DALLAS-FORT WORTH REGIONAL TRANSPORTATION STUDY

SUMMARY OF DEVELOPMENT OF TRAVEL DEMAND MODELS

In 1977 the decision was made to develop and validate travel demand models for the purpose of making traffic projections for the years 1990 and 2000.

In order to accomplish this task it was necessary to develop maps depicting the 1977 system of freeways and major thoroughfares. Using this system, census tract lines and the survey zones developed in 1964 for the origin-destination surveys, 1938 internal serial zones (traffic assignment zones) were delineated. This work was accomplished by the Regional Planning Office staff in Grand Prairie.

Over 6,000 traffic counts were made on the major thoroughfare system. The counts were for 24-hour week day periods and made by the Cities of Dallas, Fort Worth, Arlington, Hurst, Richardson, Plano, Garland and Mesquite and by the Transportation Planning Division.

Socio-economic data (planning variables) were gathered for each of the 1938 serial zones. The socio-economic data furnished included population, number of dwelling units, mean family income in 1969 dollars, basic and non-basic employment. Those data were obtained by a cooperative effort of North Central Texas Council of Governments, the Cities involved and the Regional Planning Office. In addition, the Regional Planning Office furnished the necessary planning variables for the following special generators:

    Elementary, Junior High and High Schools (No. of employees and students)

    Colleges and Universities (No. of employees, total students and No. of
        students living on campus)

    Hospitals (No. of employees and beds)

    Country Clubs - Golf Courses (No. of employees)

    All major Airports (No. of employees and deplaning passengers)

    Military facilities (Civilian employment, assigned personnel and personnel
        living on base)

1

All of the necessary planning variable data was furnished the Transportation Planning Division in August, 1979. The next several months were spent in checking the validity of these data. Table A summarizes these data.

The models developed and a brief explanation of the mechanics pertinent to their development are shown below:

Auto Ownership

The term "Autos" refers to all personal use vehicles. These models estimate the number of households (D.U.) having 0, 1, 2 and 3 plus autos for each trip production rate group.

Trip production rate groups were correlated primarily to mean family income expressed in 1969 dollars. A high percentage of multi-family housing was also a factor used to determine the trip production rate group for each zone.

In order to provide a more accurate estimate, the study area was divided into three areas. These area delineations and the incomes associated with each trip production rate group are defined on Table C.

The development of these models were based upon the seven origin-destination survey conducted by SDHPT during the 1968-1970 period and a small sample survey conducted in Corpus Christi in January - February, 1977. However the Dallas-Fort Worth Urban Area citizens survey conducted in 1977 by NCTCOG was used most extensively to update the 1968-1970 survey data.

Refinements to the models were made based upon analysis of model output and the actual registration figures furnished for Dallas and Tarrant Counties by the Motor Vehicle Division of SDHPT.

The final models are shown graphically in figures 1, 2, 3 and 4. The models results are shown in Tables B and C.

2

Vehicle Trip Production

These models estimate the total number of internal auto-driver trip productions for each zone. The trip production rate group and the number of households having 0, 1, 2 and 3 plus autos for each zone is input to these models. Previously conducted surveys by SDHPT were the basis for developing these models.

In order to obtain more accuracy, the study area was subdivided into four areas. (These are defined on Table D.)

The models used are shown graphically in figures 5, 6, 7 and 8 and in tabular form in Table D. The results of these models and vehicle trips by purpose models are shown in Table E.

Vehicle Trips by Purpose

Internal auto-driver vehicle trips by purpose models estimate the percentage of the trip productions in each zone that will be home based work (HBW), home based non work (HBNW) and non home based (NHB).

Those estimates are based upon the trip production rate group for each zone. The model is shown graphically in figure 9 and in tabular form in Table F. The model results are shown in Table E.

Trip Attractions

Vehicle trip attractions were developed using a trip rate for each purpose including commercial use truck trips for each category of employment and for each dwelling unit.

The study area was subdivided into generation areas, each area with a different rate structure. The area delineations and the trip rates were based upon the 1964 origin-destination survey and refined during the modelling process as deemed necessary. Total trip attractions for each purpose were scaled to equal the total trip productions for that purpose. Results of these calculations are also shown on Table E.

External Trips

External trips are defined as those trips having at least the origin or destination
outside the study area.

External local trips are those having only the origin or destination outside the
study area. External through trips have both the origin and destination outside
the study area.

The estimation of these trip interchanges were based as far as possible upon the
1964 origin-destination survey.

The external trips were first divided by local and through trips. Local trip volumes
at each external station to each of 49 internal sectors were estimated manually and
fed into an external distribution computer program. This program estimates the
station to zone interchange based upon the relative attractions of each zone within
the sector.

The external through trip matrix was developed manually using the 1964 survey directly.

Summary of these results are shown in Table E.

Trip Distribution

The distribution of the generated trips was accomplished using a newly developed
technique commonly called the Atomistic Trip Distribution Model.[1] (See footnotes
at end of this Section on Trip Distribution.) This technique was used rather than
the Texas Trip Distribution Model because of its superiority in handling large zones
common to sketch planning and a mixture of very small and very large zones common
to subarea focusing. The need for a superior distribution model for sketch planning
and subarea focusing is documented by research done by Texas Transportation Institute
(TTI).[2]

The Atomistic model requires an input of the trip length frequency curve for each purpose. To provide average trip lengths, data from twenty-eight Texas origin-destination surveys were analyzed. Plots of the average trip lengths by Urban population for each trip purpose were produced. Best fit curves were then produced. From these curves an average trip length for each purpose was estimated. Using a curve fit model developed by TTI[3], the trip length frequencies were obtained.

The trip length frequency distribution for each trip purpose is shown in Figures 10, 11, 12 and 13.

One of the sailent factors of both distribution models used in Texas is their ability to balance trip length frequencies and trip attractions simultaneously. Table G shows the results of trip length balance and the intrazonal trips produced by the model.

Table H gives an indication of attraction volume balance for HBW trips. For example, 1,217 of the 1938 zones were balanced within 5% of the desired attractions. Only one zone with an attraction volume greater than 5,000 failed to balance within plus or minus 1%. Tables I, J and K show simular information for HBNW, NHB and TKTX trips.

Table L shows the accumulated attraction balances by sector for HBW trips. (This sector structure along with other sector structures will be displayed for the benefit of those wishing to see them.) Table M, N and O show the same data for HBNW, NHB and TKTX trips.

Footnotes

1. Benson: "A Spatially Disaggregate Trip Distribution Modeling Technique" TTI Report 0194-4

2. Benson, Teniente, Zipp: "An Analysis of the Effects of Zone Size in the Trip Distribution Modeling Process." TTI Report 0194-3

3. Benson, Teniente: "An Improved Model for the Estimation of Trip Length Frequency Distributions." TTI Report 0194-5

Traffic Assignment

The traffic assignment mirrors all of the input developed previously and as such presents a composite of the results of the models.

A traffic assignment technique using existing Volumes as a restraint was used. Several summary and analysis techniques were used to determine the ability of the developed trips to match the existing travel patterns as portrayed by the ground counts.

One such summary is shown in Table P. Here vehicle miles of travel by super sectors are shown along with other pertinent data that can be used to analyze future assignments.

Summary

This report is intended to be presented in an informal manner to see if all concerned agree the models are valid and will be useful for predicting traffic.

In addition to data presented in this report numerous displays too large to be incorporated herein will be available at all meetings. These and the supportive computer outputs will remain on file at the Regional Planning Office for a more detailed study.

Included in these will be the actual traffic assignment maps and a map showing 92 traffic corridors that were preselected. These corridors will show counted volumes, assigned volumes and the percent assigned of the counted.

The travel demand modeling staff of the Transportation Planning Division feels that good models will be best represent 70 to 80 percent of the trips being made. As analysts, it is our task to determine where those trips are that do not fit the general models, quantify them and make the necessary refinements in our models to insure their incorporation into the travel patterns of the urban area. This we have tried to do using our judgement based upon our years of experience.

PERSONAL USE VEHICLES per HOUSEHOLD by INCOME
TARRANT & FRINGE COS. LESS ARLINGTON-PLANO AREAS
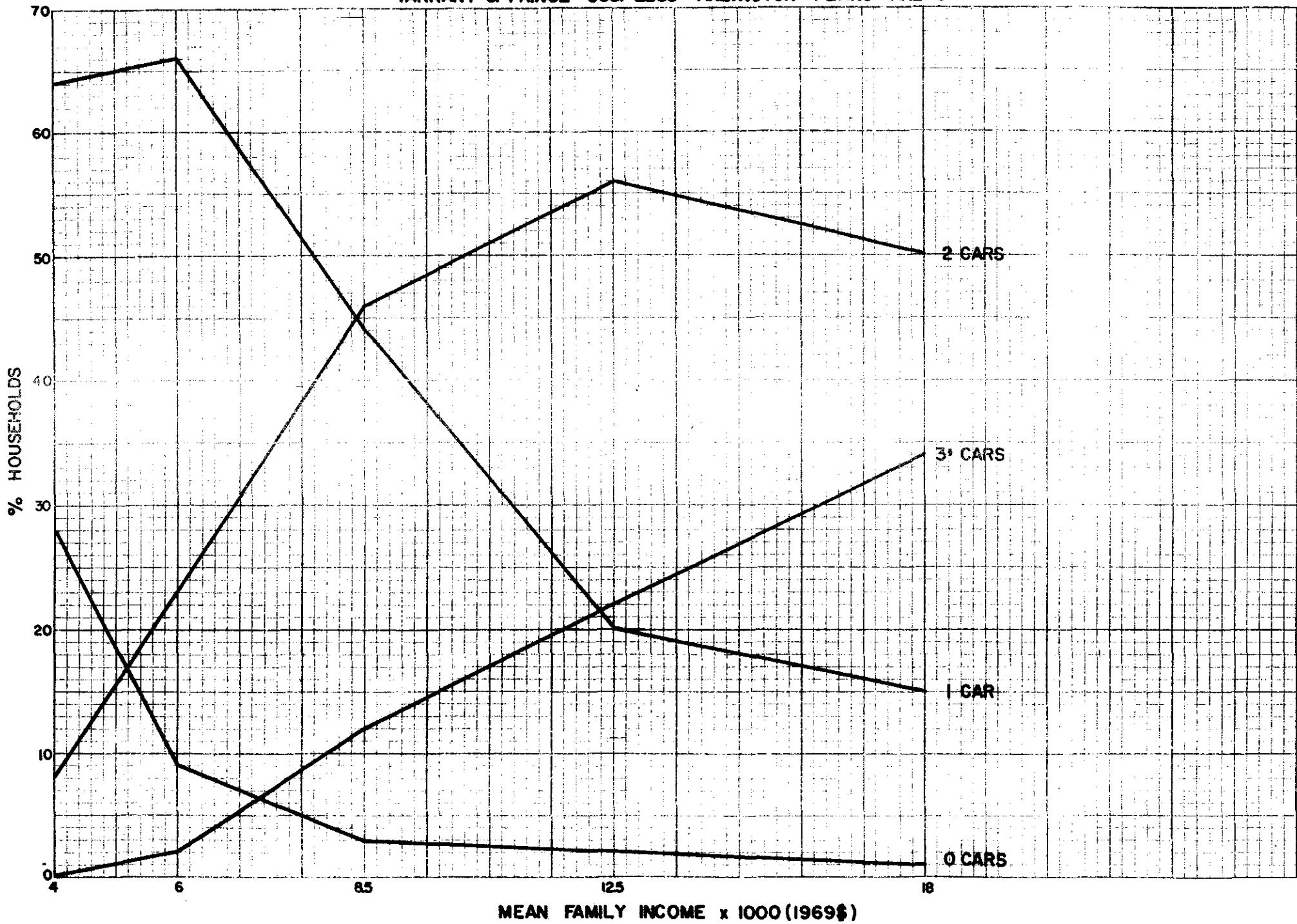
FIGURE 1

