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ANALYSIS OF TRIP GENERATION FACTORS INVOLVED IN GROUND PASSENGER TRANS-PORTATION WITHIN MONTGOMERY AND GREENE COUNTIES, OHIO

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Captain John M. Barry Captain Philip D. Bown

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ANALYSIS OF TRIP GENERATION FACTORS INVOLVED IN GROUND PASSENGER TRANSPORTATION WITHIN MONTGOMERY AND GREENE COUNTIES, OHIO

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

John M. Barry, M.A. Captain, USAF

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January 1972

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and approved in an oral examination, has been accepted by the undersigned on behalf of the faculty ... the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

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Chapter 1

INTRODUCTION

Problem Statement

Developing any regional transportation system is an uncertain and costly undertaking. The fixed elements of a highway network or mass transit scheme are very difficult and expensive to change. Therefore, an intensive problem analysis should precede the design of any transportation system. The systems that are being built must adequately service the present as well as future populations. If these systems do not satisfy transportation needs, other systems must be constructed to replace them. The techniques and principles used in analyzing trip generation data have provided some insight into the proper transportation systems to be used in the future. Using this approach, the authors decided to apply this type of analysis to the local area surrounding Wright-Patterson Air Force Base, Montgomery and Greene Counties. The basic problem of the research effort was to quantify and relate the factors that affect ground passenger transportation in Montgomery and Greene Counties. Some of the factors which have been found to influence ground passenger transportation are population densities, land use, types of employment and their

populations, and family size. Hopefully, the relationships between these factors and the need for transportation will provide sufficient information required to allocate scarce ansportation resources wisely.

Background

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The requirement for adequate transportation exists to satisfy man's need for survival, food, shelter, and recreation. This need is extremely critical in America today, where present transportation schemes are deteriorating. Prior to the 1950's, the planning of most transportation networks was based upon simple traffic counts. These traffic counts recorded the traffic volume with respect to time on a transportation route. If the traffic volume per unit time period was greater than the existing route could handle, the route was either expanded or supplemented. In an attempt to provide greater insight into existing travel patterns, origin-destination studies were accomplished. This description usually took the form of tables of trip origins and destinations. Future urban travel volumes were developed by extending the past traffic growth rate curve into the future by extrapolation techniques. However, many transportation studies made no projections of transportation requirements.¹ These studies only

¹U.S. Department of Transportation/Federal Highway Administration, Bureau of Public Roads, <u>Guidelines for Trip Generation</u> <u>Analysis</u>, Washington: Government Printing Office, 1967, p. 1.

emphasized the alleviation of existing traffic problems while very little was done to quantify the relationships between land use patterns and travel for the solution of future traffic problems.

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The approach of determining transportation requirements based on the single parameter was basically unsound. There are many other interdependent factors that must be considered in calculating transportation needs. Mitchell and Rapkin's book, Urban Traffic, a Function of Land Use was one of the first books to question the validity of the traffic count method of determining transportation needs.² Traffic counts only described what route was traveled and the number of ground passengers traveling on that route. This method could not explain the questions of why and where the passengers were traveling. Traffic counts showed that x number of passengers traveled on a particular route past a particular point and thus could not actually analyze the passenger's real transportation requirement. For example, passengers traveled from point A to B on route AE. Maybe these passengers' ultimate destination was not point B, but some point C where a commercial establishment or a factory existed. Traffic counts indicated that route AB was a valid transportation requirement and that it could be expanded or supplemented according to traffic volume. This faulty reasoning led to the allocation of transportation

²R. B. Mitchell and C. Rapkin, <u>Urban Traffic, a Function of</u> Land Use (New York: Columbia University Press, 1954), p. 150.

resources to routes AB and AC whereas the real transportation requirement existed along an undeveloped path AC. Figure 1, below, illustrates this problem. Therefore, unnecessary resources were expended in constructing additional routes instead of a single more direct and cost effective route. This unfortunate situation can be observed in many urban and suburban areas today where the shortest distance between two points is not a straight line but a maze. Highways are usually expanded or modified when populations develop around them. Secretary Alan T. Boyd, the first Secretary of the Department of Transportation acknowledged this situation when he stated, "Don't

Destination--Attractor of Transportation



- Transportation requirement indicated by traffic count
- ----- The real transportation requirement indicated by tripend generation analysis

Figure 1

Graphical Analysis of Hypothetical Transportation Requirements in Area ABC Using Traffic Counts and Tripend Generation Analysis

forget that future innovations in transportation will have to be superimposed on a system that already exists -- a system which is being expanded and being built to last for a long, long time.³ The classical explanations to justify this maze was that transportation routes follow populations. This rationalization was challenged by C. A. Doxiades in his book, Urban Growth and the Future of the American City. Doxiades found the reverse to be true; populations follow transportation routes. Figure 2, page 6, depicts transportation networks as a basic factor in attracting populations.⁴ This conclusion received recent public support when Dr. Paul Cherington, former Assistant Secretary for Transportation for Policy and Internal Affairs stated that ". . . We have been operating on a mistaken principle -- the transportation routes should go where the people are. It's wrong, people tend to go where the transportation is!"⁵ Therefore more emphasis must be placed on analyzing transportation requirements. Since the development of these new ideas, several recent transportation studies have emerged which expanded the techniques of analyzing transportation requirements. Some of these studies are mentioned in the following

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⁴C.A. Doxiades, <u>Urban Renewal and the Future of the Ameri-</u> <u>can City</u> (Chicago: Public Administration Service, 1966), p. 22.

⁵Appel, "The Coming Revolution in Transportation," <u>National</u> <u>Geographic Magazine</u>, September, 1969, p. 314.

³Frederick C. Appel, "The Coming Revolution in Transportation," <u>National Geographic Magazine</u>, September, 1969, p. 314.



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paragraphs.

Three classic or significant transportation studies were conducted in the past two decades. <u>The Report on the Detroit Metropoli-</u> <u>tan Area Traffic Study</u> (1953), <u>The Chicago Area Transportation Study</u> (1960), and <u>The Pittsburgh Area Transportation Study</u> (1961) were among the first attempts to use modern tripend generation methods for predicting transportation requirements. In Chapter V of the Detroit Study Report, it was hypothesized that ". . . travel in an urban area, both in volume and spatial distribution is an orderly phenomenon."⁶ If the key variables that affect travel and the result which each has on travel can be isolated, then it is possible to predict tripends.

A basic question asked in transportation studies is why do the transportation requirements and the factors that affect these requirements vary from one area to the next? The differences in population density, existing road networks, and the availability of mass transit account for most of the variance in requirements. The difference in the factors that affect these requirements are more difficult to detect. For example, why might the factors that produce tripends in Montgomery and Greene Counties vary from those factors found significant in the <u>Chicago Area Transportation Study</u>? The answer lies in Rapkin's hypothesis that transportation is a functic : of land use. Two land areas

⁶Report on the Detroit Metropolitan Area Traffic Study, Part I, Data Summary and Interpretation, Detroit, July, 1955, p. 77.

with similar transportation facilities can exhibit different relationships between the transportation requirements, measured in tripends and such independent variables as employees per zone, dwelling units per zone, and cars owned per zone. The reason for these different relationships is dissimilar uses of the land. For example area A may have a higher industrial percentage while area B may have a higher residential percentage. This indicates that area A transportation requirements may show a significant dependent relationship on employees per zone while area B's requirements may show a relationship to the number of dwelling units per zone. The total relationship of the number of tripends in both these areas depends on both these factors rather than one or the other. Area A's requirement would be more dependent on the number of dwelling units per zone than the number of employees per zone. Figure 3, page 9, shows these two fictitious areas and the possible tripend relationships. Therefore, the different relationships between independent variables that affect tripends are partly the result of different land uses. Next, the past transportation studies in Montgomery and Greene Counties were explored.

Montgomery and Greene Counties have had a history of significant transportation studies. Tammen and Bergendoff Associates of Kansas City, Missouri, developed the <u>Arterial Highway Plan, Dayton</u>, <u>Ohio, Urban Area</u> in 1953. Harland Bartholomew Associates of St. Louis presented <u>A Report on Transportation</u>, <u>Dayton</u>, <u>Ohio</u>, in 1957. This latter report involved an origin-destination (O-D) random



Type of Employment/Zone

1. Employees/Zone

3. Total Population/Zone

2.

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Significant Independent Variables

1. Dwelling Units/Zone

2. Cars Owned/Zone

3. Total Population/Zone



Graphical Representation of Two Land Areas with Similar Transportation Facilities Exhibiting Different Relationships Between Transportation Requirements and Socio-Economic Characteristics

sample sent to all registered vehicle owners in Montgomery and Greene Counties. In 1965, the Regional Transportation Committee of Montgomery and Greene Counties completed the <u>Regional Transporta-</u> <u>tion Plan</u>. This plan was based on the 1957 O-D study and forecasted the transportation requirements and networks for the two counties through 1980. The Regional Transportation Committee was succeeded by the Montgomery and Greene County Transportation Coordinating Committee (TCC). The TCC was formed in order to continue research and planning for transportation requirements in these two counties. In the fall of 1968, the TCC conducted an O-D study which consisted of a systematic random home interview sample of one out of every fifteen residents in the two counties. In order to validate the data from this sample, a correlation analysis was run for the production of tripends by the TCC. The purpose of this O-D survey was to provide a data base for determining future transportation requirements. However, the limited resources of the TCC delayed the determination of these transportation requirements. In the next section, the rationale behind this analysis is discussed.

Rationale for Trip Generation Analysis

The desired end product in trip generation analysis is an accurate identification and quantification of trips beginning and ending in the various analysis units within a transportation study area. These tripend volumes are difficult, if not impossible, to forecast directly. Decisions made in the households with respect to travel are attributed to such diverse variables as the families economic status, locational environment, and demographic characteristics. The ultimate goal of trip generation analysis, therefore, is to establish an adequate functional relationship between tripend volumes and the land use and socioeconomic characteristics of the zones from which they originate or to which they are destined. Trip generation analysis attempts to develop relationships which help to answer such questions as: why does a family living in a high rise apartment close to the central city business district (CCBD) average three trips per day, while the daily average for

a family living in suburbia is eleven trips per day? Generally, these questions can be considered in terms of three land use factors which influence trip generation: intensity, character, and location.⁷

Intensity of land use expresses the amount of an activity or characteristic found in a given area unit and is usually stated in terms of density variables such as dwelling units per zone or employees per zone. Variations in intensity have a distinct impact on the number and types of trips that are generated in a study area. Figures 4 and 5 on pages 12 and 13, from the Pittsburgh Area Transportation Study illustrate that the number of trips per dwelling unit generally shows a notable decrease as the number of dwelling units per residential area increases. An examination of Figure 5 indicates that a family living in a house in a district with a density of ten dwelling units per acre makes an average of six person trips per day, while a family in an apartment house area which has a density of sixty dwelling units per acre makes only three trips per day. Why was there such a disparity in the number of trips made over the scale of intensity? High rise apartment communities often include small shops, grocery, and drug stores within the buildings which reduce the need for vehicle trips to purchase food or convenience goods. Inner city households exhibit many of the characteristics of the higher density areas. For example, small

⁷U.S. Department of Transportation, <u>Guidelines for Trip Gener-</u> ation Analysis (Washington: Government Printing Office, 1967), p. 7.





corner commercial establishments are often located within easy walking distance so that fewer vehicle transit trips are necessary. The density in both the high rise apartment communities and the inner city areas, in terms of dwelling units or households per residential acre would fall on the lower, flat portion of the curves in Figures 4 and 5 on pages 12 and 13. Previous studies have indicated that when residential density falls below approximately ten dwelling units per acre, trip generation rates rise quite rapidly as demonstrated in Figures 4 and 5. This is the case of the spacious suburbs where the family car is not only a way of life, but a necessity. Most trips made by a household will be via this means. The convenient corner market, which was common to older inner city neighborhoods, is now the giant one hundred acre shopping center located several miles away.

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The trip land use intensity relationship is not sufficient to form the basis for the entire residential trip generation analysis. Although the relationships in Figures 4 and 5 appear to be highly significant, they do not explain all the variation in trip generation. If the total variation was accounted for, all the data points would describe a single, smooth curve that can be expressed mathematically. Obviously, then there are other factors influencing trip making. One of these other factors concerns the characteristics of the household reflecting the socio-economic identity of the analysis unit. For example, two variables associated with residential land use that are indices of household

characteristics are family income and car ownership. The intensity of residential land use in terms of dwelling units per zone may be equal. The characteristics of these households. such as family income or family size, may be different. The contribution of a variable describing these characteristics is quite evident in the explanation of trip generation. For example, families in the higher income ranges are often multi-transport vehicle (i.e. motorcycle and cars) families which result in increased mobility. Low income families often do not own a car and must rely on public transit, thus generating fewer privately owned vehicle trips. Higher income families exhibit an increased amount of travel from the home for purposes other than work. This increase in trip generation is found in the shopping and social recreational purpose categories. These general assumptions were tested and found to be valid in the Kansas City and the St. Louis O-D studies.⁸

The number and factors that affect tripends provide useful information to the transportation planner. The number of tripends acts as an indicator of transportation requirements of an area and provides the planner with a decision tool for allocating resources. The higher the number of tripends an area exhibits, the higher priority it will receive in further transportation analysis and resource allocation.

⁸U.S. Department of Transportation/Bureau of Public Roads, <u>Guidelines for Trip Generation Analysis</u> (Washington: Government Printing Office, 1967), pp. 11-12.

The relationships between the number of tripends and the factors that affect them is important in updating and forecasting tripends. Tripend equations resulting from validated O-D surveys are good for about ten years.⁹ A significant increase in any of the tripend parameters such as population can be used to readjust the basic tripend equations. Therefore, tripend generation analysis has been very useful to the transportation planner in determining transportation requirements. In the next section, the scope of this particular trip generation analysis is specified.

Scope

The thesis was limited to research and analysis of the ground passenger transportation modes of car, truck, and bus in Montgomery and Greene Counties in Ohio. Figure 6, page 17, depicts the analysis area covered in this thesis. It did not, however, address itself to the present political conditions, zoning laws, or fiscal requirements necessary to implement and support the conclusions of this study. Furthermere, the thesis did not define the traffic control systems or networks needed to satisfy the transportation requirements in these two counties. Only internal production and attraction of trips within these counties were studied. Internal trips (i.e. tripends that originate and terminate

⁹Mr. Ron Rude, Transportation Planner, Montgomery and Greene Counties Transportation Coordinating Committee, in a personal interview, June, 1971. Permission to quote secured.



within the two counties) were analyzed because they comprised from eighty to ninety percent of the movements in a study area as determined in previous transportation studies. ¹⁰ This research effort was restricted to determining tripend volumes and the relationships various socio-economic factors have upon tripend production. These socioeconomic factors were occupation, population density, employment density, car ownership, school enrollment, and dwelling units per zone.

Objectives

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The following were the objectives of this thesis:

1. To extract selected trip generation characteristics from the 1968 TCC Origin-Destination Survey.

2. To identify and quantify the tripends in Montgomery and Greene Counties.

3. To provide equations for estimating tripends for zones within Montgomery and Greene Counties.

From these objectives the following hypotheses were developed.

