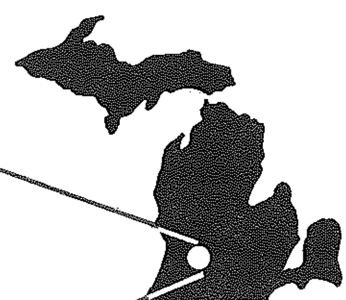
ALAMAZOO area transportation study



TRIP GENERATION

AND

GRAVITY MODEL CALIBRATION

TECHNICAL REPORT NO. 4

AMV ALAN M. VOORHEES & ASSOCIATES, INC.

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KALAMAZOO AREA TRANSPORTATION STUDY

Trip Generation
and
Gravity Model Calibration

Technical Report No. 4

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SYNOPSIS

The development of the matematical models for trip generation and trip distribution are an important aspect of the Kalamazoo Area Transportation Study. The purpose of these models is to develop basic tools for predicting future traffic demand. This is accomplished by analyzing existing trip generation and distribution to obtain an understanding of the underlying characteristics of the region and to structure the models to reflect these intricate workings.

The portion of the study documented in this report can be grouped into three major areas. The first is the development of a series of equations to reflect the trips generated by the various types of land use and land activity within the area. Special generators, which do not follow the averages indicated by these equations, were analyzed and adjustment factors developed.

The second area is the development of trip distribution models to predict the trip interchange between the various land uses by trip purpose. The basic model structure is one that distributes trips in proportion to the trip generation of an area, and inversely to the distance between the areas. As in the case of the trip generation models, these models also required adjustment for unique socio-economic characteristics existing within the area.

The third portion is a final validation of all the various models. Many checks were made throughout the development of each of the models. A final verification was made by first combining all the various models and survey year land-use data to develop traffic volumes. These volumes were then compared to the actual existing traffic volumes throughout the study area. Thus, the total study effort to this point, from data collection through model calibration including the network simulation, could be verified. The results of these checks, individually and collectively, demonstrate that in all respects the models are valid for use in forecasting future travel demands.

CHAPTER I

INTRODUCTION

This phase of the transportation study has as its objectives an understanding of fundamental relationships of travel demands and the quantification of these relationships in a series of mathematical formulae which will permit the accurate estimation of traffic from land activity data. In meeting this objective, the study drew upon the experience of many transportation studies conducted throughout the United States. Based upon previous experience, a central framework for traffic forecasting was selected and the analysis performed by the study was limited to quantifying the various factors and relationships required to apply the selected technique to the Kalamazoo Area Transportation Study. The purpose of this technical report is to explain the techniques and methodology used to calibrate a traffic model for this area.

The field of urban traffic estimation and analysis has developed in four basic stages. The original concept, used in the 1920's, was the development and application of traffic-counting procedures, and later, the statistical techniques required to expand these counts. The collection of this type of basic data still has many uses in planning and engineering agencies, especially for solving traffic management and operational problems. It was realized, however, that the traffic counts in themselves could not be used to estimate or predict the actual movement of traffic. The statistics which were collected merely indicated the usage of existing facilities without regard to the basic travel desires of motorists between the various sections of the city.

To provide a more comprehensive source of information on the transportation requirements of an urban area, the origin-destination type of survey was developed in the late 1930's. This method, with its various forms of roadside, home interview, and truck and taxi interviews, has served well and provides reliable data on existing travel desires. Nevertheless, traffic engineers soon recognized the shortcomings of planning transportation facilities based only on existing origin-destination surveys. This shortcoming became particularly apparent right after the conclusion of World War II with the rapid expansion of urban areas.

The third major step in this evolutionary process came with the development of mathematical techniques to expand existing travel patterns as obtained with origin-destination surveys to reflect anticipated future development of a city. While this growth factor technique of expanding existing origin-destination data represented a significant advance in the field of traffic analysis, it had many serious limitations. First, it could not estimate future travel patterns to and from areas which were presently undeveloped, as there was no existing travel data to expand. Second, the technique could not anticipate travel patterns which resulted from major changes in land use. Nor could the technique anticipate changes in travel patterns and demands resulting from the construction of new highway facilities, such as an expressway.

The most recent stage in the development of urban traffic analysis techniques came about in the late 1950's with the development of several traffic simulation models aimed at overcoming the deficiencies of the previous growth factor method. Of these traffic models, the procedure known as the "gravity model" is the most widely used and recognized. This procedure has been used and tested in cities across the nation, in cities as small as 5,000 population to those as large as Los Angeles. Therefore, the methodology utilized in this study profited from the research and experience gained in many other similar studies throughout the United States and Canada.

TRAFFIC MODELS

The gravity model derives its name from the fact that vehicle trips are distributed by a formula which closely resembles Newton's formula for gravitational attraction. The gravity model formula distributes trips in proportion to the trip generation of an area which represents its mass, and inversely to the distance between the areas. This distance is usually measured in terms of travel time.

Mathematically, this model can be expressed by the following formula:

$$T_{ij} = P_i \frac{\dfrac{A_j K_{ij}}{(d_{ij})^b}}{\displaystyle\sum_{j=1}^{n} \dfrac{A_j K_{ij}}{(d_{ij})^b}}$$

Where:

T_{ij} = trips produced at zone i which are attracted by zone j

P_i = total trips produced at zone i

A_j = total trips attracted to zone j

d_{ij} = driving time from zone i to zone j

b = empirically determined exponent to account for the effect that zonal separation has on zone-to-zone movement

K_{ij} = socio-economic factor between zone i and zone j

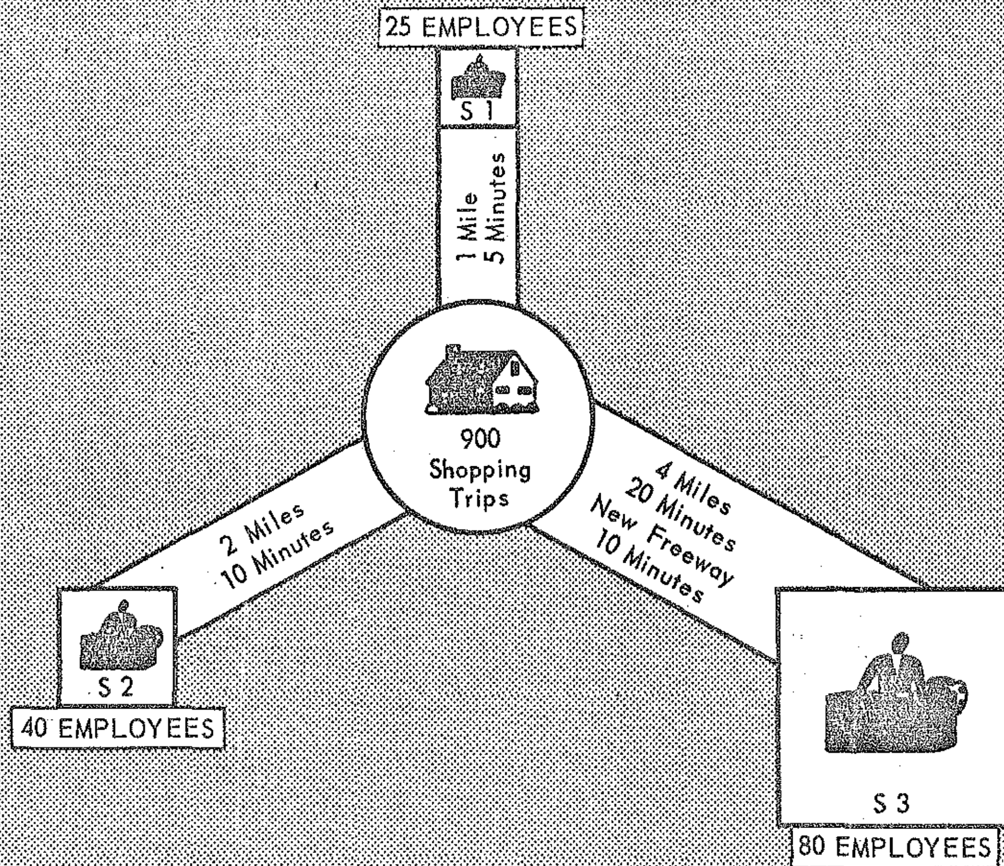
For computational purposes, the above formula has been converted to the following form in actual application.

$$T_{ij} = P_i \frac{A_j F_{ij} K_{ij}}{\displaystyle\sum_{j=1}^{n} A_j F_{ij} K_{ij}}$$

Where:

F_{ij} = empirically determined "Friction Factor" equal to $\dfrac{1}{(d_{ij})^b}$

Figure 1 illustrates a simplified example of the computations involved in an application of the gravity model. The example has two parts. The first shows the distribution of shopping trips made by the residents of a hypothetical residential area to three shopping centers on the basis of local or arterial street travel times. The second shows how the distribution of trips



DISTRIBUTION I		
Existing "Pull"	Percent of Total "Pull"	Number of Trips
S 1 = $\frac{25}{(5)2}$ = 1.0	62.5	563
S 2 = $\frac{40}{(10)2}$ = 0.4	25.0	225
S 3 = $\frac{80}{(20)2}$ = 0.2	12.5	112
Total "Pull" = 1.6	100.0	900

DISTRIBUTION II		
"Pull" After Freeway is Built	Percent of Total "Pull"	Number of Trips
S 1 = $\frac{25}{(5)2}$ = 1.0	45.4	408
S 2 = $\frac{40}{(10)2}$ = 0.4	18.2	164
S 3 = $\frac{80}{(10)2}$ = 0.8	36.4	328
Total "Pull" = 2.2	100.0	900

FIGURE 1: HYPOTHETICAL APPLICATION OF THE GRAVITY MODEL

is changed by the construction of a freeway to one of the shopping centers.

We know that expressways do, in fact, change travel patterns; and the fact that the gravity model recognizes and quantitatively evaluates such changes sets it apart from many other methods of analysis. It is well to note that the highway network is only one of the many factors which can change with time. Rapid growth in presently undeveloped areas, or changes in land use through redevelopment, cannot be accounted for by extrapolation of existing travel patterns, except through the subjective manipulations of growth factors by the analyst. However, all these changes are subjected to objective analysis by the gravity model.

The example given illustrated the application of the gravity model to shopping trips. Since trips for different purposes show distinctly different characteristics with respect to both resistance to travel time and land activity trip generation relationships, it is necessary to develop separate models for each of several basic trip purpose categories.

STUDY DESIGN AND REPORT ORGANIZATION

While the basic gravity model has been used many times, and the basic structure of the equations need not be verified, the quantification of the various factors incorporated must be systematically developed and validated for the Kalamazoo Area. This requires thorough examination of the information on existing travel patterns that was obtained in the surveys. In this study, the trip generation and distribution models were developed at the district level in order to maintain statistical stability and reduce the likelihood of spurious estimations. The expanded study area was subdivided into 81 internal districts and 27 external stations. Criteria used to develop districts was based on having approximately 60 interviews (600 dwelling units) in each district or a large number of attractions. For example, the General Motors plant was in a district by itself. The 81 internal districts were further subdivided into 315 zones. Thus 342 zones (including external stations) were used for assignment to the highway network.

The zonal trip distribution was developed by subdividing the district trip transfer matrix based on land activity data for the individual zones. All home based trips were subdivided on a production and attraction basis. By using this technique, the statistical stability of the models could be maintained and also assignments of the trip transfer could be achieved.

The necessary analysis to accomplish this objective required a six-step procedure, as follows:

Step 1 -- Development of Trip Production Equations

Based on the residential characteristics at the origin of the trip -- defined as the home or residence end of the trip (cars, labor force, car occupancy, etc.) -- special relationships between the selected trip purpose productions and these variables were developed. The transportation study is concerned with travel on the public transit system as well as with highway transportation. Formal analysis of transit travel generation, however, was confined to the work trip purpose category, because these trips occur primarily in the peak hours and are therefore the most critical for system design purposes.

Step 2 -- Development of Attraction Equations

From an analysis of land activity measures at the destination of the trip -- defined as the non-home end of the trip -- which indicate certain job types, specific equations were developed which reflect the numbers of trips by trip purpose category that are attracted to each kind of land activity. As with the trip production analysis, investigations were made of the non-auto trips at the attraction end of the work trips to account for such areas as the central business district and large industrial plans which serve as the main destination for transit work trips and for higher-than-average car pooling. The final attraction equations were also checked for logic and geographical bias and corrected as necessary.

Step 3 -- Special Generator Analysis

Based upon a detailed analysis of the area, certain facilities and areas were isolated because of their unique traffic-generating characteristics. These are the facilities that in general do not follow the averages indicated by the production or attraction equations. Shopping centers, hospitals, the central business district, drive-in theaters, and Western Michigan University students were identified as being unique, and specific factors were applied to them. This analysis will serve as a basis for estimating the behavior of future generators indicated by the future land use plan.

Step 4 -- Development of Friction Factors

From an analysis of existing trip length frequencies for each purpose of trip, specific "F" factors were calculated. These "F" factors were developed to reproduce the trip length distribution measured in the survey of travel patterns.

Step 5 -- Socio-Economic Calibration

The models were checked to insure that the procedures did in fact reproduce the travel patterns for the selected trip purpose categories. The estimated movements from the gravity model were accumulated and compared to the information obtained from the travel surveys. Where significant differences existed between these two sources of data, special investigations were conducted to determine the reasons. Only when the differences were satisfactorily explained as related to socio-economic causes was an adjustment factor calculated and used in the model.

Step 6 -- Final Calibration

Based on the results of Steps 1 through 5, total estimated district vehicular trips were split into zonal trips and assigned to the highway network. These volumes were checked against the ground count information. This comparison provided a final verification of all of the procedures to be used in forecasting future travel, by assuring that the models were accurately simulating existing travel patterns.

The following sections of this report are structured to follow the basic outline discussed above.

CHAPTER II

TRIP PRODUCTIONS AND ATTRACTIONS

This chapter discusses the selection of trip purpose groups for analysis of trip generation, the development of and the statistical checks of the equations for estimation of trip generation, and the overall validation of these procedures.

SELECTION OF TRIP PURPOSE GROUPS

To examine the patterns and regularity of urban travel, it is necessary to divide the observed trips into groups. In establishing these groups for analysis, two requirements must be met. First, each group must exhibit stable patterns resulting from consistent behavior by the travelers comprising the group. Second, the group must be sensitive to known types of land activity. To achieve the objective of traffic forecasting, each travel group must be related in a consistent way with one or several measurable types of land activity. The land activity measures to be used are limited to those which can in themselves be projected or forecasted for the sub-areas of the region.

Urban travel can be structured by mode of travel, purpose of travel, hour of travel and, of course, by the pairs of points forming the origin and destination of the trips. Experience from the analysis of urban travel patterns in many other cities has shown certain groups to be preferable to others. The number of the groupings that can be examined is limited by the necessity to maintain stable samples for statistical analysis. A series of summary tabulations of the travel data from the interview surveys was examined to determine the optimum groups for the current transportation planning program in the Kalamazoo area.

Since through trips are generally independent of land activity in the study area, these were separated for independent forecasting. Internal-to-external and external-to-internal trips were left combined with wholly internal travel, and this large group was further subdivided into groups according to purpose. Truck trips involving trucking uses of the vehicle were next separated. The remaining travel was examined by purpose and by mode. It was found that over 90 percent of this travel is made by automobile, including personal use of trucks. The rest was divided between transit, school bus, truck, and taxi passengers and walking trips (enumerated only when they represented travel from home to work). Trips by mode are shown in Appendix A.

The high preponderance of automobile transportation indicated that adequate forecasts for planning would be obtained by developing trip generation and distribution procedures for automobile travel only for most of the internal nontrucking group. Approximately 70 percent of these trips either began or ended at home; these are termed "home based trips" and are classified according to the type of activity engaged in at the non-home end. Experience has shown that it is preferable to analyze these trips as travel between home at one end and the function served at the other end without regard to whether the actual direction of travel is away from home or returning to it. It is apparent that the number of trips leaving and returning to homes in a given area is closely related to the number of homes in the area. Furthermore, each trip leaving home requires a counterpart return trip. These home based trips were classified into three groups, as follows:

- Home Based Work
- Home Based Shop -- includes shopping for convenience items and for shopping goods

- Home Based Other -- includes personal business, school, social/recreation, change mode of travel, eat meal, medical/dental, and serve passenger.

Generation of trips at their home end is termed "trip production." The term, "trip attraction," relates to the generation of these trips at their non-home end. More precisely, trip attraction is a measure of the relative likelihood of a particular area satisfying the objectives of a trip. For example, shopping trips will be attracted to various areas in proportion to the amount of commercial activity present. A separate class of trips are those which neither begin nor end at home. Examples of this type are the salesmen making calls and the housewives shopping from store to store. These trips, which comprise approximately 30 percent of the vehicle trips in the area, are grouped together as a "non-home based" category. Taxi trips, of which there were few, were combined with the non-home based purpose. The separate truck group is similar to this type in that the trips are not produced from homes by the residents.

Trip generation estimating equations and the gravity model distribution calibration was undertaken for each of the four groups of automobile trips and for the truck group. Automobile trips are represented by the auto-driver mode from the home interview and external surveys together with personal truck use and taxi trips. Table 1 shows the number of trips in each group and the proportion each use is of the total non-through vehicle trips. Table 2 shows the number of internal and external trips for each purpose group in addition to through trips.

Because home based work trips constitute a large percent of the total trips and because they are concentrated in the peak hours when the

TABLE 1

DISTRIBUTION OF VEHICLE TRIPS
BY FORECASTING GROUP

Group	1966 Daily Vehicle Trips	Percentage
Auto-driver home based work	102, 045	20. 0
Auto-driver home based shop	73, 160	14. 3
Auto-driver home based other	160, 508	31. 4
Auto-driver non-home based	156, 506	30. 5
Truck	19, 446	3. 8
TOTAL	511, 665	100. 0

Notes:

1. Does not include the 13, 666 through trips.
2. Panel and pick-up type trucks were included with auto-driver non-home based trips.

TABLE 2
VEHICLE-TRIP SUMMARY

Autos	Internal	External Attr.	External Prod.	Through	Total
Home Based Work	64, 282	11, 770	25, 993	--	102, 045
Home Based Shop	65, 341	973	6, 846	--	73, 160
Home Based Other	144, 677	8, 000	7, 831	--	160, 508
Non-Home Based	154, 556	1, 045	905	--	156, 506
Through	--	--	--	9, 348	9, 348
Trucks					
Local	15, 396	2, 014	2, 036	--	19, 446
Through	--	--	--	4, 318	4, 318
TOTAL	444, 252	23, 802	43, 611	13, 666	525, 331

demand on transportation facilities is greatest, work trips by all modes were examined.

All trip production and attraction estimating equations were derived through the use of multiple regression techniques from the data obtained in the travel surveys and measures of land activity. Population, employment, and other land activity measures were quantified by transportation zone from the land use survey, census data, Michigan Employment Security data, and other information maintained by the regional and local planning agencies. In addition, current data on population and employment was secured by the Origin-Destination Survey. Differences between the various data sources were resolved until a "best estimate" of each category of land activity was determined. This is discussed in detail in Technical Report No. 2, "Survey Data Accuracy Checks and Screenline Adjustments." The study area is divided into 315 transportation zones, which are the basic geographic units common to all of the data used. The zones are combined into 81 districts for analysis of the data in larger groups. Alternative estimating equations were formulated from experience in other areas and were tested and calibrated to local travel habits by multiple-linear regression techniques. All of the estimating equations have been developed in terms of nine measures of land activity that are being projected and quantified by transportation zone to describe and quantify the future land use pattern. In some cases, the equations utilize stratification of the variables based upon income class or areas within the study area such as the downtown business area, intermediate and outlying urban areas, and rural areas.

The nine basic land activity measures used are:

- Population

- Dwelling Units
- Labor Force (resident)
- Median Income
- Cars registered by college or university dormitory students
- Manufacturing Employment
- Retail Employment
- Other Employment
- Students attending high school or college

Table 3 shows the simple correlations between the basic land activity variables used and the simple correlations between the trips by category and the land activity. These correlations were developed by using data aggregated to districts. The trip production and attraction equations were also developed at the district level to secure the greater stability of larger groups.

While separate equations are required to estimate the production and attraction of trips in each purpose group, there are many similarities among certain of the groups. To take advantage of this, similar equations are discussed together in this chapter. Each equation is summarized, however, in a standardized table showing the final coefficients, statistical comparisons with observed trips, results of the regression analysis, and listing the unique generators requiring special adjustments to estimate present travel. A graph showing the estimated and observed trips produced or attracted in each transportation district is also included for each equation. For equations requiring special adjustments, the regression statistics for the "before adjustments" and the "after adjustments" is shown. The "before adjustment" was done by running the regression analysis without including the data for the "adjusted district." The "after adjustment" shows the

TABLE 3

SIMPLE CORRELATIONS OF VARIABLES

	Population	Dwelling Units (DU)	Labor Force Resident	Median Income Times DU	Cars	Manufacturing Employment	Retail Employment	Other Employment	Total Employment
Dwelling-Unit Data									
Population	--	.81	.62	.62	.82	-.19	-.18	-.14	-.21
Dwelling Units	.81	--	.30	.38	.55	-.26	-.07	.02	-.15
Labor Force (Res.)	.62	.30	.--	.77	.87	-.28	-.24	-.31	-.35
Median Income Times DU	.62	.38	77	--	.86	-.25	.07	-.09	-.19
Cars	.82	.55	.87	.86	--	-.30	-.18	-.19	-.29
Employment Data									
Manufacturing	-.19	-.26	-.28	-.25	-.30	--	.22	.39	.80
Retail	-.18	-.07	-.24	.07	-.18	.22	--	.86	.72
Other	-.14	.02	-.31	-.09	-.19	.39	.86	--	.86
Total	-.21	-.15	-.35	-.19	-.29	.80	.72	.86	--
Home Based Trip Productions									
Home Based Work	.71	.35	.86	.79	.90	-.14	-.05	-.04	-.11
Home Based Shop	.73	.42	.81	.78	.87	-.26	-.14	-.18	-.26
Home Based Other	.66	.48	.73	.79	.85	-.28	-.12	-.18	-.27
Home Based Trip Attractions									
Home Based Work	-.24	-.14	-.37	-.28	-.33	.82	.66	.81	.98
Home Based Shop	-.07	-.09	-.07	.12	-.06	.10	.75	.48	.43
Home Based Other	.07	.35	-.22	.01	-.04	.11	.76	.80	.58
Other Trips									
Non-Home Based	-.08	.04	-.24	.00	-.13	.40	.92	.90	.83
Truck	-.01	-.02	-.14	-.07	-.09	.70	.60	.74	.86

Note: Values shown are R at district level.

regression statistics on the data with the "adjusted district"; the adjustments were applied to the land activity. A summary of all adjustments used is summarized in Appendix B. Variables tested, but not used in the final equations, are discussed with the appropriate equations.

A listing of 1966 land activity and trips by centroid with district subtotals is shown in Appendix G and Appendix H, respectively.

HOME BASED WORK TRIPS

Work Trip Production

The basic determinant of work trip production is labor force. The greater the labor force residing in the district, the larger the number of work trips that will be produced from it. However, the trip production estimating equation must be structured to produce auto driver work trips, and therefore adjustment factors must be included to account for the non-auto driver trips, such as transit trips, auto passenger trips, taxi trips, and walk trips. The equation must also allow for absenteeism and the fact that not everyone works on each normal weekday.

The basic form of the equation used for calculating auto driver, work trip production is:

$$\text{Auto Driver, Work Trip Production} = a + \frac{b\ (\text{Labor Force})(\text{Proportion by Auto})}{\text{Car Occupancy}}$$

where a	= constant intercept generated by linear regression analysis techniques,
b	= regression coefficient generated by linear regression analysis techniques,
Labor Force	= total labor force by place of residence,
Proportion by Auto	= proportion of total work trips that are made by auto, and
Car Occupancy	= the number of persons per car.

Previous work on similar studies has established the relationships between the car ownership level in a district, and the values of proportion by auto and car occupancy. These relationships were checked for the Kalamazoo Area as measured in the 1966 Origin-Destination Survey by aggregating the districts having similar car ownership rates and tabulating the corresponding ratios for these two factors. The results of this analysis are shown on Figure 2. Both in the estimate for existing conditions (used for the correlation test) and for forecasting the future, the curves shown are used in conjunction with the car ownership in each district to determine the actual values to be used at the district level.

There is no indication that the relationship between car ownership and the use of cars for work trip changes with time and therefore it can be assumed that the relationship found in 1966 will hold for 1990. However, the overall car occupancy in the future will be lower than today because of increasing car ownership. Similarly, the future proportion by auto can be assumed to bear the same relationship to car ownership unless, of course, widespread use of new travel modes is anticipated from technological advances.

Table 4 shows the final estimating equation for auto driver, home based work trip production, and the results of the comparison with trip productions measured in the survey. Figure 3 shows the comparison of estimated and actual productions by district. No special adjustments were used in the estimate for this purpose.

<u>Work Trip Attraction</u>

Since the gravity model requires a measure or index of trip attraction to each district for each trip purpose used, an equation for estimating auto driver home based work attraction was also developed.