PERSONAL USE VEHICLES per HOUSEHOLD by INCOME
ARLINGTON-PLANO AREAS

MEAN FAMILY INCOME x 1000 (1969$)

% HOUSEHOLDS

2 CARS
3+ CARS
1 CAR
0 CARS
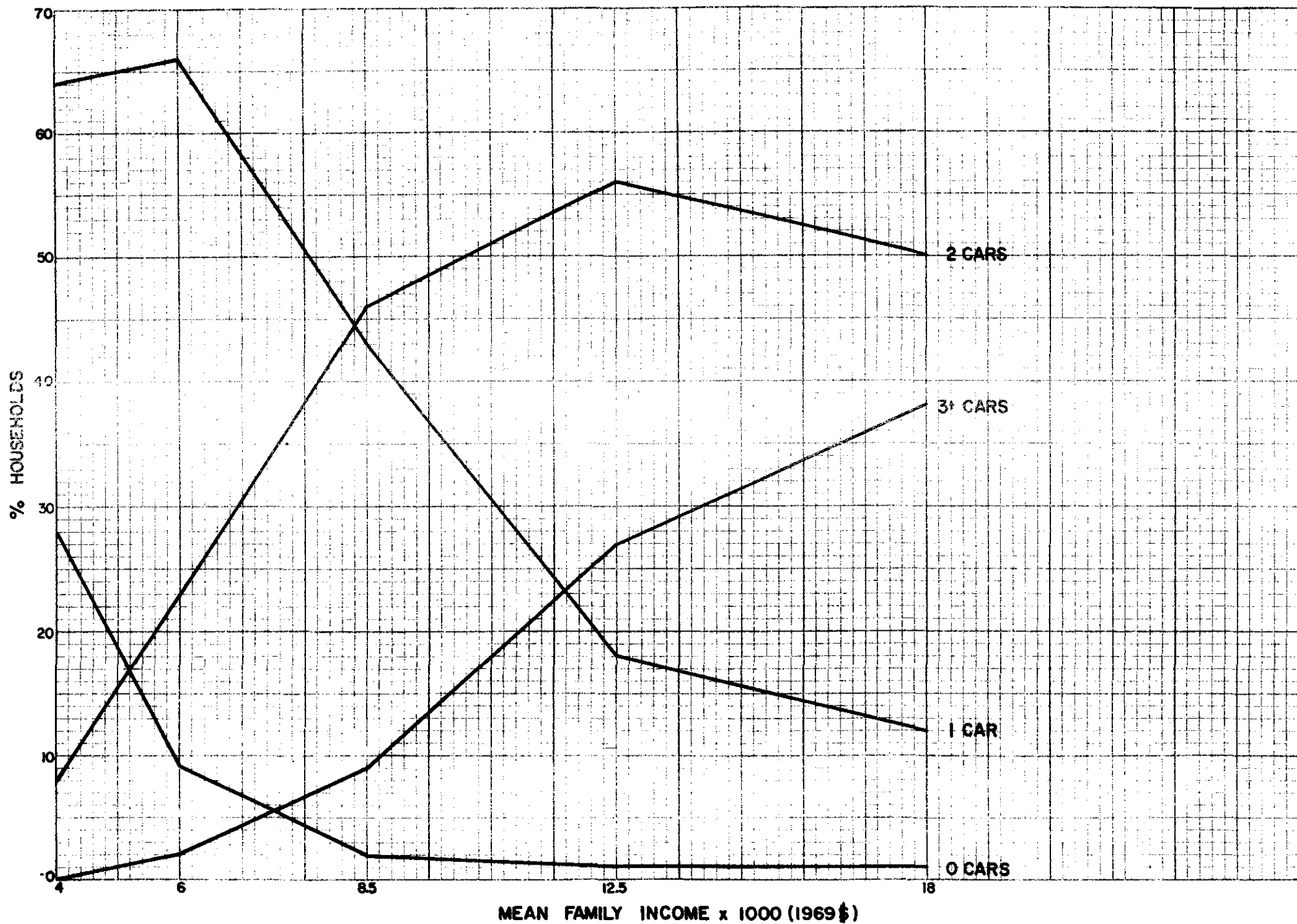
FIGURE 2

PERSONAL USE VEHICLES per HOUSEHOLD by INCOME
DALLAS COUNTY

MEAN FAMILY INCOME x 1000 (1969$)
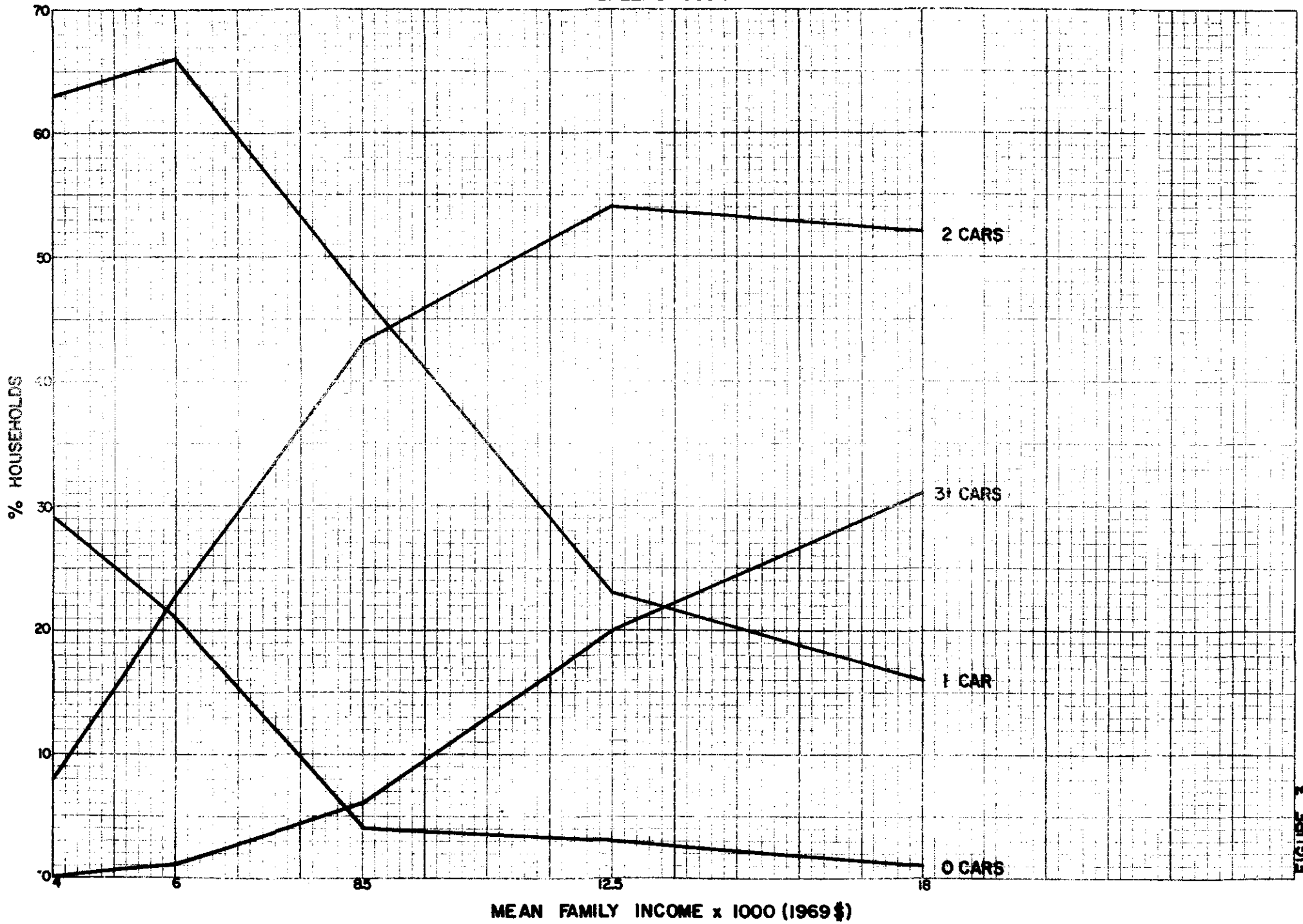
FIGURE 3