Hypotheses

1. The socio-economic characteristics of occupation, population density, employment density, car ownership, school enrollment,

^{. 10} U.S. Department of Transportation/Bureau of Public Roads, <u>Guidelines for Trip Generation Analysis</u> (Washington: Government Printing Office, 1967), p. 51.

and dwelling units per zone are all significant for use as predictors of both tripend productions and attractions in Montgomery and Greene Counties.

2. There are differences between variables in predicting tripends in Montgomery and Greene Counties.

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Chapter 2

METHODOLOGY

Nature and Source of Data

The data used to test the hypotheses was obtained from the 1968 Montgomery and Greene Counties Transportation Coordinating Committee (TCC) Origin and Destination (O-D) Survey. The request for and authority to use this data is cited in Appendix A. The survey consisted of a systematic random sample of one out of every fifteen households in Montgomery and Greene Counties. For the study the TCC divided the area into 825 traffic zones. The data collected was gathered through home interviews with a response rate of 93.5 percent. Appendix B contains the forms used for this interview. The data was stored on an 800 Binary Coded Digit, nine track magnetic IBM tape. The separation of this data into different categories is contained in Appendix C. Appendix D contains a printout of the first 100 records on the tape arrayed in the format specified in Appendix C. The TCC completed validation of this data prior to the beginning of this thesis. Despite this assurance, the authors ran their own validation program and found errors in the TCC tape. These errors were mainly the result of inaccurate keypunching when the tape was made. All of the errors on the tape, which totaled to forty, were corrected by means of an edit

computer program.

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The 1968 O-D survey data is recent in terms of transportation studies since O-D data for forecasting transportation requirements usually lag analysis by five to seven years. For example, the results of the 1965 Montgomery and Greene Counties Transportation Plan were based on an O-D survey that was seven years old. As has been previously stated, the results of trip generation analysis are usually valid for forecasting transportation requirements up to ten years. Only the occurrence of unexpected events such as the emergence of new manufacturing, recreational, commercial, or residential centers or a natural disaster in a zone can invalidate trip generation equations. If the magnitude of these events was not too extreme, the equations could still be used. The major reason for trip generation equations to remain valid for such a long time is that socio-economic characteristics of an area do not usually change rapidly with respect to time.¹ Characteristics such as dwelling unit density, employee density, and number of cars owned per person remain fairly constant in time. Therefore trip generation equations remain valid as long as these characteristics remain fairly stable. In order to properly produce trip generation equations a logical method of classifying and extracting the data was required.

¹Mr. Ron Rude, Transportation Planner, Montgomery and Greene Counties Transportation Coordinating Committee, in a personal interview, June, 1971. Permission to quote secured.

Classification and Extraction of Data

The data stored on computer tape was arranged on two cards. Card one contained household information while card two consisted of trips produced by each household. There were a total of 15,008 card ones and 123,874 card twos adding up to a total of 138,882 cards on the tape. Table 1, page 23, shows the independent and dependent variables used in this thesis. Since data for the survey was collected by households, the independent variables were sorted and accumulated by zones of residence. The dependent variables which reflected tripends were classified and aggregated according to one of two elements, the zones trips were produced in or zones trips were attracted to. Production and attraction tripends were categorized respectively into zones of origin and zones of destination. Furthermore, since the survey was based on a systematic sample of one of every fifteen households all the variables were multiplied by a zone of residence expansion factor. Most zones in the analysis had a factor near this figure. The complete computer program and its flowchart for the data extraction is included in Appendix F. The results of this extraction program are contained in Appendix G.

The tripends generated by each household were divided into eight different purposes for the production and attraction of trips. These different purposes are also listed in Table 1, page 23. Trips were divided into these various categories in order to generate tripend equations.

Table 1

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Extraction of TCC 1968 Origin-Destination Survey Data into Independent and Dependent Variables Used in Trip Generation Analysis

A. Independent Variables that were Tested in Zonal Trip Generation Analysis

_		
	Original Storage of Data	Arrangement and/or Extraction of Data
	Units	Aggregate
1.	Persons per household	Persons per zone
2.	Automobiles per household	Cars per zone
3.	Students per household	Students per zone
4.	Employment per household	Employment per zone
5.	Unemployment per household	Unemployment per zone
6.	Selected occupations per household*	
	a. Professional people per household	Professional people per zone
	b. Protective people per household	Protective people per zone
7.	Number of dwelling units	Dwelling units per zone

B. Dependent Variables that were Tested in Zonal Trip Generation Analysis

Original Storage of Data	Arrangement and/or Extraction of Data
Units	Aggregate
Number of trips generated by household according to zones of origin and destination	Trips/Zone according to the following purposes 1. Home 2. Work 3. Personal business 4. Shopping 5. School 6. All other trips 7. All trips

*A further breakdown of the occupations related to professional and protective people appears in Appendix E.

Data Analysis

In analyzing the data, only those zones that showed tripend activity with household data recorded in them were used. Zones that did not contain urban characteristics were deleted in the trip generation analysis.² A listing of the zones that showed tripend activity for each of the sixteen production and attraction dependent variables is contained in Appendix H.

After the initial screening process, a computer curve fit program ran all sixteen trip production and attraction purposes against the independent variables extracted from the TCC tape. This procedure calculated the coefficients of determination (r^2) and also gave the least squares fit for four types of curves; linear, exponential, logarithmic, and hyperbolic. The coefficient of simple determination (r^2) measures the amount of total variance in the dependent variable explained by the independent variable in the equation over that which could be explained by the meaning of the dependent variable alone. A value of r^2 near ± 1 indicated a high degree of linear association. The criteria used in testing the r^2 values was the selection of any variable having an r^2 greater than .30. The reason behind this procedure was that if any value greater than this was chosen, a limited number of

²U.S. Department of Transportation/Bureau of Public Roads, <u>Guidelines for Trip Ceneration Analysis</u> (Washington: Government Printing Office, 1967), p. 112.

variables would have been selected. However, additional criteria may be necessary in selecting the socio-economic variables.

From this analysis, the best curve fit of the relationships was selected in order to determine necessary transgenerations for the stepwise multiple regression analysis. These transgenerations basically transformed the nonlinear functions into the particular logarithmic, exponential, or hyperbolic function they applied to in order to achieve linearity.³ The stepwise multiple regression analysis (SMRA) was the statistical technique used to develop the sixteen different equations predicting tripends by purpose. Five basic assumptions had to be satisfied in the multiple regression analysis in order to draw valid inferences and conclusions from the data. These included (1) Linearity, (2) Uniform scatter of deviations about the regression line, (3) Independence among the deviations, (4) Normal distribution of deviations about the regression line, and (5) Colinearity.⁴ Additionally, it was assumed that all socio-economic characteristics tested in the analysis were homogeneous among zones and the majority of trips in the area studied originated from the home. In the past few years, multiple regression computer programs have made the development of trip generation equations a relatively fast "prepackaged" process if

⁴Ibid., p. 609.

³William S. Spurr and Charles P. Bonini, <u>Statistical Analysis</u> for Business Decisions (Homewood, Illinois: Richard D. Irwin, Inc., 1967), p. 605.
an analyst has the proper computer and programmers available. While this permitted the development of multivariable equations, these programs resulted in the analyst becoming more disassociated from the data he was analyzing. As a result, complex equations were developed which were statistically adequate, but had little or no thought given to the reasonableness of the results. The University of California at Los Angeles Biomedical Series Stepwise Regression BMD02R program was the computer program used to generate the basic tripend equations.

Stepwise multiple regression analysis (SMRA) is similar to linear regression analysis. The major difference between these two analyses is that SMRA can produce an n dimensional relationship between independent variables and a single dependent variable. Simple linear regression analysis is capable of producing only a two dimensional relationship. The following equations 2.1 and 2.2 illus-

Sample Linear Regression Equation

(2.1)
$$Y = A + B X$$

Equation resulting from Stepwise Linear Regressional Analysis using X_n independent factors.

(2.2)
$$Y = A + B_1 X_1 + B_2 X_2 + B_3 X_3 \dots + B_n X_n$$

where

Y = a dependent variable A ='a constant

 $B_n = coefficient of independent variables$

SMRA generates individual relationships of the dependent variable to the independent variables and then successively adds variables to a regression equation with the objective of obtaining the best final equation. Variable's continue to be added until the maximum step is reached, there are no more variables, or there are no more variables which satisfy the desired statistical tests.

A simple correlation matrix was a useful tool in evaluating variables for logical and causative associations. The coefficient of simple correlation was a measure of association between two variables and the matrix of these combinations gave the correlation coefficients for all possible combinations of variables.

Other useful statistics in the analysis included the multiple correlation coefficient (R), the standard error of the estimate (Sy \times), and the t ratio test. The multiple correlation coefficient, R, indicated the degree of association between the independent and dependent variables in the tripend equations. The higher the value R is in measuring the equation results, the greater the reliability of the equation. The standard error of the estimate indicated the degree of variation of the data about the regression line. It measures the error to be expected in predicting the dependent variable from the independent variables in the equation. The \pm ratio, shown in equation 2.3,

calculates the t value for each independent variable in the regression equation.⁵

(2.3)

$$b_i = \frac{b_i}{S_{b_i}}$$

where

t_{b;} = t ratio test statistic

 b_i = the regression coefficient of an independent variable S_{b_i} = the standard error of the regression coefficient

Both elements needed to compute the t ratio are printed out in the stepwise regression analysis run. The result from this equation, the calculated t value, is compared against the t critical value for significance as described in the next section.

The next segment of the analysis consisted of SMRA runs using forced variables. These forced variables were basically the highest r^2 obtained from the curve f^{i+} program or logical transportation relationships that have been found significant in previous trip generation analyses.⁶ After these forced variables provided an indication of what the equations might be, additional SMRA runs were made with no restrictions on the order of the variables entering the equation. The

⁶Ibid., p. 95.

⁵U.S. Department of Transportation/Bureau of Public Roads, <u>Guidelines for Trip Generation Analysis</u> (Washington: Government Printing Office, 1967), p. 84.

results of these combined stepwise multiple regression runs provided the basis for the final predictive production and attraction equations. The t significance test was then used to select significant independent variables for the various equations. Also at this stage the standard error of the estimate, multiple correlation coefficient, and the t ratio test were used as other indicators of the reliability of the predictive equations.

Hypotheses Testing

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A criteria in the hypotheses testing was the appropriate significance level. The .95 significance level on a t distribution was selected since prior and existing transportation studies used this level of significance.⁷ Also the t test was used to determine whether the estimated coefficient was significantly different from some hypothesized value of the true regression coefficient (B_i). Using a table of the t distribution, the null hypothesis ($B_i = 0$) was rejected if the t statistic was greater than or equal to the t value of the table.⁸ This test was conducted on each regression coefficient to indicate when any of the independent variables are of no further value in predicting values

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⁷Mr. Ron Rude, Transportation Planner, Montgomery and Greene Counties Transportation Coordinating Committee, in a personal interview, June, 1971. Permission to quote secured.

⁸Spurr and Bonini, <u>Statistical Aralysis for Business Decisions</u> (Homewood, Illinois: Richard D. Irwin, Inc., 1967), p. 608.

of the dependent variable. Any independent variable whose regression coefficient did not meet the t test was eliminated from the equations as an indication that the variable did not have a significant relationship with the dependent variable.

The first hypothesis ("The socio-economic characteristics of occupation, population density. employment density, car ownership, school enrollment, and dwelling units per zone are all significant for use as predictors of both tripend productions and attractions in Montgomery and Greene Counties. ") was tested through use of the t test. If the socio-economic characteristics previously stated were significant for use as predictors of tripends, their t statistical value was greater than or equal to the t critical value at the .05 significance level. The absence of any hypothesized factors in these equations indicated that these factors did not have a significant relationship on the generation of tripends.

The second hypothesis ("There are differences between variables in predicting tripends in Montgomery and Greene Counties.") was tested using the beta coefficient (β). The beta coefficient gives a direct measure of the relative importance of independent variables in a predictive equation. The formula for the beta coefficient is shown in Equation 2.4.⁹

⁹U.S. Department of Transportation/Bureau of Public Roads, <u>Guidelines for Trip Generation Analysis</u> (Washington: Government Printing Office, 1967), p. 85.

(2.4)

$$\beta_i = \frac{b_i \quad S_{x_i}}{S_y}$$

where

 β_i = the beta coefficient

bi = the regression coefficient for the ith independent
variable

 S_{x_i} = the standard deviation of the ith dependent variable S_v = the standard deviation of the dependent variable

Thus this statistic provided the basis for proving that differences do exist between the independent variables.

Reasonableness of Results of the Analysis

The situation that faced the authors was one of making a competent selection of variables to be included in the analysis from many possibilities. A corollary to the problem was the task of selecting the proper functional bivarate relationships. Since these relationships were not readily discernible, the authors relied on scatter diagrams and a least squares curve fit generated by a computer operated cathrode ray tube on the raw data. When non-linear relationships were identifiable, the independent variable(s) were transferred into logarithmic or power functions so that the relationships became linear. Total reliance was not placed on scatter diagrams alone, however, since the relationship represented between two variables usually changes when a third variable is added.

In the selection of independent variables, the logic of the proposed relationship was considered. Variables which appeared to be most reasonably related to the dependent variable were considered for analysis.¹⁰ For example, employment is a more logical attractor rather than producer of tripends. This choice was based on some subjective reasoning rather than relying on the computer program alone to sift the data and find a relationship. In the case of SMRA, the computer, at each step, entered the variable which provided the greatest reduction in the residual sum of the squares into the equation. The procedure considered only the associative relationship between the independent and dependent variables. Such relationships might have been caused by chance. Thus, the authors used variables which reflected casual relationships as well. For example, it was expected that the characteristics which described the household contributed positively to the production of home based vehicle trip productions. On the other hand, an equation for transit trip production might have a negative correlation with the dependent variable. This assumed that on the average, as car ownership decreased, transit trips increased. Therefore, the logical nature of the relationships was considered prior to developing the regression equations.

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The colinearity of the variables was also checked for

¹⁰U.S. Department of Transportation/Bureau of Public Roads, <u>Guidelines for Trip Generation Analysis</u> (Washington: Government Printing Office, 1967), p. 28.

reasonableness of results of the analysis. Colinearity or correlation between two independent variables in multiple regression can have a great effect on the standard error of the regression coefficient. When two independent variables are highly correlated the net regression coefficient may be unreliable. ¹¹ A solution to this problem is to eliminate the independent variable which is considered less important to the equation. In this way colinearity was used as a check towards the reliability of the individual variables in the regression analysis.

Another method of determining reasonableness of results was the graphs of residual values of the particular dependent variable tested against its significant independent variable. These plots provided a check of the standard error of the estimate in the predictive equations. These graphs indicated how well the values were scattered around the regression equation. In this manner then, the graphs were another measure of the reasonableness of results of the analysis.

¹¹Spurr and Bonini, <u>Statistical Analysis for Business Decisions</u> (Homewood, Illinois: Richard D. Irwin, Inc., 1967), p. 610.

Chapter 3

ANALYSIS

The analysis chapter of the thesis is divided into three parts. The first part consists of the results of a curve fit analysis of socioeconomic factors. The generation of significant equations from these factors forms the second portion of the analysis. The final section consists of detailed analysis and implications of the significant predictive equations.