This index must represent the "level of activity" of the zone in terms of trips. It is clear that for work trips the attraction index is the

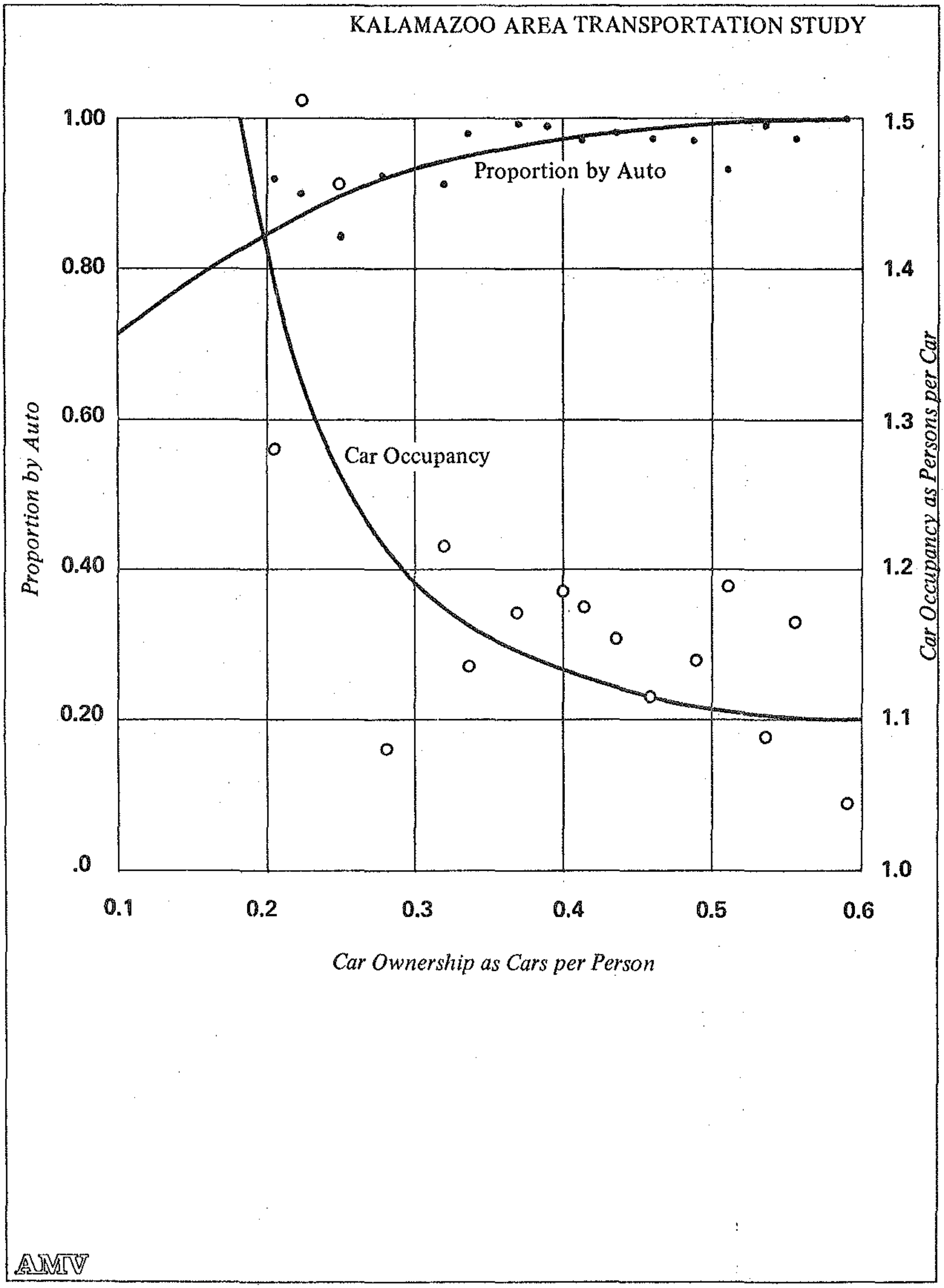


FIGURE 2: CAR USAGE FOR HOME BASED WORK TRIPS

TABLE 4

AUTO DRIVER HOME BASED WORK
PRODUCTION AND ATTRACTION ESTIMATING EQUATIONS

District Work Productions = 65 + 1.39 (Labor Force) $\left(\frac{\text{Proportion by Auto}}{\text{Car Occupancy}}\right)$

Mean Observed (District)	= 939 (No adjustments were necessary)
Standard Error of Estimate	= 146
Coefficient of Variance	= 15.5%
Coefficient of Determination (R^2)	= 0.86

"t" (Labor Force) $\left(\frac{\text{Proportion by Auto}}{\text{Car Occupancy}}\right)$ = 22.3

District Work Attractions = 128 + 1.41 (Total Employment)(Proportion by Auto Driver)

		Before Adjust.	After Adjust.
Mean Observed (District)	=	1117	1115
Standard Error of Estimate	=	322	320
Coefficient of Variance	=	28.8	28.7
Coefficient of Determination	=	.96	.96
"t" (Total Employment)(Proportion by by Auto Driver)	=	45.6	45.6

District Adjusted	Reason
71	Goodwill Industries and Others

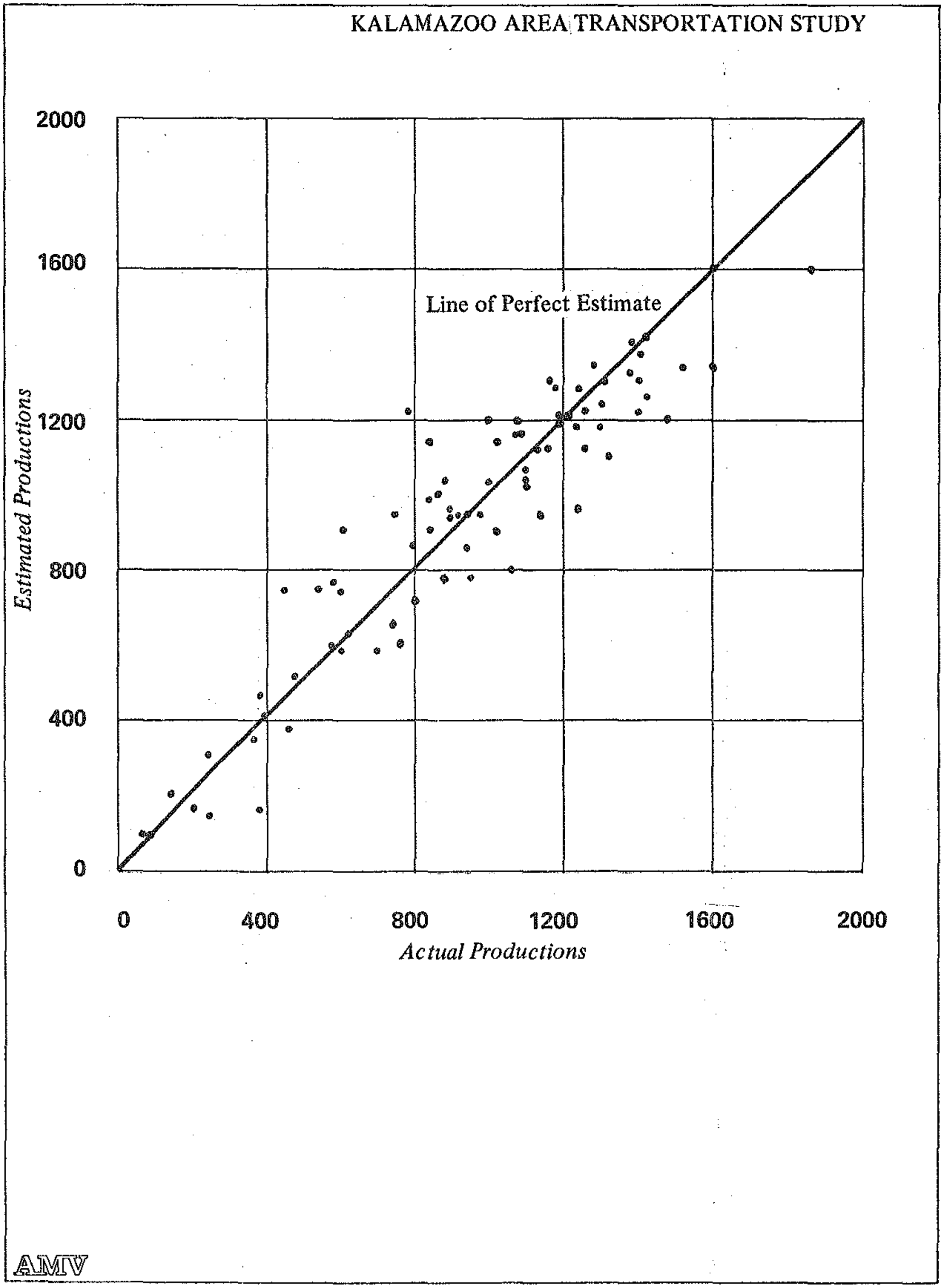


FIGURE 3: HOME BASED WORK PRODUCTION BY DISTRICT

number of jobs located in the zone adjusted by the number of employees arriving at the zone by modes other than auto driver. The following basic form of the equation to compute work trip attraction was:

$$\text{Auto Driver Work Trip Attraction} = a + b\,(\text{Total Employment})(\text{Proportion by Auto Driver})$$

An analysis of the mode of travel was made for all survey person trips from home to work. A summary of these trips is presented in Table 5.

TABLE 5

PERSON TRIPS BY MODE OF TRAVEL FROM HOME TO WORK

	Internal-Internal	
MODE	TRIPS	PERCENT OF TOTAL
Auto Driver	33, 801	82. 7
Auto Passenger	5, 612	13. 7
Bus Passenger	535	1. 3
Walk	502	1. 2
Other (Taxi, Truck or School Bus Passenger)	433	1. 1
TOTAL	40, 883	100. 0

During this analysis of travel mode, it was found that two districts had a significantly large percent of non-auto driver trips. One was the Central Business District (District 1), which had 18 percent of the total work trips arriving as auto passengers. The other district was Upjohn Corporation (District 60) on Portage Road, where 8 percent of the total work trips arrived via transit. Upjohn operates its own transit service which accounts for this large percent. A summary of the significant percent work trips by mode for these two districts and all other combined are shown in Table 6.

TABLE 6

PERCENT WORK TRIPS BY MODE

District of Employment	Walk Trips	Auto Passenger	Transit	Truck or Taxi	Total Non-Auto Driver	Auto Driver
1	2	18	2	2	24	76
60	*	14	8	4	26	74
All Other	*	13	*	*	13	87

*Less than 1 percent.

The actual equation and the correlation of the estimated present attractions with the trips measured in the survey was presented in Table 4 and is illustrated in Figure 4.

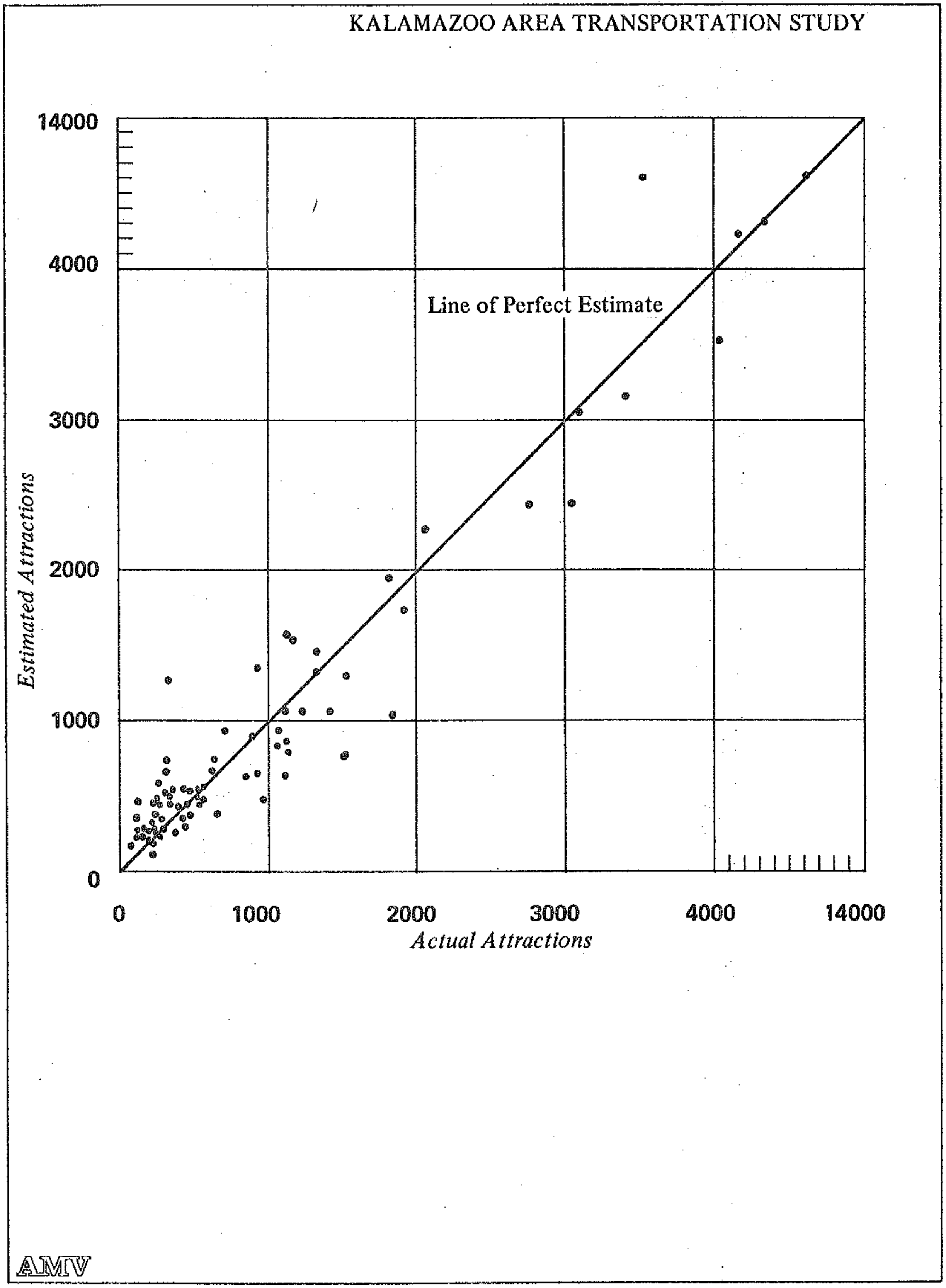


FIGURE 4: HOME BASED WORK ATTRACTIONS BY DISTRICT

HOME BASED NON-WORK TRIPS

Productions

In estimating the production of auto driver, home based shopping and home based other trips, car ownership was found to be the most significant index. The estimating equations for these travel groups and the correlation of the estimated present attractions with the trips measured in the survey are shown in Table 7 and in Figures 5 and 6. In Table 7, it will be noted that cars were stratified as urban or rural in order to better reflect differences in car usage in these areas. Figure 7 shows the districts included in each of these two categories.

As discussed later, car ownership is responsive to variations in income level and labor force. The findings that trip production rates for these trip purposes vary directly with car ownership is consistent with experience in other cities. Other variables examined include population and dwelling units. Neither of these was found to add significantly to improving the forecast.

Attractions

For an attraction estimating equation to be both logical and reliable, the non-home end of the trip must be related to the land activity at that trip end which causes the trip to be made. The estimating equations for these travel groups and the correlation of the estimated present attractions with the trips measured in the survey are shown in Table 8 and in Figures 8 and 9.

For shopping trips, the number of retail employees working in the zone is the basic important variable. It was found, however, that the trips

TABLE 7

AUTO DRIVER HOME BASED SHOP AND OTHER PRODUCTION ESTIMATING EQUATIONS

District Shop Productions = -39 + 0.94 (Cars Rural) + 1.10 (Cars Urban)

		Before Adjust.	After Adjust.
Mean Observed (District)	=	822	819
Standard Error of Estimate	=	182	180
Coefficient of Variance	=	22.2%	22.0%
Coefficient of Determination (R^2)	=	0.79	0.80
"t" (Cars Rural)	=	15.1	15.3
"t" (Cars Urban)	=	16.6	16.7

District Adjusted	Reason
23	University students

District Other Productions = 17 + 1.83 (Cars Rural) + 2.48 (Cars Urban)

Mean Observed (District)	=	1885 (No adjustments were necessary)
Standard Error of Estimate	=	357
Coefficient of Variance	=	19.0%
Coefficient of Determination (R^2)	=	0.82
"t" (Cars Rural)	=	14.9
"t" (Cars Urban)	=	19.0

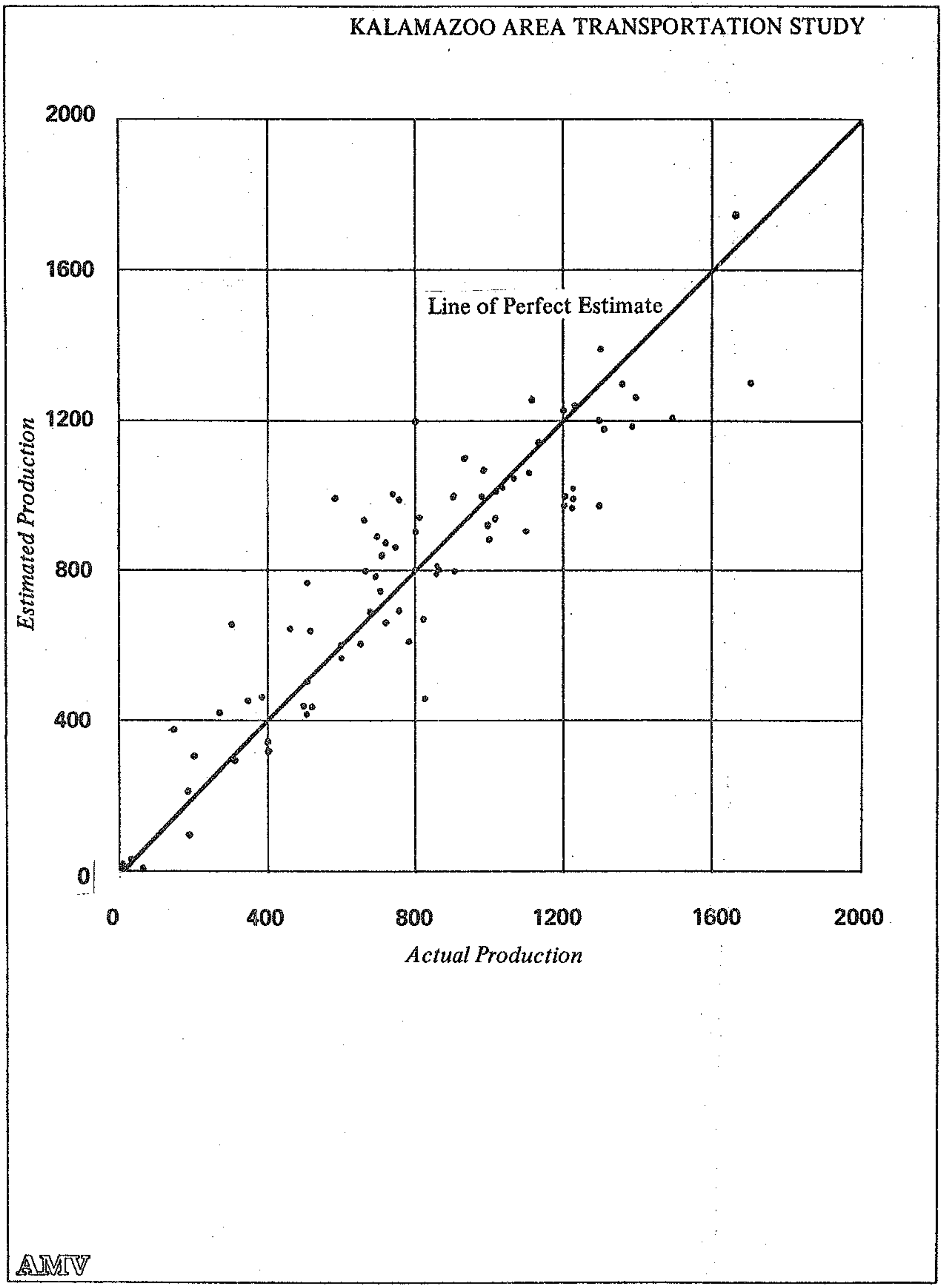


FIGURE 5: HOME BASED SHOP PRODUCTIONS BY DISTRICT

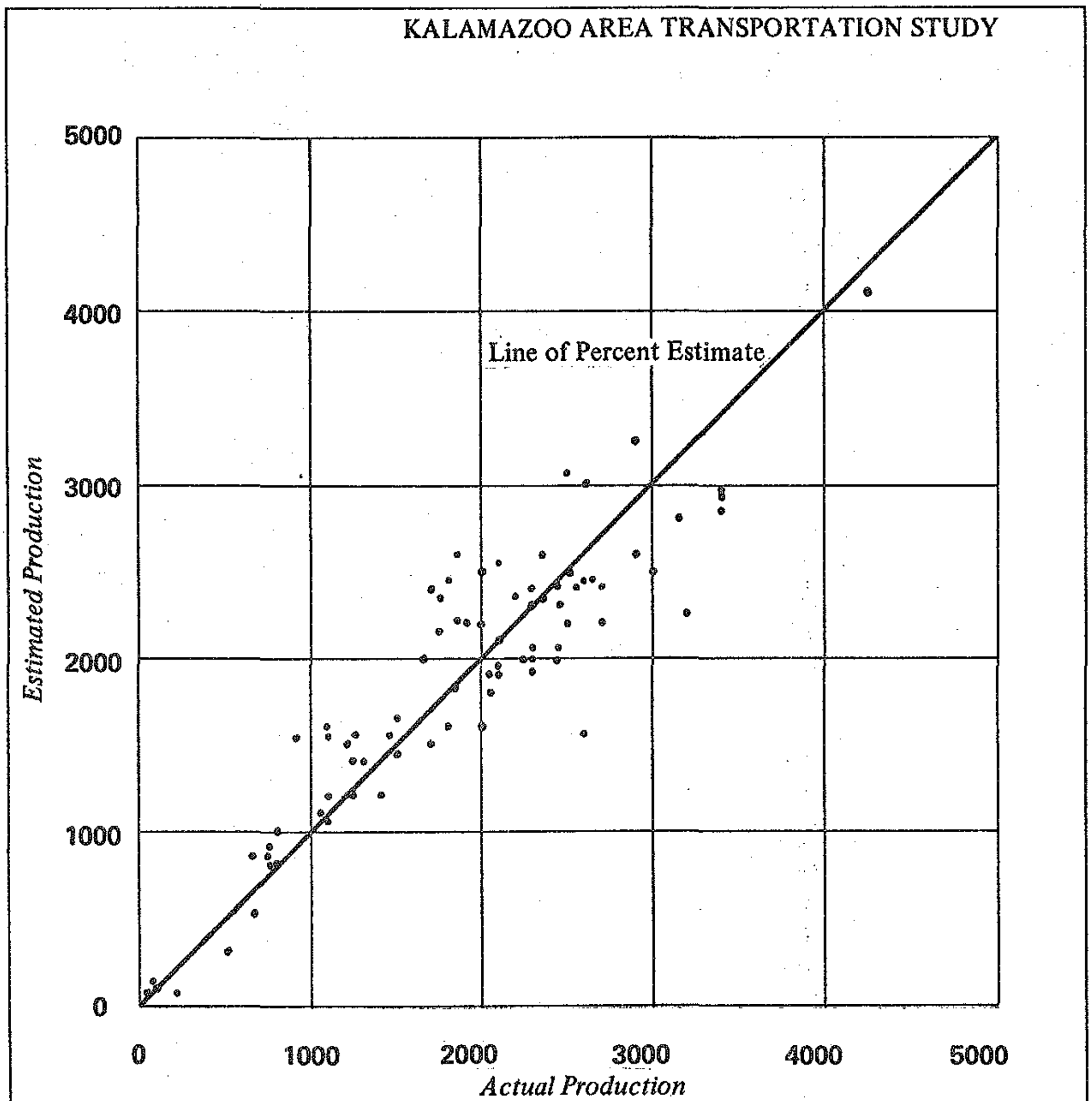


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FIGURE 6: HOME BASED OTHER PRODUCTIONS BY DISTRICT

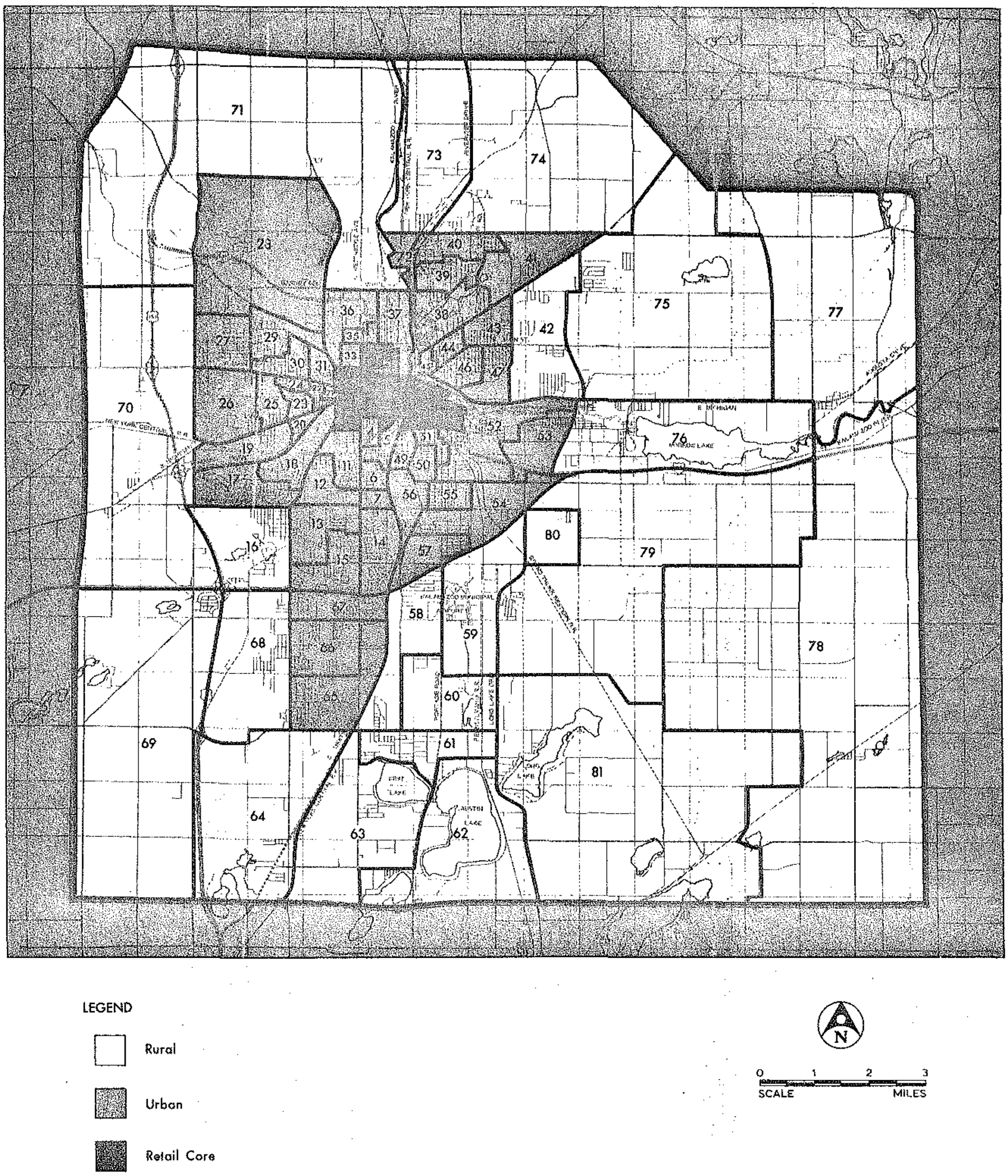

FIGURE 7 STUDY AREA STRATIFICATION

TABLE 8

AUTO DRIVER HOME BASED SHOP AND OTHER ATTRACTION ESTIMATING EQUATIONS

District Shop Attractions = -47 + 20.9 (Retail Employment, Shopping Centers) + 3.64 (Retail Employment, Retail Core) + 10.9 (Retail Employment, Remainder)

		Before Adjust.	After Adjust.
Mean Observed (District)	=	905	891
Standard Error of Estimate	=	307	303
Coefficient of Variance	=	33.9%	34.0%
Coefficient of Determination (R^2)	=	0.96	0.96
"t" (Retail Employment, Shopping Centers)	=	31.0	31.4
"t" (Retail Employment, Retail Core)	=	28.1	28.5
"t" (Retail Employment, Remainder)	=	23.1	23.4

Districts Adjusted	Reason
26	Nonshopping Retail Employees
52	Lumber Yard

District Other Attractions = 384 + 0.24 (Population) + 1.35 (High School and College Student Attendance) + 1.47 (Retail and Other Employment)

		Before Adjust.	After Adjust.
Mean Observed (District)	=	1833	1883
Standard Error of Estimate	=	534	527
Coefficient of Variance	=	29.1%	28.0%
Coefficient of Determination (R^2)	=	0.90	0.91
"t" (Population)	=	3.09	3.14
"t" (High School and College Student Attend)	=	12.6	12.8
"t" (Retail and Other Employment)	=	22.4	23.5