DALLAS-FORT WORTH REGIONAL TRANSPORTATION STUDY
PERCENT PERSONNAL USE VEHICLES PER HOUSEHOLD BY TRIP PRODUCTION RATE GROUP
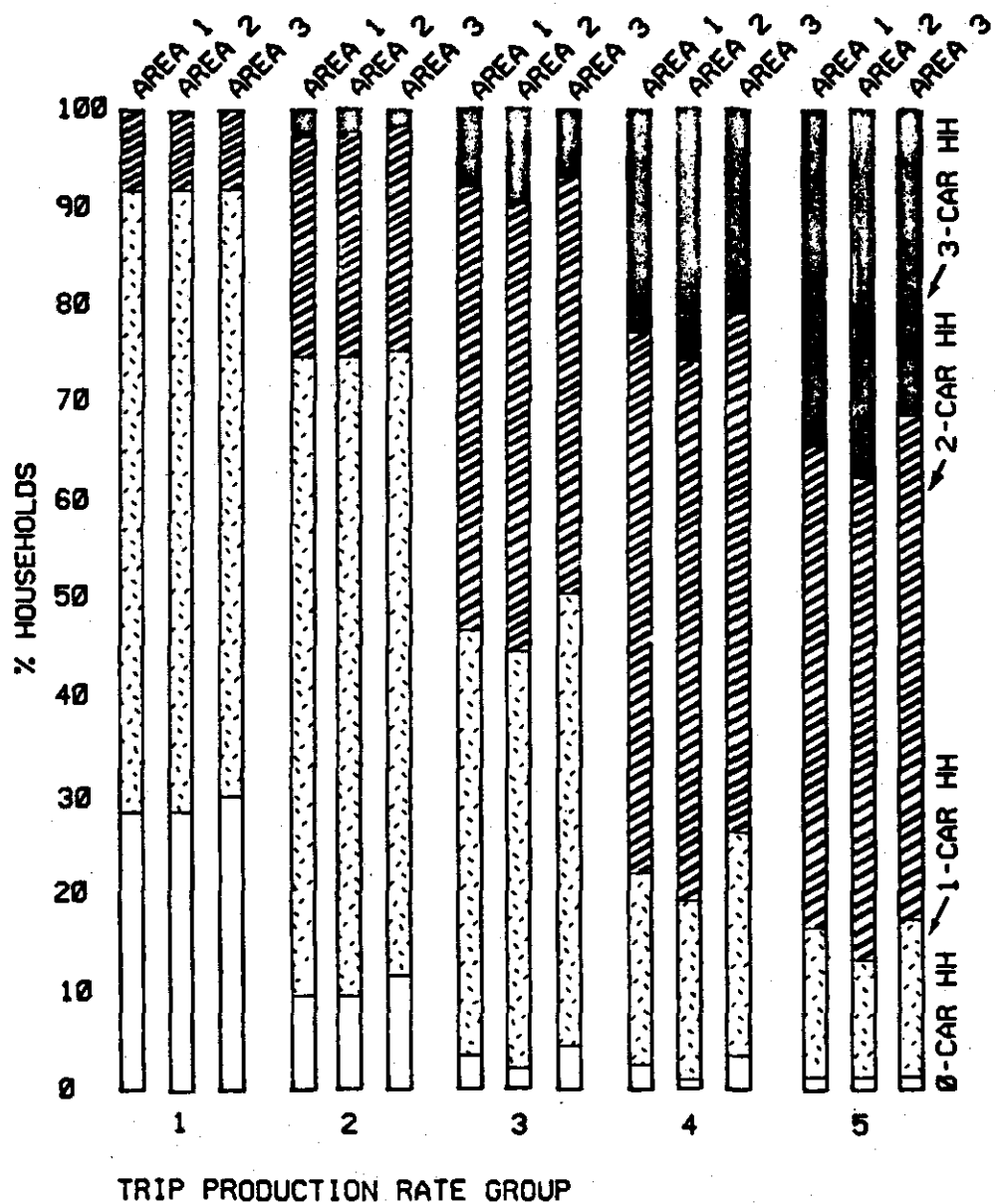
AUTOS PER HOUSEHOLD	GROUP 1 AREA			GROUP 2 AREA			GROUP 3 AREA			GROUP 4 AREA			GROUP 5 AREA		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
0	28	28	29	9	9	11	3	2	4	2	1	3	1	1	1
1	64	64	63	66	66	66	44	43	47	20	18	23	15	12	16
2	8	8	8	23	23	22	46	46	43	56	56	54	50	50	52
3+	0	0	0	2	2	1	7	9	6	22	25	20	34	37	31

LEGEND

GROUP 1-LOW INCOME   (MEAN-$4,000)

GROUP 2-LOW MIDDLE   (MEAN-$6,000)

GROUP 3-MIDDLE   (MEAN-$8,500)

GROUP 4-HIGH MIDDLE   (MEAN-$12,500)

GROUP 5-HIGH   (MEAN-$18,000)

AREA 1-TARRANT&FRINGE CO.S LESS
ARLINGTON AND PLANO AREAS

AREA 2-ARLINGTON AND PLANO AREA

AREA 3-DALLAS CO.

FIGURE 4

VEHICLE TRIPS per DWELLING UNIT by INCOME
AREA I (TARRANT & FRINGE COS. LESS ARLINGTON-PLANO AREAS)

VEHICLE TRIPS / D.U.

3+ CARS

2 CARS

1 CAR

0 CARS

MEAN FAMILY INCOME x 1000 (1969 $)
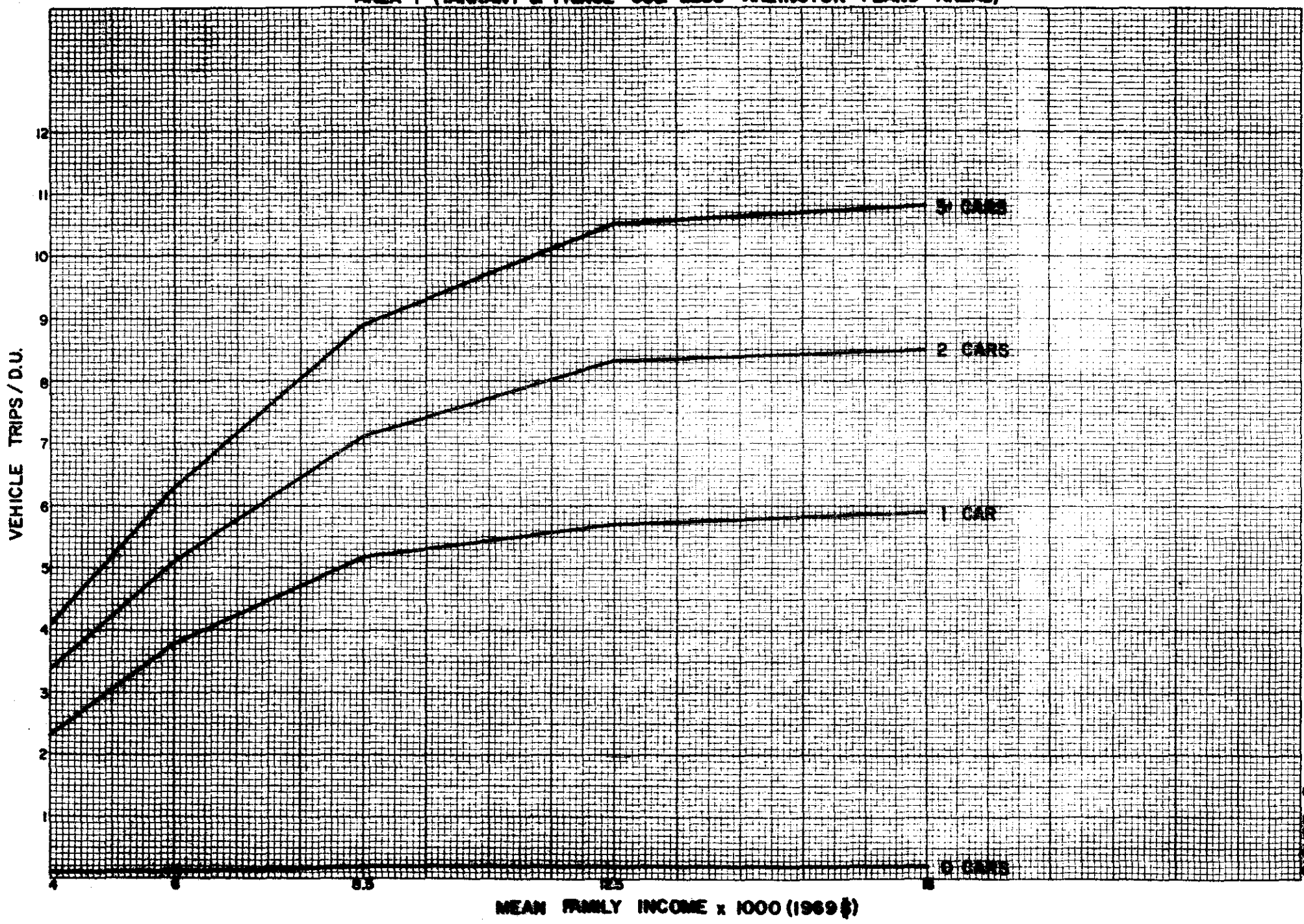
FIGURE 5

VEHICLE TRIPS per DWELLING UNIT by INCOME
AREA 2 (ARLINGTON-PLANO AREAS)

MEAN FAMILY INCOME x 1000 (1969 $)
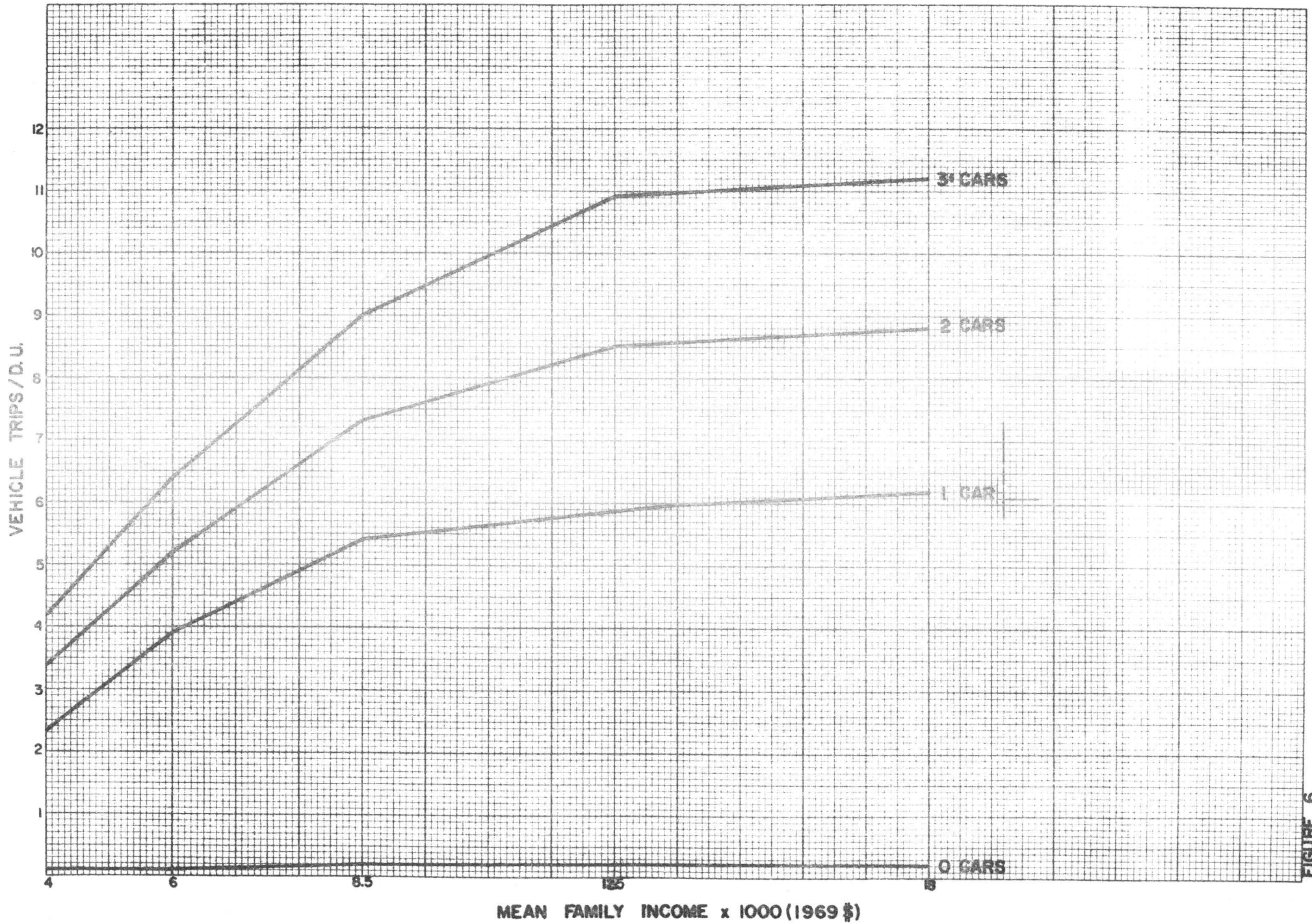
FIGURE 6

VEHICLE TRIPS per DWELLING UNIT by INCOME
AREA 3 (DALLAS CO. LESS IRVING, GRAND PRAIRIE, AND GARLAND)

VEHICLE TRIPS / D.U.