Curve Fit Analysis of Socio-Economic Factors

The first step in analysis of the data was the curve testing of all independent variables against the sixteen trip purposes for production and attraction equations on a bivariate or two variable basis. The results of this test displaying the best least squares curve fit and highest coefficients of determination of these relationships are presented in Tables 2 and 3 on pages 35 and 36. Next, logical relationships among the independent variables and the different trip purposes (dependent variables) as well as relationships from coefficients of determination (r^2), were tested in the stepwise multiple regression analysis program (SMRA). Two criteria were used in testing the r^2 values. The primary criterion was the selection of any variable O

Table 2

Bivariate Coefficients of Determination (r²) for Production Tripends by Purpose and Socio-Economic Characteristics

							1	35
Lin	Lin	Lin	Нур	Log	Hyp	Log	Lin	lic
. 83	. 004	. 15	. 007	. 36	.04	. 31	.51	
Log	Hyp	Lin	Lin	Log	Lin	Log	Log	= Ilyperbo
.10	.02	.12	. 004	. 03	. 06	. 03	.08	
Log	Hyp	Lin	Lin	Log	Lin	Exp	Log	riable)
. 90	. 002	.10	. 005	. 31	. 05	.19	.52	mic Ilyp
Log	Lin	Lin	Нур	Log	Нур	Log	Log	ependent Val
. 89	.04	. 03	. 001	.36	• 04	. 25	.59	y = Logarith
Log	Hyp	Lin	Hyp	Log	Hyp	Log	Log	teristics (Ind
. 89	. 0003	. 03	.001	. 36	.04	.25	• 59	onential Log
Log	Lin	Lin	Lin	Log	Hyp	Exp	Log	ionic Charac
. 89	. 001	. 14	. 008	. 36	.04	.28	.59	Exp = Exp
Lin	Нур	Lin	Lin	Log	Lin	Lin	Log	Socio-Ecor
. 92	. 002	.12	. 0005	.31	. 006	. 25	.52	Jin = Lincar
Lin . 94	Hyp .004	Lin .12	Lin . 002	Lin .31	Hyp .04	Lin .26	Lin	Curve:]
Home	Work	Personal Business	Shopping	Social Recreational	School	All Others	All Purposes	cy to Type of (
	i) osodan	I yd ei eldeire	onoqiuT V Juoba	notion (pqpd)	bord			×
	Home Lin Lin Log Log Log Log Log Log I.in .94 .92 .89 .89 .90 .10 .83	Home Lin Lin Log Log Log Log Log Log Log Log Log Lin S3 . .94 .92 .89 .89 .90 .10 .83 . Work Hyp Hyp Lin Hyp .10 .83 . 004 .002 .001 .003 .04 .002 .02 .004	Home Lin Lin Log Log Log Log Log Lin .83 .94 .92 .89 .89 .90 .10 .83 Work Hyp Hyp Lin Hyp Lin Hyp 0003 Lin Hyp 2002 .004 .004 .002 .001 .0003 .04 .002 .02 .004 Business .12 .12 .14 .03 .03 .03 .10 .12 Lin Lin Lin Lin Lin 15	Home Lin Lin Log Log Log Log Log Log Log Log Log 1, 10 .83 .94 .92 .89 .89 .90 .90 .10 .83 .004 Work Hyp Hyp Lin Hyp 0.0003 .04 .002 .02 .004 .004 .002 .001 .0003 .04 .002 .02 .004 .012 .12 .12 .14 .03 .03 .10 .12 .15 Business Lin Lin Lin Lin Hyp I, 001 .005 .004 .007	HomeLinLinLogLogLogLogLogLogLogLogLogLogLogLogLinS39.4.92.89.92.89.90.90.10.90.10.83WorkHypHypHyp.001Hyp.003.04.002.004NorkHyp.001Hyp.0003.04.002.002.004NorkI.inLinLinLin.011.012.002.004NorkNork.12.12.14.03.03.03.10.12.15ShoppingLinLinLinLinHypHyp.001.001.16.004ShoppingLinLinLinHyp.001.001.001.005.004.007Goopondent ShoppingLinLinLinLin.001.001.005.004.007Coopondent ShoppingLinLogLog.001.001.001.005.004.007Coopondent ShoppingLinLogLog.001.001.003.003.03.03SocialLinLinLinLin.001.003.003.004.007Recreational.31.31.36.36.36.31.03.03.063	HomeLinLogLogLogLogLogLogLogS \cdot 94 \cdot 92 \cdot 89 \cdot 89 \cdot 89 \cdot 89 \cdot 90 \cdot 10 \cdot 83WorkHypHypHyp \cdot 92 \cdot 92 \cdot 90 \cdot 10 \cdot 83WorkHypHyp \cdot 90 \cdot 001 \cdot 0003 \cdot 04 \cdot 002 \cdot 004ProductionLinLinLinLinLin \cdot 113 \cdot 113Business \cdot 112 \cdot 112 \cdot 114 \cdot 003 \cdot 013 \cdot 010 \cdot 102 \cdot 104ShoppingLinLinLinLin \cdot 014 \cdot 003 \cdot 013 \cdot 013 \cdot 115SchoolLinLinLinLinLin \cdot 011 \cdot 011 \cdot 013 \cdot 013 \cdot 014RecreationalLinLinLinLin \cdot 016 \cdot 003 \cdot 004 \cdot 003SchoolHypHypHypHypHyp \cdot 016 \cdot 004 \cdot 003SchoolHypHypHypHyp \cdot 016 \cdot 004 \cdot 003SchoolHypHyp \cdot 016 \cdot 04 \cdot 016 \cdot 016 \cdot 04SchoolHypHyp \cdot 04 \cdot 04 \cdot 04 \cdot 04 \cdot 04	$ \begin{array}{c ccccc} \mbox{Home} & \mbox{Lin} & \mbox{Lin} & \mbox{Lin} & \mbox{Lin} & \mbox{Lin} & \mbox{Hyp} & \mb$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$

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Table 3

Tripends by Purpose and Socio-Economic Characteristics Bivariate Coefficients of Determination (r^2) for Attraction

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Dwelli Ilnit	Lin .8	Lin .0	Lin . 1	Lin . 0	Log • 4	Log . 0(Log .3]	Lin	
Employ-	Log	Hyp	Нур	Lin	Hyp	Lin	Log	Log	yperbolic
ment	. 11	. 02	. 003	. 004	.04	. 06	. 03	. 08	
Students	Lin	Нур	Lin	Lin	Log	. Lin	Log	Log	riable)
	. 76	. 003	.10	.01	.31	. 05	.20	.52	c Ilyp = H
Protective	Log	Lin	Lin	Hyp	Log	Lin	Log	Log	pendent Va
People	• 89	. 05	. 03	.001	.37	. 005	.26	• 59	Jogarithmic
Professional	Log	Hyp	Lin	Hyp	Log	Lin	Log	Log	cristics (Inde-
People	. 89	. 0003	. 04	.001	.37	.01	.26	59	ntial Log = 1
Employment	Log	Lin	Lin	Lin	Log	Hyp	Exp	Log	nonic Charact
	. 89	.001	.14	. 009	.37	• 003	27	. 59	Exp = Expone
Pcrsons	Lin	Lin	Lin	Lin	Log	Lin	Lin	Log	Socio-Eco
	. 92	.0001	. 12	. 001	. 35	. 007	. 25	52	1 = Linear
Cars	Lin . 94	Hyp . 004	Lin . 12	Lin . 002	Log .37	Lin . 004	Exp .27	Lin .51	Curve: Lir
	Home	Work	Personal Business	Shopping	Social Recreational	School	All Others	All Purposes	Key to Type of
		asoda	spie) pa Paus	abnoqi' i'asV Ju	D noir: obnogo	onbor4 D)			+4

having an r^2 greater than .30. If the first criterion could not be met, the two highest r^2 's for the particular purpose examined were chosen. An r^2 of .30 and higher was chosen in order to provide a level sufficient both for variable generation and variable selection. To illustrate this point, only one-third of the values in both the attraction and production tables had r^2 's greater than .30.

In order that the proper functions would be tested for the correct predictive equations, the curve functions from the curve fit program were transgenerated in the SMRA program. In analyzing 825 zones in the area studied, an incorrect inference could be made by assuming complete linearity among variables in the various predictive equations. This limitation was accounted for in the program by the previously mentioned step. Also it should be noted that the stepwise regression program did not compute the exponential power as the power of this function approached zero. For example, the power of several exponential functions analyzed was .0018, beyond the capabilities of the stepwise regression program. Therefore in each instance where this occurred in the curve fit program, the second highest coefficient of determination was substituted for the exponential function. In all cases where this was applied, the differences were slight and in no instance did they affect the final predictive equations.

Generation of Equations from the Socio-Economic Factors

The second step of forcing variables into the equation provided some benefit to the analysis. Two criteria used in forcing variables were: (1) the logical relationships of the independent variables to the particular dependent variable trip purposes and (2) the highest coefficients of determination among the independent variables. However, the logical relationships that were forced did not prove successful. Among these relationships were: home work trip productions and attractions related to employment per zone; home shopping trip production and attractions related to cars and persons per zone; employment per zone as an attractor of trips to the home; and persons per zone as a strong indicator toward home social recreational trip attraction. These forced logical relationships represented some of the significant variables the Department of Transportation had found in tripend prediction through their years of research in the area. ¹ Of all forced logical relationships tested, none were significant at the study's predetermined significance level of . 95.

Forcing the equations as a result of the curve fit program gave much better outcomes. Of the eleven predictive equations where high r^2 independent variables were forced, seven produced significant independent variables. Furthermore, of the remaining four predictive

¹U.S. Department of Transportation/Bureau of Public Roads, <u>Guidelines for Trip Generation Analysis</u> (Washington: Government Printing Office, 1967), p. 44.

equations which did not produce significant variables, two had no significant independent variables in them and were consequently eliminated as predictive equations. The only two equations where the highest coefficient of determination through curve fit analysis did not prove important was all home based production and attraction trips. In these equations the highest r^2 showed that three variables should be forced: total employment per zone, professional persons per zone, and protective persons per zone. This may well seem unreasonable for the productive equation, since employment and occupations are normally considered better attractors than producers of tripends. However for the attraction equation other than the dominant influence of the variable, cars, no additional reasonable explanation of this result can be given. Therefore use of the curve fit program with some reasonable idea of pertinent re ationships would appear to give the researcher a place from which to start in trip generation analysis.

After forcing of the variables was concluded and compared against the t critical value to determine significant variables, the first hypothesis was tested. Eleven of the sixtcen equations produced one or more significant socio-economic characteristics. While these equations were statistically correct, one could question a few in regard to their reasonableness. Although possessing significant socioeconomic characteristics, attraction equations did not appear to provide realistic variables whereas production equations did. However, taking the hypothesized socio-economic characteristics as a whole,

four of the eight characteristics appeared in one or more equations. Only employment per zone, protective persons per zone, unemployment per zone, and dwelling units per zone were not significant among the socio-economic characteristics hypothesized. One-half of the characteristics were significant which points to possible hypotheses concerning these four. In this light, cars appeared as a significant variable in eight of the eleven predictive equations. Therefore, the first hypothesis can be rejected--not all socio-economic characteristics are significant as predictors of production and attraction tripends in the area studied.

After testing the first hypothesis, additional stepwise regression runs were made allowing a natural addition or deletion of variables in order to obtain the best final predictive equations. The results from these particular runs, which are explained in the next section of this chapter formed the basic predictive equations found in Tables 4 and 5 on pages 41 and 42. At this point, the second hypothesis was examined. Testing for the second hypothesis was accomplished through use of the beta coefficient which provides a direct measure of the relative importance of independent variables in the multivariate equations to which it applied. The results of this testing appear in Table 6, page 43. In testing the three multivariate equations in the analysis, cars which appeared in every equation was found to be different than the other particular variable in the equations. In all

41		
		∜All units are per zone
	= 195.88 + 3.87 (cars)	All Trips
	= - 20.99 + .59 (cars)	All Other Trips
ı	= 121.87 + .11 (students)	School Trips
	= 317.02 + .30 (cars) - 110.17 log (professionals)	- Social Recreational Trıps
, .	$= 211.40 + \frac{37,552.88}{\text{cars}}$	Work Trips
1	= - 5.60 + 1.60 (cars) + .42 (persons)	- Home Based Trips*
;	int Production Equations for Predicting Tripends Per Zone	Significe
•	Table_4	
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(Table 5	on Equations for Predicting ads Per Zone	- 45.35 + 1.65 (cars) + .41 'pers	209.83 + <u>37,797.42</u> cars	147.14 + .10 (students)	- 2.19 + .23 (persons)	668.84 + 3.89 (cars)	-		
		Significant Attractí Tripei		и	11	n	n			
			Home Based Trips*	Work Trips	School Trips	All Other Trips	All Trips	ll units are per zone		
0								*A1		

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Table 6

Comparison of the Significant Independent Variables in Multivariate Tripend Equations Using Beta Coefficients

			β_{Coel}	ficients
			Cars	Persons
Home Based Trip Productions	11	- 5.60 + 1.60 (cars) + .42 (persons	. 62	.37
Social Recreational Trip Productions	11	317.02 + .30 (cars) - 110.17 log (professionals	. 68	. 23
Home Based Trip Attractions	. 11	- 45.35 + 1.65 (cars) + .41 (persons)	. 63	.36

43

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cases, cars per zone had at least a two to one ratio compared to its associate variable in the equations. Two of the three equations were entirely linear relationships while the third, social recreational trip production, had a linear and logarithmic function. This simple yet useful statistic, the beta coefficient, proved the second hypothesis to be correct--differences among the significant independent variables did exist.

After the second hypothesis was tested, the analysis was divided into production and attraction tripend equations. Using this segmentation, six production and five attraction equations were found significant at the .05 level. The production and attraction equations are listed in Tables 4 and 5 on pages 41 and 42.

Production Equations

The six significant production tripends included the following purposes: trips from home, work, social recreational, school, all other home trip productions, and all home trip productions.