Districts Adjusted	Reason
3	Bronson Hospital
58	Drive-In Theatre

KALAMAZOO AREA TRANSPORTATION STUDY

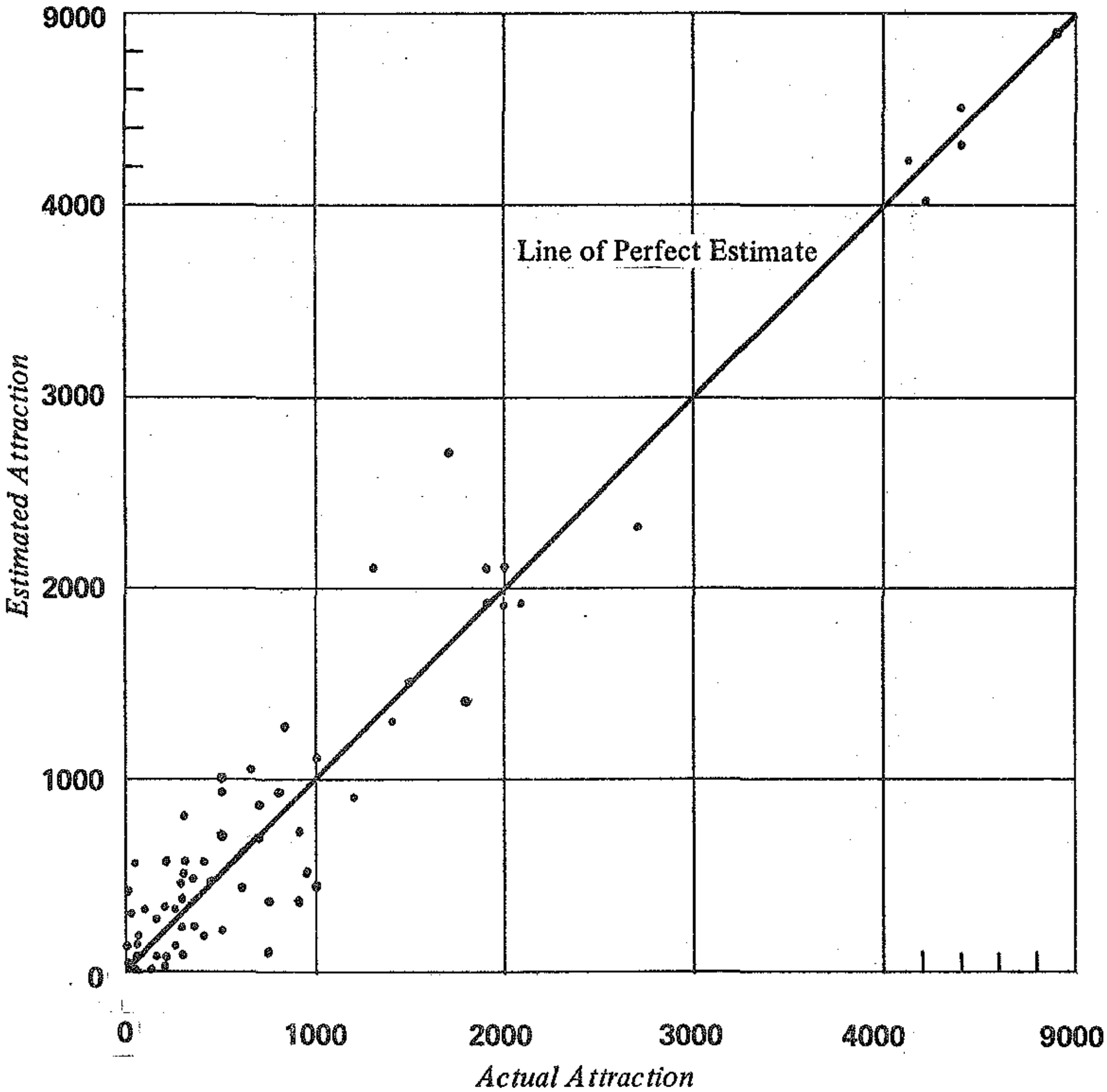

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FIGURE 8: HOME BASED SHOP ATTRACTIONS BY DISTRICT

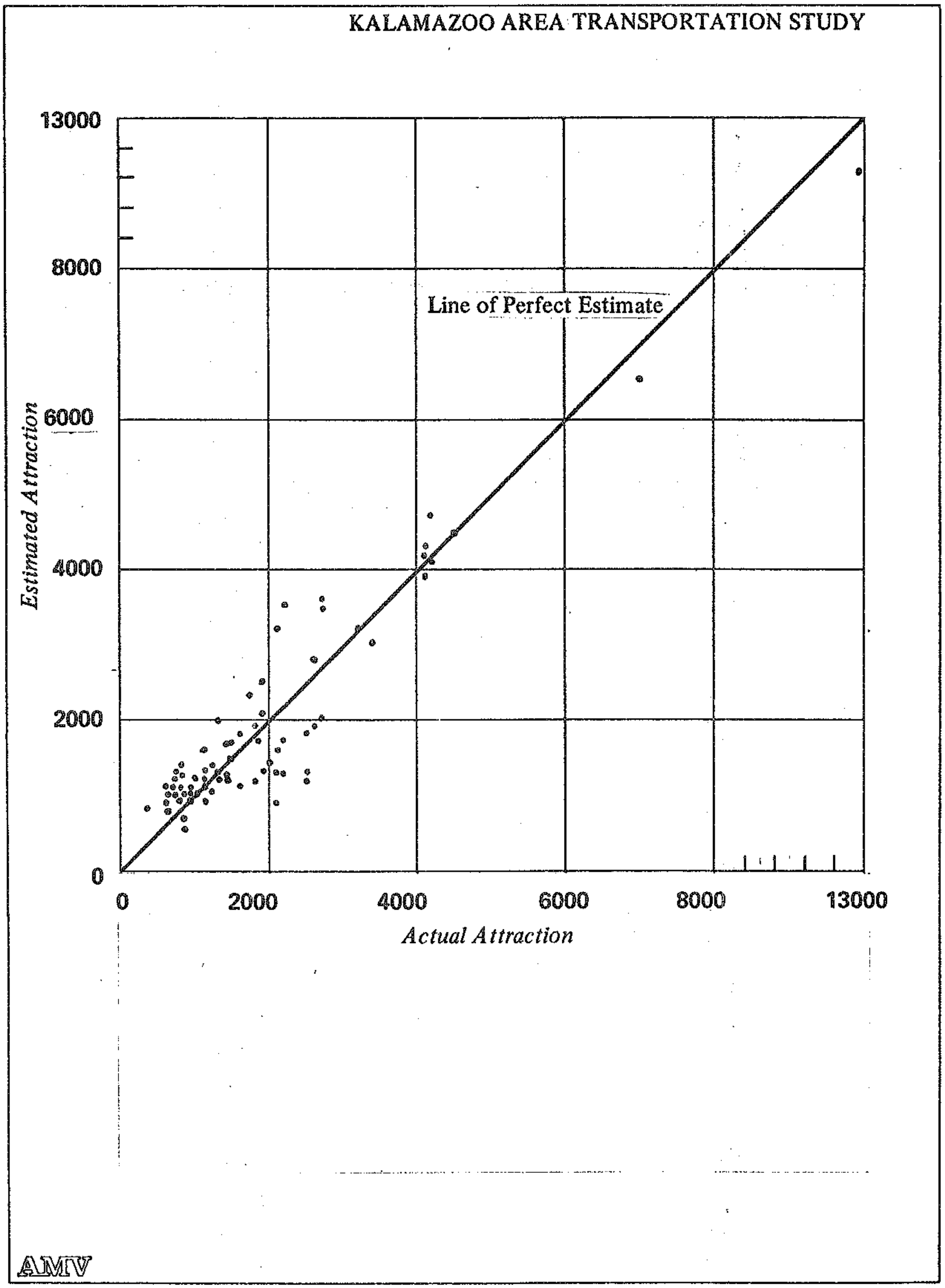


FIGURE 9: HOME BASED OTHER ATTRACTIONS BY DISTRICT

attracted per retail employee varied widely, depending upon the type of retail development. To account for this variation, it is necessary to stratify retail centers by "retail core," "shopping centers," and "remainder." The districts comprising the "core" were illustrated in Figure 7. The districts comprising the "shopping centers" are shown in Table 9.

TABLE 9

DISTRICTS WITH REGIONAL SHOPPING CENTERS

District	Regional Shopping Centers
12	Shopping Center
14	Thrifty Acres, Topps Discount Center
27	Westwood Shopping Center
30	Strip Development for Students
36	Thrifty Acres
40	Parchment
46	Shopping adjacent to Eastwood Shopping Center
47	Eastwood Shopping Center
66	Southland Shopping Center

All retail employees within these districts were classed as "shopping center" employees. In the district zone splitting procedures (as will be explained later), the actual zone comprising the shopping centers was considered.

Districts comprising the "core" will probably remain constant for the forecast year while there will undoubtedly be additional "regional shopping centers." These new centers will have to be classed as such before using this estimating equation.

Adjustments to the final equation were found necessary in Districts 26 and 52 where non-shopping type retail employees were working.

For home based other trips, the variables (1) population, (2) high school and college students' attendance, (3) retail, and (4) other employment are the most significant variables. Population identifies the propensity to make social/recreation trips; high school or college students' attendance relates strongly to school trips and some social/recreation trips associated with the colleges and schools; retail and other employment relate to transact business, eat meal, and medical/dental type trips. Each of these land activities relate to portions of serve passenger trips.

Many other variables were tested, but none was found to add significantly to the equation. Some of the variables tested were manufacturing employment, dwelling units, and a stratification of other employment, as follows:

- Agricultural
- Mining
- Construction
- Transportation
- Communications
- Utilities
- Wholesale
- Finance, Insurance, Real Estate
- Services

- Government
- Self-Employed

In addition, various groupings of these employment categories were tested, but they did not add significantly to improving the equation. Adjustments to the final equation were necessary in District 58 because of a large drive-in theater, and District 3 where Bronson Hospital is located.

NON-HOME BASED AND TRUCK TRIP GENERATION

Estimation of non-home based auto driver trips and truck trips requires a two-step procedure. The questions, "How many trips?" and "Where are they produced and attracted?" must be approached separately. The other trip purpose groups that have been discussed up to this point were all home based trips, and the production equations for these give a direct measure of the total trips produced as well as an estimate of the place of production within the study area. In the case of non-home based trips, however, the total number of trips is related to overall activity in the area, but the production and attraction of these trips in the various parts of the area requires consideration of the level of various types of activity in each part of the area. Experience shows that the total number of non-home based trips can be estimated from the total cars owned in the area, and that this relationship is expected to hold into the future. The present ratio of 2.32 non-home based internal-to-internal trips per car owned can be used to control the total production of these trips.

For non-home based and truck trips, the land activity which causes production of trips at a given point is the same kind of activity that attracts such trips to that point. The number of trips produced, or beginning from each district is the same as the number of trips attracted to the district. For this reason, a single equation of the attraction type has been developed and it is used once to estimate productions and again to estimate attractions.

The final estimating equation along with the regression statistics for non-home based trips and comparison of the actual versus estimated trips is presented in Table 10 and Figure 10, respectively. Although

TABLE 10

AUTO DRIVER NON-HOME BASED PRODUCTION
OR ATTRACTION ESTIMATING EQUATION

District Non-Home Based Productions or Attractions=

510 + 0.23 (Population) + 0.37 (Manufacturing Employment)
+ 4.54 (Retail Employment) + 0.77 (Other Employment)

	Before Adjustment	After Adjustment
Mean Observed (District)	1845	1920
Standard Error of Estimate	491	484
Coefficient of Variance	26.6%	25.2%
Coefficient of Determination (R^2)	0.93	0.94
"t" (Population)	3.18	3.31
"t" (Manufacturing Employment)	4.84	5.22
"t" (Retail Employment)	10.4	15.4
"t" (Other Employment)	4.2	7.0

Districts Adjusted

3	Bronson Hospital
14	Topps Discount Center and Thrifty Acres

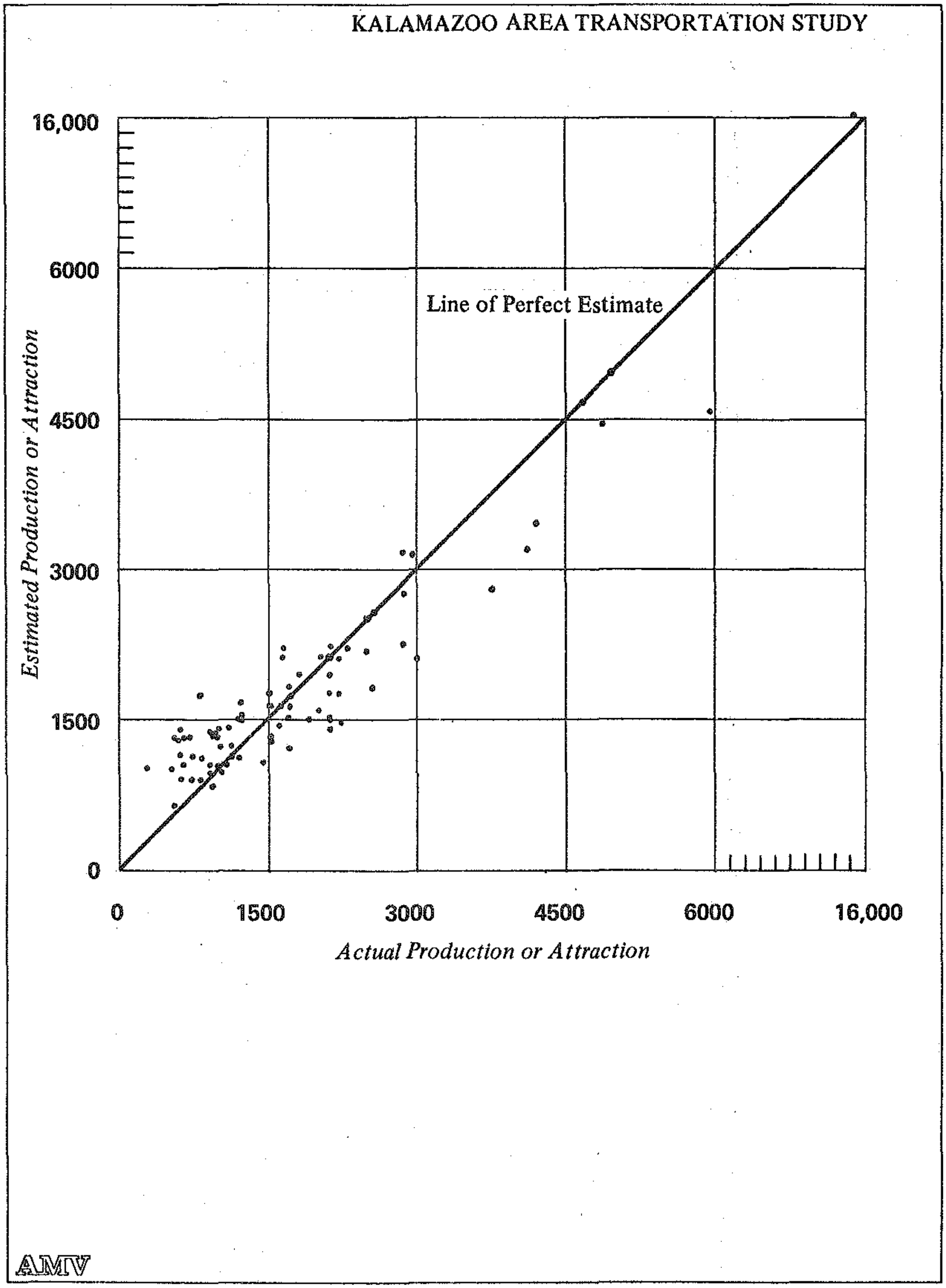


FIGURE 10: AUTO DRIVER NON-HOME BASED PRODUCTION OR ATTRACTION BY DISTRICT

the variables tested for home based other attractions were also tested for this equation, they did not add significantly to the accuracy of the estimations of non-home based trips.

Special adjustments were necessary in District 3 to reflect additional trips to Bronson Hospital and in District 14 to reflect additional trips to Topps Discount Center and Thrifty Acres Shopping Center. In District 14, 20 percent of the total trips are between the zones containing the two discount stores. This, in addition to the special nature of trips attracted to discount business and the special characteristics of Westnedge Avenue required that a special adjustment be made.
For truck trips, the final estimating equation, together with the regression statistics and the comparisons of the actual versus estimated trips, is shown in Table 11 and Figure 11, respectively. Again, other variables tested were those as listed in the discussion on home based other trip attractions. No adjustments to truck trips were made.
While the equation gives a good index of the production and attraction to the various districts, a more direct relationship to overall growth is needed to forecast the total truck trips. Since the portion of total vehicle miles accounted for by truck travel has remained essentially constant since World War II, and no change in the relative average trip lengths of truck and auto trips is expected, the total number of trips for the truck purpose can be assumed to grow at the same rate as car ownership, the estimator for auto trip growth. Total truck trips in the future can be forecasted by maintaining truck trips as a constant ratio to total trips in the area.

TABLE 11

TRUCK PRODUCTION OR ATTRACTION ESTIMATING EQUATION

District Truck Productions or Attractions = -45 + 0.059 (Population)
+ 0.17 (Total Employment)

Mean Observed (District)	=	215
Standard Error of Estimate	=	130
Coefficient of Variance	=	60.5%
Coefficient of Determination (R^2)	=	0.77
"t" (Population)	=	3.22
"t" (Total Employment)	=	16.3

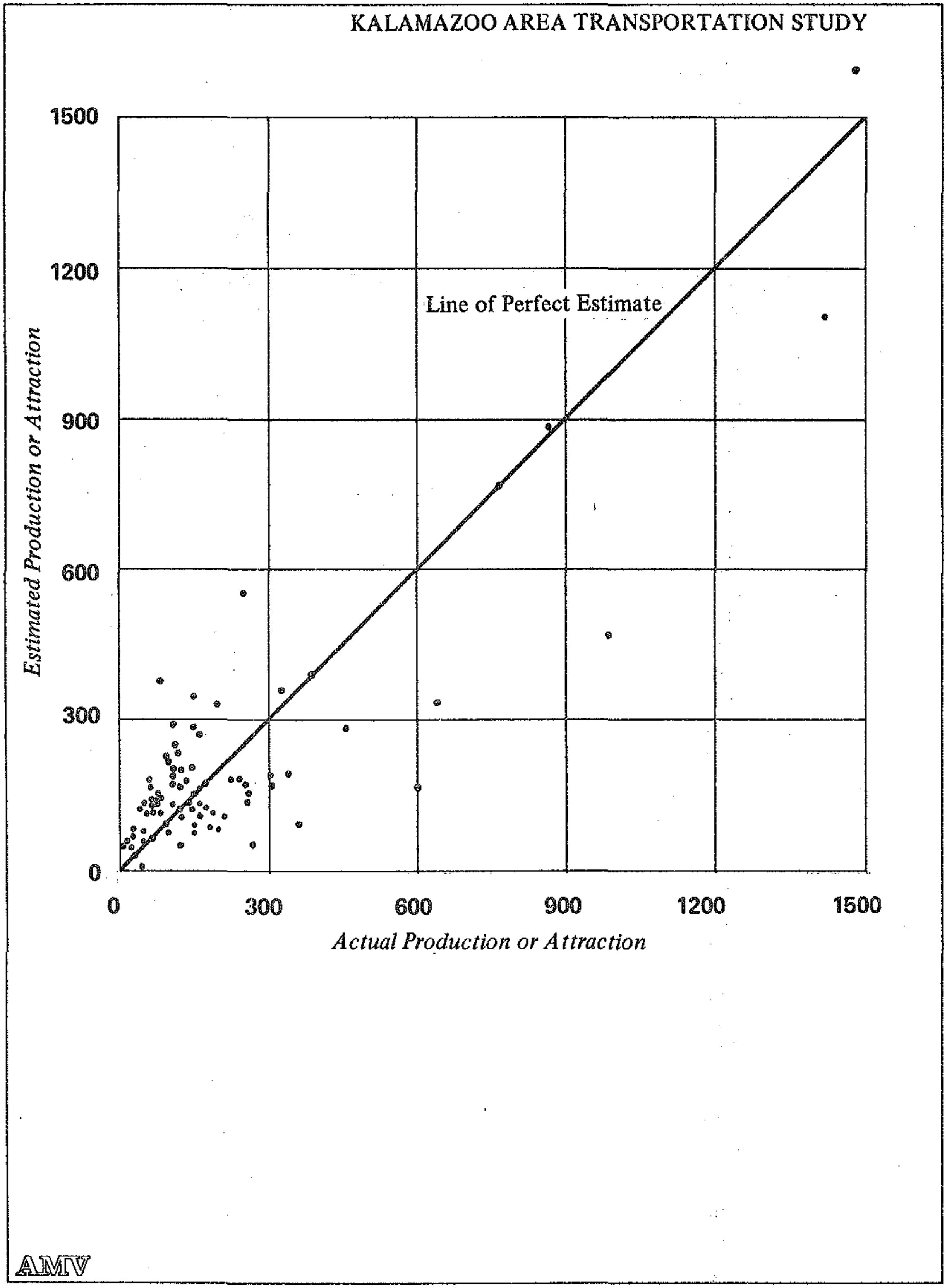


FIGURE 11: TRUCK PRODUCTION OR ATTRACTION BY DISTRICT

TOTAL PRODUCTION AND ATTRACTION

As a final check on the entire set of trip production and attraction estimating equations, a composite estimate of total productions and of total attractions was computed and compared with the observed trips produced and attracted to each zone. These comparisons are shown in Figures 12 and 13 which indicate a distinct clustering of the points about the line of perfect estimate.

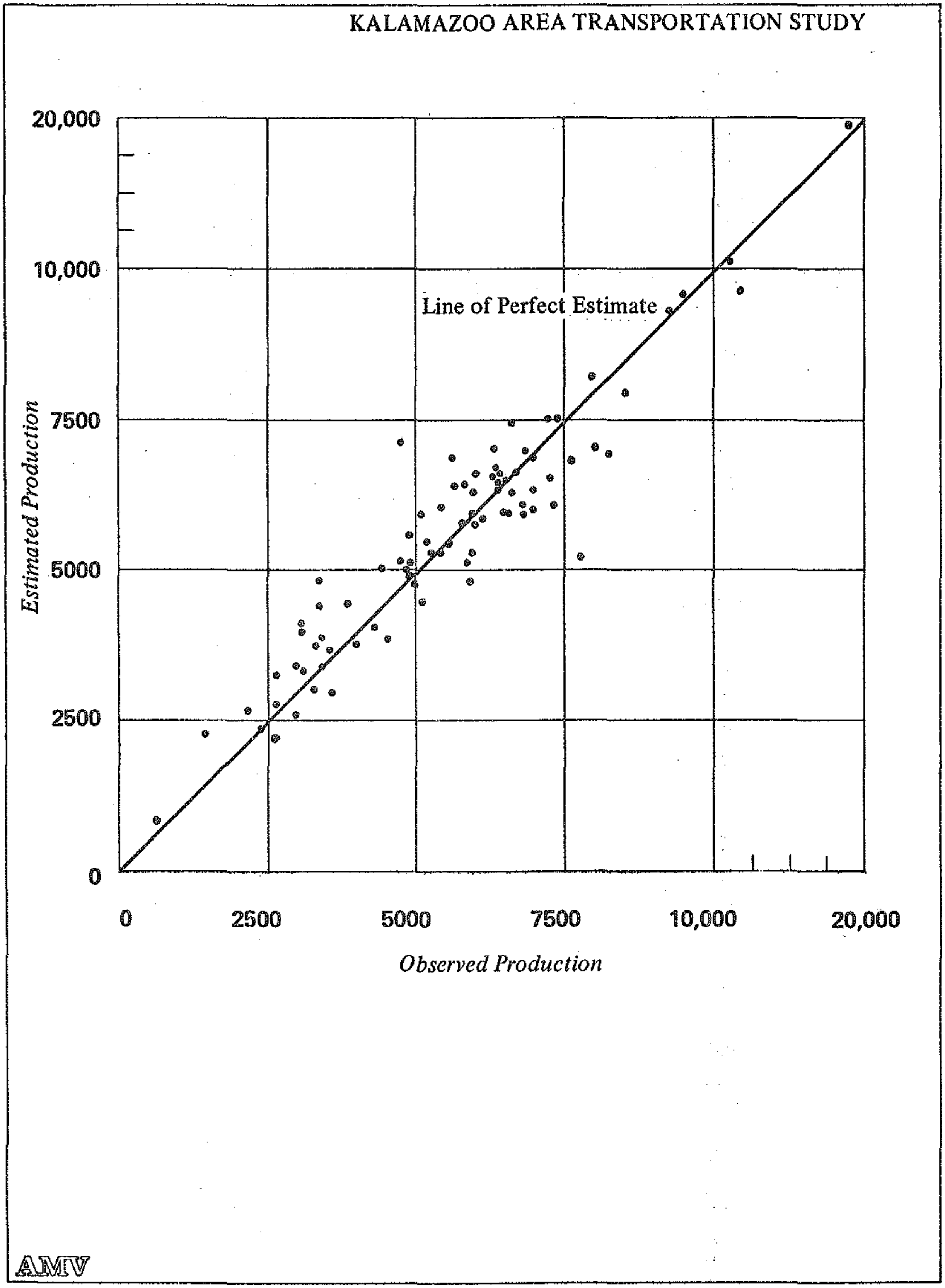


FIGURE 12: TOTAL VEHICLE PRODUCTION BY TRANSPORTATION DISTRICT

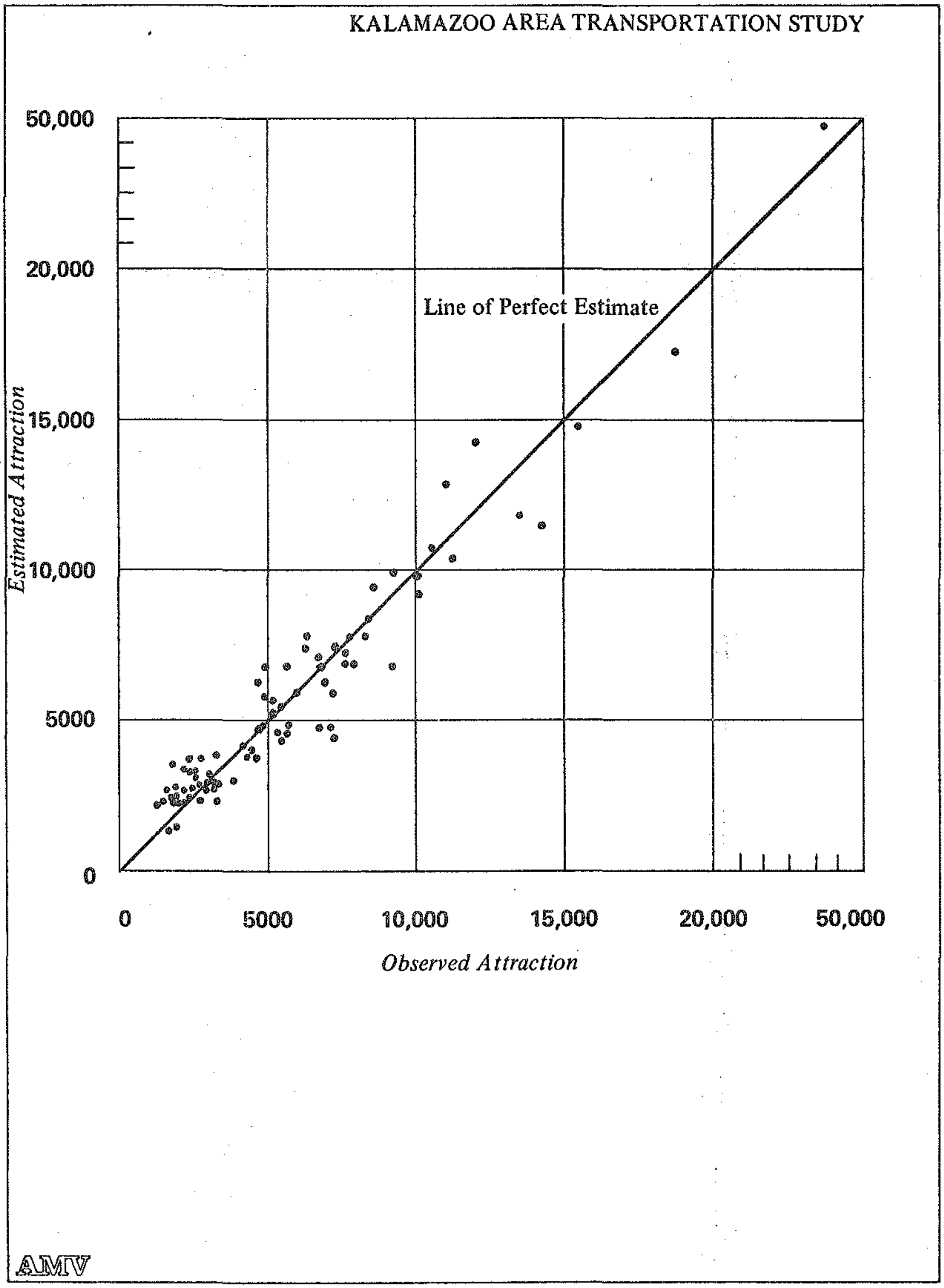


FIGURE 13: TOTAL VEHICLE ATTRACTION BY TRANSPORTATION DISTRICT

CHAPTER III

CAR OWNERSHIP

Research in many studies has shown that car ownership rates are influenced very strongly by family income, but in a non-linear relationship. In other words, as family income increases, car ownership increases also, but not in the same proportion. In Kalamazoo, this relationship was also observed.