3+ CARS

2 CARS

1 CAR

0 CARS

MEAN FAMILY INCOME x 1000 (1969 $)
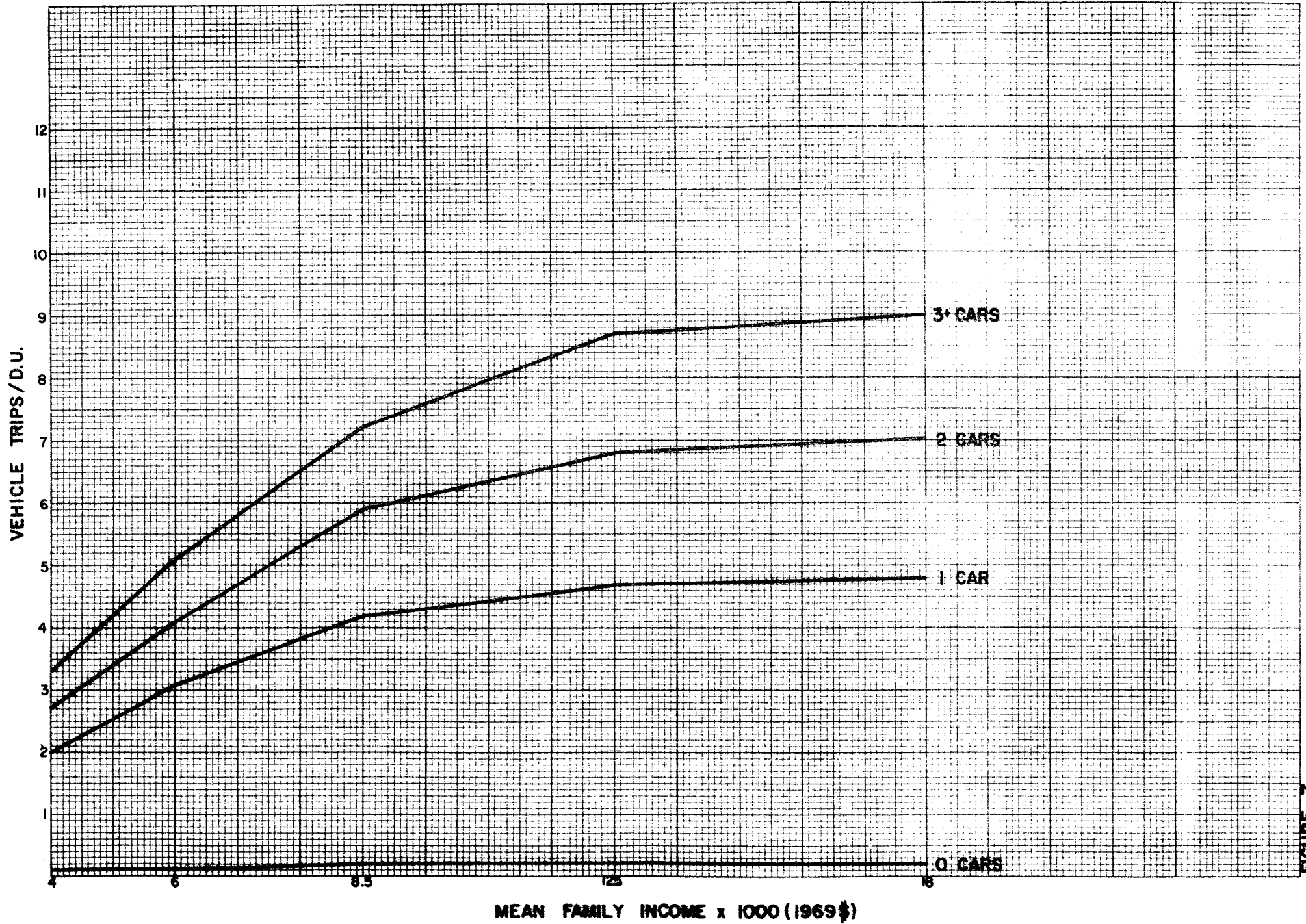
FIGURE 7

VEHICLE TRIPS per DWELLING UNIT by INCOME
AREA 4 (IRVING, GRAND PRAIRIE, AND GARLAND AREAS)

MEAN FAMILY INCOME x 1000 (1969 $)
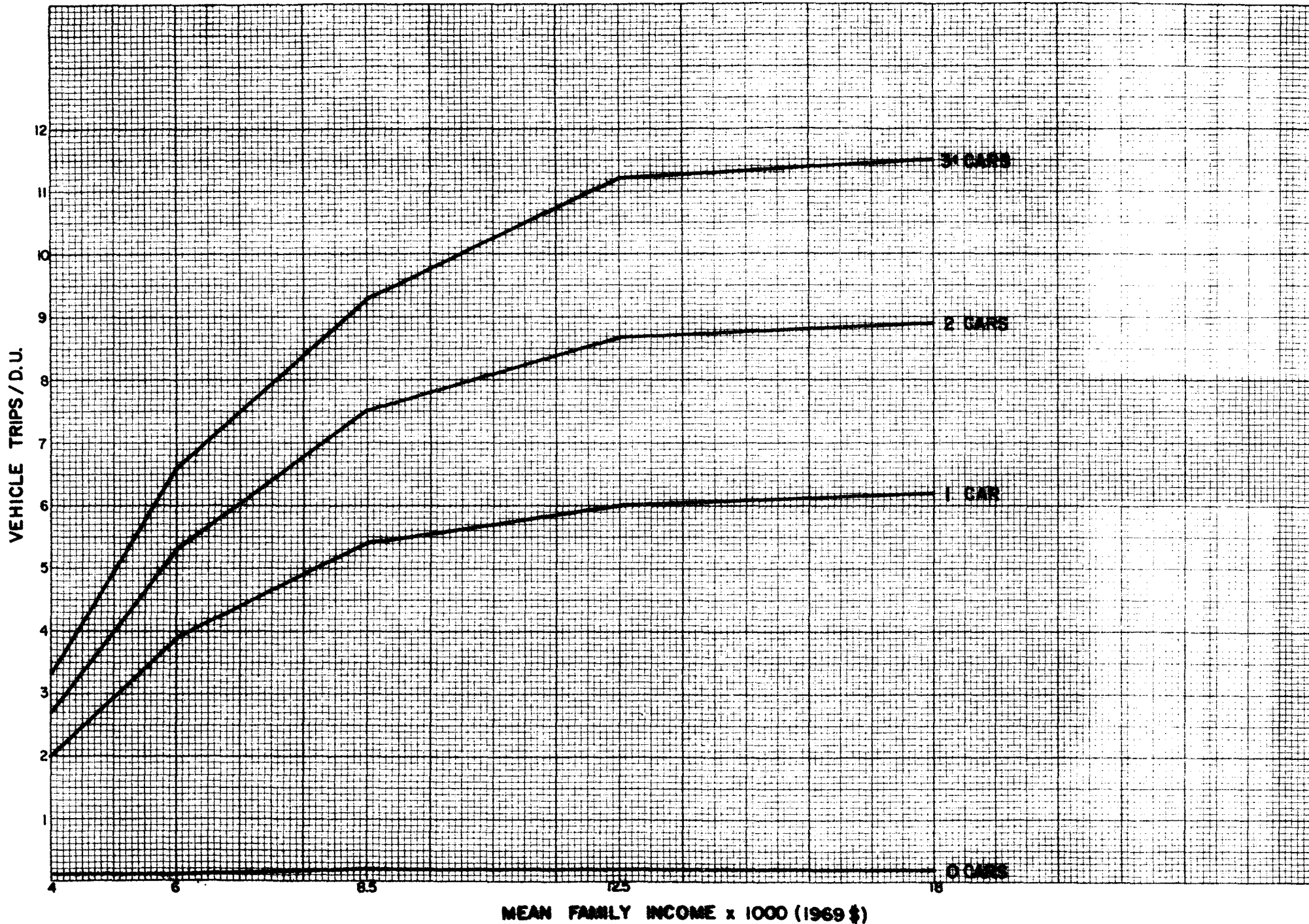
FIGURE 8

