GENERATOR NAME _____ NUMBER _____ STATION NUMBER _____

	PASSENGER CARS, PICKUPS AND PANELS								COMMERCIAL VEHICLES								BUSES						* OTHER VEH	PED	TOTAL	
							SUB TOTAL		NON DIESEL			DIESEL			SUB TOTAL		NON DIESEL		DIESEL		SUB TOTAL					
TIME PERIOD	1	2	3	4	5	6+	VEH	OCC	1	2	3+	1	2	3+	VEH	OCC	VEH	OCC	VEH	OCC	VEH	OCC	VEH	PER	VEH	OCC
MIDNIGHT																										
000-100																										
100-200																										
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1100-200																										
TOTAL																										

* BICYCLES & MOTORCYCLES

RECORDER _____

Exhibit B-2

Inbound Vehicles and Persons by Classification by Hour Period

	Hour Period	Pass. Veh. Veh.	Pass. Veh. Pers.	Pickup Trucks Veh.	Pickup Trucks Pers.	Other Comm. Veh.	Other Comm. Pers.	Buses Veh.	Buses Pers.	Other* Modes Veh.	Other* Modes Pers.	Pedestrians	Total Veh.	Total Per
	12:00 - 1:00	71	101	7	9	2	3	0	0	1	1	2	81	116
	1:00 - 2:00	27	38	3	4	1	2	0	0	1	1	1	32	46
	2:00 - 3:00	12	17	1	1	0	0	0	0	0	0	0	13	18
	3:00 - 4:00	5	7	1	1	0	0	0	0	0	0	0	6	8
	4:00 - 5:00	20	29	2	3	1	2	0	0	0	0	1	23	35
	5:00 - 6:00	70	100	7	9	1	2	0	0	2	2	2	80	115
AM	6:00 - 7:00	591	739	75	98	5	5	0	0	13	13	5	684	860
	7:00 - 8:00	1650	2313	256	317	21	26	2	47	42	42	17	2171	2762
	8:00 - 9:00	595	857	55	70	7	15	6	142	13	13	6	676	1103
	9:00 - 10:00	402	580	27	39	17	23	3	71	9	9	2	458	724
	10:00 - 11:00	437	623	29	38	18	28	1	24	10	10	14	495	737
	11:00 - 12:00	490	698	33	44	21	34	1	24	11	11	16	556	827
	12:00 - 1:00	789	1125	63	83	25	40	2	48	17	17	26	896	1339
	1:00 - 2:00	555	791	44	58	17	27	2	48	12	12	19	630	935
	2:00 - 3:00	465	725	37	65	15	22	1	24	10	10	23	528	869
	3:00 - 4:00	492	836	50	63	16	34	6	142	11	11	34	575	1120
	4:00 - 5:00	469	769	28	44	20	40	0	0	10	10	91	527	954
	5:00 - 6:00	459	771	30	42	6	6	0	0	10	10	4	505	833
PM	6:00 - 7:00	330	470	22	29	4	6	1	24	7	7	7	364	543
	7:00 - 8:00	209	298	14	18	3	5	0	0	4	4	5	230	330
	8:00 - 9:00	182	260	12	16	2	3	0	0	4	4	4	200	287
	9:00 - 10:00	165	235	17	22	3	5	1	24	4	4	4	190	290
	10:00 - 11:00	168	240	17	22	4	6	0	0	4	4	4	193	276
	11:00 - 12:00	146	208	15	20	3	5	0	0	3	3	3	167	239
Total Inbound		8,599	12,830	845	1,115	212	339	26	618	298	198	290	10,280	15,390
Total 24-Hour Inbound and Outbound Vehicles and Persons		17,998	25,660	1,690	2,230	424	678	52	1,236	396	396	580	20,560	30,780

*Motorcycles and Bicycles