Analysis

The equation predicting trips from home provided two significant variables, cars per zone and persons per zone. Each variable surpassed the t critical value of 1.67 for 79 cases in the stepwise multiple regression program as seen in Table 7, page 45. The multiple correlation coefficient (R) was significantly high at .98 while the

			Fripend Equat	ions			
Production Tripends per zone by	Significant Socio-Economic Characteristics	Calculated t Values	Step Variable Entered Equation	Sample Size	T Critical Value	Multiple Correlation Coefficient R	Standard error of estimate Sy·x
Furpose	Cars Persons	7.18 3.67	7	62	1.67	.97 .98	305. 92 256. 23
Work	Cars	2.20	1	77	1.67	• 00	340.74
Pcr sonal Business	None	·		62	1.67		
Shopping	None			63	1.67		
Social Recreational	Cars Professionals	3.36 2.25	 7	62	1.67	.55 .59	170. 77 166. 89
School	Students	2.20	1	52	1.68	.30	382.30
All Others	Cars Employment*	3.71 1.81	7 7	77	1.67	. 69	283.49 281.77
All Durndes	Cars	3.93	Ч	62	1.67	. 85	1137.39

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standard error of the estimate (Sy . x) was 256.23. The second figure can be explained by the magnitude of the data in this study. For such a large number of tripends as can be found in this analysis, a range of numbers for the standard error of the estimate between 166.89 and 1137.39 seems insignificant. Another credible point was the plot of the residual values of Y against the significant variables for all the predictive equations. The graphs indicated for all equations that the assumptions for multiple regression analysis had been met. In the trip purposes categories of work, and all trips, only cars in each case was found to be the significant independent variable. The calculated t value for all trips was somewhat similar in value and yet larger than that for work. The multiple correlation coefficient was .09 for work compared to . 85 for all. Once again the standard error of the estimate was in the range of 150-400. A difference existed only in the case of all trip purposes. This particular standard error of the estimate could logically be explained by the fact that all categories were totaled for the dependent variable, all trip purposes. Cars was also the significant variable in the predictive equation for all other trip purposes. In the table of production equations, employment per zone was also listed as a significant variable due to colinearity between cars and employment per zone. In the correlation matrix for this particular production equation, the correlation between the two was .843 while correlations of cars and employment per zone to the dependent variable was only . 695 and . 524 respectively. Since the

cars variable entered the equation first and had the highest t ratio. employment was determined to be the variable less important to the equation. While other variables had colinearity in both production and attraction equations, this particular equation was the only one whose colinearity did affect the significant variables in the equation. School as a trip production had students per zone as its only significant independent variable. The R value was one of the lowest for productions .30 as well as a higher value of the standard error of the estimate 382.30 as previously discussed. For this purpose the fact that the t ratio was the lowest to pass the t critical value can explain these particular values for R and Sy .x. The social recreational trip production produced two significant independent variables, cars and professional people per zone. While cars per zone was not an unexpected significant variable, professional people per zone provided a mild surprise. This particular variable added an R value of . 59 and a low value of 166.89 to the equation. Personal business and shopping for trip productions did not uncover any significant independent variables. From the stepwise regression analysis results comes the basic predictive trip production equations listed in Table 4, page 41.

Implications

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In nearly all of these equations, four of six to be exact, every independent variable was linear. The only exceptions to these were home work trip productions with cars as a hyperbolic function and the

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social recreational trip production where one of the two significant variables, professional people per zone, was a logarithmic function. The independent variable or variables in each production purpose equation were quite logical and confirmed past transportation studies on household data. In this regard, the variables were similar to a nationwide study of household data by the University of Michigan.² However, in the same light, the emergence of professional people per zone in the Montgomery and Greene Counties region implied the need for updating of significant socio-economic characteristics. Professional people may well be the leaders in today's mobile society in regards to social and recreational trips. In many instances, present day professional people take days off to enjoy themselves. Therefore this particular variable's relevance toward social recreational trips appears logical. The continual presence of cars in the production equations is another indication of how mobile our present day society is over past generations. Persons as a significant variable for home based trips bear out the assumption that the more people in a household, the more trips made from that home. Finally students appear to be a plausible, significant variable in predicting production of trips to school. This is an indication of several factors that have emerged in today's society. The first factor is the practice of mothers driving

²U.S. Department of Transportation/Bureau of Public Roads, <u>Guidelines for Trip Generation Analysis</u> (Washington: Government Printing Office, 1967), p. 70.

grade school children to school. The second factor is that many high school students drive their own cars to school today. A final factor can be traced to the decline of the neighborhood school in the suburbs. This factor requires busing school children over the same distances walked by previous generations. Therefore, this variable as all the others previously mentioned in production tripend purposes is quite logical. As for the attraction equations, they were found to be similar to the generated production equations.

Attraction Equations

Stepwise regression analysis results for the attraction equations are contained in Table 8, page 50. The five significant attraction tripends included the following purposes: trips to home, work, school, all other trips, and all home trip attractions.

<u>Analysis</u>

Trip attractions to home had two significant independent variables, cars and persons per zone. The multiple correlation coefficient, R, was quite high at . 98 and the standard error of the estimate $(Sy \cdot x)$ was 258.48, the lowest value of all the predictive attraction equations as seen in the table. The data was similar to the results of the trips from home production equation although the t ratios for the variables in the attraction equation, taken together, were higher. All other significant attraction equations had only one independent variable: students for school attraction, persons for all other trip attractions,

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	Stepwis	e Multiple Reg ¹ Attraction T	ression Anal ripend Equat	ysis Result ions	s for		
						7 4 14: -1 -	Standard
Production ripends per zone bv	Significant Socio-Economic Characteristics	Calculated t	Step Variable Entered	Sample	T Critical Value	Multiple Correlation Coefficient R	error of estimate Sy·X
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School	Students	1.93	1	51	1. 00	•	
All Others	Persons	3.02	1	77	1.67	. 62	307.08
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and cars for both work and all trip attraction purposes. The t ratio for students in school attraction tripends and cars in work attraction tripends were both barely above the t critical value and had the two highest standard errors of the estimates outside of all trip attractions. This again, was somewhat similar to the production results in this The predictive equation for all trip attracparticular trip purpose. tions produced the second highest value of R among the attraction equations . 85 but also gave the highest standard error of the estimate for both production and attraction equations. Again this high value appeared to be the result of pooling all trip attraction purposes as previously mentioned for all production trip purposes. Persons per zone was the significant variabl, in the predictive equation for all other trip purposes. The other trip attractions: personal business, shopping, and recreational trips did not contain any significant variables. From this stepwise regression analysis, the basic predictive attraction tripends equations are found in Table 5, page 42.

Implications

Four of the five equations had linear relationships. The only exception was the work trip attraction equation where the significant variable, cars, was a hyperbolic function. The variables that appeared in the attraction equations seemed somewhat illogical as attractors of tripends. For example, in nearly all cases, cars is not an attractor in transportation studies. However, statistically in the

analysis this socio-economic characteristic was the predominant significant variable. Normally, cars are better predictors of production tripends. From this, one might reason that if better attraction variables had been taken in the study, cars might not have dominated the attraction equations. For example, improved attraction variables could be square footage of warehouse, office and retail space, number of retail workers, number of theater seats available in the area surveyed, and number of people served by fast food franchises in the area. In almost every case the attraction equation results appeared similar to the production equations. This points to several possible findings. One is that either production or attraction equations are not totally logical. Additionally, since the sur vey was household oriented, the production equations from origin trips would appear to be more logical than the attraction equations. Also it appeared that it was unnecessary for this survey to break down trip purposes into eight different categories. Five of the sixteen equations had no significant variables. This indicated that trip purposes may have been overstratified for this particular survey. In smaller areas (und er 100, 000 population) three trip purpose categories have been used su cressfully: home based work, home based other and non-home ba sed trips.³

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³U.S. Department of Transportation / Bureau of Public Roads, <u>Guidelines for Trip Generation Analysis</u> (Washington: Government Printing Office, 1967), p. 44.

Summary of Findings

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In this chapter eight trip purposes extracted from the 1968 TCC Origin-Destination Survey were tested for production and attraction equations at the .05 significance level using the t significance test. After the significant production and attraction equations were found, the two hypotheses in the thesis were examined.

1. The first hypothesis was that the socio-economic characteristics of occupation, population density, employment density, car ownership, school enrollment, and dwelling units per zone are all significant predictors of both tripend productions and attractions in Montgomery and Greene Counties. This hypothesis was tested using the t significance test. However, only four of the eight characteristics appeared in one or more of the equations. Therefore, the first hypothesis was rejected--not all socio-economic characteristics were significant for use as predictors of both tripends and attractions.

2. The second hypothesis stated that there were differences between variables in predicting tripends in Montgomery and Greene Counties. This hypothesis was tested using the beta coefficient. The results of the test proved that the hypothesis could not be rejected. Differences between significant independent variables did exist.

3. Six significant production tripend equations were found for the following purposes: trips from home, work, social recreational, school, all other home trip productions, and all home trip productions. Trips from home provided two significant variables, cars per zone and persons per zone. In the trip purpose categories of work, all other trips and all trips, only cars was found to be the significant independent variable. In the case of all other trip productions, colinearity appeared between two variables, cars and employment. Since employment was determined to be the variable less important to the equation it was eliminated. School as a trip production had students per zone as its only significant independent variable. The social recreational trip production also produced two significant independent variables, cars and professional people per zone.

4. Five attraction tripend equations were found cignificant for the following purposes: trips to home, work, school, all other trips, and all home trip attractions. Trip attractions to home had two significant independent variables, cars and persons per zone. All other significant attraction equations had only one independent variable: students for school attraction, persons for all other trip attractions, and cars for both work and all trip attraction purposes. All other trip purposes, personal business and shopping in both production and attraction tripends, and social recreational trip attractions did not contain any significant variables.

Chapter 4

SUMMARY, FINDINGS, AND CONCLUSIONS

Summary

Developing any regional t. ansportation system is an uncertain and costly undertaking. The fixed elements of a highway network or mass transit scheme are very difficult and expensive to change. Therefore, an intensive problem analysis should precede the design of any transportation system. In order that this may be properly performed, the factors that affect ground passenger transportation must be quantified and related. In this thesis the area surrounding Wright-Patterson Air Force Base, Greene and Montgomery Counties, Ohio was examined in this respect.

The research effort had three basic objectives: (1) to extract selected trip generation characteristics from the 1968 TCC Origin-Destination Survey, (2) to identify and quantify the tripends in Montgomery and Greene Counties, and (3) to provide equations for estimating tripends for zones within Montgomery and Greene Counties. The research effort was restricted to tripend volumes and the relationships various socio-economic factors have upon tripend production. These socio-economic factors were occupation, population density, employment density, car ownership, school enrollment, and dwelling units, all expressed per zone. From these factors the following hypotheses were examined: (1) All socio-economic characteristics analyzed are significant as predictors of production and attraction tripends in Montgomery and Greene Counties and (2) Differences among the significant independent variables do exist.

The methodology used in the research effort consisted of two parts. The first part was a curve fit analysis of the socio-economic factors hypothesized. The curve fit program provided a best least squares curve fit of all independent variables against sixteen trip purposes for production and attraction equations on a bivariate or two variable basis. From this part, equations were generated from the various socio-economic factors using a stepwise multiple regression program. The significant variables from among these socio-economic factors were then determined through use of the t significance test. The first hypothesis was examined by use of this test. In order to test the second hypothesis concerning differences between significant variables, the beta coefficient was used. The findings from this procedure are presented in the next section.

Findings

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1. The first hypothesis was that the socio-economic characteristics of occupation, population density, employment density, car ownership, school enrollment, and dwelling units per zone are all significant predictors of both tripend productions and attractions in Montgomery and Greene Counties. Only four of the eight characteristics appeared in one or more of the predictive equations. Therefore the first hypothesis was rejected--not all socio-economic characteristics were significant for use as predictors of both tripends and attractions.

2. The second hypothesis stated there were differences between variables in predicting tripends in Montgomery and Greene Counties. The results of this test using the beta coefficient proved that the hypothesis could not be rejected. Differences between significant independent variables did exist.

3. Six significant production tripend equations were found for the following purposes: trips from home, work, social recreational, school, all other home trip productions, and all home trip productions. Trips from home provided two significant variables, cars per zone and persons per zone. In the trip purposes categories of work, all other trips and all trips, only cars was found to be the significant independent variable. In the case of all other trip productions colinearity appeared between two variables, cars and employment. Since employment was determined to be the variable less important to the equation it was eliminated. School as a trip production had students per zone as its only significant independent variable. The social recreational trip production also produced two significant independent variables, cars and professional people per zone.

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4. Five attraction tripend equations were found significant for the following purposes: trips to home, work, school, all other trips, and all home trip attractions. Trip attractions to home had two significant independent variables, cars and persons per zone. All other significant attraction equations had only one independent variable: students for school attraction. Forsons for all other trip attractions, and cars for both work and all trip attraction purposes. All other trip purposes, personal business and shopping in both production and attraction tripends and social recreational trip attractions, did not contain any significant variables.

From these findings, the following conclusions were reached.

Conclusions

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1. Design of the Survey. --As mentioned in the summary an intensive problem analysis should precede the design of any transportation system. In the 1968 TCC study a complete design of the survey did not appear to be performed which caused several problems. First, an overstratification of data was evident in both the number of zones used in the survey and the type of socio-economic information collected. In the Pittsburgh and Chicago Area Transportation Studies (PATS & CATS) where 1.47 million and 6.8 million people in the area were covered in the studies respectively, only 226 and 582 zones were used for analysis. Furthemore PATS had 420 square miles in their study while CATS included 1236 square miles.¹ For 700,000 people and 881 square miles in the Montgomery and Greene Counties region in 1968, 825 zones for the TCC study would not seem to follow suit. Many of the socio-economic characteristics were too finely segmented to produce truly reliable equations. Data which are "cut too thin" produce mean numbers of trips of small magnitude (with correspondingly high sampling variation) but the number of observations in each analysis area [zone] may be insufficient to obtain reliable estimates.² In this same light, inspection of the data indicated a lack of homogenity among zones. Many zones in the analysis had no tripends or socioeconomic characteristics recorded. For example, zone numbers 2127, 6516, and 9313 in Appendix G did not contain data values on any characteristics. Better descriptions of trip purposes should have been utilized in the survey questionnaire. For example in considering social recreational trips very specific purposes for origins and destinations would have been desirable. Correspondingly, trips to parks, movies, and restaurants would provide better insight into this particular trip purpose. Also related to the design of the survey was the finding that

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¹U.S. Department of Transportation/Office of Highway Planning, Modal Split (Washington: Government Printing Office, 1966), pp. 7, 16.

²U.S. Department of Transportation/Bureau of Public Roads, <u>Guidelines for Trip Generation Analysis</u> (Washington: Government Printing Office, 1967), p. 44.

the significant predictive equations contained many variables which were oriented to production of trips. In this sense cars per zone was the major variable in the predictive equations. If better attraction variables had been selected in the initial design, cars might not have so totally dominated the predictive equations. Additionally since the survey was household oriented, the production equations would appear to be more reasonable than the attraction equations.

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2. Statistical Analysis Used in Trip Generation. -- During the past few years multiple regression computer programs have made the development of trip generation equations a relatively fast "pre-packaged" process. While this permitted the development of multivariable equations, these programs resulted in the analyst becoming more disassociated from the data. As a result, complex equations were developed which were statistically adequate but had little or no thought given to the reasonableness of the results. This situation appears to be the case in the Department of Transportation studies in trip generation analysis. The statistical techniques used are simple and useful, yet more rigorous procedures appear to be needed. An illustration of this is that no check can be made for predictive equations when the data is collected once every ten years. A method is presently needed to verify the accuracy of these predictive equations. As more experience and knowledge is gained in this relatively new area, the statistical techniques are certain to improve. Also it remains important to

pretest the study area and survey questionnaire in order to determine which socio-economic characteristics should be collected in the actual survey. This procedure will conserve not only time, but tend to produce more meaningful results.

3. Immediate Need to Analyze Trip Generation Analysis. -- In today's rapidly changing environment, there is a continual need in trip generation analysis to keep up with changes in the character and intensity of land use, population distribution and other pertinent socio-economic characteristics. In this atmosphere it is mandatory that immediate analysis be made on the most recent surveys conducted in the areas studied. Most origin and destination studies usually lag analysis by five to seven years. This procedure musical eversed in order to deal effectively with designing transmission retworks needed to service present as well as future point is ons.