DALLAS-FORT WORTH REGIONAL TRANSPORTATION STUDY
PER CENT of TRIPS by PURPOSE by TRIP PRODUCTION RATE GROUPS (INCOME)
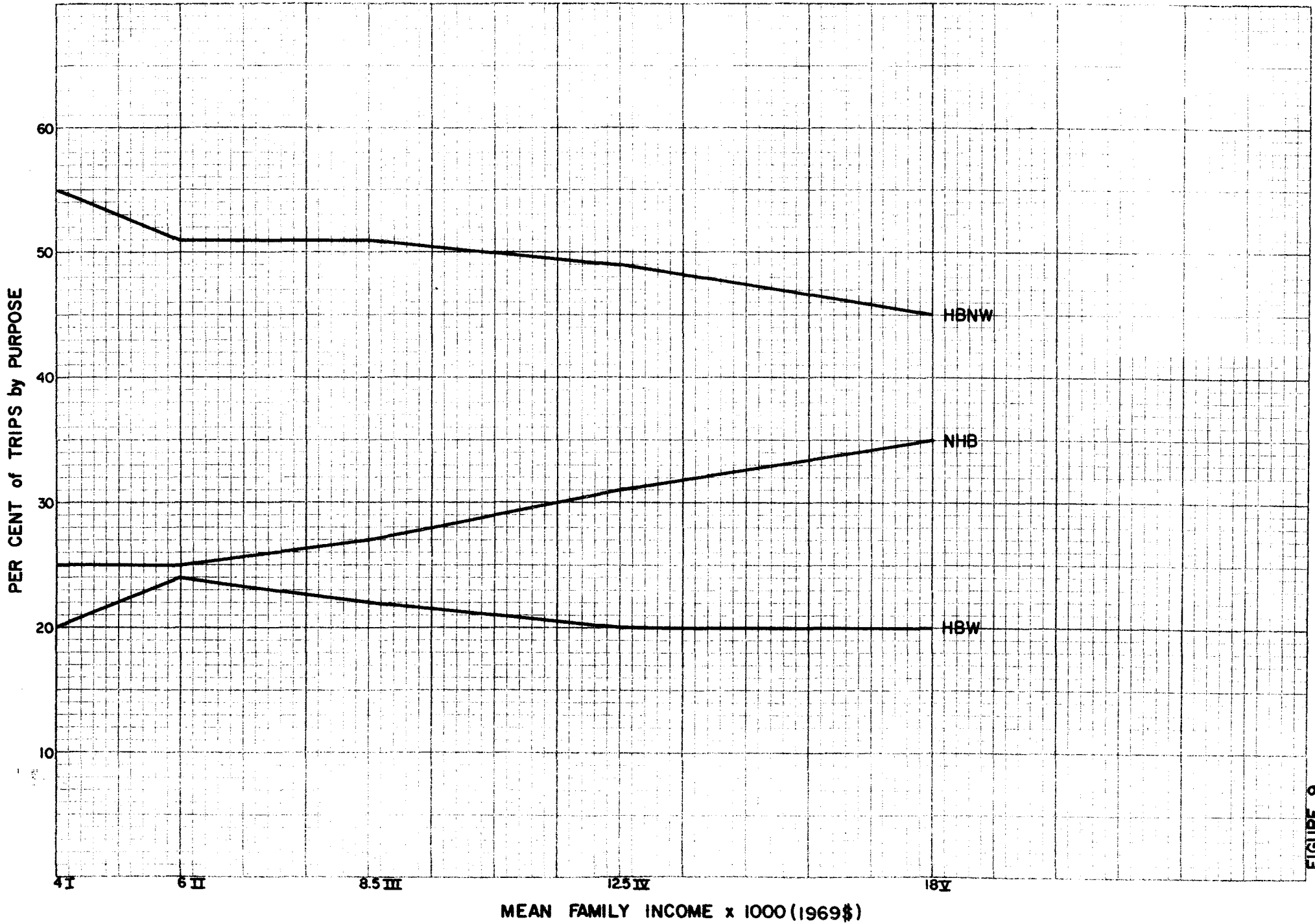
FIGURE 9

DALLAS — FORT WORTH TRANSPORTATION STUDY
1977 TRIP LENGTH DISTRIBUTION CURVE
HOME BASED WORK
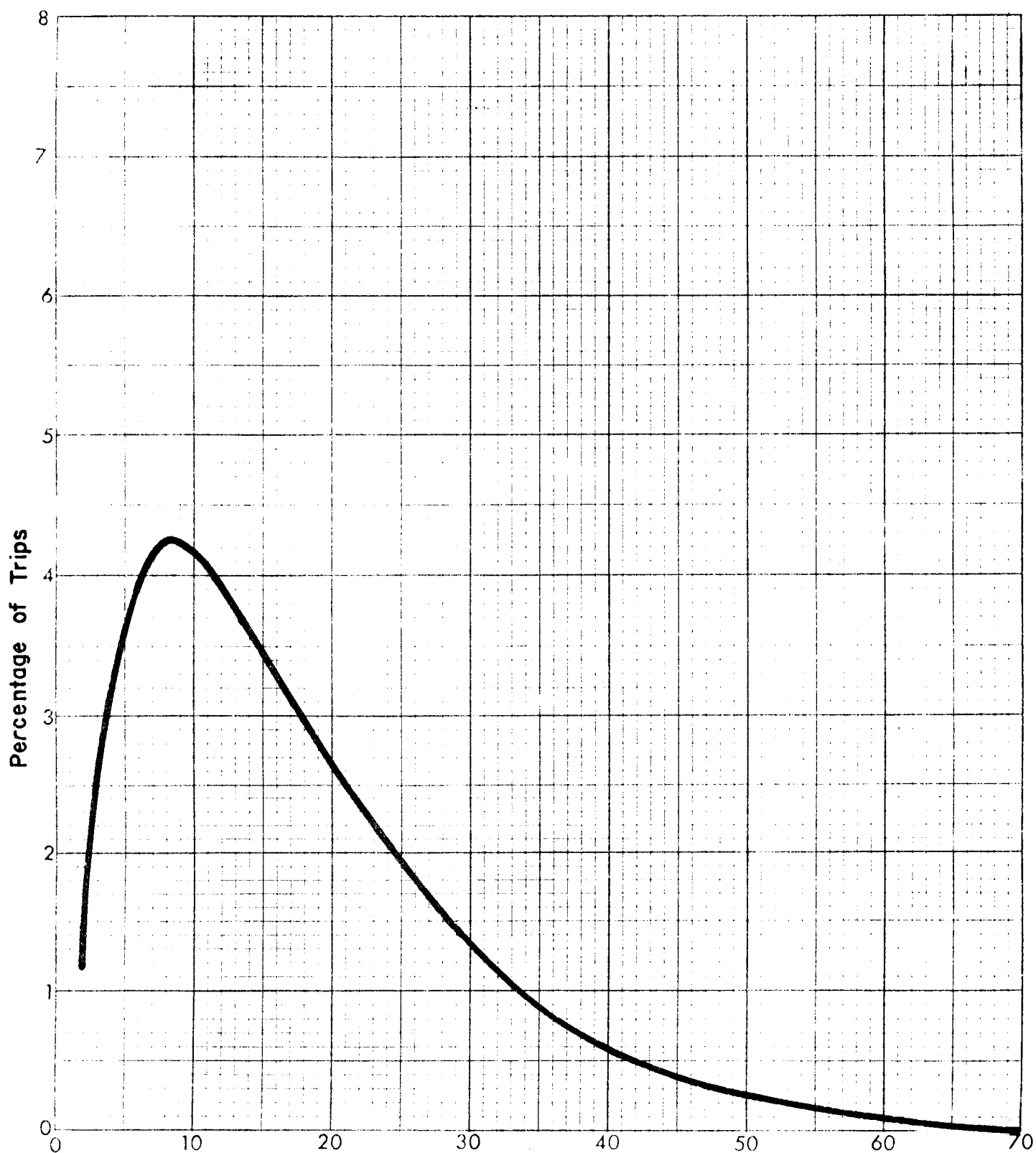
Travel Time (in minutes)