For this reason, and also because of the very large, simple correlation between labor force and cars, it was decided to stratify labor force by income ranges. This was done by classifying all districts with a median family income of under $8, 000 per year as "low income," from $8, 000 to $9, 999 per year as "medium income," and $10, 000 and over as "high income." Labor force stratified in this manner was tested and found to be over-predicting in the downtown areas and under-predicting around Western Michigan University. Thus, labor force in the downtown area was taken as a separate stratum since car ownership in this area was low. In addition, data on cars registered by Western Michigan University's on-campus students was obtained for testing in the equation. Each of these variables added very significantly to the equation.

The final equation is shown in Table 12 together with the regression statistics. The actual versus the estimated trips is shown in Figure 14.

For the future, districts comprising the "core" will be the same as today, unless high-rise apartments for high-income residents, or other major renovation is projected. The other variables, of course, are expected to vary over time.

TABLE 12

AUTO OWNERSHIP ESTIMATING EQUATION

District Auto Ownership = 8 + 1.0 (Dormitory Registered Cars) + 0.66 (Labor Force, Core) + 1.16 (Labor Force, Medium Income) + 1.24 (Labor Force, High Income) + 1.02 (Labor Force, Low Income)

Mean Observed (District)	=	823 (No adjustments were necessary)
Standard Error of Estimate	=	89
Coefficient of Variance	=	10.8%
Coefficient of Determination (R^2)	=	0.94
"t" (Dormitory Registered Cars)	=	8.95
"t" (Labor Force, Core)	=	9.81
"t" (Labor Force, Medium Income)	=	31.7
"t" (Labor Force, High Income)	=	25.9
"t" (Labor Force, Low Income)	=	23.2

Note:

Low Income	=	None to $7,999
Medium Income	=	8,000 - 9,999
High Income	=	10,000 and over

Districts with Labor Force in Core: 1, 2, 3, 32, 34

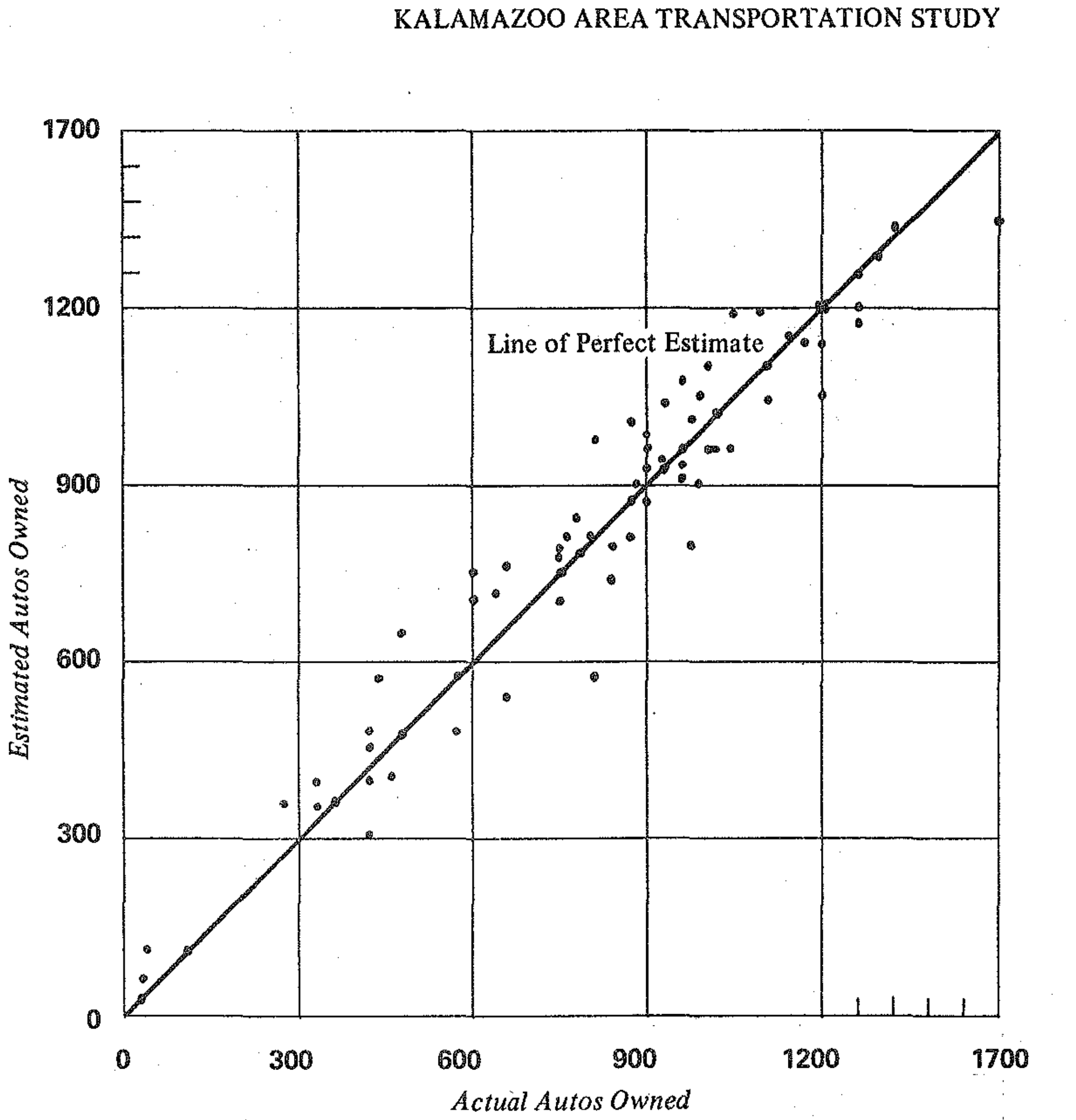


FIGURE 14: AUTOS OWNED BY DISTRICT

CHAPTER IV

TRIP DISTRIBUTION

As indicated by the gravity model formula stated in the Introduction, four factors must be analyzed and quantified before the model can be applied to the study area. Chapter II dealt with two of these--trip production and trip attraction. The remaining two factors are concerned with spatial (F_{ij}) and socio-economic (K_{ij}) characteristics. Unlike trip production and attraction, these two factors do not deal with traffic at a single point, but rather are concerned with trip movements from one point in the system to another. These factors were developed to "fit" the gravity model to known existing travel patterns so that they could be applied to forecast the future distribution of trips in each of the trip-purpose categories analyzed. This chapter summarizes the procedures for and the results of the development of these factors.

FRICTION FACTORS

This phase of the analysis was concerned with the development of the proper exponent of travel time associated with each trip purpose. For ease of computation, an exponent is not directly used in the gravity model. Instead, a set of friction factors is calculated, where

$$F = \frac{1}{t^b}$$

The use of "F" factors instead of exponents makes it possible to use a variable exponent, a procedure which previous studies have shown to be desirable. It should be noted that the absolute value of each "F" factor is unimportant. Only the relative values of the "F" factors for various trip lengths within each trip-purpose category affect the behavior of the gravity model. The need for a variable exponent arises in part from the mathematically complex shape of the curve of trip-length distribution.

The set of "F" factors for each trip purpose category quantifies the total effect of spatial separation between zones. The total effect is based on the total "time separation," which is the sum of the over-the-road driving time between zones and the terminal times within the origin and destination zones. Terminal time reflects the impedance to making a vehicle trip to or from a zone due to difficulty and time required to park the vehicle and in getting between an actual parking location and the true origin or destination point of the trip. Terminal times were subjectively developed for each zone based on knowledge of the study area and on zonal characteristics such as the amount of traffic congestion which affect terminal time. In this study, terminal times ranging from zero minutes in the outlying rural zones to three minutes in the downtown zones gave good results. Terminal times for external centroids were assigned as five minutes to roads carrying primarily local traffic, ten minutes to U. S. 131, and fifteen minutes to I-94.

Intrazonal times of one minute for the rural zones and zero minutes for all other zones were input to the model. Since the total intrazonal times consist of twice the terminal times plus the intratimes, the resulting total intrazonal times varied from one minute in the rural zones to six minutes in the downtown zones. This produced the best consistent estimate of intrazonal trips, and was verified by the number of intradistrict trips obtained. The terminal and intrazonal times for each zone are listed in Appendix C.

After the zone-to-zone driving times had been summarized from the highway network and the intrazonal and terminal times had been added into this zonal time matrix, it was used as the base for developing a district-to-district travel time matrix. The district-to-district time matrix is a weighted average of the zonal times computed by using the zonal vehicle trip matrix as the weighting criterion for the zone-to-zone times.

The best set of "F" factors associated with each trip purpose was determined through a process of trial and adjustment by first assuming a set of friction factors for each purpose and building a trial model with the productions and attractions from the Origin-Destination Survey to obtain trip interchanges between districts. The results of the trial gravity model were then compared to the survey data and adjustments were made to the "F" factors in light of the following criteria:

- Trip-length distributions obtained from the gravity model should fit closely with the corresponding survey trip-length distributions
- The average trip lengths produced by the model should be in close agreement with those measured in the survey
- A semi-logarithmic plot of the "F" factors versus trip lengths should be a relatively smooth curve with no "unexplainable" inflection points

If these criteria were not achieved, it was necessary to adjust the "F" factors according to the following formula:

$$F_A = F_P \frac{\% OD_t}{\% GM_t}$$

where:

F_A = Adjusted "F" factor

F_P = Previous "F" factor

$\% OD_t$ = Percentage survey trips for a given length increment (t) of total trips in that purpose category

$\% GM_t$ = Percentage model trips for a given trip length increment (t) of total trips in that purpose category.

These adjusted "F" factors were then plotted on semi-log paper and a smooth curve fitted to them to determine a new set of "F" factors for input into the gravity model. This process was repeated until the gravity model distribution substantially matched the survey trip-length distribution. Figure 15 shows the final "F" factor versus trip-length relationship for each of the five models used for the analysis.

The gravity model, for all trip purposes, was iterated three times for trips attracted to the external stations. The iteration process forces the trips attracted to these external centroids to conform more closely with the original estimates of attraction input to the model.

SOCIO-ECONOMIC FACTORS

Any mathematical model, by nature, simulates average or normal conditions. Before applying a model to a particular urban area, it is therefore necessary to compare it to the actual travel patterns and to adjust it, if necessary, to insure that it accurately simulates any unique social or economic conditions existing in the study area. Such adjustment permits the analyst to reflect the influence of variables not considered in the model.

After trip-length distributions were calibrated for each purpose, trip transfers generated by the gravity model were compared to the survey trip interchange. An analysis was made for each of the purposes at the district level to obtain stability in the numbers of trips being investigated.

To gain a basic understanding of the data that could point to a meaningful analysis of the socio-economic structure of the region, additional analyses were conducted by further grouping of some of the districts. Throughout the analysis, constant alertness was maintained for trends and persistencies in differences which, even though based upon small numbers, would aggregate into a larger sample size that could result in greater stability. Aggregates of grouped differences were also checked by making several assignments of gravity model trip transfers to the desire-line network and comparing these with similar assignments of survey data.

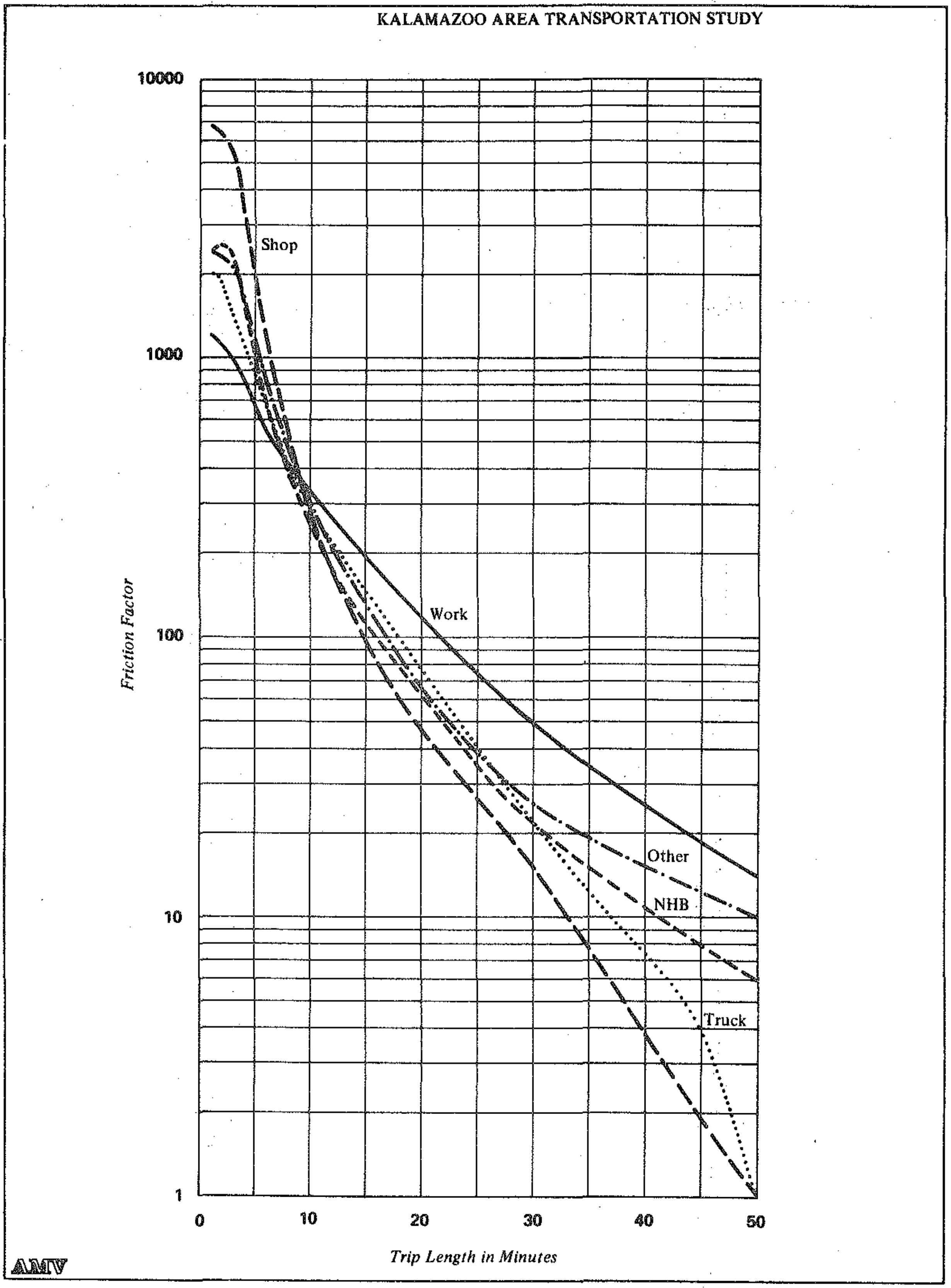


FIGURE 15: FRICTION FACTORS

In this way, it was possible to obtain an understanding of many of the underlying characteristics of the region and to adjust the basic model structure to match these intricate workings. It is important to recognize, however, that the need for this understanding goes beyond the mere exercise of calibrating the model. The primary purpose of this effort is to guide its application in the forecasting process and to assure that the tool developed and tested for the existing condition is, in fact, applicable to the future. In those cases where adjustments were found necessary and could be substantiated by known socio-economic characteristics, "K" factors were calculated and applied to the gravity model.

The following sections discuss the underlying reasons for the "K" factors developed. These adjustments are grouped into five general classifications for discussion.

Self-Contained Communities

Certain areas, due to their high degree of self-containment, tend to interact at a substantially lower-than-average rate with the surrounding areas and consequently a greater-than-average number of intra-area trips are made. Since the gravity model reflects average region-wide travel patterns, the intra-area trips for such areas are underestimated. This occurred in the Western Michigan University area, in some of the older major industrial areas, and in small communities in the rural portions of the study area.

Western Michigan University with its 18, 400 students, and Kalamazoo College with an enrollment of 1, 200, form a separate community in Western Kalamazoo. This community contains its own well-developed institutional, commercial, and recreational facilities serving the young academically-oriented populace.

Many of the rural portions of the study area also indicated a relatively high degree of self-containment. Because of the large size of the study area, much of the rural portion does not have a "suburban" relationship to Kalamazoo. Many of the rural residents continue to work and trade in nearby areas and do not interact with central Kalamazoo as much as the average for the entire area would indicate. Such biases were particularly evident around the business areas of Parchment and Galesburg.

Kalamazoo Central Commercial Area (District 1)

Generally, in this type of regional study, there is a definite trip distribution bias to the central commercial area. This is to be expected since the model which is based on regional averages cannot account for the special attractiveness historically enjoyed by central business districts. Thus, for all purposes, there were underassignments of trips to this area. In addition, the extent of the bias from residential areas was related to income level, since higher income trip makers tend to be attracted to the work, shop, and business opportunities in the central area at a higher-than-average rate. It is expected that these biases will continue to exist in the future.

Shopping Trips

Biases were noted in the assignment of shopping trips to the major commercial areas. Large department stores, such as Sears, Thrifty Acres, and Topps Discount Center, attract what is known as "goods shopping." They are unique attractors of shopping trips due to their large variety of merchandise. This enables consumers to purchase goods not available in their local communities, facilitates comparison shopping, and allows for the purchase of many types of goods in one shopping trip. Since there are only a few of these stores in the region, they attract trips from all portions of the study area at higher rates than the gravity model predicts. Thus, the short trips to these regional stores tend to be overestimated by the model and long trips underestimated, requiring adjustment to counteract this tendency.

On the other hand, there are several smaller shopping centers that contain a supermarket and several small stores. These centers provide solely for what is known as "convenience shopping." Their goods consist primarily of groceries and other items widely available in the region, and these centers tend to attract mostly short trips. The bias in the gravity model is the reverse of that for the regional department store and an opposite type of adjustment is required.

Topographic Barrier

The Kalamazoo Area is severed by a topographic barrier along a north-south axis that lies just to the east of the Central Commercial Area. The Kalamazoo River, which flows from the east edge of the downtown area toward the north, is the focus of the barrier in the northern half of the study area. The river is closely paralleled by the north-south tracks of the Penn Central Railroad and the adjacent large industrial complex, which add significantly to the barrier effect of the river itself. The railroad tracks continue through the southern half of the study area as a major barrier, and are reinforced by a series of parks and the Brandt Mill and Monarch Mill Ponds. While several roads penetrate the barrier to connect the west and east sides, travel from one side to the other is often circuitous and psychologically the other side seems further away than it really is. Strong commercial strips along Westnedge Avenue on the west side and along Portage Street and Lovers Lane on the east side give a measure of internal self-sufficiency to each of the two halves of the study area.

With this land development pattern, it is expected that trip making is relatively less frequent from one side to the other than between similarly spaced zones not separated by the barrier strip. The travel survey found that relatively fewer trips across the barrier are made by the people of the Kalamazoo Area, confirming the physchological effect of the barrier on travel habits. To adjust the gravity model so as to account for this bias, "K" factors to reduce the incidence of trips across the barrier were introduced between the districts lying on opposite sides of the barrier in the northerly half of the study area and similarly between districts on opposite sides in the southerly half of the area. Since the Central Commercial Area serves all of the region in its own unique way, this area was not included in the adjustments for the barrier. In addition, the bias was not found to be important for the long trips between the southwest quarter and the northeast quarter of the study area or for trips between the northwest and southeast quarters.

Special Interaction

For a variety of other reasons, "K" factors were applied between a small number of other area-to-area combinations. These adjustments reflect unique conditions resulting from unusual attributes of one or both areas that produce abnormal trip interchange patterns.

Western Michigan University is a center for regional and state-wide conferences and work shops which attract a great number of people from outside the study area. Therefore, it was necessary to adjust for trips between the university and the major external stations.

The outlying rural areas have a higher-than-average percentage of their trips interchanging with adjacent rural areas in contrast to a relatively lower attraction of the rural areas for the trips generated in the suburban parts of Kalamazoo. Adjustments were applied to account for this bias.

The General Motors plant is new to the area, having opened in 1966. It was found that the trip patterns for the many new employees at this plant were different than those typical of the older established industries. A large proportion of the GM employees commuted from outside the study area and the trips from within the study area were substantially longer than average. It is apparent that the new plant attracted workers from many communities in Western Michigan. However, it is expected that the residential distribution of these employees will conform more to the typical pattern of the other major industrial complexes in the future.

Another type of special interaction occurs between the high schools in the Kalamazoo area, and the surrounding residential areas served by each of them. Since school trips were included in the "home based other" purpose group, special adjustments to that group were required to introduce the unique trip distribution pattern attracted to the high schools. Other schools did not attract unusual patterns of auto driver trips.

Forecasting the Adjustments

To successfully use "K" factors, one must be certain that it is possible to forecast the conditions necessitating their use in the future. For all but the General Motors District, the biases exhibited in the present travel patterns will continue to exist. However, the magnitude of all "K" factors used in the model must be reevaluated before they are used in making a future travel estimate.

The "K" factor analysis for an urban transportation study is never simple. It is a complex undertaking requiring basic understanding of the social and economic structure of the region. Nevertheless, it is a most important part of the analysis since it provides a means through which to tune the model to the particular characteristics of the area. It is believed that all important unusual travel patterns have been adequately isolated and that the calibrated process has imparted the basic understanding of the region necessary to assure accurate adjustment of the model to future conditions. Appendix D lists all of the "K" factors required for the Kalamazoo Area Transportation Study.

CHAPTER V

FINAL VERIFICATION

The procedures and checks described in the previous sections were concerned with two basic phases of the traffic forecasting procedure--those used to predict trip generation (productions and attractions) and those concerned with the distribution of vehicular traffic. As a final check on the trip distribution model, a comparison of the average trip length and the trip-length distribution produced by the gravity model was made with the corresponding characteristics determined in the travel survey. To check the ability of the model to match survey values in traffic corridors, the district-to-district gravity-model trip transfers were assigned to the desire-line network and compared with similar survey values. The trips predicted by the model must be split to a zone-to-zone level through the use of proportioning factor equations developed for home based, non-home based, and truck trips (see Appendix E--Proportioning Factor Equations). This is needed so that detailed assignments of the trip table to the real highway network can be made. The resulting zone-to-zone total vehicle trips were assigned to the existing highway network, and the assigned volumes compared to the actual 1966 ADT traffic volumes developed from on-the-ground traffic counts. Thus, the total study effort to this point, from data collection through model calibration and including the network simulation, could be verified.

Trip-Length Check

After the friction factors and socio-economic factors were applied to the productions and attractions, a gravity model trip-length distribution was generated and compared to the survey trip-length distribution. Table 13 shows the comparison of the average trip lengths produced by the gravity model and the survey values. The model average for each purpose group agrees closely with the survey average.

TABLE 13

AVERAGE TRIP-LENGTH COMPARISONS

Purpose	Survey	Gravity Model	Gravity Model/Survey
Home Based Work	15.719	15.704	1.00
Home Based Shop	9.352	9.468	1.01
Home Based Other	10.576	10.522	.99
Non-Home Based	9.371	9.257	.99
Truck	12.997	12.827	.99
Total	11.150	11.114	1.00

NOTE: This trip comparison was made after the insertion of "K" factors.

Figures 16 through 21 show comparisons of the gravity model and survey trip-length distributions by one-minute increments for each individual purpose and for all purposes combined. As can be observed, a close match with no major deviations has been attained by the calibrated gravity model.

Desire-Line Network Comparison

A comparison of the survey and gravity model district-to-district trips assigned to the desire-line network was made and analyzed. Figure 22 shows the consistent agreement of these two data sets in all parts of the area, confirming that no significant bias in any part of the study area has been introduced.

Zonal Trip End Comparisons

Using the Proportioning Factor Equations that are listed in Appendix E, the district-to-district trips were split to zone-to-zone trips. A simple example of this technique of splitting trips is shown in Appendix F. As a check on this procedure, the survey district-to-district trips were split to zone-to-zone trips using this technique. Statistical comparisons of these "estimated survey" trips with the actual survey trips are shown in Table 14. This table also shows the statistical comparisons at the zonal level of the gravity model and synthetic model trip ends with the survey trip ends.

Screenline and Cutline Comparisons

After the gravity model and the synthetic model trip table assignments to the highway network were complete, comparisons of the volumes crossing the screenline and various cutlines were made with ground counts and with the survey assignment.