4. Emergence of New Attractor, in the Montgomery and Greene Counties region. -- The emergence of new manufacturing, recreational, commercial, or residential centers can invalidate trip generation equations. For example, two major shopping centers, the Dayton and Upper Valley Malls, have opened in the area studied since the TCC Survey was conducted. The tripends attracted to these centers can significantly alter the predictive equations found in this analysis. This points to the need for constant reevaluation of the predictive equations for these significant influences.

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APPENDIX A

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CORRESPONDENCE BETWEEN THE SCHOOL OF SYSTEMS AND LOGISTICS AND THE MONTGOMERY AND GREENE COUNTY TRANSPORTATION COORDINATING COMMITTEE

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7 JUL 1971

Mr. Jack Jensen
Acting Executive Director
Montgomory & Greene County Transportation
Coordinating Committee
32 North Main Street
Dayton, Ohio 45402

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CAPTAINS BARRY

Captains John Barry and Philip Bown are preparing a thesis entitled, "Analysis of Trip Generation Factors Involved in Ground Passenger Transportation within Montgomery and Greene Counties." This thesis is a requirement towards a Master of Science Degree in Logistics Management from the School of Systems and Logistics at Wright-Patterson AFB.

They are requesting a copy of your 1968 Origin-Destination survey data which is stored on computer tape. They have informally coordinated this request through Mr. Rude of your office. If it is agreeable with you, we will cut a duplicate tape of this data on one of our IBM 360 computers. We have confirmed that your tapes are compatible with our equipment. Your tape will be duplicated by a qualified computer operator. The data extracted from your 1968 Origin-Destination survey will receive full acknowledgment in this thesis.

In addition to providing the basic data for the thesis effort, we expect this thesis to be of benefit to the transit committee and thus the citizens of the Dayton area. Thank you for your time and assistance.

Cordially,



RAY W. ALVORD, Colonel, USAF Chief, Graduate Education Division School of Systems and Logistics THIRD NATIONAL BLDG - 32 N. MAIN STREET - DAYTON, OHIO 45402 - PHONE 513 - 225 - 2136

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July 15, 1971

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Colonel Ray W. Alvord, USAF Chief, Graduate Education Division School of Systems and Logistics Air Force Institute of Technology Wright-Patterson Air Force Base Dayton, Ohio 45433

Dear Colonel Alvord:

In response to your letter of July 7, 1971, regarding origindestination data for Captain John Barry and Captain Phillip Bown, we have provided Captain Bown with the following material:

- f.^{*} Computer tape (TCC #72) containing 1 and 2 card origin-destination data;
- 2. 1968 analysis zone map; -
- 3. 1980 land use map;
- 4. Field forms for 1 and 2 card origin-destination data;
- 5. Origin-destination data record formats.

It will be the responsibility of Captain Barry and Captain Bown to return the computer tape to our office in the condition in which it was loaned as soon as it has been copied. They may keep items 2 through 5 for use in their thesis work.

It is our understanding that this material will be used in preparing a thesis related to person trip generation in the Dayton region. At the conclusion of this project we would be interested in obtaining a copy of the thesis or the results of the analysis performed.

For any further assistance which may be required please do not hesitate to contact Mr. Ronald Rude of our staff.

Very truly yours 2 Lile L

Jack L. Jensen Executive Director

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ICC - TRANSPORTATION COORDINATION COMPARTIES



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FORMAT OF HOME INTERVIEW SURVEY USED IN THE 1968 TCC ORIGIN-DESTINATION RANDOM SYSTEMATIC

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13 THEN TO 11231415[6[7]0]12[3]415[6[7]0]12[3]415[6[7]0]12[3]415[6[7]0]12[3]415[6[7]0]12[3]415[6[7]0]12[3]415[4]414 TO 14 THEN TO 14 THENTT 14 THENTTO 14 THENTT 14 THENTT 14 THENTT 14 TH				-					
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APPENDIX C

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COMPUTER RECORD STORAGE FORMAT OF THE 1968 TCC ORIGIN-DESTINATION SURVEY

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Origin-Destination Record Format

Card 1

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Household Information

Identification Columns 1 Card number (1). 2-6 Census Tract Block Number Sample number 7-10 11-13 Blank Call backs 14 15 Number of cars 16-17 Number of persons 18-19 Number of persons over 5 years old 20 Number of roomers Number of persons employed 21 I 22 Number of persons with no trips 23 Dwelling unit status V = VacantX = RefusalC = Contacted no return N = No contactBlank = Interview obtained 24-25 Blank . 26-30 Census tract number - 1970 31-34 Land use 1 Residential 2[:] Mfg (light) 3 Mfg (heavy) 4 Transportation, communication and Utilities 5 Trade 6 Services 7 Cultural, entertainment, recreation 8 Resource production & extraction (agriculture, mining, etc.) 9 Underdeveloped land and water areas 35-36 Number of years resident Number of persons enrolled in school 37-38 39-67 Blank -68-71 Zone of residence Column 68 = Sector

Card 1

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Columns	Identification
68-71	Zone of residence-Cont. Column 69 = Ring Columns 70, 71 - Applusia Zone
72-75	Zone factor (2 decimals)
76-80	Census tract factor (2 decimals)

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Origin-Destination Record Format

Card 2

Internal Trips

Columns

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Statistic Statistics

Child Voltan

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Identification

1 3-6 7-10 11-12 13-14	Card number (2) Census Tract Block Number Sample number Blank Trip Number
15-16	Person number
17	Sex
	M = Male
,	F = Female
18-19	Occupation
20-29	Origin
	If internal
	Column 20 = Blank
	Columns 21-24 = Land use (see columns
	31-34 card 1)
	Columns 25-29 = Census Tract Block
	Number
	If external
	Column 20 = E
	Columns 21-22 = State
	Columns 23-25 = County IBM codes
	Columns 26-29 = City
30~39	Destination
	Same format as shown for Origin in
	Columns 20-29
40	Mode
	1 = Auto driver
	2 = Auto passenger
	3 = Bus
	4 = Rapid transit
	5 = Taxi
	6 = Truck passenger
	7 = Walk to work
	8 = School bus

September 21, 1970

Columns	Identification
Continuits	Identification
41	Trip purpose from 1 = Work 2 = Personal business
¢	3 = Shopping 4 = Social-recreational
	5 = School 6 = Eat meal
•	7 = Medical-dental 8 = Serve passenger
•	9 = Change travel mode 0 = Home
4 ⁴	Same as codes for trip purpose from in column 41
43-46	Start time 24 hour clock - in hundreths of an hour
	Midnight to $1:00 \text{ AM} = 00 \text{ hour}$
47-50	Arrival time
51-52	Blank
53-54	Relationship
	1 = Head-of-household
	2 = Husband
`	S = W He
	4 - Daughter of daughter-m-law
	6 = Mother or mother in law
	7 = Father or father-in-law
	8 = Aunt
	9 = Uncle
	10 = Sister or sister-in-law
	11 = Brother or brother-in-law
	12 = All other
	13 = Roomer
t (- 5ΰ	Month
	l = January
	2 = February
	3 = March
	4 = April
	5 - May
	6 - June
	(-) .1y

Card 2

September	21,	1970
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Columns	Identification
55-56	Month-Cont.
	· 8 = August
	9 = September
	10 = October
	ll = November
	12 = December
57-58	Date
59	Day
	l = Monday
	2 = Tuesday
	3 = Wednesday
	4 = Thursday
	5 = Friday
60-63	Origin
	Column 60 = Sector
	Column 61 = Ring
	Columns 62-63 = Analysis zone
	or
	All zeros for external end
64-67	Destination
	Same as for origin in columns 60-63
68-71	Zone of residence
	Column 68 = Sector
	Column 69 = Ring
	Column 70-71 = Analysis Zone
72-75	Zone factor (2 decimals)
76-80	Census tract factor (2 decimals)

-Card 2

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APPENDIX D

PRINTOUT OF FIRST 100 RECORDS ON THE COMPUTER TAPE CONTAINING DATA FROM 1968 TCC ORIGIN-DESTINATION SURVEY

2 ul10312533551002305146731572 2 2 2 2 2 0111102503450115554166001572 1111192530153445341054415/2 1111192533454015334166401572 2 u111192530055105513534100001572 5334166041572 U1111113112555455541660015/2 U1)1111555401175534166u115/2 5:34166401572 13111115510503450541060015/2 U31111155345,1155241660015/2 U1111115521553455334166U01572 0111111555495249554166061972 2/311064015/2 2 u111392553441115534166u01572 041119255285354555456001572 23321467015/2 2 031011541003715670146/015/2 0310110539941065305146/015/2 U1.11.1153345.0255.341660U15/ U11)19241115534553416688157 Ú1111115302533453456644157 U 3 1 1 1 1 1 1 5 0 3 4 7 5 0 1 5 0 1 5 / 111119253115500051153410500157 111119253135333534533416544157 031011953199409540914674157 533416644157 U4111925554552655565534166m157 U11011551005J465J467915/ u311111533453115534166µU15/ 5、341 664 41557 7 0 3 642 553 118 803 1 teadur 15 turbel f 2101 14000000 11510454110413001325 ..754..744110123502307 taujuhjujijit7uj1703 070918121111 725 754 1 119.0119119119119119191 States of the second of the second se 1/200741524242404275 00010/51028000000011 11119003/213159015/5 55300475516519081925 14.00.00.0014015301525 9901066 566 616 24144455411514251033 1400091912012051292 111105/1/101014171853 11110061/13014531467 -5113J4051805 775 347Ju3635201 640 itali Javálla Bağ 619 533 545814244 14883995161 112503592201 いもうふいタイヤ・113 19114/504495 = J. ÷ 111116 11400 5 11450 3 **∼**: 1 LAND / 11410 1 6444 6/244/441 () - 1 - 1 - 1 - 1 - 1 7600 1123-9644 0/28 8/20 0/24-74 6/1144464 1400004 140006930 Leevense 311. 1440-00-00 641514031 111115/11/ 14484434 5-116.44054 14494946451 1-446003 621414236 51200500515 11116006/ 1111:001/ <u>່</u>ວ 5 ••• د Ċ .: 2 2011 < U] U 1111 とりてい 1101 0 010C C 111.45 21 44 ... 1 ... 7 - · T 1: -----11 0 1 1+ 11 2142 2101 1.0.1 1..... 5115 21:12 u f 11JL 1, 1, 1:4) 21 01 21 11 1 2100 こしき ÷ L c. 2 v . Ч יי. די ר. ד N 1,1 2 20 ני 2 ۲٦ ы С N 2 5 ∾ * 2.4 Ę 2 1 -1 25 -N , L 0 10 <u>-</u> . ۍ ت ť. 7 N 3 N 1 21 5 ۰. ŝ 2 -3-~ £ 5 00000 ى ب ب 9 M M --0 1 1 1 0 1 10113 つうりょう 001000 011110 00003 **CLUUU** לטייטא **נ**הההט ש 244634443 2001.03 200405 160631 011015 010000 1.0001 00-00 234443 5 1 4 1 4 5 101.00 200633 2001005 くじょいう 642082 1006.17 20003 200007 200007 ע ה ה יו 7 0 0 0 0 1

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APPENDIX E

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SEGMENTATION OF PROFESSIONAL AND PROTECTIVE PERSONS PER ZONE INTO THEIR APPROPRIATE OCCUPATIONS AS DEFINED IN THE 1968 TCC ORIGIN-DESTINATION SURVEY

Occupations of professional and semi-professional people as defined in the TCC Survey:

Architects, engineers, etc. --civil, electrical, mechanical, marine, aeronautical, surveyors, airplane pilots, etc.

Designers, draftsmen, surveyors, technical aids, accountants, embalmers, morticians and other professional and semiprofessional workers

Educational and scientific--teachers, scientists and professional research workers

Entertainment--artists, authors, journalists, photographers, musicians, etc.

Legal--lawyers, judges, etc.

Medical--doctors, surgeons, dentists, etc.

Nurses and social welfare workers

Osteopaths, chiropractors, etc.

Religious--clergymen, etc.

Veterinarians

Occupations of protective services people as defined in the TCC Survey:

Civilian defense lookouts (airplane and fire), wardens, etc. --fulltime employees only

Commissioned officers of the military forces

Enlisted men, draftees and non-commissioned officers of the military forces

Members of fire departments

Policemen, sheriffs, marshals, guards, game wardens, etc. Private detectives

Watchmen and police, privately employed



IFESTS TIP BERERATION ANALYSIS

.1... SIDA ZUARS(025),75GH(020),ZPERS(026),ZERP(026),DCARS(000), (j. 2025; (1), [=1, 6))/9000, 0057, 1101-, 1158, 1201, 1215, 1301, 1316, aur Eustern), fiend (aan), JEnie (aun), DESIZE (860), NYKS (860), USCH (860) 10-12-131-2412(426),2446(426),254Ab(426),2564(326),2865(326) alaction (Precaze), (PI2(a26), (PI2(326), [PI3(326), [PI3(326), [PI4(326), aint stor TPF 0 (326), IPF L (326), IPF 2 (826), IPF 5 (826), IPF 4 (826), [1-1 - 5 | 4 | 2 | 4 | (2 0), 2 < 0 | (8 2 0), P K 0 [(8 2 0), 5 I U 0 (8 2 ^), U h E M P (6 2 6) 11441,14-472101,2160,2201,2242,2541,2356,2401,2419,5141,5115. 25241,5224,5341,0561,4101,4112,4241,7210,4001,4314,5141,5108, >/401, / 100, 8101, 0.120, 3201, 5243, 8501, 5528, 9201, 9272, 9301, 9405. BULL INTSIS THIP DE MALTUN AGALYSIS [1 [1 (a 2 () , I r f a T p (a 2 a) , I P [A], E (8 2 b) i [: F 5 (.. 2 ~) , T P F +] 4 (0 2 £) , T P F A L (3 2 0) \sim SIGAE LUDLP VAR FRUD CAND 1 LUDER VAR FAUR LARD VUTAR ZÜPE REAPERS elressing eletter (ofte) VAR FLOT CARD 2 alaters19a a7u21 (u2a) Vark Fruis CARD 1 640) 7207 1 VOIS (08) SIDLE DUP VAR FAUT CARD /14 / STULL TURE CRANES 1. 1. 4.47 a 10 510+E 912 1 I I V I V I 2111 HARIY SIPLE Sinrt S 1 0 1 E <u>ں</u> ပ υ υ <u>ں</u> c e Ċ Reproduced from best available co

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C SLF/RATE TRIP PURPOSE FROM ASTORE BY ZONE OF ADAE OF THE PUSTAGA PROFUSIOAS. 114441 (274) = 1) (C 11 / 17 / 1 / 2 / 4 C $P(\mathcal{A} \cup \mathcal{V} \cap \mathcal{A}) = P(\mathcal{A} \cup \mathcal{V} \cap \mathcal{A} \cap \mathcal{A}) + \mathcal{L} P(\mathcal{A} \cup \mathcal{A} \cap \mathcal{A} \cap \mathcal{A}) + \mathcal{L} P(\mathcal{A} \cap \mathcal{A} $2 \sqrt{2} + (67) + (67) + (7) +$ PRUF(U/K)=PRUF(U/R)+ZFAG 5109(nZK)=5100(22R)+2FAG IF(InCuP.E...13)00 10 40 1 2 3 1:0 1, 2, 0 ιο υι 1 - 1 1 Z U 120 07 J g 0 8.0 ù v -2 0 0 c 2 c F(11P1.40.9)60 IF([[P]...7)60 F(11PF.e0.3)35 F(11PF.4.1)GU [F(11P1.c0.2)60 F(1PF.E0.3)60 [F(](P+.LU.5)60 F(11PF. tu. 0)60 [F (] 1 PF . LU. 4) CU IF(11PF.E0.5)60 36 10 122 նզ ել ոն 60 TU 20 60 10 20 с 11. С 5= 2. d 3 U 0 . 9 Reproduced from best available copy. 4 5 Y 8 8 8 9 2 5 - 22 S - 2 3 S - 2 3 S 1 1 16 2 ú 2 ú ນ ບ シフランの 5 50 0 6 6 ÷ . 6