Figure 10

DALLAS — FORT WORTH TRANSPORTATION STUDY
1977 TRIP LENGTH DISTRIBUTION CURVE
HOME BASED NON WORK

Travel Time (in minutes)
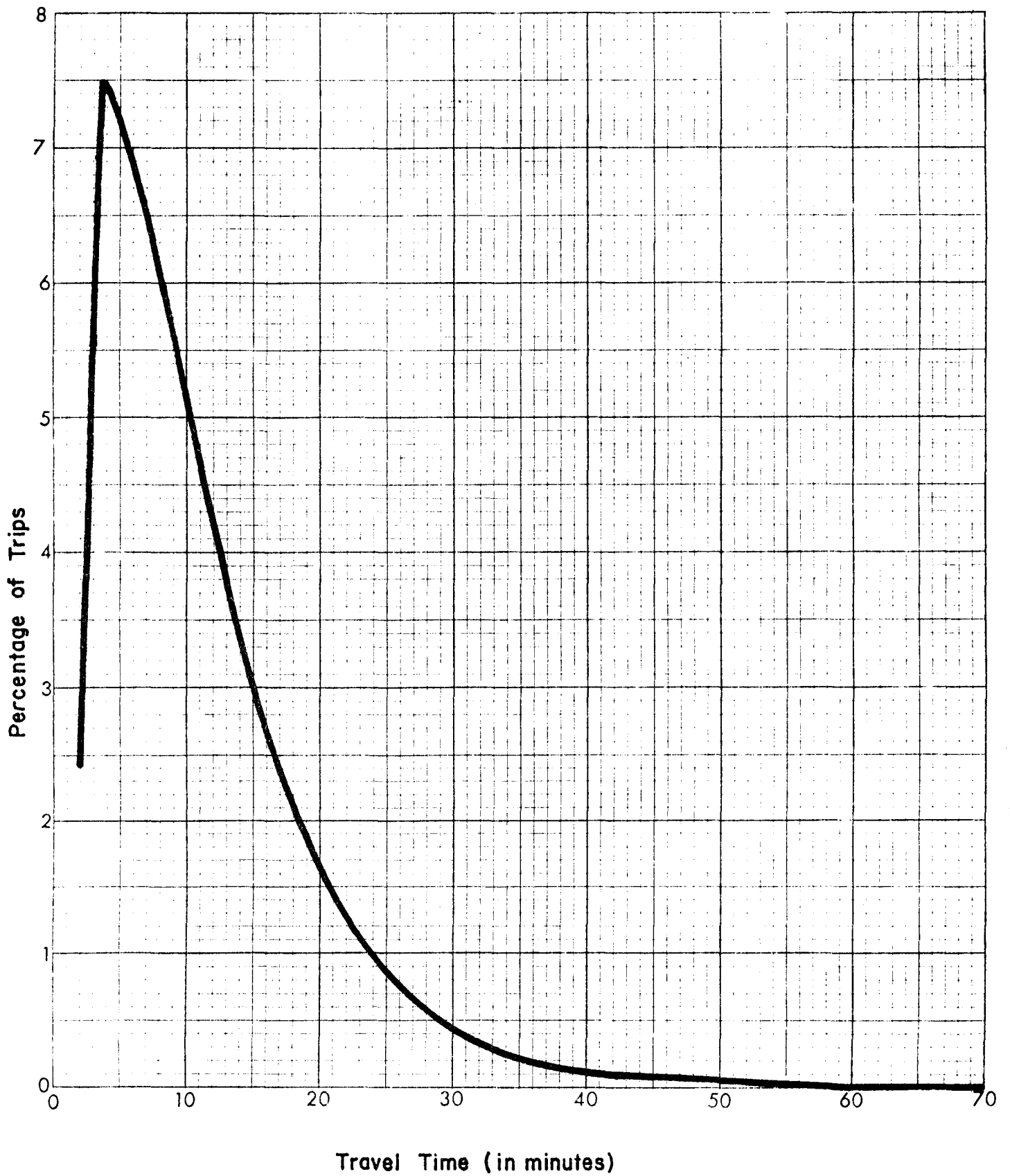
Figure II

DALLAS — FORT WORTH TRANSPORTATION STUDY
1977 TRIP LENGTH DISTRIBUTION CURVE
NON HOME BASED

Travel Time (in minutes)
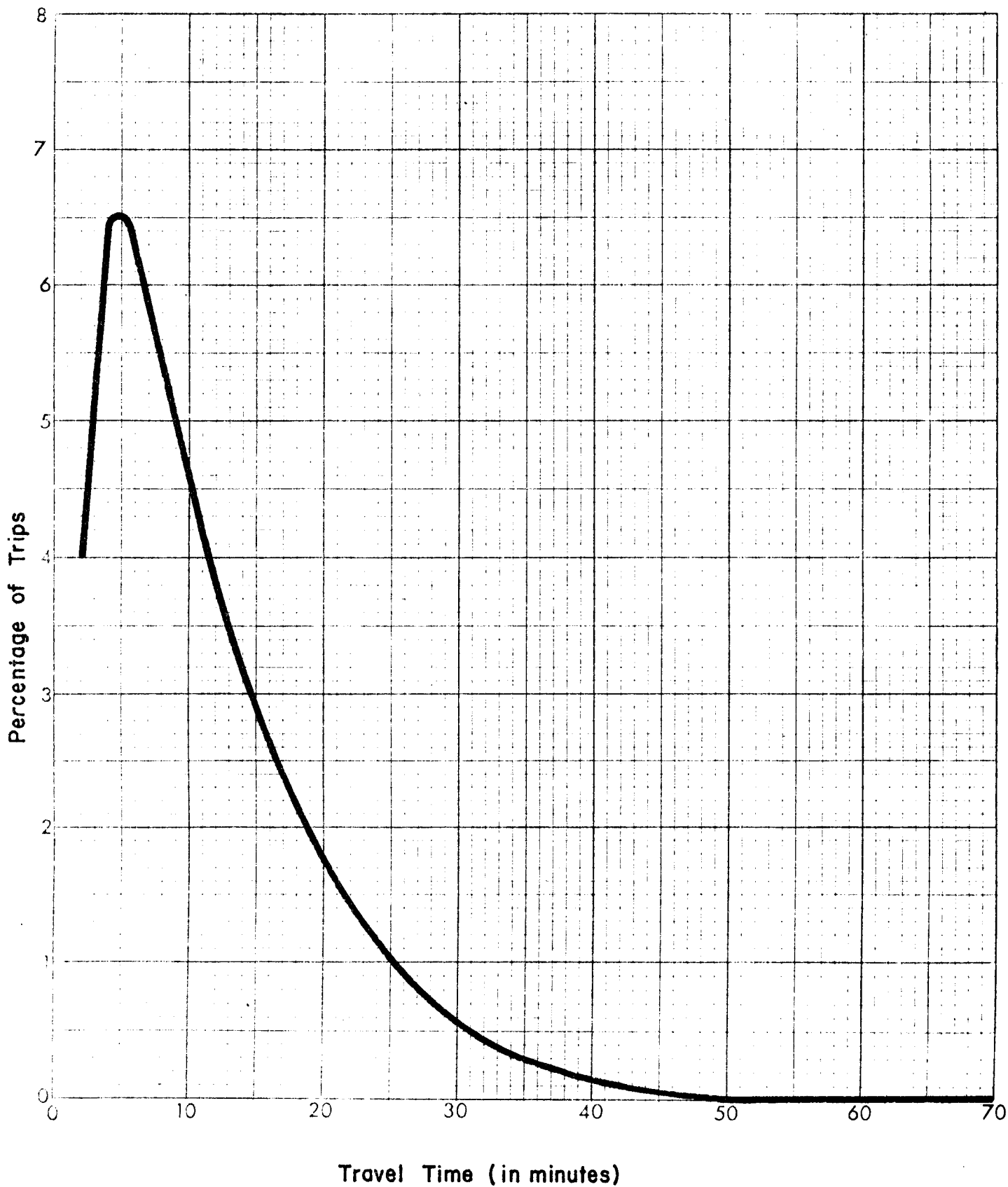
Figure 12

DALLAS — FORT WORTH TRANSPORTATION STUDY
1977 TRIP LENGTH DISTRIBUTION CURVE
TRUCK — TAXI

Travel Time (in minutes)
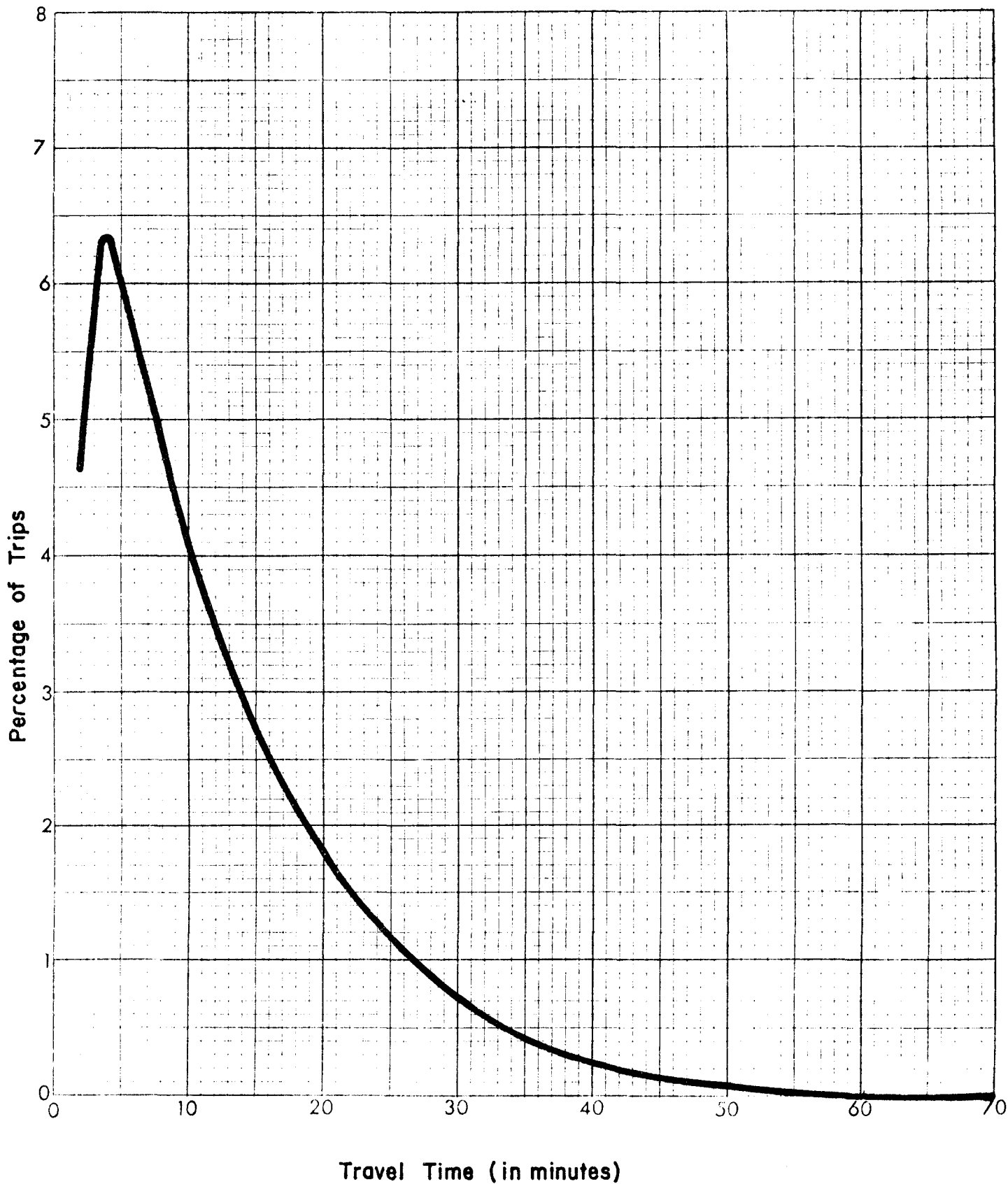
Figure 13

Dallas-Fort Worth Regional Transportation Study

Planning Variable Data Items

Data Item	1977	1990	2000
Population	2,375,734		
Dwelling Units	877,122		
Persons/DU	2.71		
No. of Autos	1,516,218		
Autos/DU	1.73		
Autos/Person	0.64		
Mean Form Income*	11,352		
Non-Basic Employee	667,010		
% of Total	54.15		
Empl/Pop.	0.28		
Empl/DU	0.76		
Basic Employee	504,423		
% of Total	40.95		
Empl/Pop.	0.21		
Empl/DU	0.58		
Other Employees**	60,383		
% of Total	4.90		
Empl/Pop.	0.03		
Empl/DU	0.07		
Total Employees	1,231,816		
Empl/Pop.	0.52		
Empl/DU	1.40		

* Expressed as 1969 dollars
** Includes Educational, Hospitals, Golf Courses and Country Clubs

Table A

Dallas-Fort Worth Regional Transportation Study

Comparison of Registered and Modeled Personal
Use Vehicles by County

1977

County	Registered Auto	Reg. Personal Use Trucks	Total Veh.	Model Veh.
Dallas	840,825	101,447	942,272	928,339
Tarrant	442,605	64,229	506,834	494,942

Personal Use Vehicles by County (Model)

County	Vehicles	No. of DU	Population	Veh./DU	Veh./Person	Person/DU
Collin*	44,084	21,815	69,268	2.02	0.64	3.18
Dallas	928,339	542,516	1,465,966	1.71	0.63	2.70
Denton*	25,358	13,292	38,553	1.91	0.66	2.90
Ellis*	5,475	2,950	7,809	1.86	0.70	2.65
Johnson*	9,228	4,769	14,936	1.94	0.62	3.13
Kaufman*	1,870	1,188	3,336	1.57	0.56	2.81
Parker*	2,061	1,315	3,619	1.57	0.57	2.75
Rockwell*	4,861	2,740	7,613	1.77	0.64	2.78
Tarrant	494,942	286,537	764,634	1.73	0.65	2.67
TOTAL	1,516,218	877,122	2,375,734	1.73	0.64	2.71

* Includes only that portion of the county within the intensive study area.