Again, the synthetic model was developed from the estimated productions and attractions, using the estimating equations and the 1966 land-activity data. Figure 23 illustrates the location of the screenline and the cutlines. Table 15 shows the values obtained from each step and the ratios between

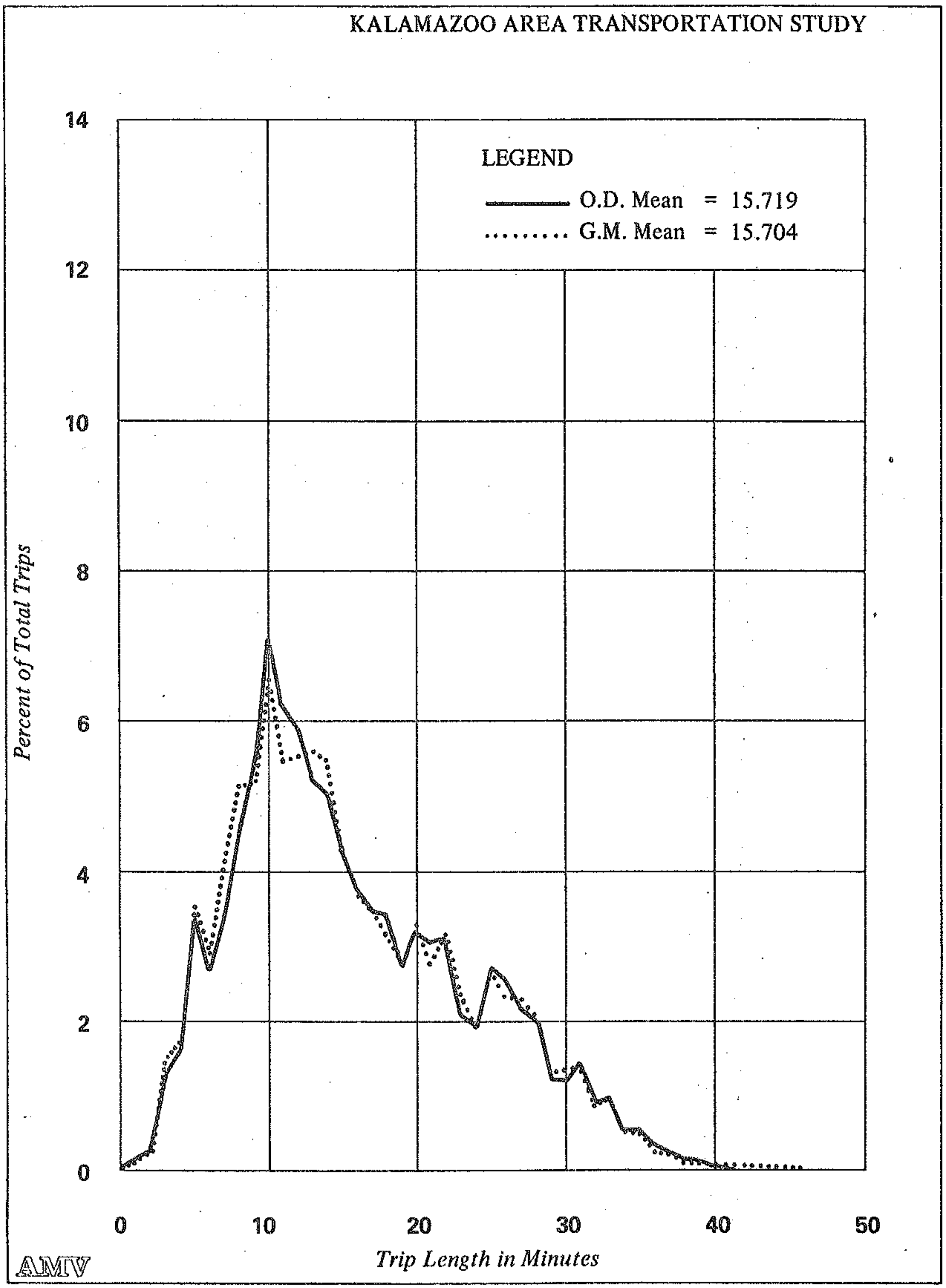


FIGURE 16: VEHICLE TRIP LENGTH DISTRIBUTION COMPARISON FOR WORK TRIPS

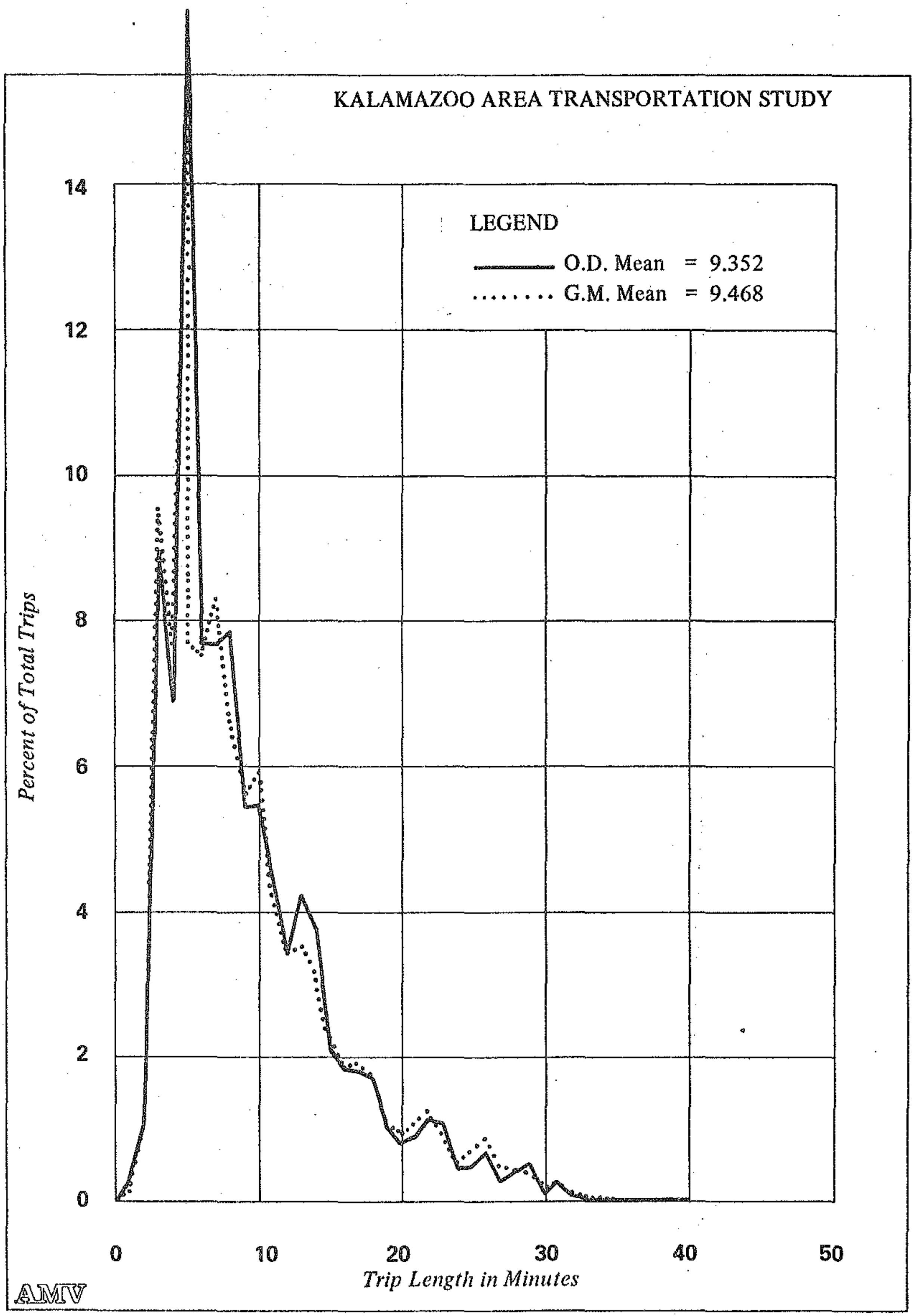


FIGURE 17: VEHICLE TRIP LENGTH DISTRIBUTION COMPARISON FOR SHOP TRIPS

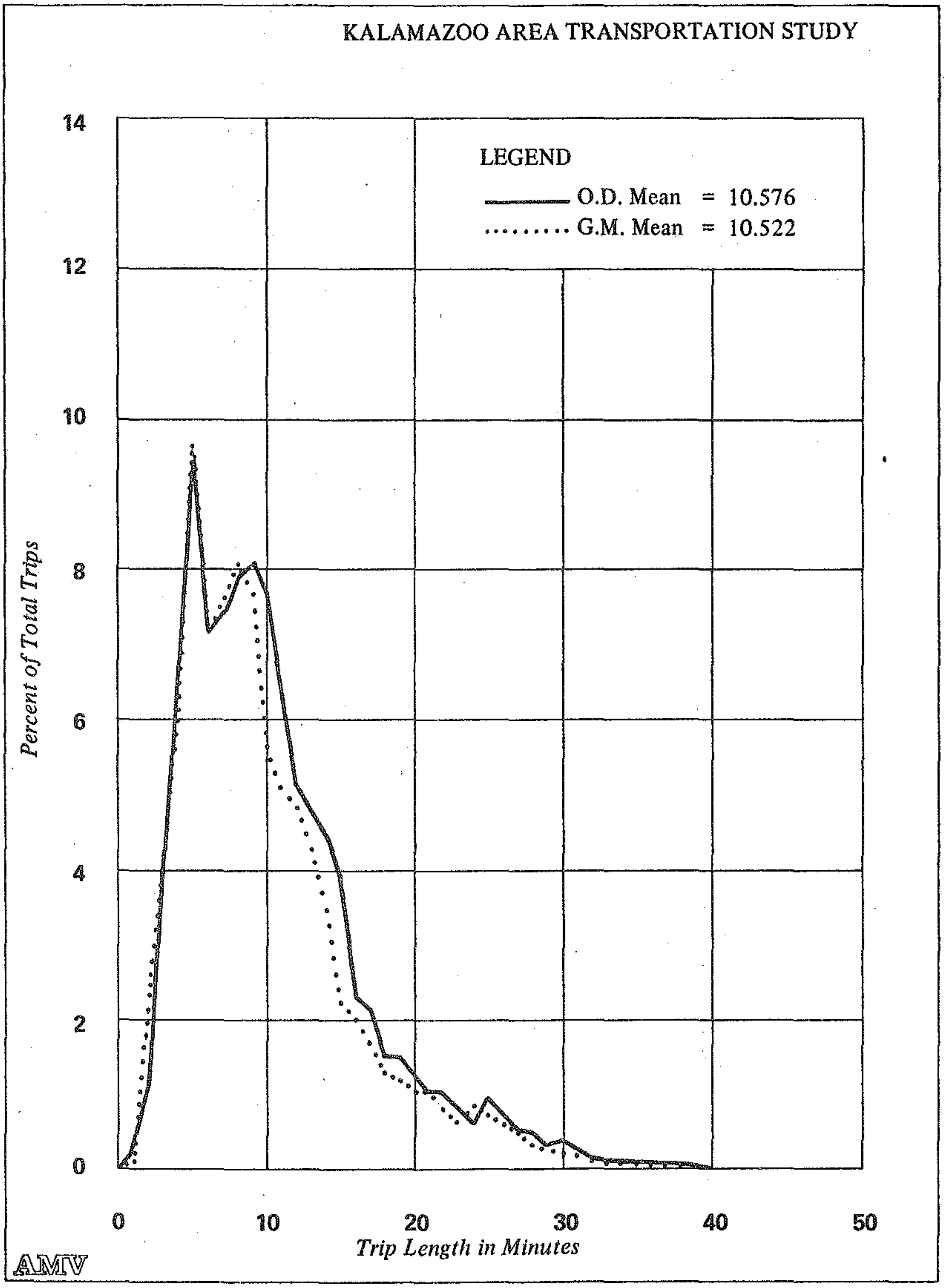


FIGURE 18: VEHICLE TRIP LENGTH DISTRIBUTION COMPARISON FOR OTHER TRIPS

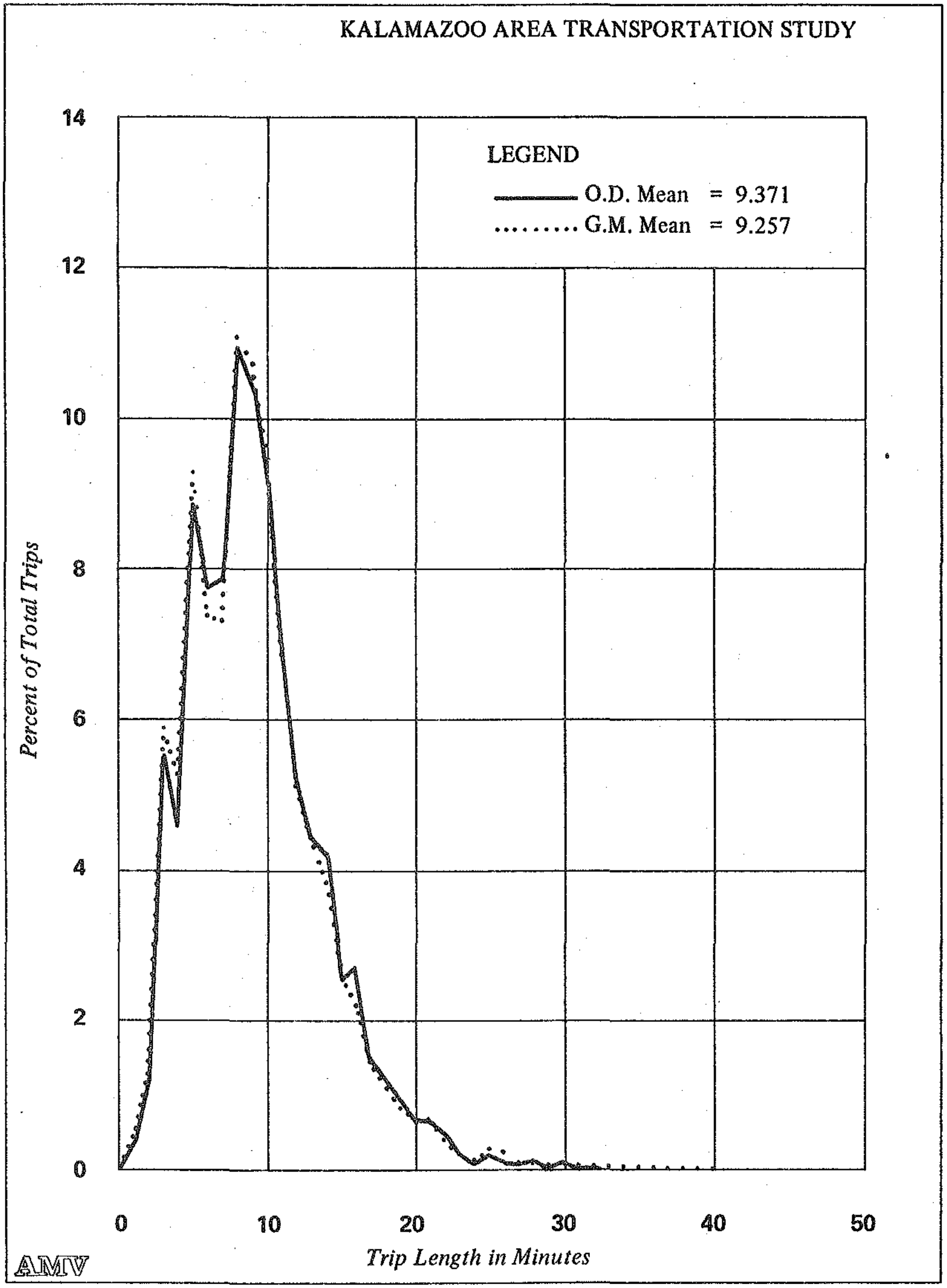


FIGURE 19: VEHICLE TRIP LENGTH DISTRIBUTION COMPARISON FOR NON-HOME BASED TRIPS

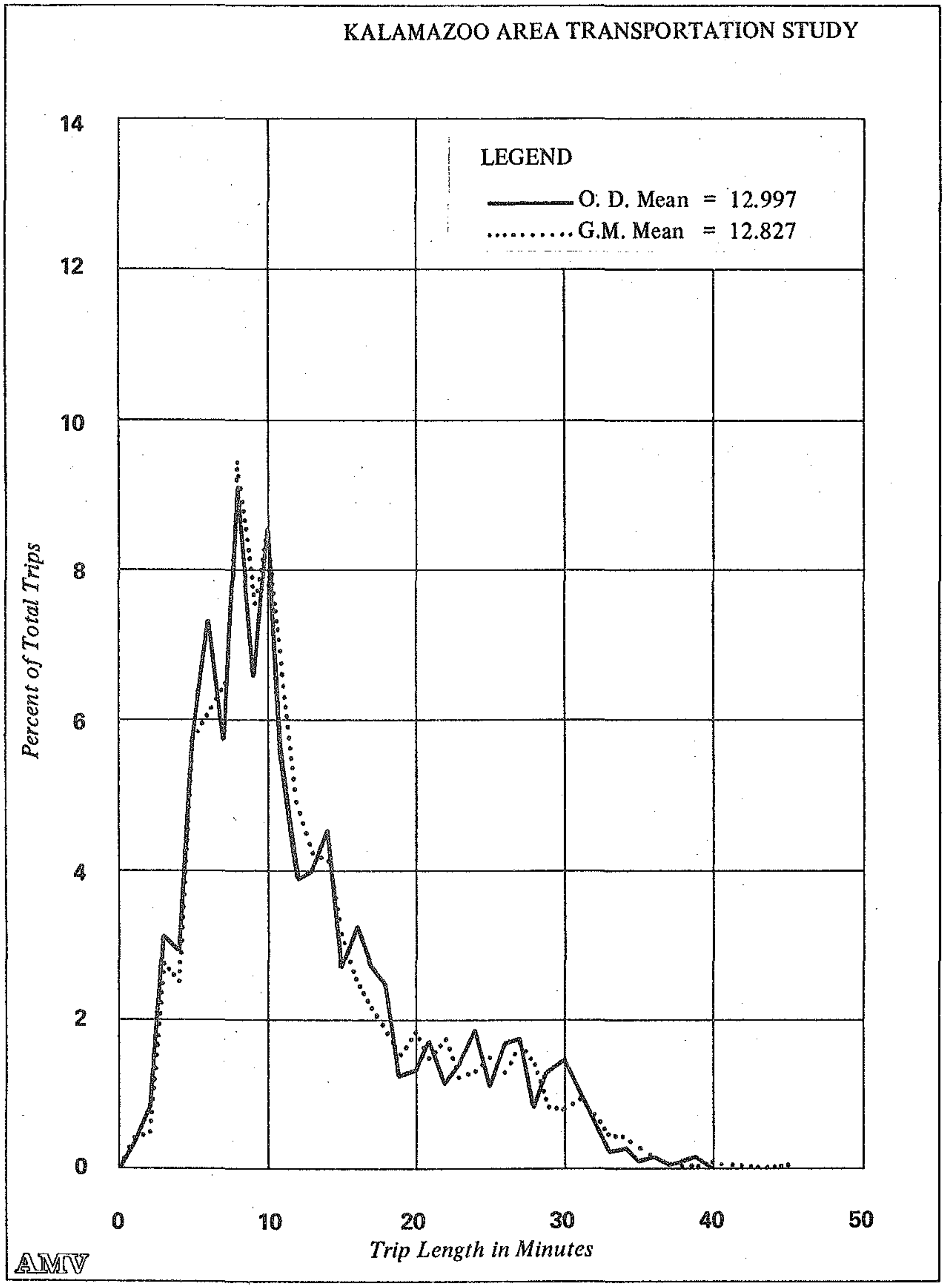


FIGURE 20: VEHICLE TRIP LENGTH DISTRIBUTION COMPARISON FOR TRUCK TRIPS

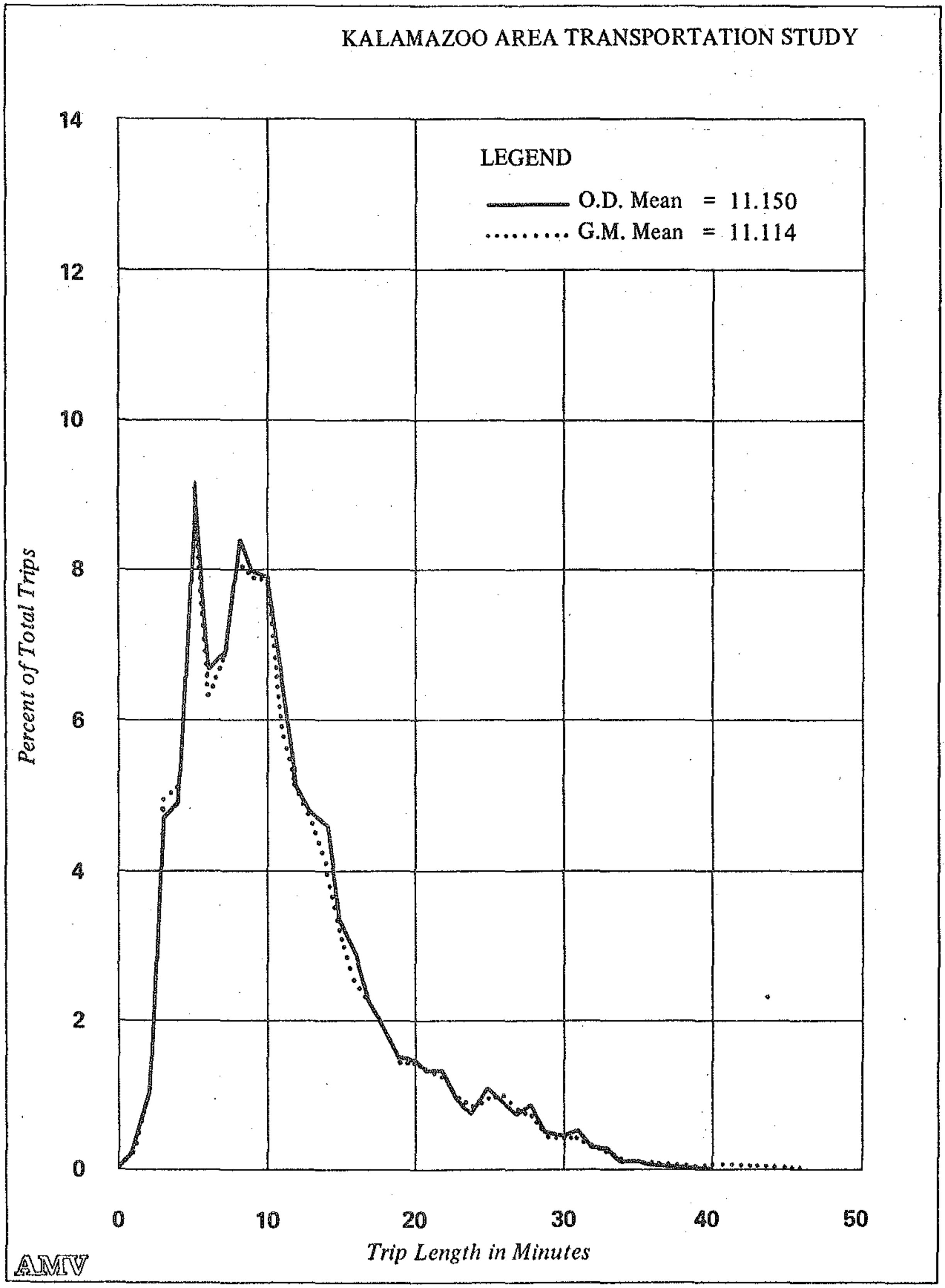
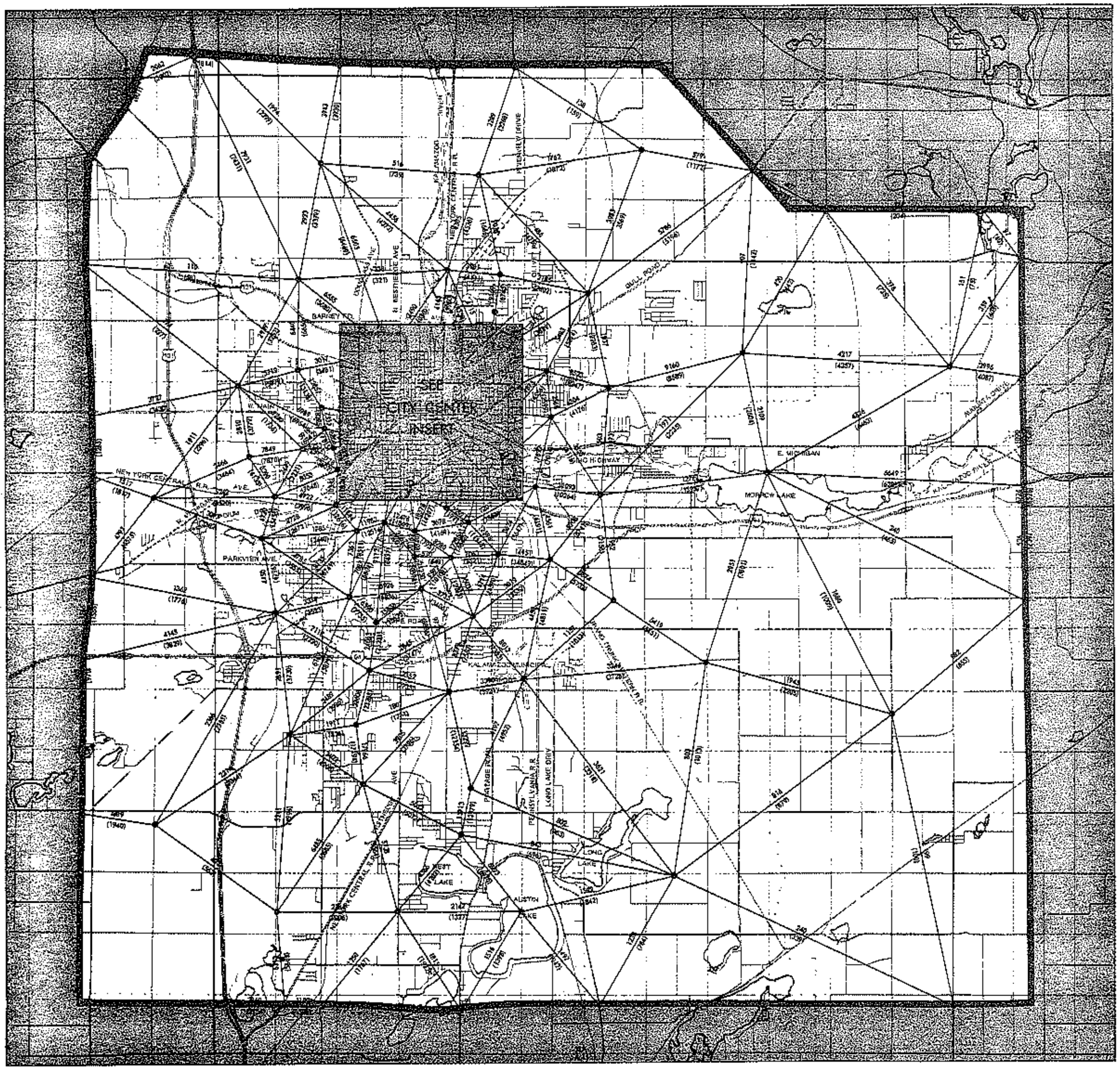


FIGURE 21: VEHICLE TRIP LENGTH DISTRIBUTION COMPARISON FOR TOTAL VEHICLE TRIPS



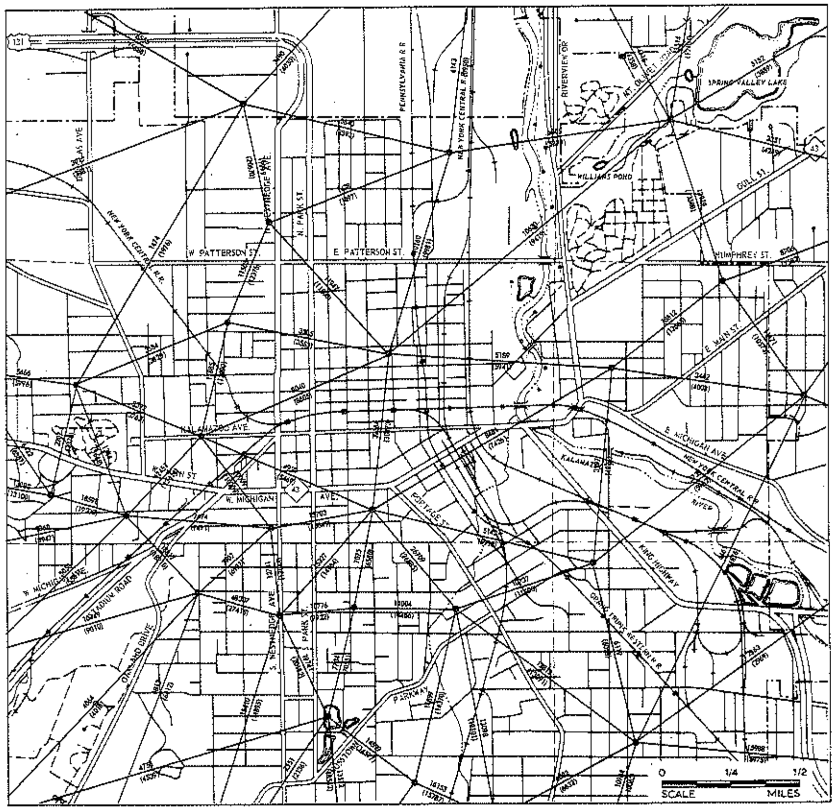
LEGEND

0000 O. & D. VOLUMES

(0000) G. M. #15 VOLUMES

N

0 1 2 3
SCALE MILES



CITY CENTER INSERT

FIGURE 22 DESIRE LINE NETWORK

TABLE 14

ZONAL TRIP END COMPARISONS WITH SURVEY

Purpose	Mean	Estimated Survey		Gravity Model		Synthetic Model	
		R^2	S. E.	R^2	S. E.	R^2	S. E.
Home Based							
Production	982	.98	127	.98	127	.96	189
Attraction	982	.91	487	.90	507	.88	541
Non-Home Based and Truck							
Production	514	.89	242	.89	241	.85	292
Attraction	514	.87	259	.86	272	.80	321

NOTE:

1. R^2 = Coefficient of Determination
2. S. E. = Standard Error of Estimate
3. Synthetic Model = Gravity Model using Productions and Attractions developed from the previously described equations and 1966 land activity data.