1PF1(820)=1PF1(320)+2FAC

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· _	P	₩₩ 10 X22 P+3(%/₩)= P+3(%20)+/FAG	50 TU 122	1Ff4(u2u)=1Pf4(12u)+2FAC	54 10 122 P	1242(220)=1242(270)+747	60 fd 122	[FF0][H(HZ0)=[PF0]H(KZ0)+ZFAC	iřfall (%20) = 1 P1 All (%20) + 2FAC	karte as Store Tkly Powpost FROM	IF([[P].E0.0) E0 [n 130	IF([[\])60 0 10	1E(11P1:t44.2)60 10 19A	[[[[[]].c0.3]60 [[100	14(11P1.E0.4)60 f0 1/0	16(11P1.En.5)6u 10 199	IF(1121.60.6)60 I0 190	If (IIP].e0.7)su tu 190	F ([1 2] • E 4 • 3) G (1 4 1 7 3	1F(11P1.E0.9)60 10 190	1210(22))=12{0(22)}+272	50 [v 1v2	1211(47n)=1211(47n)+2FAG	60 10 192
	0 U	ç i	•	1 0 1		110		120	122	C SLF	720						•				100		1.10	
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KEAU (10,200) (ILARU.CARS, PERS,PUD,ROOM,EMP, TRIPNO,ISTAT.LAND. FGR1AT(I1,13X,F1.0,F2.0,F2.0,F1.0,F1.0,F1.0,F1.0,IA1.7X.61. DETERNINE TUTAL BAELLING UNTICTOD) CONTACTED IF LU INFRPVIEN UMININED AREAD ANUTHER CARD ZUNE #5 1410 826 LUCATIONS OF 12R IF (ISTAT. NE. IGLANK) GU 10 883 3VJ7+(07#)H101d1=(07E)H101d1 1 P 1 A L L (N L) = [P [A L L (2 L) + 2 F A C 3 K, F 2. () . F 2. () . 29 X, 14 . F 1. 2) 1FT4(11/1)=1214(11/1)+2FAC F13(421)=1213(421)+2FAC 1 P 15 (1, 2, 0) = 1 P 15 (1, 2, 1) + 2 F A C JP12(422)=1P12(424)+2FAC AND PRICI CARD 1 DAFA r(11...e.s)60 10 999 YKS, SCF, IZR, ZFAC) WACNSPACE 10 J DAFA LEXT RECORD 190=100+1. 60 TU 680 30 10 192 00 IU 192 50 TU 192 GU TU 192 U N N D C REAU SUFJ C- REAF C REAP 1 92 . 177 ن *۷* ۴ 100 170 140 156 208 ບ U ں Reproduced from best available copy Ú 244 123 129 130 132 1.50 1.34 435 136 L3J 139 145 148 150 1.57 14 U 110 144 145 120 121 131 112 -1 4 1

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ULATE ISALPEAUELT VARIANLES FOR ZURAL ANALYSIS ASTOKEBY SUPARATE SSIDKE 20.0./LAND USE BY IZR FUR HDDEP VARIABLES INTERVIENS OUTAINED 2CARS(5.24)=2CA4S(NZR)+CARS+ZFAC 216 45(-77K)=ZPEKS(N2R)+PERS+2FAC 2\$CH(P_K)=2\$CH(PZR)+5Ch+2FAC ¿EnP(s./k)=/édP(%2k)+Ed2+2FAC ZPU(42k)=ZJU(82k)+ZFAC 340 360 695 IF(12.01.12R)60 10 242 **3 0 0** 3 2 0 1F(12.+P.0.12R)NZK=RK US 710 12=L1X1,L1X2 01 IF (LARP. 69.1)60 10 01 0 2 LIM1=L_2016(2+11-1) 12 ZUKAL AJALYSIS L[M2=L/UNE(2+11) 10 IF (LARv ... E0.3) 60 IF (LAND. - LO. 7) CU f(LA60.+E0.5)60 1 + (LAP. 1 - LU - 6) 60 00 740 IL=1,54 WLAIE lhe RO. 1 [M] = 7 1 3] + 1 . an In Jun CONFLAUE CUPILNUE I+NN=XN USÈU 1773 3 C CAL 242 710 700 ບບ Reproduced from best available copy. Ö 3.0 4 υ υ 50 53 55 5 ป 69 7 u 173 174 7 % 52 151 19 ъ С 30 000 50 11 72 5 5.9 4 0 67

SIGFE INDEP VARIANLES BY ALIRIBUTE.D.U. C TACHELENT & UP N.U. IN SAMPLE (ISIZE) JRIP(1S1ZP)=(PEKS-TRIP40)*SFSC 0.U. SAAPLE EVERY 20 INTERVIENS If(IfILE.60.1383+2)90 10 999 CALCHLATE REW SAMPLE IACTUR(STAC) 2 T K A i (1. Z K) = Z [K A U (N / K) + Z F A C IF (SALP.EQ. UCT)60 10 430 STORE BEP VARIANLES, TRIPS/D.U. 2KL S(H_K) = / KE S(N / R) + 2F AC 2156(n2K)=2116(N2R)+2FAC Z5ER(42R)=ZSER(12R)+ZFAC <kbc(h2k)=2kbc(n2k)+2fac</pre> ICARS(ISIZL)=CARS+SFAC IF(II...E.()60 10 999 C INCREMENT SAMPLE CHLCK SAMP=71N1/20.0 SFAC=2u · u · LFAC 1 S I Z E = 1 S I Z i + L uUCT=uuut+1. 00 Tu 408 0 10 411 P 10 10 400 00 10 400 60 IU 884 C TAKE 303 320 340 300 3 8 Ú 400 430 ى c ပ Reproduced from best available copy. 0 L35 LHS ۲ ۵ ۲ L9 ó 193 201 503 179 183 t H 1 **1** 3 0 133 9 U 193 467 LdJ 141 167 101 192 197 170 177

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KEY TO VARIABLE NAMES

Name	Function
NZONE	Store zone numbers
LZONE	Store zone number ranges
ZDU^{1}	Store dwelling units/zone
PROF	Store professionals/zone
PROT	Store protective people/zone
STUD	Store students/zone
UNEMP	Store unemployed/zone
TPF0	Store home trip productions
TPF1	Store home based work productions
TPF2	Store home based personal business productions
TPF3	Store home based shopping productions
TPF4	Store home based social recreational productions
TPF5	Store home based school productions
TPFOTH .	Store home based all other productions
TPFALL	Store home based all trip productions
TPT0	Store home trip attractions
TPT1	Store home based work attractions
TPT2	Store home based personal business attractions
TPT3	Store home based shopping attractions
TPT4	Store home based social recreational attractions
TPT5	Store home based school attractions
TPTOTH	Store home based all other attractions
TPTALL	Store home based all trip attractions
ZCARS	Cars per zone
ZSCH	Students per zone
ZPERS	Persons per zone
ZEMP	Employment per zone
DCARS ²	Cars per dwelling unit
DPERS ²	Persons per dwelling unit
DPO5 ²	Persons over 5 ycars old per dwelling unit
DEMP	Employment per dwelling unit
DFSIZE	Family size per dwelling unit
DYRS ²	Number of years resident per dwelling unit
DSCH	Students per dwelling unit

¹Variable storage names beginning with "Z" were used for zonal trip generation analysis and variables starting with "D" can be used for dwelling unit analysis.

²Not used in this analysis.

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Name	Function
TINT	Calculate total interviews obtained
ISIZE	Calculate dwelling whit sample
TDU	Total dwelling unit: contacted
RES	Response rate
SFAC	Sample factor for dwelling unit sample
IFILE	Total number of records
NZO	Zone of origin
NZD	Zone of destination
NZR	Zone of residence
ICARD	Card number
IOCUP	Occupation category
IMODE	Transportation mode
ITPF	Trip production (from) purpose
ITPT	Trip attraction (to) purpose
ZFAC	Zone factor
CARS	Number of cars per dwelling unit
PERS	Number of persons per dwelling unit
PO5	Number of persons over 5 per dwelling unit
ROOM	Number of roomers per dwelling unit
EMP	Employment per dwelling unit
ISTAT	Status of dwelling unit
TRIPNO	Persons with no trips per dwelling unit
LAND	Land use
YRS ²	Number of years resident per dwelling unit
SCH 2	Number of students per dwelling unit
ZREC ²	Recreational zone
ZRES	Residential zone
ZMFG ²	Manufacturing zone
ZTRAD ⁴	Trading zone
ZSER ²	Services zone

²Not used in this analysis.

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KEY TO FLOWCHART PROGRAM

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	Computer Program	
Symbol	Line Number	Operation
A .	1-25	Create on-line storage for zonal dwelling unit variables extracted from tape.
	.26	Store zone number ranges.
В	28-44	Initialize counters.
C, D		Extract selected data from tape.
E	45-47	Read card 2 data from tape.
F	27,48	Check for end of file.
G	49	Determine card number.
н	50, 51	Eliminate data on walking mode.
R	52-71	Sort zone numbers by zones of residence, origin, and desti- nation.
5	72-78	Sort occupations.
T	79-85	Store occupations by zone of residence.
U	86-98	Sort trip purpose.
V, W	97-110	Store trip purposes by zone of origin.
x	111-121	Sort trip productions.
• • Y, Z	122-135	Store trip productions by zone of destination.
1	136, 137	Read another record.
I	138-144	Read card 2 format.