Table B

Dallas-Fort Worth Regional Transportation Study

Autos per Dwelling Unit by Trip Production Group (Income) and
By Geographical Area

Trip Production Rate Group*	Area**	DU***	Autos***	Autos/DU
I	1	4,597	3,678	0.80
	2	(Merged with Area 1)		
	3	19,400	15,323	0.79
	4	(Merged with Area 3)		
Subtotal		23,997	19,001	0.79
II	1	26,169	30,870	1.18
	2	2,352	2,774	1.18
	3	51,711	58,430	1.13
	4	5,496	6,210	1.13
Subtotal		85,728	98,284	1.15
III	1	79,592	124,953	1.57
	2	20,932	33,908	1.62
	3	133,799	202,020	1.51
	4	16,613	25,090	1.51
Subtotal		250,936	385,971	1.54
IV	1	112,381	222,553	1.98
	2	24,534	50,304	2.05
	3	178,884	341,672	1.91
	4	38,487	73,509	1.91
Subtotal		354,286	688,038	1.94
V	1	28,870	62,648	2.17
	2	19,265	42,964	2.23
	3	95,266	202,922	2.13
	4	7,696	16,390	2.13
Subtotal		151,097	324,924	2.15
TOTAL		866,044	1,516,218	1.75

* Trip Production Rate Groups: I = $4,000; II - $6,000; III = $8,500; IV = $12,500
                                V = $18,000

** Area 1 - Tarrant and Fringe Counties less Arlington and Plano Areas
   Area 2 - Arlington and Plano Areas
   Area 3 - Dallas County less Grand Prairie, Garland and Irving
   Area 4 - Grand Prairie, Garland and Irving

*** These data exclude special generators   Table C

Dallas-Fort Worth Regional Transportation Study

Vehicle Trips Per Dwelling Unit by Trip Production Rate Group (Income) and By Autos Owned and Geographical Area

		Area 1	Area 2	Area 3	Area 4
Group I	0	0.1	0.1	0.1	0.1
	1	2.4	2.4	2.0	2.0
	2	3.4	3.4	2.7	2.7
	3+	4.2	4.2	3.3	3.3
Group II	0	0.1	0.1	0.1	0.1
	1	3.8	3.9	3.1	3.9
	2	5.1	5.2	4.1	5.3
	3+	6.3	6.4	5.1	6.6
Group III	0	0.2	0.2	0.2	0.2
	1	5.2	5.4	4.2	5.4
	2	7.1	7.3	5.9	7.5
	3+	8.9	9.0	7.2	9.2
Group IV	0	0.2	0.2	0.2	0.2
	1	5.7	5.9	4.7	6.0
	2	8.3	8.5	6.8	8.6
	3+	10.5	10.9	8.7	11.2
Group V	0	0.2	0.2	0.2	0.2
	1	5.9	6.2	4.9	6.2
	2	8.5	8.8	7.1	8.9
	3+	10.8	11.2	9.0	11.5

Area 1 - Tarrant and Fringe Less Arlington and Plano areas
Area 2 - Arlington and Plano Areas
Area 3 - Dallas County less Irving, Grand Prairie and Garland
Area 4 - Irving, Grand Prairie and Garland

Group I - Mean Income = $4,000 (1969$)
Group II - Mean Income = $6,000 (1969$)
Group III - Mean Income = $8,500 (1969$)
Group IV - Mean Income = $12,500 (1969$)
Group V - Mean Income = $18,000 (1969$)

Table D

Dallas-Fort Worth Regional Transportation Study

Trip Generation Data

Data Item	1977	1990	2000
HBW Trips			
Productions	1,147,182		
% of Total	20.6		
Per DU	1.31		
Unscaled Attr.	1,181,333		
Scale Factor	0.9690		
HBNW Trips			
Productions	2,720,840		
% of Total	48.9		
Per DU	3.10		
Unscaled Attr.	2,767,293		
Scale Factor	0.9811		
NHB Trips			
Productions	1,697,201		
% of Total	30.5		
Per DU	1.93		
Unscaled Attr.	1,693,753		
Scale Factor	1.0021		
Total Internal			
A-D Production	5,565,223		
Per DU	6.34		
TK-TX Trips			
Productions	662,971		
Attractions	646,101		
Scale Factor	1.0264		
External Local	278,817		
External Thru	11,170		
Total External	289,987		
Total Trips	6,518,181		

Table E

Dallas-Fort Worth Regional Transportation Study

Per Cent Trips by Purpose by Trip Production Rate Groups

Trip Production Rate Group	Income (Mean)	% of Total Trip by Purpose		
		HBW	HBNW	NHB
I	$4,000	20	55	25
II	$6,000	24	51	25
III	$8,500	22	51	27
IV	$12,500	20	49	31
V	$18,000	20	45	35

Table F

Dallas-Fort Worth Regional Transportation Study

Trip Distribution Data

Data Item	1977 Desired	Resulting
Trip Length Sums (Min)		
HBW	17.76	17.77
HBNW	10.61	10.66
NHB	11.39	11.39
TKTX	12.32	12.32
Intra Zonal Trips		
HBW Total	18,605	
%	1.62	
HBNW Total	149,147	
%	5.48	
NHB Total	87,230	
%	5.14	
TXTK Total	35,979	
%	5.43	

Table G

ATTRACTION VOLUME BALANCE SUMMARY (ITERATION 5)

CROSS CLASSIFICATION OF ATTRACTION ZONES BY DESIRED ATTRACTION VOLUME
AND PERCENT ERROR OF RESULTING ATTRACTION VOLUME

1977   H BW

PERCENT ERROR

DESIRED ATTRACTION RANGES	-100	-75 TO -100	-50 TO -75	-25 TO -50	-10 TO -25	-5 TO -10	-1 TO -5	0 TO -1	0	0 TO 1	1 TO 5	5 TO 10	10 TO 25	25 TO 50	50 TO 75	75 TO 100	100 AND ABOVE	TOTAL
0.0									212									212
0.1 - 0.9																		0
1.0 - 9.9	47	4	26	25	11			31	33				6	29	12	13	42	279
10.0 - 24.9		1	9	21	29	16	2	10	1		5	11	20	22	10	4	2	163
25.0 - 49.9				16	26	14	11	4			6	10	25	16	2			130
50.0 - 99.9				2	21	27	15	6			20	21	30	7	1			150
100.0 - 199.9					18	26	24	8		6	37	26	24					169
200.0 - 299.9					4	17	31	9		8	29	29	5					132
300.0 - 399.9					1	15	36	12		4	33	8						109
400.0 - 499.9						4	28	7		12	32	4						87
500.0 - 599.9						3	25	13		4	23	4						72
600.0 - 699.9						4	20	10		9	17	1						61
700.0 - 799.9						1	24	9		9	24	1						68
800.0 - 899.9							14	10		7	12	1						44
900.0 - 999.9							8	11		7	10							36
1000.0 - 1999.9							35	48		34	38							155
2000.0 - 2999.9							5	17		26	3							51
3000.0 - 3999.9							1	15		7	1							24
4000.0 - 4999.9							1	5		6								12
5000.0 - 5999.9							1	6		3								10
6000.0 - 6999.9								4		1								5
7000.0 - 7999.9								2										2
8000.0 - 8999.9								5		1								6
9000.0 - 9999.9								12		2								14
10000.0 AND ABOVE								12		2								14
TOTAL	47	5	35	64	110	127	281	254	246	146	290	116	110	74	25	17	44	1991

Table H

ATTRACTION VOLUME BALANCE SUMMARY (ITERATICN 5)

CRCSS CLASSIFICATION OF ATTRACTION ZCNES BY CESIRED ATTRACTICN VCLUME
AND PERCENT ERROR OF RESULTING ATTRACTION VOLUME

1977 HBNW

PERCENT ERROR

DESIRED ATTRACTICN RANGES	-100	-75 TC -100	-50 TO -75	-25 TC -50	-10 TC -25	-5 TO -10	-1 TC -5	0 TO -1	0	0 TO 1	1 TO 5	5 TC 10	10 TC 25	25 TC 50	50 TC 75	75 TC 100	100 AND ABOVE	TOTAL
0.0									95									95
0.1 - 0.9																		0
1.0 - 9.9	31	2	16	33	8		19	19					18	12	18	8	28	212
10.0 - 24.9			1	10	30	7	2	7	8		3	11	17	24	8	1		129
25.0 - 49.9				8	23	17	5	3	2		12	5	28	5	1	1		110
50.0 - 99.9				1	26	19	21	5			18	18	27	2				137
100.0 - 199.9					7	24	24	14		7	27	30	16	1				150
200.0 - 299.9						10	23	8		2	27	20	2					92
300.0 - 399.9					2	7	24	5	2	6	26	14	1					87
400.0 - 499.9					1	4	23	2		9	26	11						76
500.0 - 599.9						3	13	2	1	10	25	3						57
600.0 - 699.9						2	11	6		12	27	2						60
700.0 - 799.9							9	1		3	16	3						32
800.0 - 899.9						2	17	6		4	17	1						47
900.0 - 999.9						1	11	2		5	18							37
1000.0 - 1999.9						1	93	38		19	90	4						245
2000.0 - 2999.9							60	10		17	61	3						151
3000.0 - 3999.9							33	9		14	42	4						102
4000.0 - 4999.9							22	3		10	14							49
5000.0 - 5999.9							17	3		2	15							37
6000.0 - 6599.9							8	1		2	5							16
7000.0 - 7599.9							7	3		3	4							17
8000.0 - 8599.9							4	1		1	5							11
9000.0 - 9999.9							22	6		6	8							42
10000.0 AND ABOVE							22	6		6	9							42
TOTAL	31	2	17	52	97	97	449	154	127	132	486	129	109	44	27	10	28	1991

Table I

ATTRACTION VOLUME BALANCE SUMMARY (ITERATION 5)

CRCSS CLASSIFICATION OF ATTRACTION ZONES BY DESIRED ATTRACTICN VCLUME AND PERCENT ERROR OF RESULTING ATTRACTION VOLUME

1977   NHB

PERCENT ERROR

DESIRED ATTRACTICN RANGES	-100	-75 TC -100	-50 TO -75	-25 TC -50	-10 TC -25	-5 TO -10	-1 TO -5	0 TO -1	0	0 TO 1	1 TO 5	5 TC 10	10 TC 25	25 TC 50	50 TC 75	75 TC 100	100 AND ABCVE	TOTAL
0.0									109									109
0.1 - 0.9																		0
1.0 - 9.9	36	2	14	34	22				51				11	22	19	4	44	259
10.0 - 24.9			6	19	27	8	2		8		2	5	18	21	8	3	6	133
25.0 - 49.9			1	9	33	8	10		7		5	8	35	13				129
50.0 - 99.9				2	39	23	19		10		22	16	25	3				159
100.0 - 199.9					14	31	46	3	8	5	17	30	15					169
200.0 - 299.9					4	20	28	7	3	4	29	11	4					110
300.0 - 399.9						15	27	5	4	12	31	5						99
400.0 - 499.9						4	30	7	1	9	17	2						70
500.0 - 599.9						3	26	7	1	7	10	3						57
600.0 - 699.9						2	21	10		12	15							60
700.0 - 799.9							20	7	1	11	15	1						55
800.0 - 899.9							12	6	2	7	18							45
900.0 - 999.9							23	14	1	4	14							56
1000.0 - 1999.9							95	62	2	48	57							264
2000.0 - 2999.9							29	25	1	23	16							94
3000.0 - 3999.9							12	10		24	8							54
4000.0 - 4999.9							3	2		6	4							15
5000.0 - 5999.9							2	2		5	3							12
6000.0 - 6999.9							2	1		3	2							8
7000.0 - 7999.9							1	2		2	4							9
8000.0 - 8999.9								1	1	2	3							7
9000.0 - 9999.9									2	4	12							18
10000.0 AND ABOVE									2	4	12							18
TOTAL	36	2	21	64	139	114	408	173	210	188	304	81	108	59	27	7	50	1991