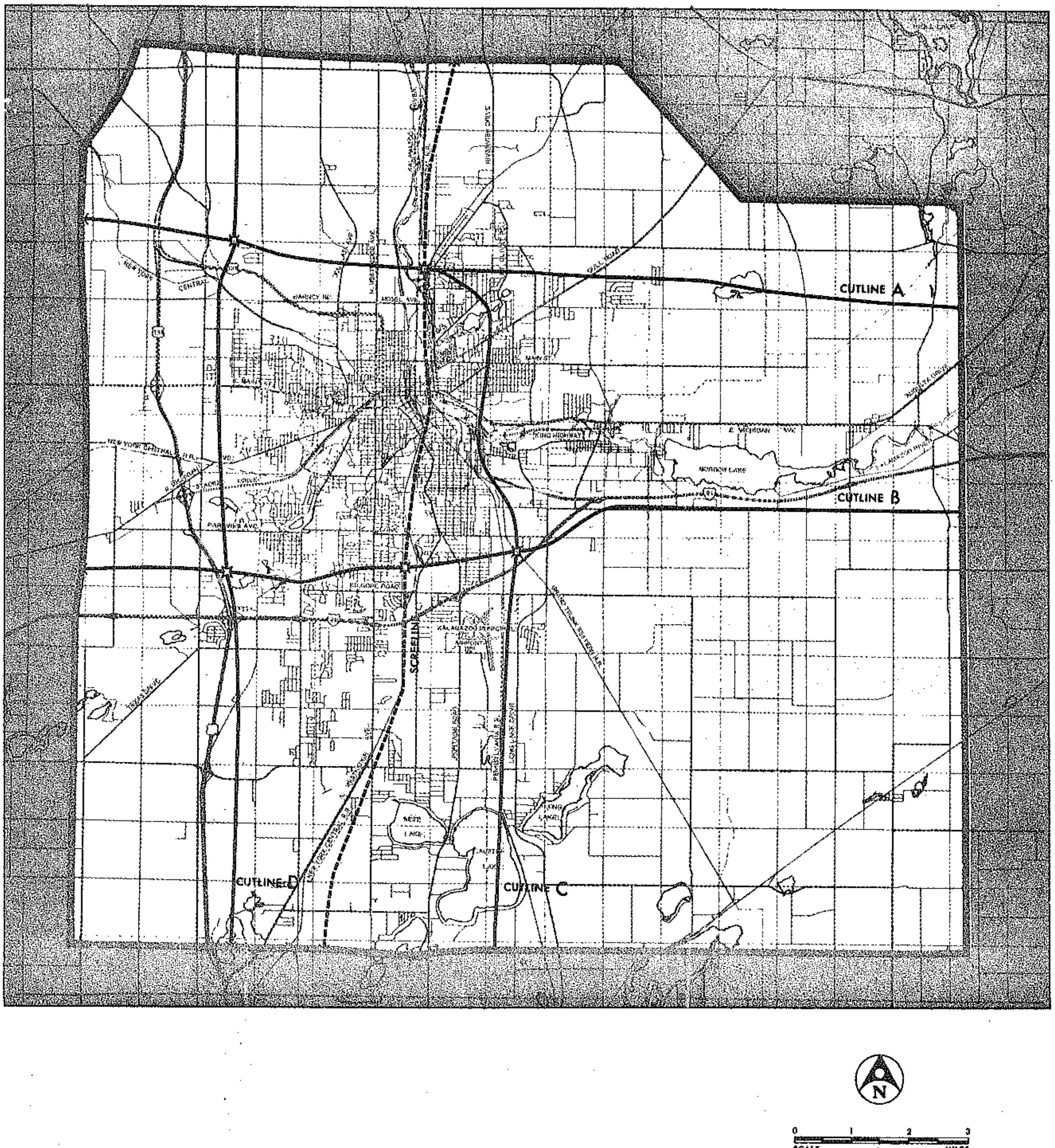


FIGURE 23 SCREENLINE & CUTLINES

these values. The results confirm that satisfactory estimation of the actual measured traffic volumes has been achieved.

Vehicle-Mile Check

As a final check on the developed forecasting procedure, comparisons of the gravity model and synthetic model were made against the survey data and ground counts for vehicle miles. This aggregate check is summarized by jurisdiction in Table 16; the jurisdictions are shown in Figure 24. As can be observed in this comparison, the gravity model aggregate travel assignment is within 5 percent of the total travel measure from the Origin-Destination Survey and the synthetic model checks within 2 percent of the gravity model.

Conclusion

The series of checks, taken individually and collectively, demonstrate that in all respects the calibrated model accurately simulates both the survey data and the ground counts. Thus, it is concluded that all of the techniques have been validated and are ready for use in the forecasting phase of the study.

TABLE 15

SCREENLINE AND CUTLINE COMPARISONS

Cutline	Ground Count	Survey	Survey / Ground Count	Gravity Model	Grav. Model / Survey	Synthetic Model	Syn. Model / Survey	Syn. Model / Grav. Model
Screenline	172,383	172,956	1.00	174,061	1.01	174,845	1.01	1.00
A	43,868	49,958	1.14	54,157	1.08	55,422	1.11	1.02
B	113,825	122,572	1.08	124,721	1.01	127,486	1.04	1.02
C	90,786	97,497	1.08	100,024	1.03	104,649	1.07	1.05
D	63,161	58,236	.92	60,597	1.04	61,816	1.06	1.02
TOTAL	484,023	501,209	1.04	513,560	1.02	524,218	1.05	1.02

NOTE: 1. Grav. Model = Gravity Model

2. Syn. Model = Synthetic Model

TABLE 16

VEHICLE MILES OF TRAVEL COMPARISONS (1,000's)

Jurisdictions	Ground Count	Survey	Survey / Ground Count	Gravity Model	Gravity Model / Survey	Synthetic Model	Synthetic Model / Survey	Synthetic / Gravity Model
1	40	34	.85	32	.94	32	.94	1.00
2	707	754	1.07	774	1.03	772	1.02	1.00
3	185	222	1.20	229	1.03	236	1.06	1.03
4	210	214	1.02	235	1.10	243	1.14	1.03
5	318	321	1.01	335	1.04	345	1.07	1.03
6	82	64	.78	67	1.05	72	1.13	1.07
7	53	46	.87	52	1.13	56	1.22	1.08
8	174	152	.87	175	1.15	179	1.18	1.02
9	27	23	.85	30	1.30	36	1.57	1.20
10	116	120	1.03	125	1.04	126	1.05	1.01
11	30	27	.90	28	1.04	27	1.00	0.96
TOTAL	1,942	1,977	1.02	2,082	1.05	2,124	1.07	1.02

JURISDICTIONS

APPENDICES

APPENDIX A

PURPOSE OF TRAVEL BY MODE
(Internal-Internal)

Purpose	Auto Driver	Auto Passenger	Bus Passenger	School Bus Passenger	Other Passenger	Truck	Total
Home-Based Work	64,282	10,998	969	465	779 4/	---	77,493
Home-Based Shop	65,341	23,014	801	530	96	---	89,782
Home-Based Other	144,677	90,750	8,084 2/	45,880	599	---	289,990
Non-Home Based	154,556 1/	38,892	1,793 3/	2,365	115	---	197,721
Truck	---	---	---	---	---	15,396	15,396
Total	428,856	163,654	11,647	49,240	1,589	15,396	670,382

PERCENTAGE OF TRIPS USING EACH MODE BY PURPOSE
(Internal-Internal)

Purpose	Auto Driver	Auto Passenger	Bus Passenger	School Bus Passenger	Other Passenger	Truck	Total
Home-Based Work	83.0	14.2	1.3	0.5	1.0	---	100.0
Home-Based Shop	72.8	25.6	0.9	0.6	0.1	---	100.0
Home-Based Other	49.9	31.3	2.8	15.8	0.2	---	100.0
Non-Home Based	78.2	19.7	0.9	1.2	0.0	---	100.0
Truck	--	--	--	--	--	100.0	100.0
Total	64.0	24.4	1.7	7.4	0.2	2.3	100.0

Note: 1/ Includes panels, pickups, and taxis

2/ 7,132 trips to or from school

3/ 1,366 trips to or from school

4/ 502 trips are "walk to work"

APPENDIX

DISTRICTS FOR WHICH SPECIAL ADJUSTMENTS WERE MADE FOR ESTIMATING EQUATIONS

			Adjustment		
District	Zone Centroid	Purpose Equation	Centroid K Factor	Activity	Explanation
3	7	Home Based Other Attractions	2.55	Other Employment	Bronson Hospital apparently attracts more trips, proportionately, in these purpose categories than other generators with employees in this land activity group.
		Non-Home Based	4.39	Other Employment	
14	38	Non-Home Based	3.21	Retail Employment	Topp's Discount Center and Thrifty Acres attract more non-home based trips than the average retail establishment in the study area based on their number of employees.
23	57	Home Based Shop Productions	0.59	Autos Owned	College students essentially constitute the entire population of the zone. Characteristically, they do not make as many shop trips as other segments of the population.
26	61	Home Based Shop Attractions	0.10	Retail Employment	A restaurant and bowling alley in this zone generate social recreation trips rather than shop trips although their employees are classified as retail.
52	146	Home Based Shop Attractions	0.15	Retail Employment	A retail lumber yard located in this zone has employees classified as retail, but because of the types of activity they support, they do not attract as many trips per employee as other types of retail establishments.

APPENDIX B (Continued)

District	Zone Centroid	Purpose Equation	Adjustment: Centroid K Factor	Adjustment: Activity	Explanation
58	164	Home Based Other Attractions	9.32	Other Employment	A drive-in theater in this area draws large volumes of trips per employee and these cannot be adequately reflected by the equation developed for the region.
71	230-231	Home Based Work Attractions	0.47	Total Employment	Comparing the employment data in this district, the O-D Survey reported approximately 650 total employment while the data from Employment Security records indicated employment of nearly 1600. This, coupled with the observation that Goodwill Industries has over 500 employees, but work trips to that zone were approximately 50, led to the conclusion that the employment at the time of the Survey was light. Therefore, factoring was necessary.

APPENDIX C

ZONAL TERMINAL AND INTRAZONAL TIMES

Terminal Times	Intrazonal Times	Zone-Centroids
		(Internal)
3	0	1 - 6
2	0	7 - 13
2	0	19 - 23
2	0	78 - 86
2	0	96 - 98
1	0	14 - 18
1	0	24 - 59
1	0	70 - 77
1	0	87 - 95
1	0	99 - 111
1	0	119 - 163
0	1	60 - 69
0	1	112 - 118
0	1	164 - 315
		(External)
10	-	316
5	-	317 - 325
15	-	326
5	-	327 - 332
10	-	333
5	-	334 - 335
15	-	336
5	-	337 - 342

Note: Intrazonal trips are prohibited at external centroids.

APPENDIX D

SOCIO-ECONOMIC ADJUSTMENT FACTORS

This appendix enumerates the specific socio-economic adjustment factors used in the gravity model. The factors are presented in six groups. The first group covers all trips to the Central Commercial Area and the second group identifies factors required to account for the major topographic barrier. The final four groups list factors for other portions of the study area by specific purpose.

<u>Group 1--Central Commercial Area</u>

A bais was found to exist in the distribution of trips to the Central Commercial Area of Kalamazoo, as was discussed in Chapter IV.

This type of bias is normally found in an urban regional study and is usually related to income levels in the various parts of the study area. Therefore, home based trips were adjusted with a separate factor for each trip purpose and each income level. The median income for the production or "home" end district of the trip was used to stratify the trips into income level ranges. However, a single adjustment factor was used for non-home based trips and another single value for all truck trips.

Another unique relationship, that is typically found for the central commercial areas in regions of this type, is that an unusually high number of trips from outside the study area are attracted to this area. Appropriate "K" factors were developed for each trip purpose to compensate for this tendency.

For all purposes, the gravity model naturally predicted intra-downtown trips. However, with the exception of truck trips, very few such trips were observed in the survey. These trips do actually take place. However, because of the congestion and difficulty of parking and unparking vehicles, most of them are made on foot. Therefore, it was necessary to adjust for this type of trip. Specific adjustment factors for the Central Commercial Area are listed in Table D-1.

TABLE D-1

ADJUSTMENT FACTORS FOR TRIPS TO CENTRAL COMMERCIAL AREA

Purpose	Low	Medium	High	All Districts	Intra-Area	External
Home Based Work	1.00	1.48	1.27	--	0.00	.88
Home Based Shop	1.62	2.16	4.20	--	0.00	2.82
Home Based Other	1.43	1.55	1.83	--	0.00	1.31
Non-Home Based	--	--	--	1.33	0.75	1.33
Truck	--	--	--	1.17	1.17	--

Note: 1. See Appendix G for median income for each district.
Low Income = Less than $8,000.
Medium Income = $8,000 to $9,999.
High Income = $10,000 and Over
2. Central Commercial Area is District No. 1.

Group 2--Topographic Barrier Adjustments

To correct for the overestimation of trips across the topographic barrier separating sectors 2 and 3 from sectors 4 and 5, adjustment factors were used to reduce inter-sector trips and to increase locally oriented intra-sector trips by purpose as necessary. These adjustment factors are listed in Table D-2 and the location of the sectors are indicated on the following study sector map.

Groups 3-6--Other Adjustment Factors by Purpose

Tables D-3, D-4, D-5, and D-6 list the remaining "K" factors used for each purpose category other than the factors listed in Tables D-1 and D-2. Table D-3 lists the district number, "K" factors, and the major

TABLE D-2

ADJUSTMENT FACTORS FOR TRIPS ACROSS NORTH-SOUTH TOPOGRAPHIC BARRIER

Interchange Sector-to-Sector*	Purpose			
	Work	Shop	Other	NHB
2 - 2	1.08	1.35	1.27	
2 - 5	.83		.75	.85
5 - 2			.90	.85
5 - 5			1.40	
3 - 3		1.40		
3 - 4		.25		
4 - 3			.77	
4 - 4			1.10	1.50

*Sector 2 - Districts 2 to 20
Sector 3 - Districts 21 to 37
Sector 4 - Districts 38 to 47
Sector 5 - Districts 48 to 57

TABLE D-3

ADJUSTMENT FACTORS FOR HOME BASED WORK TRIPS

Attraction Districts	Major Attractor	Production Districts	"K" Factor
23	Western Michigan University	1-7, 10-17, 27-29, 33-69, 71-81, 82, 92, 102	0.65 3.70
34	Industrial Area	30-35	1.89
40-42, 73-79	Rural to Rural	40-42, 73-79	1.80
60	Upjohn Corp.	1-81 94-99	1.12 0.53
72	Brown Paper Co.	35-41, 71-77	1.40
77	Galesburg	77	6.50
80	Gen. Motors Corp.	1-81 82, 92, 102	0.73 3.92

TABLE D-4

ADJUSTMENT FACTORS FOR HOME BASED SHOP TRIPS

Attraction Districts	Major Attractor	Type of Shopping	Local Production Districts	Local "K" Factor	Nonlocal Production Districts	Nonlocal "K" Factor
5	Sears	Regional Goods	1, 3-7, 10-12, 48-51	.80	2, 8-9, 13-20	1.30
					21-47, 52-108	1.45
14	Thrifty Acres Topps Discount	Regional Goods	7, 12-15, 56-57, 67	.71	2-6, 8-11 16-20	1.30
27	Westwood Shopping Center	Convenience	25-30	1.40	1-24, 31-108	.20
47	Eastwood Shopping Center	Convenience			1-20, 38-41, 48-108	.72
					21-37	.25
56	Corklane Shopping Center	Convenience	5-7, 14, 49-50, 54-57	1.35	1-4, 8-13, 15, 48, 51-53, 58-108	.61
66	Southland Shopping Center	Convenience	58, 60, 61, 63-69	1.15	1-57, 59, 62, 70-108	.63
72	Parchment CBD	Local Only			1-35, 42-70, 75-108	.23
77, 78	Galesburg	Local	78	6.10		

TABLE D-5

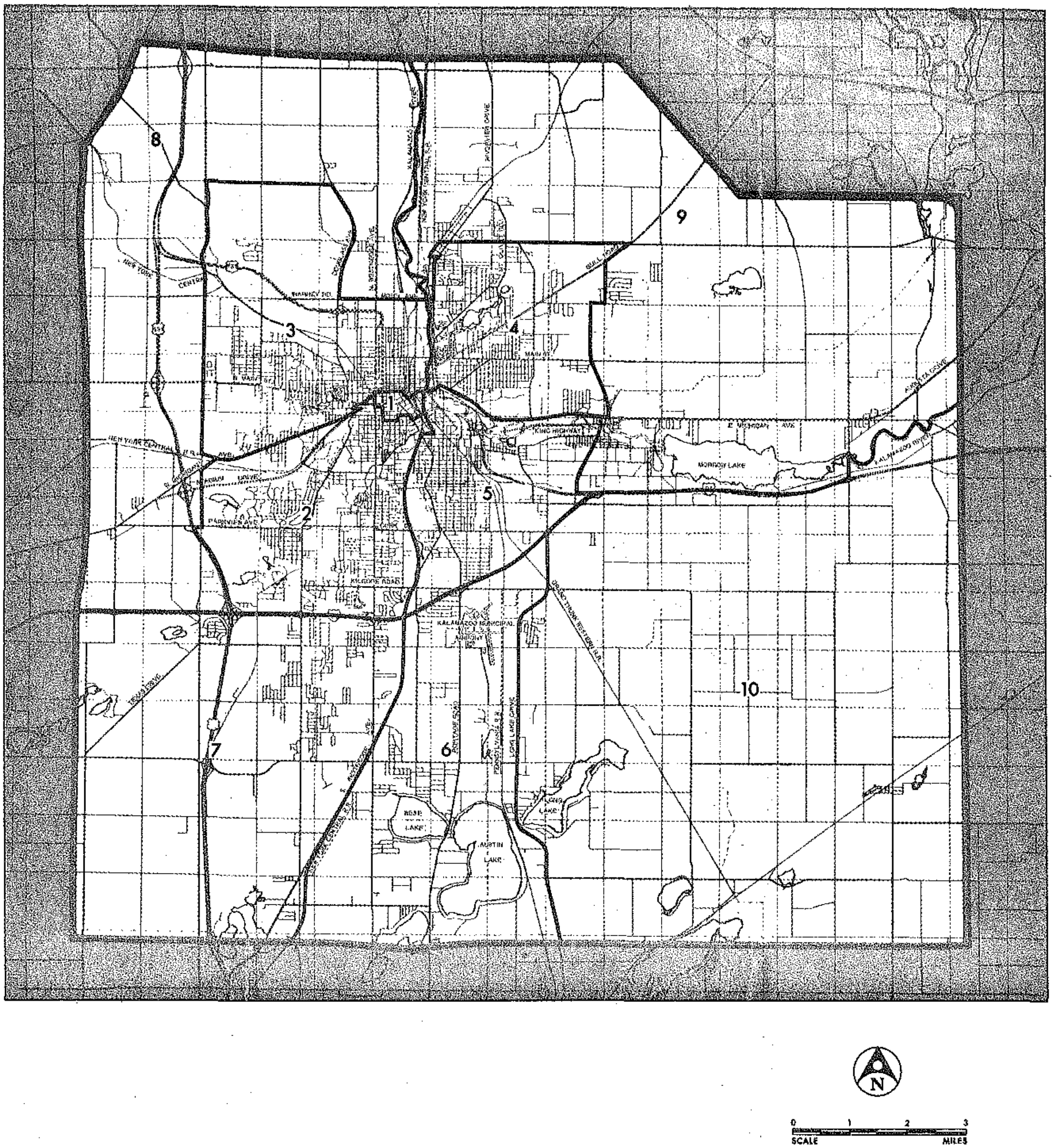
ADJUSTMENT FACTORS FOR HOME BASED OTHER TRIPS

Attraction Districts	Major Attractor	Production Districts	"K" Factor
8	Msgr. O'Brien H. S.	8-10, 20-22, 24, 30-34	0.61
14	Topps, Thrifty Acres	6-7, 11-18	0.54
		56-57	0.20
15	Hackett High School	1-4, 8-11, 19-108	0.71
		5-7, 12-18	1.83
18	N. Christian H. S. & Western Mich. Univ.	8-11, 18, 25, 26, 70	0.35
19	Western Mich. Univ.	18-19, 25-26	0.25
23	Western Mich. Univ.	18, 20, 22-27, 29-30	0.40
40	Parchment H. S.	1-38, 41-72, 74-108	0.60
		39, 40, 73	2.00
42	Comstock High School	1-41, 43-74, 76-108	0.39
		42, 75	2.75
58	Drive-In Theatre	59-69, 81	0.70
61	Portage Central H. S.	58-69	1.30
		1-57, 70-108	0.43
67	Portage Northern H. S.	12-18	0.55
		54-63	0.50
70	Urban to Rural	28-29, 70-71	1.50
71	Rural to Rural	28-29, 70-71	4.60
73-81	Rural to Rural	73-81	2.50
		82-108	1.20

TABLE D-6

ADJUSTMENT FACTORS FOR NON-HOME BASED TRIPS

Attraction Districts	Major Attractor	Production Districts	"K" Factor
23	Western Mich. Univ.	1-17, 21, 26-81	0.70
34	Indus.-Com. Area	34	1.30
40	Parchment	39-40, 73	2.65
		41-47	1.50
48	Industrial Area	48, 51	0.25
50	Residential Area	50	0.75
71	Urban to Rural	27-29, 36, 70-73, 82-84, 106-108	3.00
	Urban to Rural	1-26, 30-35, 37-69, 74-81, 85-105	1.80
73-81	Special Urban to Rural	1-72, 82-108	1.45
	Rural to Rural	73-81	2.40
77	Galesburg	77	4.00



STUDY SECTORS

attractors for which the adjustments were made for home based work trips. The basic causes for these factors are described in Chapter IV.

Table D-4 enumerates the adjustment factors used for home based shop trips. These adjustments were applied to distinguish between the unique distribution patterns for regional shopping areas and the smaller convenience shopping areas. Major department stores, such as Sears, appealed to the whole study area; whereas smaller shopping centers which provide more widely available commodities generally appeal mostly to nearby residents.

Tables D-5 and D-6 list the adjustments for home based other trips and non-home based trips, respectively.

APPENDIX E

PROPORTIONING FACTOR EQUATIONS
Vehicle Productions and Attractions

1. Home Based Productions = 4.52 (Cars)

2. Home Based Attractions = 56 + 0.63 (Population) + 1.40 (Total Employment) + 1.23 (Students' Attendance at High School and College) + 22.44 (Shopping Center Employment) + 7.47 (Other Retail Employment)

3. Non-Home Based and Truck* = 92 + 0.43 (Population) + 4.18 (Retail Employment) + 0.57 (Total Employment)

* Productions and Attractions are by definition equal.

NOTE: These equations are used to derive proportioning factors to allocate district-to-district trips to zone-to-zone trips. See Appendix F for a simple example of the allocation procedure.

APPENDIX F

EXAMPLE OF DISTRICT-ZONE TRIP-SPLITTING TECHNIQUE

Assume Figure 1 depicts a study area with three districts to be split into a total of eight zones. The solid lines represent district (and zone) boundaries, and the broken lines are zone boundaries. The circled numbers are zone numbers and the uncircled are district numbers. Figure 2 is the input district-to-district trip table, and Figure 3 represents the input P/A control card deck. Figure 4 is the output zone-to-zone trip table.

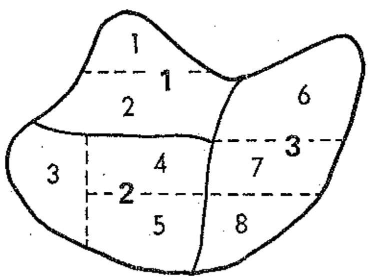


Figure 1 Study Area

From \ To	1	2	3
1	200	600	800
2	700	400	200
3	900	1200	100

Figure 2 District Trip Table

Zone	District	%P	%A
1	1	50	20
2	1	50	80
3	2	10	40
4	2	40	50
5	2	50	10
6	3	10	40
7	3	10	20
8	3	80	40

Figure 3 P/A Control Table

From \ To	1	2	3	4	5	6	7	8
1	20	80	120	150	30	160	80	160
2	20	80	120	150	30	160	80	160
3	14	56	16	20	4	8	4	8
4	56	224	64	80	32	16	16	32
5	70	280	80	100	20	40	20	40
6	18	72	48	60	12	4	2	4
7	18	72	48	60	12	4	2	4
8	144	576	384	480	96	32	16	32

Figure 4 Zone Trip Table

APPENDIX G

LAND-ACTIVITY DATA

K A L A M A Z O O   A R E A   T R A N S P O R T A T I O N   S T U D Y

1966 LAND ACTIVITY DATA

DIST	CENT	POPULATION	DWELLING UNITS	LABOR FORCE	MEDIAN INCOME	AUTOS REG. AT DORMITORY	TOTAL AUTOS	--------EMPLOYMENT BY INDUSTRY-------- MANUFAC-TURING	RETAIL	OTHER	TOTAL	STUDENTS IN HIGH SCHOOL OR COLLEGE
1	1	197	92	131	9000		144	1346	1242	2794	5382	
1	2	26	13	13	9000				12	54	66	
1	3							43	100	116	259	
1	4	262	262	262	9000		105	195	684	1070	1949	
1	5	157	92	66	9000		79	42	310	1567	1919	
1		642	459	472	9000		328	1626	2348	5601	9575	
2	6	1017	570	583	7500		422	10	21	288	319	
2		1017	570	583	7500		422	10	21	288	319	
3	7	265	223	233	4500		42		116	742	858	
3	8	307	117	106	4500		85	494	34	175	703	
3	9	678	212	148	4500		265		37	140	177	
3	10	201	95	127	4500		74		20	151	171	
3		1451	647	614	4500		466	494	207	1208	1909	
4	11	1119	467	566	5500		492		12	57	69	
4	12	517	221	209	5500		258	18	71	236	325	
4		1636	688	775	5500		750	18	83	293	394	
5	13	81	23	23	6500		12		25	125	150	
5	14	1093	345	460	6500		345		404	250	654	
5	15	311	104	138	6500		115		67	91	158	
5		1485	472	621	6500		472		496	466	962	
6	16	1113	406	541	12500		593	127	7	212	346	
6	17	728	177	239	12500		302		3	39	42	
6		1841	583	780	12500		895	127	10	251	388	
7	18	1313	399	588	7500		588		11	96	107	
7		1313	399	588	7500		588		11	96	107	
8	19	236	149	136	6500		136		206	105	311	1480
8	20	1215	694	558	6500		508		154	317	471	
8		1451	843	694	6500		644		360	422	782	1480
9	21	1949	570	410	6500		616	32	10	46	88	
9		1949	570	410	6500		616	32	10	46	88	
10	22	952	449	407	6500		428		106	400	506	1899
10	23	899	353	353	6500		353		35	100	135	

KALAMAZOO AREA TRANSPORTATION STUDY

1966 LAND ACTIVITY DATA

DIST	CENT	POPULATION	DWELLING UNITS	LABOR FORCE	MEDIAN INCOME	AUTOS REG. AT DORMITORY	TOTAL AUTOS	-------EMPLOYMENT BY INDUSTRY------- MANUFAC-TURING	RETAIL	OTHER	TOTAL	STUDENTS IN HIGH SCHOOL OR COLLEGE
10		1851	802	760	6500		781		141	500	641	1899
11	24	909	330	448	9000		401		20	193	213	
11	25	260	106	130	9000		118			122	122	
11	26	920	283	354	9000		531		11	221	232	
11		2089	719	932	9000		1050		31	536	567	
12	27	745	270	238	12500		389		23	48	71	
12	28	248	86	86	12500		151		44	61	105	
12	29	788	292	313	12500		443		2	130	132	
12		1781	648	637	12500		983		69	239	308	
13	30	882	294	325	12500		431		16	89	105	
13	31	683	221	252	12500		315			8	8	
13	32	389	126	147	12500		210		40	130	170	
13		1954	641	724	12500		956		56	227	283	
14	33	467	125	171	12500		205	24		21	45	
14	34	479	137	194	12500		205		13	6	19	
14	35	274	103	125	12500		171			6	6	
14	36	342	103	125	12500		137	428	81	105	614	
14	37	23	11	11	12500		11	61	13	73	147	
14	38	1140	274	319	12500		422	2	200	47	249	
14		2725	753	945	12500		1151	515	307	258	1080	
15	39	1135	427	488	12500		634	18	25	77	120	300
15	40	1342	366	439	12500		671	27	30	133	190	
15		2477	793	927	12500		1305	45	55	210	310	300
16	41	357	107	95	9000		190			44	44	
16	42	524	143	179	9000		262			5	5	
16	43	1321	417	488	9000		488		50	53	103	
16	44	643	262	321	9000		357					
16		2845	929	1083	9000		1297		50	102	152	
17	45	374	105	117	12500		199		2	3	5	
17	46	889	234	281	12500		374	12		4	16	
17	47	796	257	328	12500		421		38	8	46	
17		2059	596	726	12500		994	12	40	15	67	
18	48	436	131	174	7500		251		14	51	65	570
18	49	937	305	360	7500		534		12	16	28	