-	Symbol	Computer Program Line Number	Operation
	J	146, 147	Determine total dwelling units contacted.
	К	148, 149	Determine if interview obtained.
3	L ,	150-159	Sort zone numbers by zone of residence.
``````````````````````````````````````	M, N	160, 169	Calculate the number of inter- views obtained.
	M, N	162-167	Calculate and store on dependent variables used in zonal analysis.
	Mʻ	168-175	Sort land uses. ³
	<b>N'</b>	176-184	Store land uses by zone of residence. ³
•	<b>o</b>	187-189	Take dwelling unit samples every 20 interviews. ³
	1	190	Read another record.
	P, Q	191-207	Sort and store variables used in dwelling unit analysis. ³
•	BB	208-214	Printout dwelling units con- tacted, interviews obtained, number of dwelling units samples.
	cc	215-224	Store zone numbers.
	DD, EE	225-233	Write values used in zonal analysis on disc.
	F'F, 'GG	234-239	Write values used in dwelling unit analysis on disc. ³
	нн, п	240-287	Print all zonal and dwelling unit variables and total number of records on file.
		288	Stop

 3 Not used in this analysis.

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### APPENDIX G

### COMPLETE EXTRACTION OF DATA FROM 1968 TCC ORIGIN-DESTINATION SURVEY BY 825 ZONES SEGMENTED INTO TRIP PURPOSES AND SOCIO-ECONOMIC CHARACTERISTICS

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# KEY TO COLUMN NUMBERS

- Zones Used to Develop Home Based Production and Attraction Equations
  - Home Based Trip Productions
- Home Work Trip Productions
- Home Personal Business Trip Productions 4
  - Home Shopping Trip Productions
- Home Social Recreational Trip Productions 9
  - Home School Trip Productions
- All Other Home Based Trip Productions ω
- All Home Based Trip Productions (sums of tripends in columns 2 through 8)
  - Home Based Trip Attractions 0
    - Home Work Trip Attractions
- Home Personal Business Trip Attractions N
  - Home Shopping Trip Attractions 3
- Home Social Recreational Trip Attractions 4
  - Home School Trip Attractions S
- All Other Home Based Trip Attractions 16
- All Home Based Trip Attractions (sums of tripends in columns 10 through 17) 23
  - Cars Per Zone 8
- Students Per Zone 61
- Persons Per Zone 20
- Employment Per Zone 21
- Professional People Per Zone 22
  - Protective People Per Zone 23 25 25 25 25
- Students Per Zone Who Made Trips
  - Unemployment Per Zone
- **Dwelling Units Per Zone**

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452.61 : 2384.46 2066.89 2512.03 1423.58 3966.80 2668.69 424.49 710.45 584.30 1247.18 5517.23 2548.69 405.43 5238.95 167.81 3210.52 857.64 1545.20 1910.25 629.96 773.82 1849.70 1167.48 2812.60 263.31 1368.14 465.90 1160.72 4158.94 766.84 1583.99 14.89 194.19 457.48 322.15 153.20 355.38 **354.1**B 014.96 29.92 28.00 92.16 22¢.53 162.62 154.22 201.83 229.03 245.84 54.165 245.51 44.51 517.62 050.33 **387.65** 226.94 212.91 116.64 10.05 381.31 207.7 ; ;; 00 15.65 45.10 15.19 1368.54 1059.23 14.94 28.03 45.82 15.65 15.37 60.02 364.02 15.17 30.45 01.43 60.96 211.5 • 0 • • • • • ~ • • • • • • 201.65 30.39 59.60 15.06 130.56 166.03 591.40 29.73 31.85 337.15 103.24 105.12 10.04 75.59 134.22 14.78 62.87 30.12 28.94 15.21 191.91 47.14 214.51 214.14 Ś • 0 • • ; • • --14.86 109.70 1743.53 44.52 455.67 46.03 29.72 23.88 186.86 8341.17 633.78 51.72 1.37.81 29.42 15.06 105.16 54.41 50.17 15.35 50.23 573.60 35.23 224.71 ... 0. S .. e • **0** • • 9 • 29.74 165.38 125.56 120.09 231.30 14.06 214.68 134.96 149.22 255.88 54.03 214.04 231.22 204 . 85 422.17 364.97 71.90 11.95 01:050 94.49 144.40 29.87 634.U1 64.21 44.31 51.2U 022.05 136.04 .52.00 11:2.27 • 899.39 753.83 931.99 2115.24 153.16 1145.68 1223.02 2943.31 14.74 507.70 120.50 235.94 242.97 135.23 722.04 45.01.45 152.60 977.17 10.04 4=3.20 212.89 806.38 562.36 572.31 158.30 4+2.67 262.97 717.50 1726.15 37/3.6/ 1202.90 2 • U 0 82.112 24.00 17.00 4 - 29 91.50 12.94 180.ô • 2 • = 2 e. • = • •= • 0 • • -• ž • : ; : . -3 3 4 5 20 13 16 18 67 22 23 25 26 17 21 27 82 50 11 30 15 10

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31.27 2036.76 152.43 62.00 137.53 256.59 2449.75 3458.80 4430.06 1300.12 243.60 598.88 1524.00 1354.45 275.02 43.32 219.95 103.94 733.80 2264.45 468.54 218.25 262.07 392.34 1323.66 76.37 399.77 1 198.23 15.00 409-03 77.33 15.83 199.41 578.25 671.37 97.90 87.36 213.90 15.39 23.68 34.00 44.76 1175.65 100.39 40.83 200.03 252.48 30.34 • 0 80 • • -• • 15.59 15.50 44.63 17.69 14.72 151.92 • • • • • • • : • • . • ٠ • • • • ٠ . : • 0 a 8 10.42 0.09 4.78 6.43 62.05 5.73 48.89 0.14 35.18 1. ; . . . 5 . Û J 4ö.78 15.00 59.05 10.01 13.91 62.03 77.56 15.20 • • 0 9 ... • • • • . ٠ . 0 3 7 i.85 15.49 15.55 1433.59 166.19 **31.**65 1uó.98 119.47 137.93 33.50 03.70 154.20 02.92 50-84 31.7 ó 15.66 74.55 14.95 17.64 1123.37 29.62 ŝ . G ē. • ÷ •; • •4 62.50 +5+•5+ 242.00 64.115 46.35 32:0.34 40.58 705.04 14.95 644.63 022.59 197.03 115.77 262.35 29.23 163.14 14.06 29.51 3:.:18 Ĭ • 5 • • • > : |= . 5 • . = 3 = 447.64 203.60 1519.70 227.00 1102.51 138.52 **31.5**0 107.50 1241.50 1240.50 6.5.42 75.47 197.21 117.14 653.92 34.60 14.44 45.87 05.95 59.1v 90.34 92.00 01.70 53.33 020.75 3 . 0 : ن. 15.16 10.17 60-002 * * * * N <del>ر</del> با . . . . . • 4 . • • • . . . • 5 -3 3 9 -.... 32 54 53 35 60 43 50 5 J 40 36 37 30 C. 7 4 43 47 4 15 47 24 2 2 3 50 56 57 4 5

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2926.58 567.36 271.60 310.36 394.89 662.60 4577.36 27.4.70 174.56 234:16 237.03 396.24 797.65 1412.55 289.98 490.04 1242.19 2121.55 1020.50 859.39 699.43 351.26 3534.49 2757.89 3162.91 2306.77 259.51 60.00 454.40 1527.37 **507.76** 23.29 57.39 36.58 70.97 137.12 11.33 15.10 92.37 400.NG 104.32 64.32 112.05 129.68 90.40 45.99 91.49 134.07 296.50 535.31 15.33 196.2 ڻ ب ر • • • • • • • • 0 • 31.93 62.33 228.57 468.21 545.58 109.01 • • •• . • • 87.06 30.26 7.5.00 251.75 29.44 30.12 121.66 30.66 201.46 224.30 16.03 29.03 16.86 40.41 152.41 33.74 15.07 31.22 12.50 72.37 14.00 29.33 233.03 180.84 • • • • د • 322.85 43.89 71.44 13.50 117.35 14.50 72.91 143.59 39.66 1:5.75 42.07 303.04 ( ) 14.55 **964.9**0 14.30 ŋ. • 0 • 0 ů. 0 • • 6 • • **0** • • 0 9• 0 S ÷. • • • • 30.42 15.46 13.50 177.53 12.20 37.29 44.14 30.38 13.20 162.59 31.48 47.23 29.76 89.59 145.53 89.56 30.00 12.20 12.00 29.93 09.53 54.74 85.1 • • ≈ • • ÷ • > 14.3U J0.12 61.31 137.13 29.93 214.82 584.34 142.14 247.26 16.31 42.75 00.49 0.00.67 61.32 49.23 14.9. .5.5. • • 8 • •0 • • • 642.43 336.06 252.63 132.09 542.30 1445.79 184.00 86.423 561.36 1047.52 1262.43 06.970 750.00 25c.ug 168.59 308.00 587.34 520.40 402.13 86.60 203.50 590.39 131.05 010.010 287.61 275.94 261.40 545.01 475.11 2050.00 1400 14.7 1315 1,16 1405 1446 14JÅ 1412 1312 1, 11 3 1314 1401 1402 1403 1404 1413 1414 1415 1416 1418 1420 1310 1771 1410 1411 1417 1422 1423 1419 1421  $\bigcirc$ 

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16			812.60	390.74	307.62	35.24	624.70	543.87	162.92	120.98	0.	602.81	124.61	269.25	69.76	224.76	122.06	:	19.94	24.94	. 0	14.78
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<b>4</b>			470.22	74.43	264.23	14.38	287.16	160.52	207.70	• 0	e	521.50	42.47	130.95	47.04	125.12	76.50	• n	113.22	61.14	14.64	14.51
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l			204.36	29.02	10.14	•	282.15	516.24	29.58	44.43	ت. ت	240.25	41.69	133.72	262.55	61.44	103.53	u .	21: • / 6	16.10	-	• =
	· · ·		229-61	241.47	3U.45	a4.59	45.042	174.59	161.67	74.77	• 0	164.17	241.71	305.11	76.21	60.01	36.42	16.10	62.12	04.78	28.94	0 •
1			2157.60	2311.56	2145.29	85.00	0 J • T P A	1731.38	705.92	1071.18	244.00	3030.70	1082.46	724.51	140.00	864 • 6 B	1744.00	•	<b>501.6</b> 0	291.40	j23•UU	32.00
			9317	9154	<b>4319</b>	9320	9321	9322	9323	9324	4325	9326	4327	9328	9329	4330	9351	4332	4333	9304	9345	y336

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64	0	. J	•0	• >	•	0.	0.	0.	G •	• 0	ų •	9.0	•0	•0	• 0	Ð.	0.	0.	• 0	e 9	• 0	126.40	266.85	410.60	209.62	84.00	315.00	30.00	193.57	58.40
<b>63</b>	• 6	• •	D	• 0	• 0	• 0	• 0	• 0	• 0	0 •	• 0	0 •	• 0	<b>.</b>	• 0	• 0	•	<b>.</b> 0	• 0	• 0	0•	• 0	0.	• 0	• 0	• 0	<b>0</b>	• 0	• 0	
77	,	• 7	<b>.</b> 0	0.	с.	, U .	0.	در •	• 0	• •	0.	•0	B. <b>.</b>	ų.	<b>0</b> •	<b>.</b> 1	•0	ŋ.	0.	• 0	د ع		26.30	• 0	<b>0</b>	• 0	165.00	570.00	208.46	-
17	•	18.00	• 0	• 6	19.50	• 0	• 0	0.	21.93	0• 0	J.	ŋ.		• 6	9.00	0.	ů.	• 0	• 0	0.	• 0	63.20	127.35 -	179.40	96.84	42.00	240.00	300.00	163.79	146.908
03	• • •	14.40	82.00	• 0	34.00	u .	e. 9	<b>.</b> 0	131.58	.0	ų.	U.	ù.	<b>0</b> .	9.00	• 1	D	. • N	с •	e .	• 5	<b>316.00</b>	098.45	<b>652.15</b>	355 • BB .	154.30	055.00	117.4.00	440.70	06.252
41	, , , , , , , , , , , , , , , , , , ,	• 0	<b>u</b> •	• 6	<b>.</b> 0	0	• 0	<b>.</b> J	• 0	• •	• 0	• 0 ,	• 0	• 0	<b>ں</b>	• 0	• 0	• 0	• 0	• 0	0 •	126.40	325.45	254.15	60.70	42.06	330.00	3-15-00	146.94	27.65
40		U.•	ų.	D	<b>U</b> .	Ua.	.U	U	<b>.</b> 0	• ກ	ų •	ч.	• 0	• 0	• D	Ŀ.	0.	9	• 2	•0	с, С	60.20	99.85	254.15	95.84	56.60	100.401	375.00	143。90	51.00
4	57	58	59	4 D	4	42.	ъ Ч	44	45 7	46	47	48	49	50	51	52	53	<b>ک</b> 4	55	56	74	101	1 2 2	.103	104	.145	106	1u7	1 1 3	1 10

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25	00.LC	• 0	0•	•	30.46	118.45	•	46.65	100.20	• 0	• 0	65.68	480.00	31.8.4	201.50	• 0	• 0	133.47	255.00	106.19	• 0	• 0	• 0	• 0	• 0	30.72	343.62	• 0	- 0	119.28	
24	94.98	34.50	0.	372.00	1185.00	1199.61	3.0 - 0.0	244.00	167.00	83.46	178.70	32.84	375.00	127.36	• 11	397.54	0 •	281.77	150.00	0.	0	• 0	328.67	64.00	1054.32	399.36	986.44	330°00	ù.	685.86	
23	47.49	• 0	• 0	• 0	• 0	29.62	46.20	• 0	33.40	• 0	• 0	ъ.	270.00	• 0	0.	91.74	29.14	•0	30.00	• 0	• 0	• 0	28.58	• 0	<b>.</b>	• 0	0•	•0	. 0.	• 0	•
22		• 0	• 7	• 0.•	729.60	311.01	• 0	100.05	66.80	27.82	534.53	• 0	90.00	• ວ	1 •	76.45	29.14	ц.	ų.	0.	132.57	ر. •	760.21	403.00	91.08	30.72	495.38	465.00	• 0	357.84	
12	126.64	163.00	62.68	476.16	653.60	533.16	92.40	326.55	317.36	139.10	53.61	2/9.14	336.00	191.04	310.00	426.12	203.98	206.94	155.00	136.53	102.03	0	571.60 -	527.00	687.60	469.80	732.06	525 • 00	• 11	775.32	•
20	234.94	457.50	250.72	1220.16	1021.00	2373.40	246.40	1057.40	1269.20	480.65	625.45	935.94	1535.00	732.32	¥30.00	1345-52	422.53	1150.74	484.60	003.46	559.74	42.00	1300.59	1241.00	1634.96	1536.00	2.345.58	1275.00	0.	1078.66	•
19	47.49	122.00	125.30	327.36	<b>392</b> •40	696.07	15.46	373.20	334.60	106.92	232.31	114.94	420.00	222 . 8 6	203.50	4 2 ° ° 2 8	58.26	439.39	120.90	45.51.	191.49	<b>ں</b> •	328.67	357.00	519.52	176.16	717.12	390.00	•0	501.49	
18	110.011	51.54	31.34	380.08	623.20	074.25	147.80	ふでか。ちら	217.10	153.61	107.22	147.78	00•cć2.	175.12	04.192	351.07	110.56	177.96	1.2	136.03	147.58	21.00	428.70	405.08	519.52	365.64	672.50	949.00	•	551.49	
r	,1110	1111	1112	1113	1114	1115	1116	1117	1118	9111	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1153	1104	1105	1136	1107	1138	1201	•

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26	19.00	26.00	405.38	33.99	532.10	95.16	79.31	488.00	114.03	304.95	261.90	294.50	130.64	702.18	270.94	109.04	122.99	144.00	203.00	54.99	118.00	335.94	139.00	60.99	195.96	71.00	64.00	66.00	159.50;	336.49
25	0•	<b>0</b>	552.78	• 0	375.60	• 0	22.66	45.75	• 0	<b>0</b>	87.30	31.00	•	224.10	• 0	•0.	0.	• 0	• 0	• 0	•		• 0	0.	• 0	•0	G .	• 0	• 0	204.82
24	, 0 •	• 5)	1389.42	517.24	1205.05 .	95.16	<b>396.55</b>	1311.50	65.16	513.00	50v.25	527.00	277.61	1464.12	827.08	572.46	<b>J51.40</b>	056.00	754.00	0 •	413.00	549.72	453.70	447.26	522.56	198.80	230.00	92.40	255.20	936.32
23	•0	•	• 6	• 0	• 0	<b>0</b>	• 0	76.25	• 0,	• 0	92.84	•0	• 0	179.28	115.38	• 0	0.	160.00	• 0	•••	• 0	•0	69.50	•0	195.96	•0	0.	• 0	0.	•
22	•	•0	59.70	0.•	641.05	120.88	Ŭ.	411.75	179.19	64.20	14.55	124.00	85.76	381.45	228.16	81.78	• 0	64.00	116.00	0.	29.50	16/.97	0	ų •	32.66	0.	0	• •	63.30	292.64
21	19.9v	• 0	463.14	53.99	782.58	79.30	07.98	472.75	1 . 0 . 32	272.85	218.25	372.00	13.9.64	1075.68	456.32	149.93	153.13	224.06	245.50	36.66	132.75	412.29	106.80 -	63.99	195.96	71.00	102.00	52.80	1/5.45	404.16