Table J

ATTRACTION VOLUME BALANCE SUMMARY (ITERATION 5)

CROSS CLASSIFICATION OF ATTRACTION ZONES BY DESIRED ATTRACTION VOLUME
AND PERCENT ERROR OF RESULTING ATTRACTION VOLUME

1977 TKTX

PERCENT ERROR

DESIRED ATTRACTION RANGES	-100	-75 TO -100	-50 TO -75	-25 TO -50	-10 TO -25	-5 TO -10	-1 TO -5	0 TO -1	0	0 TO 1	1 TO 5	5 TO 10	10 TO 25	25 TO 50	50 TO 75	75 TO 100	100 AND ABOVE	TOTAL
0.0									180									190
0.1 - 0.9																		0
1.0 - 9.9	49	5	24	55	23				67				15	18	24	4	73	357
10.0 - 24.9			4	26	36	15	3		25		2	14	17	30	15	5	6	198
25.0 - 49.9			1	13	28	9	9		8		10	20	31	16	2			147
50.0 - 99.9				5	29	24	30		12		16	25	28	8				177
100.0 - 199.9					21	38	48	5	9	6	43	28	21					219
200.0 - 299.9					1	34	51	13		8	44	16	8					175
300.0 - 399.9					2	9	45	10	5	9	24	6	1					111
400.0 - 499.9					1	3	39	9	2	7	25	4						90
500.0 - 599.9						2	25	7	1	6	14	2						57
600.0 - 699.9						6	13	7	1	6	7	1						41
700.0 - 799.9						1	9	2	1	7	11							31
800.0 - 899.9							3	4		8	9							24
900.0 - 999.9							10	8		6	5							29
1000.0 - 1999.9							34	17		21	29							101
2000.0 - 2999.9							5	4		7	5							21
3000.0 - 3999.9							1	2		4	6							13
4000.0 - 4999.9							1			5	3							9
5000.0 - 5999.9										1	2							3
6000.0 - 6599.9																		0
7000.0 - 7999.9							2											2
8000.0 - 8999.9								1		1	3							5
9000.0 - 9999.9											1							1
10000.0 AND ABOVE											1							1
TOTAL	49	5	29	99	141	141	328	89	311	102	259	116	121	72	41	9	79	1991

Table K

SECTOR ATTRACTION BALANCE, ITERATICN 5

1977 HBW

SECTOR	PRODUCTIONS	ATTRACTIONS DESIRED	ATTRACTIONS RESULTING	DIFFERENCE	PERCENT ERROR	CHI SQ	NC. ZONES	NO. + CR - 50	CVER 50 NC.	CVER 50 AVERAGE	UNDER 50 NO.	UNDER 50 AVERAGE
1	413377.	392241.	392029.	-212.	-0.1	0.1	703.	702.	0	0.	1	-84.
2	658545.	728198.	728037.	-151.	-0.0	0.0	950.	945.	2	55.	3	-58.
3	20785.	4680.	4677.	-3.	-0.1	0.0	74.	74.	0	0.		0.
4	34852.	15203.	15332.	129.	0.8	0.5	88.	88.	0	0.	0	0.
5	4032.	1521.	1546.	25.	1.6	0.2	25.	25.	0	0.	0	0.
6	1616.	437.	461.	24.	5.5	0.4	21.	21.	0	0.	0	0.
7	4550.	860.	853.	-7.	-0.8	0.0	37.	37.	0	0.	0	0.
8	7588.	3631.	3672.	41.	1.1	0.2	25.	25.	0	0.	0	0.
9	1787.	420.	420.	0.	0.0	0.0	15.	15.	0	0.	0	0.
10	0.	0.	0.	0.	0.0	0.0	1.	1.	0	0.	0	0.
11	0.	0.	0.	0.	0.0	0.0	9.	9.	0	0.	0	0.
12	0.	0.	0.	0.	0.0	0.0	7.	7.	0	0.	0	0.
13	0.	0.	0.	0.	0.0	0.0	4.	4.	0	0.	0	0.
14	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
15	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
16	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
17	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
TOTALS	1147182.	1147191.	1147027.			1.4	1991.	1985.	2	55.	4	-142.

Table L

SECTOR ATTRACTION BALANCE, ITERATION 5

1977 HBNW

SECTOR	PRODUCTIONS	ATTRACTIONS DESIRED	RESULTING	DIFFERENCE	PERCENT ERROR	CHI SQ	NO. ZONES	NO. + OR - 50	OVER 50 NO.	AVERAGE	UNDER 50 NO.	AVERAGE
1	987261.	959650.	984868.	25218.	2.6	644.2	703.	545.	155	130.	3	-80.
2	1556243.	1644214.	1616755.	-27459.	-1.7	484.5	950.	761.	14	75.	175	-141.
3	49724.	24060.	23925.	-135.	-0.6	0.4	74.	73.	0	0.	1	-78.
4	90487.	64963.	66042.	1079.	1.7	14.5	88.	80.	8	82.	0	0.
5	9751.	6122.	6254.	132.	2.2	1.8	25.	25.	0	0.	0	0.
6	3752.	1922.	1925.	3.	0.2	0.0	21.	21.	0	0.	0	0.
7	10981.	2722.	2698.	-24.	-0.9	0.1	37.	37.	0	0.	0	0.
8	19499.	14772.	15506.	734.	5.0	29.1	25.	21.	4	155.	0	0.
9	4142.	2414.	2541.	127.	5.3	3.9	15.	14.	1	62.	0	0.
10	0.	0.	0.	0.	0.0	0.0	1.	1.	0	0.	0	0.
11	0.	0.	0.	0.	0.0	0.0	9.	9.	0	0.	0	0.
12	0.	0.	0.	0.	0.0	0.0	7.	7.	0	0.	0	0.
13	0.	0.	0.	0.	0.0	0.0	4.	4.	0	0.	0	0.
14	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
15	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
16	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
17	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
TOTALS	2720840.	2720839.	2720514.			1178.3	1991.	1630.	182	504.	179	-258.

Table M

SECTOR ATTRACTION BALANCE, ITERATION 5
1977 NHB

| | | ATTRACTIONS | | | | | NO. | CVER 50 | | UNDER 50 | |
| | | | | | | NC. | + OR - | | | | |
SECTOR	PRODUCTIONS	DESIRED	RESULTING	DIFFERENCE	PERCENT ERROR	CHI SQ	ZONES	50	NC.	AVERAGE	NO.	AVERAGE
1	484761.	484761.	477514.	-7247.	-1.5	108.3	703.	672.	0	0.	31	-82.
2	1145478.	1145478.	1153044.	7566.	0.7	50.0	950.	912.	38	123.	0	0.
3	13842.	13842.	13824.	-18.	-0.1	0.0	74.	74.	0	0.	0	0.
4	37584.	37584.	37346.	-238.	-0.6	1.5	88.	88.	0	0.	0	0.
5	3609.	3609.	3594.	-15.	-0.4	0.1	25.	25.	0	0.	0	0.
6	1118.	1118.	1117.	-1.	-0.1	0.0	21.	21.	0	0.	0	0.
7	1551.	1551.	1567.	16.	1.0	0.2	37.	37.	0	0.	0	0.
8	8044.	8044.	7870.	-174.	-2.2	3.8	25.	24.	0	0.	1	-57.
9	1214.	1214.	1181.	-33.	-2.7	0.9	15.	15.	0	0.	0	0.
10	0.	0.	0.	0.	0.0	0.0	1.	1.	0	0.	0	0.
11	0.	0.	0.	0.	0.0	0.0	9.	9.	0	0.	0	0.
12	0.	0.	0.	0.	0.0	0.0	7.	7.	0	0.	0	0.
13	0.	0.	0.	0.	0.0	0.0	4.	4.	0	0.	0	0.
14	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
15	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
16	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
17	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
TOTALS	1657201.	1657201.	1657057.			164.7	1991.	1921.	38	123.	32	-135.

Table N

SECTOR ATTRACTION BALANCE, ITERATION 5

1977 TKTX

SECTOR	PRODUCTIONS	ATTRACTIONS DESIRED	ATTRACTIONS RESULTING	DIFFERENCE	PERCENT ERROR	CHI SQ	NO. ZONES	NO. + OR - 50	OVER 50 NO.	OVER 50 AVERAGE	UNDER 50 NO.	UNDER 50 AVERAGE
1	196533.	196533.	193103.	-3430.	-1.7	59.9	703.	694.	1	56.	8	-83.
2	448548.	448548.	451705.	3157.	0.7	22.2	950.	935.	14	77.	1	-53.
3	2945.	2945.	3089.	144.	4.9	7.0	74.	74.	0	0.	0	0.
4	9833.	9833.	9853.	20.	0.2	0.0	88.	88.	0	0.	0	0.
5	1180.	1180.	1194.	14.	1.2	0.2	25.	25.	0	0.	0	0.
6	337.	337.	330.	-7.	-2.1	0.1	21.	21.	0	0.	0	0.
7	733.	733.	742.	9.	1.2	0.1	37.	37.	0	0.	0	0.
8	2606.	2606.	2588.	-18.	-0.7	0.1	25.	25.	0	0.	0	0.
9	256.	256.	248.	-8.	-3.1	0.3	15.	15.	0	0.	0	0.
10	0.	0.	0.	0.	0.0	0.0	1.	1.	0	0.	0	0.
11	0.	0.	0.	0.	0.0	0.0	9.	9.	0	0.	0	0.
12	0.	0.	0.	0.	0.0	0.0	7.	7.	0	0.	0	0.
13	0.	0.	0.	0.	0.0	0.0	4.	4.	0	0.	0	0.
14	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
15	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
16	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
17	0.	0.	0.	0.	0.0	0.0	8.	8.	0	0.	0	0.
TOTALS	662971.	662971.	662852.			90.0	1991.	1967.	15	133.	9	-136.

Table 0