KALAMAZOO AREA TRANSPORTATION STUDY

1966 LAND ACTIVITY DATA

DIST	CENT	POPULATION	DWELLING UNITS	LABOR FORCE	MEDIAN INCOME	AUTOS REG. AT DORMITORY	TOTAL AUTOS	EMPLOYMENT BY INDUSTRY: MANUFAC-TURING	EMPLOYMENT BY INDUSTRY: RETAIL	EMPLOYMENT BY INDUSTRY: OTHER	EMPLOYMENT BY INDUSTRY: TOTAL	STUDENTS IN HIGH SCHOOL OR COLLEGE
18	50	55	55	55	7500		55			1126	1126	
18	51	382	207		7500	100	109			560	560	
18		1810	698	589	7500	100	949		26	1753	1779	570
19	52	1426	572	562	7500	200	799		5	400	405	2500
19		1426	572	562	7500	200	799		5	400	405	2500
20	53	3121	1275	133	1000	200	357		4	600	604	1500
20		3121	1275	133	1000	200	357		4	600	604	1500
21	54	468	239	42	1000		42		2		2	
21		468	239	42	1000		42		2		2	
22	55	371	116	162	12500		209			2	2	
22	56	336	174	70	12500		209	16	4	153	173	
22		707	290	232	12500		418	16	4	155	175	
23	57	4202	2142	122	1000	700	867		39	699	738	3000
23		4202	2142	122	1000	700	867		39	699	738	3000
24	58	740	280	230	12500		330		31	57	88	
24		740	280	230	12500		330		31	57	88	
25	59	1516	721	223	1000	200	424		10	54	64	
25		1516	721	223	1000	200	424		10	54	64	
26	60	842	238	324	12500		346		2	39	41	
26	61	886	324	454	12500		475	69	62	137	268	
26		1728	562	778	12500		821	69	64	176	309	
27	62	845	193	268	9000		364		56	92	148	
27	63	1541	482	610	9000		835		30	43	73	
27	64	1156	289	364	9000		460		10	7	17	
27		3542	964	1242	9000		1659		96	142	238	
28	65	604	148	212	9000		223			78	78	
28	66	180	42	53	9000		85			2	2	
28	67	297	53	85	9000		95	1		10	11	
28	68	159	42	74	9000		85					
28	69	254	117	170	9000		148		9	24	33	

K A L A M A Z O O   A R E A   T R A N S P O R T A T I O N   S T U D Y

1966 LAND ACTIVITY DATA

DIST	CENT	POPULATION	DWELLING UNITS	LABOR FORCE	MEDIAN INCOME	AUTOS REG. AT DORMITORY	TOTAL AUTOS	-------EMPLOYMENT BY INDUSTRY------- MANUFAC-TURING	RETAIL	OTHER	TOTAL	STUDENTS IN HIGH SCHOOL OR COLLEGE
28	70	212	95	127	9000		138	132	8	31	171	
28		1706	497	721	9000		774	133	17	145	295	
29	71	777	284	242	7500		284	25	5	84	114	
29	72	641	179	231	7500		305			38	38	
29	73	819	221	315	7500		294			1	1	
29		2237	684	788	7500		883	25	5	123	153	
30	74	1209	373	396	9000		520		13	80	93	
30	75	1062	339	407	9000		407	6	48	106	160	
30		2271	712	803	9000		927	6	61	186	253	
31	76	757	249	271	6500		316	20		374	394	
31	77	1107	339	452	6500		441		3	41	44	
31		1864	588	723	6500		757	20	3	415	438	
32	78	1714	773	694	6500		773		25	70	95	
32	79	717	224	202	6500		134	258	52	59	369	
32		2431	997	896	6500		907	258	77	129	464	
33	80	1550	492	566	6500		578	129	9	91	229	
33		1550	492	566	6500		578	129	9	91	229	
34	81	172	37	49	5500		25	406	67	476	949	
34	82	221	86	61	5500		25	752	127	306	1185	
34	83							36	40	84	160	
34	84	554	123	172	5500		123	941		50	991	
34	85	935	258	320	5500		246		57	222	279	
34	86	1636	406	566	5500		381	7	9	110	126	
34		3518	910	1168	5500		800	2142	300	1248	3690	
35	87	633	189	211	6500		189	49	20	67	136	
35	88	1010	233	266	6500		366			17	17	
35		1643	422	477	6500		555	49	20	84	153	
36	89	285	114	80	6500		91	25	200	121	346	
36	90	103	46	57	6500		23	192		46	238	
36	91	661	160	205	6500		228	1	2	78	81	
36	92	80	23	23	6500		23		3		3	
36	93	217	68	91	6500		68	127		176	303	
36		1346	411	456	6500		433	345	205	421	971	

K A L A M A Z O O   A R E A   T R A N S P O R T A T I O N   S T U D Y

1966 LAND ACTIVITY DATA

DIST	CENT	POPULATION	DWELLING UNITS	LABOR FORCE	MEDIAN INCOME	AUTOS REG. AT DORMITORY	TOTAL AUTOS	EMPLOYMENT BY INDUSTRY: MANUFAC-TURING	RETAIL	OTHER	TOTAL	STUDENTS IN HIGH SCHOOL OR COLLEGE
37	94	1464	339	472	5500		351	2404	28	528	2960	
37	95							1210	11	59	1280	
37	96	133	36	61	5500		61	354	1	110	465	
37	97	133	36	24	5500		24	210	26	47	283	
37		1730	411	557	5500		436	4178	66	744	4988	
38	98	235	64	64	7500		75					
38	99							2		22	24	
38	100									1	1	
38	101	396	150	214	7500		193		20	350	370	
38	102	310	96	193	7500		182			19	19	
38	103	171	64	107	7500		96		1	30	31	
38	104	310	75	107	7500		118		25	13	38	
38	105	749	193	257	7500		310			65	65	
38		2171	642	942	7500		974	2	46	500	548	
39	106	835	244	360	9000		418			54	54	
39	107	603	174	267	9000		325		6	37	43	
39	108	1264	313	394	9000		464		3		3	
39		2702	731	1021	9000		1207		9	91	100	
40	109	1010	344	400	9000		500	6	44	43	93	
40	110	833	233	355	9000		400			37	37	610
40	111	555	133	222	9000		289			10	10	
40		2398	710	977	9000		1189	6	44	90	140	610
41	112	740	640	92	6500		110			35	35	
41	113	750	200	372	6500		360	25	12	36	73	
41		1490	840	464	6500		470	25	12	71	108	
42	114	263	95	105	9000		179		9	17	26	
42	115	840	231	357	9000		347	7	4	78	89	
42	116	200	74	105	9000		126					
42	117	641	179	252	9000		284		17	75	92	
42	118	788	200	242	9000		263			77	77	
42		2732	779	1061	9000		1199	7	30	247	284	
43	119	627	228	319	9000		319		3	47	50	
43	120	125	57	68	9000		80			32	32	
43	121	809	205	262	9000		308	5		1	6	
43	122	604	182	251	9000		274			78	78	
43		2165	672	900	9000		981	5	3	158	166	
44	123	307	127	148	7500		127	2	10	84	96	

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1966 LAND ACTIVITY DATA

DIST	CENT	POPULATION	DWELLING UNITS	LABOR FORCE	MEDIAN INCOME	AUTOS REG. AT DORMITORY	TOTAL AUTOS	EMPLOYMENT BY INDUSTRY: MANUFAC-TURING	EMPLOYMENT BY INDUSTRY: RETAIL	EMPLOYMENT BY INDUSTRY: OTHER	EMPLOYMENT BY INDUSTRY: TOTAL	STUDENTS IN HIGH SCHOOL OR COLLEGE
44	124	1134	392	509	7500		488		8	25	33	
44		1441	519	657	7500		615	2	18	109	129	
45	125	822	260	322	7500		312	75	23	61	159	
45	126	31	21	21	7500		21	16	5	108	129	
45		853	281	343	7500		333	91	28	169	288	
46	127	1086	314	358	5500		347		24	33	57	
46	128	157	56	78	5500		67	43	3	41	87	
46	129	1445	448	482	5500		582		56	57	113	
46		2688	818	918	5500		996	43	83	131	257	
47	130	1809	500	777	9000		888		100	68	168	
47	131	122	22	22	9000		44	661	4	85	750	
47		1931	522	799	9000		932	661	104	153	918	
48	132	92	39	26	7500		26		72	195	267	
48	133	563	170	170	7500		157	597	7	185	789	
48	134	131	39	65	7500		79	20	32	146	198	
48	135							130	46	355	531	
48	136	1166	275	406	7500		314	13	5	26	44	
48	137	144	66	92	7500		79	75	65	422	562	
48		2096	589	759	7500		655	835	227	1329	2391	
49	138	1169	418	553	9000		455	24	177	133	334	
49	139	308	111	185	9000		135	55	61	62	178	
49		1477	529	738	9000		590	79	238	195	512	
50	140	421	152	211	6500		187	197	49	691	937	
50	141	1778	608	737	6500		702	9	17	185	211	
50		2199	760	948	6500		889	206	66	876	1148	
51	142	1654	452	571	7500		595	18	96	300	414	
51	143	1369	428	476	7500		428	12	7	16	35	
51		3023	880	1047	7500		1023	30	103	316	449	
52	144	607	214	238	6500		286		1	6	7	
52	145							499		70	569	
52	146	500	119	143	6500		167	2612	127	941	3680	
52	147	83	24	24	6500		24	23	3	222	248	
52	148	536	202	202	6500		238	9	17	97	123	
52	149	250	71	107	6500		119	1209	27	289	1525	

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1966 LAND ACTIVITY DATA

DIST	CENT	POPULATION	DWELLING UNITS	LABOR FORCE	MEDIAN INCOME	AUTOS REG. AT DORMITORY	TOTAL AUTOS	-------EMPLOYMENT BY INDUSTRY------- MANUFAC-TURING	RETAIL	OTHER	TOTAL	STUDENTS IN HIGH SCHOOL OR COLLEGE
52		1976	630	714	6500		834	4352	175	1625	6152	
53	150	961	305	384	6500		486	13	24	50	87	
53	151	328	124	136	6500		170	51	14	150	215	
53		1289	429	520	6500		656	64	38	200	302	
54	152	161	43	43	9000		54		7	7	14	
54	153	214	54	75	9000		64	239		143	382	
54	154	118	32	43	9000		32	151	30	747	928	
54	155	1145	428	524	9000		556	52	7	68	127	
54	156	503	182	230	59000		257		10	51	61	
54		2141	739	915	59000		963	442	54	1016	1512	
55	157	1760	486	594	9000		659		7	85	92	
55	158	1048	346	378	9000		508			10	10	
55		2808	832	972	9000		1167		7	95	102	
56	159	1192	460	602	7500		543	420	62	127	609	
56	160	378	130	165	7500		212		140	17	157	
56		1570	590	767	7500		755	420	202	144	766	
57	161	1104	345	506	12500		529		11	1	12	
57	162	1024	345	472	12500		506	23	76	79	178	
57	163				12500			25		5	30	1400
57		2128	690	978	12500		1035	48	87	85	220	1400
58	164	1133	391	566	9000		567	6	55	150	211	
58	165	227	62	82	9000		82			7	7	
58	166	649	144	206	9000		216	16		32	48	
58	167	52	10	10	9000		10			60	60	
58		2061	607	864	9000		875	22	55	249	326	
59	168	120	20	20	12500		20	744	15	295	1054	
59	169											
59	170							15	165	70	250	
59		120	20	20			20	759	180	365	1304	
60	171	700	180	297	9000		265	2900	10	380	3290	
60		700	180	297	9000		265	2900	10	380	3290	
61	172	21	10	21	9000		10			57	57	

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1966 LAND ACTIVITY DATA

DIST	CENT	POPULATION	DWELLING UNITS	LABOR FORCE	MEDIAN INCOME	AUTOS REG. AT DORMITORY	TOTAL AUTOS	EMPLOYMENT BY INDUSTRY: MANUFAC- TURING	RETAIL	OTHER	TOTAL	STUDENTS IN HIGH SCHOOL OR COLLEGE
61	173	1040	330	443	9000		536		33	18	51	
61	174	1514	412	556	9000		546		4	298	302	866
61		2575	752	1020	9000		1092		37	373	410	866
62	175	781	214	321	9000		353		35	10	45	
62	176	310	64	86	9000		96			6	6	
62	177	952	300	396	9000		482	13		66	79	
62	178	642	161	203	9000		332	84	2	64	150	
62		2685	739	1006	9000		1263	97	37	146	280	
63	179	1030	270	385	9000		478	14		19	33	
63	180	988	333	447	9000		468	8		12	20	
63	181	832	198	281	9000		343	25	12	55	92	
63		2850	801	1113	9000		1289	47	12	86	145	
64	182	1610	380	530	9000		630	7	68	48	123	
64	183	150	50	60	9000		60	29		4	33	
64	184	550	130	150	9000		200	64	28	42	134	
64		2310	560	740	9000		890	100	96	94	290	
65	185	954	223	297	9000		350	2	97	234	333	
65	186	1314	265	350	9000		466			9	9	
65	187	700	180	244	9000		297	423	120	116	659	
65		2968	668	891	9000		1113	425	217	359	1001	
66	188	1102	257	310	12500		428		242	73	315	
66	189	2236	514	653	12500		792			50	50	
66		3338	771	963	12500		1220		242	123	365	
67	190	167	48	71	9000		60	700		110	810	
67	191	2225	595	821	9000		881		50	324	374	1451
67		2392	643	892	9000		941	700	50	434	1184	1451
68	192	357	95	147	12500		168			8	8	
68	193	2069	462	588	12500		788			48	48	
68	194	945	221	357	12500		410		6	5	11	
68		3371	778	1092	12500		1366		6	61	67	
69	195	233	56	78	9000		89		3		3	
69	196	855	200	233	9000		266					
69	197	78	22	33	9000		44					
69	198	111	44	44	9000		78			15	15	

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1966 LAND ACTIVITY DATA

DIST	CENT	POPULATION	DWELLING UNITS	LABOR FORCE	MEDIAN INCOME	AUTOS REG. AT DORMITORY	TOTAL AUTOS	-------EMPLOYMENT BY INDUSTRY------- MANUFAC-TURING	RETAIL	OTHER	TOTAL	STUDENTS IN HIGH SCHOOL OR COLLEGE
69	199	67	22	22	9000		44		3		3	
69	200	200	56	78	9000		100		2	3	5	
69	201	244	78	100	9000		122					
69	202	11	11	11	9000							
69		1799	489	599	9000		743		8	18	26	
70	203	297	77	110	9000		121			15	15	
70	204	99	22	22	9000		33			1	1	
70	205	187	44	44	9000		77					
70	206	275	143	154	9000		242		2		2	
70	207	264	77	110	9000		110			5	5	
70	208	231	121	143	9000		154		48	8	56	
70	209	22	11	22	9000		22					
70	210	242	55	99	9000		88		8	11	19	
70	211	286	66	121	9000		154		10	1	11	
70	212								16	56	72	
70	213	77	33	33	9000		33			2	2	
70	214	231	88	121	9000		165			8	8	
70		2211	737	979	9000		1199		84	107	191	
71	215	42	21	31	9000		21					
71	216	73	21	21	9000		31			12	12	
71	217	94	10	10	9000		10					
71	218	177	42	42	9000		94			1	1	
71	219	42	10	10	9000		10					
71	220	94	21	31	9000		21		3		3	
71	221	62	10	10	9000		21					
71	222	135	21	21	9000		31					
71	223	42	21	31	9000		21		26	28	54	
71	224	322	94	114	9000		166		13	4	17	
71	225	62	31	31	9000		31					
71	226	42	31	21	9000		31		4	46	50	
71	227	187	42	62	9000		83			6	6	
71	228	333	73	104	9000		114					
71	229	707	177	250	9000		333			21	21	
71	230	291	73	125	9000		156	534	1	87	622	
71	231	42	10	10	9000		10	551		198	749	
71	232	281	94	94	9000		125			35	35	
71		3028	802	1018	9000		1309	1085	47	438	1570	
72	233	260	70	110	4500		110	1598	186	118	1902	
72		260	70	110	4500		110	1598	186	118	1902	
73	234	235	75	107	6500		96	10		4	14	
73	235	342	86	139	6500		150			28	28	
73	236	460	139	171	6500		161	138		23	161	

1966 LAND ACTIVITY DATA

DIST	CENT	POPULATION	DWELLING UNITS	LABOR FORCE	MEDIAN INCOME	AUTOS REG. AT DORMITORY	TOTAL AUTOS	EMPLOYMENT BY INDUSTRY MANUFAC-TURING	RETAIL	OTHER	TOTAL	STUDENTS IN HIGH SCHOOL OR COLLEGE
73	237	1113	310	460	6500		471	22	4	21	47	
73		2150	610	877	6500		878	170	4	76	250	
74	238	918	235	286	9000		377		5	21	26	
74	239	51	10	10	9000		10			1	1	
74	240	694	173	265	9000		275		6	14	20	
74	241	235	61	133	9000		163			2	2	
74	242	133	31	51	9000		51					
74	243	112	31	51	9000		82					
74	244	82	31	61	9000		61					
74	245									5	5	
74	246	10	10	10	9000		10					
74		2235	582	867	9000		1029		11	43	54	
75	247							87		11	98	
75	248	200	50	60	9000		80			2	2	
75	249	910	230	270	9000		430	2	7	7	16	
75	250	440	100	150	9000		170	48		38	86	
75	251	100	40	60	9000		50			3	3	
75	252	110	30	50	9000		40		1		1	
75	253	380	90	130	9000		160	156	4	79	239	
75	254	490	120	200	9000		190		5	23	28	
75		2630	660	920	9000		1120	293	17	163	473	
76	255	747	242	283	6500		343		37	63	100	
76	256	758	212	303	6500		323			2	2	
76	257	384	71	101	6500		101					
76	258									102	102	
76	259	20	10	20	6500		10					
76	260	697	172	232	6500		253	472	7	92	571	
76		2606	707	939	6500		1030	472	44	259	775	
77	261	82	20	20	7500		31					
77	262	51	10	10	7500		20					
77	263	41	20	31	7500		20					
77	264	51	20	31	7500		61					
77	265	41	10	31	7500		41					
77	266	122	41	51	7500		71			9	9	
77	267	71	10	20	7500		20			1	1	
77	268	592	214	316	7500		255	31	45	226	302	
77	269	133	41	61	7500		51		13	2	15	
77	270	184	51	92	7500		92	5	88	29	122	
77	271	602	194	316	7500		316	9	47	151	207	
77		1970	631	979	7500		978	45	193	418	656	
78	272	239	62	104	7500		73					

K A L A M A Z O O   A R E A   T R A N S P O R T A T I O N   S T U D Y

1966 LAND ACTIVITY DATA

DIST	CENT	POPULATION	DWELLING UNITS	LABOR FORCE	MEDIAN INCOME	AUTOS REG. AT DORMITORY	TOTAL AUTOS	-------EMPLOYMENT BY INDUSTRY------- MANUFAC-TURING	RETAIL	OTHER	TOTAL	STUDENTS IN HIGH SCHOOL OR COLLEGE
78	273	250	73	104	7500		104			1	1	
78	274	10	10		7500		10					
78	275	73	21	21	7500		31			62	62	
78	276	125	21	21	7500		52					
78	277	42	10	10	7500		21					
78	278	125	31	42	7500		42					
78	279											
78	280	166	52	104	7500		73			25	25	
78	281	166	52	62	7500		62					
78	282	73	21	21	7500		21					
78	283	52	21	21	7500		31					
78	284	31	10	21	7500		21					
78	285	187	42	62	7500		83					
78	286	114	21	42	7500		42					
78	287	42	10	21	7500		21					
78	288	42	10	21	7500		21					
78	289	52	10	10	7500		21	12		2	14	
78	290	52	10	10	7500		31					
78	291	114	21	31	7500		42					
78	292	114	21	42	7500		42					
78		2069	529	770	7500		844	12		90	102	
79	293	104	21	42	9000		42		1		1	
79	294	94	31	31	9000		42			5	5	
79	295	250	62	83	9000		104			18	18	
79	296	21	10	21	9000		21					
79	297	156	42	73	9000		62			32	32	
79	298	10	10		9000			131		17	148	
79	299	83	21	31	9000		31					
79	300	1435	312	437	9000		416	155	4	68	227	
79	301	83	21	42	9000		42	41		5	46	
79	302	135	31	31	9000		42		5	1	6	
79		2371	561	791	9000		802	327	10	146	483	
80	303	180	50	80	9000		90	2046		454	2500	
80		180	50	80	9000		90	2046		454	2500	
81	304	352	88	121	9000		143			1	1	
81	305	264	121	154	9000		165					
81	306	88	22	22	9000		33					
81	307	22	11	11	9000		11					
81	308											
81	309	253	66	77	9000		110					
81	310	220	66	66	9000		88					
81	311	198	44	66	9000		77					
81	312	132	33	44	9000		55		13	15	28	
81	313	1331	374	583	9000		649	3	2	25	30	

APPENDIX H

VEHICLE TRIP PRODUCTIONS AND ATTRACTIONS BY PURPOSE

K A L A M A Z O O   A R E A   T R A N S P O R T A T I O N   S T U D Y

1966 LAND ACTIVITY DATA

DIST	CENT	POPULATION	DWELLING UNITS	LABOR FORCE	MEDIAN INCOME	AUTOS REG. AT DORMITORY	TOTAL AUTOS	EMPLOYMENT BY INDUSTRY: MANUFAC-TURING	RETAIL	OTHER	TOTAL	STUDENTS IN HIGH SCHOOL OR COLLEGE
81	314	209	44	88	9000		88					
81	315	44	11	11	9000		11					
81		3113	880	1243	9000		1430	3	15	41	59	
TOTALS		163392	51988	59089		1400	66773	28668	8474	31021	68163	15576

1966 VEHICLE TRIPS

		PRODUCTIONS						ATTRACTIONS					
		HOME BASED			NON-HOME			HOME BASED			NON-HOME		
DIST	CENT	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL
1	1	294	101	265	6756	363	7779	4957	5559	6108	5947	375	22946
1	2	57	10	9	598	76	750	498	233	273	518	75	1597
1	3	32	1	1	658	471	1163	672	86	109	595	495	1957
1	4	189	52	166	4462	264	5133	2260	1648	3025	4273	272	11486
1	5	187	44	337	3596	293	4457	1715	1101	3467	3424	258	9965
1		759	208	778	16070	1467	19282	10102	8627	12982	14762	1476	47949
2	6	452	276	815	1345	25	2913	502	367	823	1511	21	3224
2		452	276	815	1345	25	2913	502	367	823	1511	21	3224
3	7	59	1	68	1836	143	2107	1524	172	3272	1956	141	7065
3	8	119	42	250	1500	104	2015	905	525	351	1403	112	3296
3	9	307	312	702	817	43	2181	303	189	457	807	68	1824
3	10	119	36	80	697	33	965	318	45	412	629	18	1422
3		604	391	1100	4850	323	7268	3050	931	4492	4795	339	13607
4	11	511	332	1237	534	33	2647	156	75	454	493	19	1197
4	12	259	152	597	2256	23	3287	746	649	2069	2422	1	5887
4		770	484	1834	2790	56	5934	902	724	2523	2915	20	7084
5	13	29	76	52	1900	47	2104	852	3330	799	2064	63	7108
5	14	425	679	1150	1738	78	4070	500	2653	947	2198	77	6375
5	15	106	77	189	298	2	672	169	168	118	365	3	823
5		560	832	1391	3936	127	6846	1521	6151	1864	4627	143	14306
6	16	740	305	1291	943	105	3384	255	176	576	979	104	2090
6	17	371	355	555	195	33	1509	2		138	198	35	373
6		1111	660	1846	1138	138	4893	257	176	714	1177	139	2463
7	18	944	600	1215	602	18	3379	124	58	621	636	17	1456
7		944	600	1215	602	18	3379	124	58	621	636	17	1456
8	19	151	86	394	1818	173	2622	329	666	1848	1770	169	4782
8	20	473	362	1516	2158	138	4747	804	169	2241	1910	136	5260
8		624	448	2010	3976	311	7369	1133	835	4089	3680	305	10042
9	21	481	293	2576	1105	52	4507	182	44	2067	999	54	3346
9		481	293	2576	1105	52	4507	182	44	2067	999	54	3346

1966 VEHICLE TRIPS

		PRODUCTIONS						ATTRACTIONS					
		HOME BASED			NON-HOME BASED			HOME BASED			NON-HOME BASED		
DIST	CENT	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL
10	22	462	463	1160	2120	19	4224	624	38	3606	1676	18	5962
10	23	385	389	1157	614	52	2597	88	406	484	776	51	1805
10		847	852	2317	2734	71	6821	712	444	4090	2452	69	7767
11	24	367	326	849	910	54	2506	381	173	631	963	66	2214
11	25	67	24	186	419	17	713	251		171	380	16	813
11	26	354	408	1330	751	35	2878	447	39	668	674	34	1862
11		788	758	2365	2080	106	6097	1079	212	1470	2017	116	4894
12	27	303	279	1107	654	66	2409	105		1035	629	66	1835
12	28	70	56	223	674	19	1042	156	1589	442	1049	17	3253
12	29	424	242	1328	645	83	2722	163	280	766	649	85	1942
12		797	577	2658	1973	168	6173	424	1869	2243	2326	168	7030
13	30	439	604	990	734	18	2785	269	94	800	651	37	1851
13	31	275	365	904	115	17	1676	48	1	210	172	20	451
13	32	221	273	381	698	17	1590	250	109	881	656	18	1914
13		935	1242	2275	1547	52	6051	567	204	1891	1479	75	4216
14	33	187	236	680	441	50	1594	135	5	555	317	57	1069
14	34	292	60	499	280	69	1200	18	7	385	347	66	823
14	35	203	19	300	202	51	775	117		195	257	50	619
14	36	138	196	560	1074	60	2028	211	1602	234	1284	57	3388
14	37	26		42	341	74	483	259	175	209	286	75	1004
14	38	446	933	1348	2420	55	5202	575	4354	1001	2597	92	8619
14		1292	1444	3429	4758	359	11282	1315	6143	2579	5088	397	15522
15	39	727	604	1389	1122	120	3962	331	68	1713	1076	136	3324
15	40	523	710	1508	758	25	3524	121	338	803	935	29	2226
15		1250	1314	2897	1880	145	7486	452	406	2516	2011	165	5550
16	41	99	124	321	208		752	138		472	169		779
16	42	201	226	568	75		1070	7		95	112		214
16	43	668	574	1167	661	66	3136	86	953	1099	879	67	3084
16	44	419	374	508	166	17	1484	3	2	265	178		448
16		1387	1298	2564	1110	83	6442	234	955	1931	1338	67	4525
17	45	158	125	679	210	33	1205	72	266	325	274	33	970

1966 VEHICLE TRIPS

		PRODUCTIONS						ATTRACTIONS					
		HOME BASED			NON-HOME BASED			HOME BASED			NON-HOME BASED		
DIST	CENT	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL
17	46	308	282	1212	130		1932	2		294	137	17	450
17	47	425	342	1065	722	66	2640	73	337	611	692	64	1777
17		891	749	2976	1062	99	5777	147	603	1230	1103	114	3197
18	48	233	132	523	557	17	1462	102		870	497	20	1489
18	49	758	547	1452	279	17	3053	41		225	296	19	581
18	50	10	75	106	745	37	973	1173		689	612	35	2509
18	51	60	150	151	1045	74	1480	728	20	2352	769	73	3942
18		1061	904	2232	2626	145	6968	2044	20	4136	2174	147	8521
19	52	575	715	2444	1997	189	5920	1115	74	4173	1490	190	7042
19		575	715	2444	1997	189	5920	1115	74	4173	1490	190	7042
20	53	245	420	738	1669	120	3192	1116		4231	1395	122	6864
20		245	420	738	1669	120	3192	1116		4231	1395	122	6864
21	54	54	34	81	461	50	680	218	19	813	451	51	1552
21		54	34	81	461	50	680	218	19	813	451	51	1552
22	55	260	183	625	110	17	1195	41		194	148	17	400
22	56	191	301	482	766	17	1757	223	99	427	686	16	1451
22		451	484	1107	876	34	2952	264	99	621	834	33	1851
23	57	374	521	1744	2433	203	5275	1847	21	7007	2264	198	11337
23		374	521	1744	2433	203	5275	1847	21	7007	2264	198	11337
24	58	367	399	762	789	1	2318	243	243	822	687	2	1997
24		367	399	762	789	1	2318	243	243	822	687	2	1997
25	59	248	493	1077	790	17	2625	160	201	618	893	16	1888
25		248	493	1077	790	17	2625	160	201	618	893	16	1888
26	60	324	277	1077	407	19	2104	80		490	478	17	1065
26	61	554	466	1380	644	70	3114	265	41	412	640	71	1429
26		878	743	2457	1051	89	5218	345	41	902	1118	88	2494
27	62	359	247	785	757	51	2199	309	1927	1064	962	57	4319

1966 VEHICLE TRIPS

		PRODUCTIONS						ATTRACTIONS					
		HOME BASED						HOME BASED					
DIST	CENT	WORK	SHOP	OTHER	NON-HOME BASED	TRUCK	TOTAL	WORK	SHOP	OTHER	NON-HOME BASED	TRUCK	TOTAL
27	63	762	919	2404	718	69	4872	74	19	568	770	73	1504
27	64	483	481	1054	461	17	2496	9		460	509	17	995
27		1604	1647	4243	1936	137	9567	392	1946	2092	2241	147	6818
28	65	302	219	559	281	38	1399	62		492	245	33	832
28	66	75	92	356	85		608	2		3	67		72
28	67	144	167	349	174	17	851	6	3	103	262	17	391
28	68	74	37	206	92		409	52		94	72	16	234
28	69	219	162	248	179	17	825	11	35	144	246	20	456
28	70	126	126	366	131	39	788	131	29	124	223	44	551
28		940	803	2084	942	111	4880	264	67	960	1115	130	2536
29	71	247	237	1106	384	107	2081	135	45	420	308	106	1014
29	72	327	256	657	316	56	1612	110		407	321	54	892
29	73	326	310	951	305	53	1945			549	337	51	937
29		900	803	2714	1005	216	5638	245	45	1376	966	211	2843
30	74	572	743	1562	497	17	3391	70		463	503	18	1054
30	75	521	570	906	1080	54	3131	184	1401	1412	1242	85	4324
30		1093	1313	2468	1577	71	6522	254	1401	1875	1745	103	5378
31	76	296	289	1068	374	58	2085	290	3	391	262	22	968
31	77	677	352	1033	273	50	2385	42		378	251	53	724
31		973	641	2101	647	108	4470	332	3	769	513	75	1692
32	78	747	842	2640	1248	100	5577	371	487	1133	1227	124	3342
32	79	103	327	541	475	24	1470	256	43	149	513	25	986
32		850	1169	3181	1723	124	7047	627	530	1282	1740	149	4328
33	80	576	784	1480	978	96	3914	340	147	784	849	109	2229
33		576	784	1480	978	96	3914	340	147	784	849	109	2229
34	81	110	2	143	1026	207	1488	934	117	344	833	211	2439
34	82	59	22	47	1381	115	1624	959	118	712	1384	117	3290
34	83	46	3	22	726	121	918	478	110	141	747	127	1603
34	84	126	130	219	712	268	1455	766	10	93	524	252	1645
34	85	262	106	418	666	51	1503	299	253	505	753	52	1862
34	86	477	449	814	522	24	2286	103	37	444	562	20	1166
34		1080	712	1663	5033	786	9274	3539	645	2239	4303	779	12005

K A L A M A Z O O   A R E A   T R A N S P O R T A T I O N   S T U D Y

1966 VEHICLE TRIPS

		PRODUCTIONS						ATTRACTIONS					
		HOME BASED			NON-HOME			HOME BASED			NON-HOME		
DIST	CENT	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL
35	87	285	97	326	459	177	1344	63	290	522	519	151	1545
35	88	475	511	952	280	4	2220	64	1	363	305	2	735
35		758	608	1278	739	181	3564	127	291	885	824	153	2280
36	89	133	135	314	1458	112	2202	490	4727	555	1522	100	7394
36	90	53	19	24	225	34	360	277	39	224	172	33	745
36	91	379	274	606	341	5	1605	107	19	117	381	4	628
36	92	23		24	77		124	55	38	89	77	3	262
36	93	66	99	78	351	214	808	403	17	110	323	176	1029
36		709	527	1046	2452	365	5099	1332	4840	1095	2475	316	10058
37	94	529	104	569	1725	670	3597	3839	220	435	1514	652	6660
37	95	14	2		647	154	817	1258		398	538	158	2352
37	96	70	41	168	341	25	645	537	22	277	310	18	1164
37	97	12	22	24	314	43	415	337	25	202	305	37	906
37		625	169	761	3027	892	5474	5971	267	1312	2667	865	11082
38	98	78	56	247	192	8	581	64	60	47	133		304
38	99	3		1	58	18	80	15	20	18	49	17	119
38	100				17		17	1	35	18	38		92
38	101	169	110	457	1011	68	1815	935	63	1003	827	67	2895
38	102	265	145	377	246	17	1051	7	19	90	262	18	396
38	103	82	130	139	56	17	424	23		1	48	16	88
38	104	123	164	426	131	4	848	76		100	169	1	346
38	105	288	549	968	157		1962	22	149	126	173		470
38		1009	1154	2615	1868	132	6778	1143	346	1403	1699	119	4710
39	106	479	458	1008	275	17	2237	34	1	375	257	17	684
39	107	302	480	909	319	53	2063	76	221	410	255	67	1029
39	108	611	439	695	310	50	2105	16		317	296	51	680
39		1392	1377	2612	904	120	6405	126	222	1102	808	135	2393
40	109	434	442	1545	1603	120	4144	343	1261	1532	1700	117	4953
40	110	399	512	1040	488	50	2489	80		1087	385	50	1602
40	111	340	284	823	143		1590	13		114	88	1	216
40		1173	1238	3408	2234	170	8223	436	1261	2733	2173	168	6771
41	112	191	191	310	339	5	1036	216		497	287	2	1002
41	113	405	154	921	156	19	1655	57	36	193	244		530
41		596	345	1231	495	24	2691	273	36	690	531	2	1532

1966 VEHICLE TRIPS

		PRODUCTIONS						ATTRACTIONS					
		HOME BASED			NON-HOME			HOME BASED			NON-HOME		
DIST	CENT	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL
42	114	153	93	247	85	4	582	9	36	61	66		172
42	115	531	381	463	290	17	1682	27	2	201	265	17	532
42	116	137	144	126	113		520	29	21	40	113	1	204
42	117	431	240	658	279	585	2193	201	36	187	325	562	1311
42	118	280	313	524	503	18	1638	263		715	283		1261
42		1532	1171	2018	1270	624	6615	529	95	1204	1072	580	3480
43	119	334	238	688	364	17	1641	54	57	573	367	16	1067
43	120	98	144	120	82	17	461	81	2	94	123	16	316
43	121	364	216	622	201	33	1436	4		256	223	33	516
43	122	284	392	375	519		1570	125	19	631	421		1196
43		1080	990	1805	1166	67	5108	264	78	1554	1134	65	3095
44	123	137	94	289	425	20	965	212	306	491	488	24	1521
44	124	607	420	592	448	50	2117	55	73	478	531	50	1187
44		744	514	881	873	70	3082	267	379	969	1019	74	2708
45	125	312	337	658	711	86	2104	128	135	700	512	90	1565
45	126	62		5	31	35	133	94	4	73	33	34	238
45		374	337	663	742	121	2237	222	139	773	545	124	1803
46	127	400	289	713	523	111	2036	111	235	542	534	138	1560
46	128	87	76	178	115	19	475	54		115	55	17	241
46	129	538	685	1106	812	140	3281	54	1475	685	999	132	3345
46		1025	1050	1997	1450	270	5792	219	1710	1342	1588	287	5146
47	130	1033	1148	2174	1441	100	5896	172	1834	841	1499	104	4450
47	131	60	56	172	204	5	497	144	69	118	165		496
47		1093	1204	2346	1645	105	6393	316	1903	959	1664	104	4946
48	132	63		22	1055	366	1506	1296	63	491	1177	375	3402
48	133	208	112	192	507	87	1106	324	20	282	419	89	1134
48	134	142	200	64	697	177	1280	449	28	307	745	124	1653
48	135	16	19	4	467	61	567	231	20	136	464	96	947
48	136	474	426	852	307	51	2110	148	39	274	351	54	866
48	137	125	67	101	894	254	1441	653	122	600	876	259	2510
48		1028	824	1235	3927	996	8010	3101	292	2090	4032	997	10512
49	138	596	464	1408	1137	90	3695	415	482	1392	1062	108	3459

1966 VEHICLE TRIPS

PRODUCTIONS

DIST	CENT	HOME BASED WORK	HOME BASED SHOP	HOME BASED OTHER	NON-HOME BASED	TRUCK	TOTAL
49	139	163	172	282	1062	68	1747
49		759	636	1690	2199	158	5442
50	140	292	280	245	1096	115	2028
50	141	916	767	1659	904	38	4284
50		1208	1047	1904	2000	153	6312
51	142	709	532	1329	1106	63	3739
51	143	714	432	776	563	50	2535
51		1423	964	2105	1669	113	6274
52	144	365	328	657	266		1616
52	145	9		3	508	21	541
52	146	436	145	558	2881	843	4863
52	147	46	41	10	305	36	438
52	148	234	456	619	542	88	1939
52	149	155	44	243	1538	482	2462
52		1245	1014	2090	6040	1470	11859
53	150	536	487	1131	599	33	2786
53	151	258	175	311	375	175	1294
53		794	662	1442	974	208	4080
54	152	22	73	229	96	3	423
54	153	140	56	252	601	222	1271
54	154	277	55	76	862	356	1626
54	155	688	786	851	476	21	2822
54	156	345	332	298	346	50	1371
54		1472	1302	1706	2381	652	7513
55	157	705	797	1500	1034	54	4090
55	158	588	466	1913	559	19	3545
55		1293	1263	3413	1593	73	7635
56	159	721	746	1565	1683	224	4939
56	160	293	124	468	1122	17	2024
56		1014	870	2033	2805	241	6963
57	161	617	617	1252	1060	62	3608

ATTRACTIONS

DIST	CENT	HOME BASED WORK	HOME BASED SHOP	HOME BASED OTHER	NON-HOME BASED	TRUCK	TOTAL
49	139	1101	1195	566	1214	77	4153
49		1516	1677	1958	2276	185	7612
50	140	873	384	756	1374	119	3506
50	141	309	97	932	805	36	2179
50		1182	481	1688	2179	155	5685
51	142	262	890	1127	1338	59	3676
51	143	53	81	667	610	49	1460
51		315	971	1794	1949	108	5136
52	144	17	94	143	316		570
52	145	924		170	422	20	1536
52	146	4758	295	736	2651	765	9205
52	147	197	3	205	250	10	665
52	148	192	102	834	578	93	1799
52	149	2265	177	591	1537	492	5062
52		8353	671	2679	5754	1380	18637
53	150	46	622	574	747	35	2024
53	151	282	123	124	326	166	1021
53		328	745	698	1073	201	3045
54	152	35		38	67	1	141
54	153	729	40	282	443	242	1736
54	154	963	10	297	708	326	2304
54	155	33		732	423	17	1205
54	156	74		582	254	50	960
54		1834	50	1931	1895	636	6346
55	157	253		1307	897	53	2510
55	158	117	39	497	509	19	1181
55		370	39	1804	1406	72	3691
56	159	1090	1099	1601	2039	243	6072
56	160	362	926	496	1239	20	3043
56		1452	2025	2097	3278	263	9115
57	161	350	149	2116	968	60	3643

KALAMAZOO AREA TRANSPORTATION STUDY

1966 VEHICLE TRIPS

DIST	CENT	PRODUCTIONS HOME BASED WORK	PRODUCTIONS HOME BASED SHOP	PRODUCTIONS HOME BASED OTHER	PRODUCTIONS NON-HOME BASED	PRODUCTIONS TRUCK	PRODUCTIONS TOTAL	ATTRACTIONS HOME BASED WORK	ATTRACTIONS HOME BASED SHOP	ATTRACTIONS HOME BASED OTHER	ATTRACTIONS NON-HOME BASED	ATTRACTIONS TRUCK	ATTRACTIONS TOTAL
57	162	621	424	1668	929	23	3665	320	657	1301	1143	5	3426
57	163												
57		1238	1041	2920	1989	85	7273	670	806	3417	2111	65	7059
58	164	645	264	1279	889	7	3084	302	294	2125	1193	9	3923
58	165	81	54	202	105	9	451	54		335	105	8	502
58	166	373	161	291	374	22	1221	149	20	609	484	18	1280
58	167	21		5	17	17	60	28		148	20	17	213
58		1120	479	1777	1385	55	4816	533	314	3217	1802	52	5918
59	168	46		4	562	184	796	1134	38	261	468	164	2065
59	169	1			27	3	31	138		35	27		200
59	170	39	7	18	1579	62	1705	647	1983	1061	1810	64	5565
59		86	7	22	2168	249	2532	1919	2021	1357	2305	228	7830
60	171	382	189	634	1824	232	3261	4362	57	1076	1475	251	7221
60		382	189	634	1824	232	3261	4362	57	1076	1475	251	7221
61	172	29		28	151		208	53	1	353	205		612
61	173	671	684	980	552	4	2891	237	183	564	630	2	1616
61	174	706	543	1233	865	66	3413	553	126	1673	825	56	3233
61		1406	1227	2241	1568	70	6512	843	310	2590	1660	58	5461
62	175	423	304	589	277	156	1749	43	744	71	320	176	1354
62	176	152	164	179	28		523	26		119	8		153
62	177	484	391	764	210	54	1903	47	98	365	168	67	745
62	178	323	308	749	113	34	1527	6	31	158	169	34	398
62		1382	1167	2281	628	244	5702	122	873	713	665	277	2650
63	179	601	568	784	325	20	2298	264		354	289	17	924
63	180	440	520	1195	304	20	2479	29	195	532	255	22	1033
63	181	371	273	479	353	44	1520	130	53	459	315	38	995
63		1412	1361	2458	982	84	6297	423	248	1345	859	77	2952
64	182	873	626	895	332	73	2799	125	175	940	374	56	1670
64	183	56	122	34	73		285	12		151	112		275
64	184	213	177	559	787	78	1814	837	343	1409	796	81	3466
64		1142	925	1488	1192	151	4898	974	518	2500	1282	137	5411

1966 VEHICLE TRIPS

PRODUCTIONS

DIST	CENT	HOME BASED WORK	HOME BASED SHOP	HOME BASED OTHER	NON-HOME BASED	TRUCK	TOTAL
65	185	427	513	901	1188	104	3133
65	186	550	584	1308	167	42	2651
65	187	371	296	946	1176	9	2798
65		1348	1393	3155	2531	155	8582
66	188	498	675	736	1764	58	3731
66	189	793	1032	1788	556	33	4202
66		1291	1707	2524	2320	91	7933
67	190	113	82	258	300	28	781
67	191	1050	1133	1469	1860	94	5606
67		1163	1215	1727	2160	122	6387
68	192	213	220	102	85	17	637
68	193	865	895	1885	675	20	4340
68	194	547	294	487	271	133	1732
68		1625	1409	2474	1031	170	6709
69	195	128	56	263	20		467
69	196	300	381	432	171	2	1286
69	197	27	77	6	9	17	136
69	198	85	113	140	54	34	426
69	199	62	2	94	60	2	220
69	200	138	79	276	55	1	549
69	201	135	56	48	39		278
69	202	2		1		2	5
69		877	764	1260	408	58	3367
70	203	131	131	137	99	1	499
70	204		94	211	26		331
70	205	73	56	142	20	2	293
70	206	223	155	326	205	18	927
70	207	167	38	450	53	33	741
70	208	127	95	273	72	3	570
70	209	45	1	38	19	17	120
70	210	126	58	264	152	35	635
70	211	82	172	278	119	1	652
70	212	12	3	17	284	19	335
70	213	6		85	99	18	208
70	214	170	136	291	43		640
70		1162	939	2512	1191	147	5951

ATTRACTIONS

DIST	CENT	HOME BASED WORK	HOME BASED SHOP	HOME BASED OTHER	NON-HOME BASED	TRUCK	TOTAL
65	185	593	1420	802	1282	108	4205
65	186	104		407	197	8	716
65	187	230	1346	564	1323	41	3504
65		927	2766	1773	2802	157	8425
66	188	441	4638	633	2106	81	7899
66	189	62	1	804	501	49	1417
66		503	4639	1437	2607	130	9316
67	190	596	21	209	383	28	1237
67	191	570	261	2496	1693	95	5115
67		1166	282	2705	2076	123	6352
68	192	7		137	67	17	228
68	193	147		652	731	17	1547
68	194	5	34	273	267	133	712
68		159	34	1062	1065	167	2487
69	195	12		4	49	1	66
69	196	29	1	87	167	16	300
69	197	3		4	12	16	35
69	198	48		40	93	36	217
69	199	30	194	92	80	4	400
69	200	37	94	47	28	2	208
69	201			1	33		34
69	202	6					6
69		165	289	275	462	75	1266
70	203	6	1	161	137	4	309
70	204			18	7		25
70	205	11	8	43	36	1	99
70	206	63	78	197	132	2	472
70	207	48	3	173	71	33	328
70	208	43	56	112	72	1	284
70	209	3	1	1	19	17	41
70	210	48	107	215	113	53	536
70	211	50	1	68	145	1	265
70	212	170	215	646	359	34	1424
70	213	9	8	118	85	17	237
70	214	6		78	47		131
70		457	478	1830	1223	163	4151

1966 VEHICLE TRIPS

		PRODUCTIONS						ATTRACTIONS					
		HOME BASED			NON-HOME BASED			HOME BASED			NON-HOME BASED		
DIST	CENT	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL
71	215	37	1	66	55		159	2		22	67		91
71	216	14	3	24	66	17	124	3		19	72	19	113
71	217	9	41	85	7		142	19	17	27	7		70
71	218	81	6	179	20		286	16	2	147	40		205
71	219	2	41	9	8	2	62	3		6		2	11
71	220	35	21	44	31		131	3		59	50		112
71	221	4	1	12	33	17	67	4		3	33	17	57
71	222	23	1	3			27			41	17		58
71	223	10	20	22	17	5	74	61		127	40	2	230
71	224	96	81	361	61		599	23	202	24	77	5	331
71	225	9	35	41	44		129		1	42	46		89
71	226	13	1	51	118	11	194	20	3	76	70	7	176
71	227	70	73	16	38		197	3		3	31		37
71	228	149	34	318	60	17	578	1		78	53	17	149
71	229	354	225	799	230	19	1627	54	1	262	230	3	550
71	230	255	73	302	521	265	1416	632	73	347	574	323	1949
71	231	6		36	138	25	205	45	40	58	160	18	321
71	232	111	142	316	63	3	635	9		212	82	1	304
71		1278	799	2684	1510	381	6652	898	339	1553	1649	414	4853
72	233	151	173	474	1925	370	3093	2780	2029	1123	2094	352	8378
72		151	173	474	1925	370	3093	2780	2029	1123	2094	352	8378
73	234	68		209	50	1	328	7		181	71	2	261
73	235	108	108	157	42	22	437	12	3	136	59	20	230
73	236	94	223	137	186	23	663	346		46	175	30	597
73	237	570	426	569	258	33	1856	85	2	346	290	50	773
73		840	757	1072	536	79	3284	450	5	709	595	102	1861
74	238	456	298	1166	358	1	2279	38	36	531	429		1034
74	239	22	34	38	14	2	110			1	13	3	17
74	240	346	332	536	84	2	1300	45	20	136	208	3	412
74	241	177	53	190	51	1	472			46	29		75
74	242	60	17	57	7		141			4	7		11
74	243	54	54	88		17	213	3				17	20
74	244	145		10	68		223	2		50	31		83
74	245	1			14		15	23		17	31		71
74	246	10	17	2			29				6		6
74		1271	805	2087	596	23	4782	111	56	785	754	23	1729
75	247	8	1	7	8	11	35	41		3	7	10	61

1966 VEHICLE TRIPS

		PRODUCTIONS						ATTRACTIONS					
		HOME BASED			NON-HOME			HOME BASED			NON-HOME		
DIST	CENT	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL	WORK	SHOP	OTHER	BASED	TRUCK	TOTAL
75	248	91	7	120	22		240	6	1	40	31		78
75	249	479	418	840	241	33	2011	10		195	226	33	464
75	250	121	173	323	92	17	726	12		70	102	33	217
75	251	66	51	73	72	152	414	14	3	124	36	151	328
75	252	54	70	124	20		268	19		51	38		108
75	253	193	172	354	68		787	44	1	59	105	2	211
75	254	225	325	447	358	77	1432	157	3	266	371	86	883
75		1237	1217	2288	881	290	5913	303	8	808	916	315	2350
76	255	428	382	723	713	33	2279	148	666	646	853	40	2353
76	256	308	362	701	350	33	1754	121	333	312	424	33	1223
76	257	155	87	160	85		487	10	17	19	106	1	153
76	258							1					1
76	259	21	18	4	17	1	61	2		35	17		54
76	260	297	228	700	478	60	1763	959	1	495	432	50	1937
76		1209	1077	2288	1643	127	6344	1241	1017	1507	1832	124	5721
77	261	29	34	26	46	17	152	1	3	24	20	16	64
77	262	94		10	20	17	141	2		71	20	18	111
77	263	4	3	5	17		29	1		56		3	60
77	264	99	35	11	25	25	195	1	1	9	24	17	52
77	265	35	20	75	34		164	31		18			49
77	266	79	53	150		17	299	4		5		1	10
77	267	86	18	37	7		148	24		4	6		34
77	268	336	181	739	1119	59	2434	508	902	577	1427	67	3481
77	269	56	104	146	97	33	436	10	2	77	54	35	178
77	270	82	69	239	90	21	501	40	5	204	121	18	388
77	271	423	194	593	1173	59	2442	470	428	1173	1024	59	3154
77		1323	711	2031	2628	248	6941	1092	1341	2218	2696	234	7581
78	272	130	108	297	43		578	2		55	63	2	122
78	273	146	94	229	118	2	589	37	34	7	148		226
78	274	7	2	39	17	4	69	8	3	37	19	4	71
78	275	34	17	8	17	18	94	21			17	17	55
78	276	23	35	124	50	17	249	2		34	65	19	120
78	277	25	1	2		1	29		1	2			3
78	278	5	72				77	3		6	7		16
78	279	6		3	7	17	33	2		34	7	17	60
78	280	126	75	11	126	73	411	54	140	229	71	69	563
78	281	54	73	83	29	18	257	51	5	7	52	37	152
78	282	22	1	21	17		61	1		4			5
78	283	26	71	3		1	101		1	38			39

1966 VEHICLE TRIPS

DIST	CENT	PRODUCTIONS: HOME BASED WORK	HOME BASED SHOP	HOME BASED OTHER	NON-HOME BASED	TRUCK	TOTAL	ATTRACTIONS: HOME BASED WORK	HOME BASED SHOP	HOME BASED OTHER	NON-HOME BASED	TRUCK	TOTAL
78	284	4	37		7		48			41	7		48
78	285	47	1	39			87	1		38			39
78	286	45	34	17	7		103	2		4	6		12
78	287	45		1	7		53	1			6		7
78	288			53	17	1	71			37	17		54
78	289	22	39	3	24		88	20			23		43
78	290		40	109		17	166			34		17	51
78	291	44	17	23	27		111	1			27		28
78	292	54	1	20	28		103				28		28
78		865	718	1085	541	169	3378	206	184	607	563	182	1742
79	293	36	36	56	65	19	212	1		76	14	17	108
79	294	56	17	148	7		228			61	24		85
79	295	109	160	72	78	17	436	24	2	41	61		128
79	296	6	17	20	17	17	77	2	36	86		19	143
79	297	21	142	166	97	1	427	29		91	81	1	202
79	298			1	54	24	79	235		19	69	28	351
79	299	43		37	7	22	109	34	1		7	21	63
79	300	721	360	623	147	50	1901	249		263	152	52	716
79	301	58		19			77		1	56	17		74
79	302	31	36	109	33	18	227	65		40	30	18	153
79		1081	768	1251	505	168	3773	639	40	733	455	156	2023
80	303	197	68	187	928	92	1472	3412		593	572	103	4680
80		197	68	187	928	92	1472	3412		593	572	103	4680
81	304	254	131	260	80	33	758	2		28	94	33	157
81	305	146	95	117	84	33	475	2	1	118	64	32	217
81	306	51	19	24			94	3					3
81	307	24		2			26			41			41
81	308	5	2	6	14		27	2		24	6	2	34
81	309	85	20	118	1		224	23		99	17		139
81	310	132	114	39	7		292	2		65	7		74
81	311	100	106	190		1	397	6		48			54
81	312	46	126	27	24	4	227	55	18	32	26	5	136
81	313	814	372	982	287	177	2632	69	745	471	419	171	1875
81	314	174	97	86	85		442	5		60	66		131
81	315	28	39	5	7		79	27		4	8		39
81		1859	1121	1856	589	248	5673	196	764	990	707	243	2900
INTERNAL TOTAL		76052	66314	152677	155601	17410	468054	90275	72187	152508	155461	17432	487863

K A L A M A Z O O   A R E A   T R A N S P O R T A T I O N   S T U D Y

1966 VEHICLE TRIPS

EXTERNAL	PRODUCTIONS HOME BASED WORK	PRODUCTIONS HOME BASED SHOP	PRODUCTIONS HOME BASED OTHER	PRODUCTIONS NON-HOME BASED	PRODUCTIONS TRUCK	PRODUCTIONS TOTAL	ATTRACTIONS HOME BASED WORK	ATTRACTIONS HOME BASED SHOP	ATTRACTIONS HOME BASED OTHER	ATTRACTIONS NON-HOME BASED	ATTRACTIONS TRUCK	ATTRACTIONS TOTAL
316	2963	338	1028	229	265	4823	1091	67	884	150	247	2439
317	247	58	62	4	15	386	105	11	71	4	21	212
318	1743	519	487	25	89	2863	453	53	414	63	96	1079
319	1167	215	363	11	60	1816	175	10	357	12	58	612
320	2532	545	778	82	103	4040	1201	117	1107	81	124	2630
321	183	43	62	7	11	306	110	20	74	4	11	219
322	80	28	33	1	7	149	44	1	26	2	9	82
323	63	3	30	6	16	118	263	8	52	1	16	340
324	897	276	372	32	62	1639	804	62	434	49	78	1427
325	364	106	174	36	43	723	301	43	147	31	39	561
326	2299	264	522	115	391	3591	1931	34	598	186	408	3159
327	253	62	63	5	51	434	127	17	55	3	32	234
328	214	33	54	5	13	319	49	7	47		16	119
329	1081	247	312	18	71	1729	442	101	366	42	54	1005
330	1180	442	389	17	57	2085	547	82	506	48	64	1247
331	145	84	67	4	5	305	74	7	65	2	1	149
332	1137	768	500	42	119	2566	667	62	370	66	108	1273
333	1182	203	374	65	132	1956	643	23	371	46	131	1214
334	600	340	183	8	19	1150	264	8	142	17	19	450
335	203	122	85	2	8	420	23	8	75	1	1	108
336	1927	575	474	92	268	3336	815	31	340	95	253	1534
337	2042	664	584	46	89	3425	785	54	589	53	72	1553
338	214	51	63		16	344	70	14	96	4	12	196
339	2163	618	529	39	66	3415	504	63	574	63	82	1286
340	109	44	32		11	196	26	18	38	3	3	88
341	381	91	95	3	10	580	77	27	98	7	15	224
342	624	107	116	11	39	897	169	25	104	10	44	362
EXTERNAL TOTAL	25993	6846	7831	905	2036	43611	11760	973	8000	1045	2014	23802
GRAND TOTAL	102045	73160	160508	156506	19446	511665	102035	73160	160508	156506	19446	511665

STAFF CREDITS

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