20	76.00	52.00	1043.40	169.95	2062 . 60	285.48	294.58	1387.75	261.64	9311.90	<b>1</b> 0 4 7 • 6 0	1100.50	457.24	2763.93	985.94	494.08	491.96	00202	710-20	109.98	457.25	1084.17	92Å.2U	243.96	óù4.21	227.20	233.10	145.20	6 i 6 . 1 (i	1024.10
61.	• 0	• 0	542.42	20.0C	845.13	47.58	113.30	793.04	81.45	256.81	407.40	341.00	139.64	973.14	327.95	212.60	140.56	240.60	246.50	• 0	147.50	213.7 <i>ů</i>	1.39.60	141.65	179.63	09.94	102.00	26-40	47.85	117.04
18	19.00	52.00	612.54	67.98	626.00	79.30	124.03	671.60	130.52	331.05	276.45	467.00	212.29	1186.26	513.36	190.82	263.55	250.00	362.50	54.99	265,50	519.18	250.20	101.05	261.28	01.40	102.00	79.20	223.31	46/.42
7	12u2	1203	1204	1205	1206	1207	1208	1209	1210	1211	,1212	1213	1214	1215	1301	1302	1303	1504	1305	1305	1307	1308	1309	1310	1311	1312	1313	1314	1315	1316

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1043.40 169.95 2062.60 285.48	<ul> <li>200</li> /ul>	
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19 334.	• 4 4	225.30	1051.40	465.62	ų .	• 0	120.16	30.04	390.52
0 361.	• 0 1	2/0.30	1.32.00	429.30	143.10	0	270.30	• 0	429.30
105 1.	54.	336.10	1096.48	565.30	275.04	122.24	554.08	•0	550.08
2 1684.	ນວ•	1116.12	2439.69	1100.40	1504.76	31.44	1729.20	•0	880.52
3 257	• 85	54.30	441.52	412.50	51.57	•0	34.38	•	360.99
4 377.	• 76	74.44	155.52	472.29	• Э	• 0	299.05	• 2	406.24
.5 834.	• č 4	943.00	3092.00	1000.74	100.22	139.14	1205.88	185.52	958.52
6 234	° 2 II	508.10	1211.95	313.95	134.55	<b>ں</b>	672.15	44.85	284.05
7 172	.20	172.20	012.70	143.50	51.41	•	516.60	<b>.</b> 0	172.20
8 311	• 0 U	436.24	1.039.88	4211.66	62.32	• 0	155.80	31.16	342.76
.9 47h.	• 6 y	476.03	1093.40	567.72	149.40	• 0	209.16	313.74	507.96
0 023.	.70	707.05	2212.05	757.35	74.25	74.25	1366.20	534-60	668.25
1 847.	•30	593.00	2010.25	926.84	503.59	149.50	117.60	44.85	00.894
2 574.	.94	347.99	1391.96	650.59	272.34	• 0	544.68	• 0	469.03
3 325.	• 52	325.44	900.41	281.39	24.62	• 0	385,06	• 0	222.15
4 152,	• 16	207.90	734.58	277.20	110.88	• 0	291.06	• 0	180.18
5 3140	• 6 4	312.20	1039-26	421.47	124.58	J.1.22	593.18	•	312.20
6 217,	• 56	145.04	652 . v 8	199.43	0 •	40.65	91.65	217.56	199.43
7 0,	•	•	0.	• 0	0.	• 0	9	• 0	•
5 U.	•	0 •	• 0	ŋ •	<b>.</b> 0	0.	• 0	•0•.	•
9 423,	• 5 1	554.26	1271.40	554.20	103.00	97.80	798.70	• 0	374.90
0 245,	. 51	274.11	121.53	303.03	23.56	72.15	202.02	<b>.</b> 0	187.59
1 534,	.40	220.00	994.36	440.16	0.	<b>0</b>	172.92	.0	345.84
2 606,	• 00	4y7.2u	1600.52	699.30	62.16	51.08	792.54	0.	497.28
3 1176.	• 4 6	497.84	2739.96	1006.20	1130.04 .	46.44	1439.64	• 0	804.96
4 564.	.40	249.110	1468.80	713.80	U0.19d	33.20	431.60	33.20	514.60
5 571.	. 6 tj	714.64	2112.04	794.00	317.64	127.04	660.96	79.44	555.80
6 631.	~ 4 U	324.72	2236.26	777.14	2Jo.13	47.58	691.84	79.30	586.82
7 400.	.40	319.20	1292.00	425.60	564.63	60 <b>.</b> 80	562.40	•0	425.60

. : 235.95 399.88 289.75 757.00 606.40 583.10 579.15 556.85 507.85 472.96 353.05 526.66 414.99 320.40 543.90 484.84 464.07 87.78 782.85 566.10 582.27 18.00 427.68 534.10 453.22 222.84 466.00 665.70 1375.44 79.01 26 1 80.10 59.72 39.50 33.32 79.00 177.36 .133.15 24.32 44.91 61.52 90.30 76.85 79.2 • • • • • • • 0 •0 • • • •• • ٠ ٠ • • 0 0 22 ۲ 1 983.68 62.92 360.46 307.60 337.70 22.5.95 91.50 545.04 574.10 195.05 875.28 609.42 354.72 269.95 475.20 350.98 1154.98 559.44 705.80 194.61 29.26 596.70 06°Ý09 466.48 358.80 1705.90 2123.90 2075.61 • • 5 9 24 ; 52.04 116.96 16.66 341.55 1-28.50 259.42 48.27 14.63 61.40 253.81 152.50 75.80 2.18.82 29--56 • • • . **.** • • **.** • • . • ٠ ÷ . 0 0 0 23 583.83 90.96 216.58 757.35 165.55 31.60 507.85 • 73 753.13 859.50 175.03 704.68 921.06 503.29 248.64 250.24 830.52 29.26 1013.10 504.90 418.04 228.75 423.92 608.40 152.00 339.94 537.25 468.90 330.16 511.17 22 ٦r 06.7.60 673.50 07.78 721.45 656.92 427.50 847.84 879.28 653.40 652.30 624.00 574.18 528.36 541.24 369.22 533.30 619.74 517.37 54.00 126.10 551.38 61.566 203.14 352.44 739.00 521.99 633.61 759-01 776.65 501.02 21 `` ł 1032.00 c97.12 3052.43 464.76 420.24 1152.59 1051.22 219.45 027.10 1346.40 793.00 1998.48 1955.64 1442.74 1950.20 024.10 3344.32 1320.03 1-14.00 395.00 1712.18 50.500 50.48 1448.21 1040.58 1105.201 1441.44 2184.69 2171.45 00.100 20 ó23•7ÿ 47.14 43.39 303.36 500.28 333.20 543.2N 507.85 3:15.20 210.30 407.04 329.70 357.42 203.32 379.10 200.10 53.31 22.00 210.70 525.79 12.00 94.8u 304.23 337.70 306.40 524.75 239.52 45.00 429.30 10100 61 N 2 71/.22 296.87 432.54 b04.10 1751.72 080.76 719.44 530.92 534.30 87.73 820.55 749.70 641.99 457.50 92.5.54 727.68 610.42 610.75 56.85 1594.26 702.00 13.60 126.41 536.87 694.06 475.45 554.40 573.13 935.15 0.000 18 ; 21512 2157 2158 2160 2155 2154 .2149 2142 2146 2147 2148 2149 2150 2123 2124 2126 22022 2203 2204 2205 2141 2143 2144 2145 2201 いってい 2207 2135 2139

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- 25	211 164.0	U 99.4U	<b>383.4</b> 0	170.40	à5.20 ⁻	• 0	284.00	•	- 142.00
25	212 - 716.1	6 596.8u	1005.32	671.4L .	104.44	• 0 •	701.24	•	507.28
25	213 851.0	8 520.10	19.40.05	743.04	110.38	• 0	287.54	59.44	594.40
N,	214 232.6	2 387.36	1210.58	629-140	145.26	• 0	597.18	0 <b>•</b>	355.08
52	215 572.9	6 2+8.64	145.92	. 326.34	404.04	ó2.16	652 • 68	•0•	202.02
- 25	1-000 912	8 213.45	573.90	243.69	172.17	76-52	841.72	• 0	153.04
22	217	•	• 0	. J.	0.	• 0 •	, j,		• • •
22	218 633.1	2 445.2 U	1261.10	503.92	133.56	• 0 •	994.28	- 59.36	356.16
1	C-469- 613	6 238.08	1454.24	. 521.84	729.12	29.76	729.12	133.92	714.24
2,2 7	220 1400.0	8 1008.12	525030	1145.52	944.28	30.96	-2616.12	•	866.88
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27, 72,	222 . 0911.3	0 400.20	1203.22	690.30	92.04	• 0	813.02	• 0	460.20
.25	223 0.	•0•	0• 1	ů.	۰ ن	•0•	• =	• 0	. •
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, 22 ,	225 992.1	2 9114.5V	2217.68	375.40	364.75	•;•	1925.88	•.0	569.01
2	256 010.2	7 1c3.3U	555 <b>.2</b> 2	212.24	734.85	0 •	587.88	.0.	1.63 . 30
N,	227 860.3	6 220.09	1422.12	575.62	457.11	•0	643.34	• <b>0</b> •	496.97
22	228 779.7	6 4 4 3 3 • 2 li	1430.44	548.72	563.16	• 0	967.48	• 0 .	462.08
22	229 304.0	0 121.60	962.48	243.20	349.60	• 0 1	212.80	• 0	212.80
22	230 - 12.6	06.61 0	7 8 . 9	.14.00	• •	• 0	24.00	•0•	28.00
22	201 554.5	5 271.62	965.76	. 457.61	610.69	0 <b>•</b>	1026.12	. <u>.</u> 0	331.98
22	:32 210.0	U 50.00	315.00	184.00	105.00	0	30.00	• 0 •	180.00
2	1.1.1.4. ESS	4 346.72	1564.24	803.76	898.32	263.68	709.20	• 0	640.16
22	34 203.5	0 201.50	527.00	243.00	93.00	0.	403.00	• 0	170-50
22	35 693.0	8 246.52	1477.64	655.30	351.92	75.40	754.00	•0	573.04
22	36 012 °h	U 122.50	1149.30	505.50	530.29	0.	245.12	• 0	524.88.
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93.00 113.40 897.26 236.00 5.33 190.06 174.15 854.82 203.00 366.96 461.10 263.04 286.02 440.72 30.99 908,81 11.00 60.00 305.40 264.00 536.04 164.01 251.43 110.00 758.00 62.01 62.01 63.00 • • 0 • 26 115.50. 29.50 45.81 30.9. • 0 • 0 • • ٠ . • . . ٠ ٠ ٠ 25 0 0 0 0 0 0 0 0 0 0 0 0 0 ¢ 0 0 0 0 0 0 o 61.08 1171.50 870.25 21.32 394.74 38.70 734.59 871.53 756.24 1719.64 591.25 2167.38 413.40 642.17 567.00 1779.05 834.22 144.62 2477.79 204.75 2152.88 551.00 2612.90 475.41 1920.01 90.00 • • : ;; • • ••• 24 73.75 15.16 .17 153.70 15.83 30.58 59.56 290.00 82.20 • 0 • 0 • 0 • • .0 • • 0 • • • 0 • ٠ • ٠ 33 170. 0 0 0 175.44 838.99 59.04 55.5.95 147.96 d50.85 410.50 353.00 531.00 446.70 34.70 522.00 764.50 434.07 27.50 1061.20 331.36 834.22 353.97 55.00 355.94 • 0 • . D • 0 • ;; ۰, • • -• ?) 22 377.00 99.546 183.24 379.50 264.25 5.33 307.02 105.45 1044.78 179.92 489.25 707.02 4:2.44 399.33 151.25 124.02 397.25 126.00 1144.75 582.38 82.64 93.00 879.51 02,01 1105.03 22.00 75.00 42.011 • 0 • 0 • 21 940.50 752.25 716.38 436.35 2011.95 462.21 1629.03 638.44 1094.46 3217.76 1243.46 246.00 21.32 2114.58 783.00 1238.49 536.25 2486.52 240.04 269.38 1064.63 00.014 154.95 3047.43 22.00 056.61 80.45% 10.681 • 0 • 0 • 2 20 1966 63.34 20.84 203.00 928.21 236.00 175.44 854,06 723.10 104.19 306.95 691.69 164.40 413.76 233.75 613.64 124.02 45.5"1 349.56 239.40 251.84 01.95 138.80 76.35 45.00 15.51 313.5 **0** • ù. • 0 19 577.59 472.00 10.66 **330.20** 154.60 1440.23 200.08 436.69 672.76 750.13 400.02 443.70 224.03 1594.72 115.55 324.02 540.26 151.20 330.42 171.26 22.00 139.50 997.63 92.97 78.75 320.67 431.27 120.09 • • • 0 • 0 18 23u5 23u6 223A 2239 2240 2242 2362 2303 2304 2307 2303 2309 2319 2153 2313 2314 2315 2316 2317 2318 2319 2320 2322 2324 2325 2241 2301 2323 2311 2321 2320

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120.88 77.00 58.00 29.00 144.90 45.00 203.06 78.55 250.05 104.00 113.76 168.0.0 70.40 158.95 483.29 266.04 91.00 77.00 112.98 120.00 229.95 136.80 190.96 227.85 21.00 192.01 143.01 264.96 • 26 28.90 136.71 • 0 • • • ••• • • • • 0 • = • 0 o, o c 0 0 0 c 25 708.96 895.86 304.50 592.80 520.80 231.20 452.98 225.40 219.94 250.05 234.00 1044.53 456.32 785.34 182.00 30%.00 355.08 540.00 674.52 1002.54 164.00 4 - . 0 0 215.60 116.00 413.14 4.8.5.52 666.16 340.00 -: 24 *,... 85.32 46.77 **69.44** 93.72 21.12 32.20 • 0 • • e •0 **0** . • 0 • **.** •0 • •0 • 0 • • . . ٠ • 0 C 0 0 0 0 O 0 23 12.50 30.40 168.63 265.86 274.00 61.00 292.60 **300-06** 63.56 105.77 333.08 **09.13** 34.28 72.80 91.14 65.00 61.20 ł • 9 • • • ð. • n • • • = • • • • ~ • • •• -22 329.16 219.82 337.26 21.00 265.86 201.16 141.90 47.13 77.00 58.00 25.3.05 104.00 499.62 70.40 91.60 27.76 120.00 43.50 167.20 277.76 334.18 45.00 245.65 142.20 190.68 166.21 561.24 309.12 205.20 ċ 21 573.22 410.40 694.40 434.70 251.36 292.00 120-20 950.70 269.50 015.10 0511-04 84.10 157.50 34.594 079.42 040.42 203.00 733.48 291.20 1057.77 145.00 00.425 469.26 917.97 077.74 60.439 100.001 460.01 Lig1.0J 71 20 173.64 310.30 54.68 7.00 96.84 105.00 303.25 00.70 05.46 318.95 42.00 22.50 41.11. 246.75 126.26 96.60 109.97 107.80 58.00 240.04 91.00 213.34 1 27 . 1.2 120.83 463.70 358.57 547.44 3.0.00 ð 0 19 83.00 77.63 186.60 395.53 195.20 445.43 162.00 250.24 4.64.64 212.60 42.00 42.00 269.60 324.94 359.26 123.20 53.00 200.74 195.03 199.08 254.24 211.54 329.84 169.97 051.02 04.671 440.51 582.72 552.84 • • ;; 18 2300 2322 2335 2401 2462 24u5 24u6 2409 2413 417 2328 2329 2464 2403 5414 2334 2335 2403 7145. 2410 2411 2412 2415 416 2119 2327 301 2418 **31 U 1** ŝ

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277.56 45.00 280.98 573.48 128.88 135.00 113.55 196.95 15.00 660.05 307.40 99.78 33.99 207.20 91.02 66 . 0 0 ¥ 469.44 240.96 17.00 250.92 363.17 541.80 709.78 8.5.00 162.03 ł è ٠ • ٠ 26 0 9 247 0 0 31.86 92.88 128.88 279.87 2 88.02 61.41 • • • • • • 0 • • • • 0 • • • ٠ ٠ ٠ ٠ ٠ ٠ . • 0 0 0 0 0 c 0 c c 0 0 0 0 25 33.26 1290.96 473.60 224.40 696.60 880.088 764.89 1146.96 171.34 3 . . 00 -445.15 918.66 51.00 655.18 600.02 121.36 1836.17 265.60 721.77 462.60 783.87 105.00 ترید ہے۔ * • • • 8 . 0 з **0** • 5 212 -= 2 24 171.71 95.58 29.34 256.02 110.53 . . . . . . • • ••••• • • • 8 • • 0 . 0 ٠ 0 0 0 9 8 0 0 0 23 512.04 26.40 30.00 447.47 10.30 61.92 154.40 53.92 331.42 140.49 1135.45 599.43 440.08 29.60 157.90 61.63 45.00 **0** • **0** • 0. • 0 • • . J υ, 9 • . . • • • • • • 0 22 ì 235.68 346.35 06.52 15.32 34.00 251.60 647.39 106.19 79.20 745.04 967.52 **b** 3 • 0 0 293.36 691.47 421.47 354.60 128.48 242.40 15.00 3 + 9 • 1 0 338.14 302.44 69-4-99 00.000 155.9 9.9.8 •••• **З**• • 🖬 2 21 1 130.00 256.50 787.44 509.78 420.66 454.20 021.15 311 . 13 2271.30 764.50 153.00 149.07 , 9.51 000.52 000.000 1520.36 2091.05 265 • 00 35.984 533.43 031.95 į **54**13.91 1486.08 722.77 **51.1.12** 150.00 • • : • • 5 20 د**ز.**113. 015 • U U 92.45 202.64 349.50 111.51 2.25.64 16.60 11.33 1.16.19 216.10 425.43 249.70 342.57 45.56 100.69 921.00 104.44 200.022 292.74 192.40 06.40 \$6.12 64.44 01.00 . • ٠ ٠ . e Ð e 9 Ð 19  $\sim$ 79.20 34.00 \$ 5 7 . 9 5 4116.62 44.09 30.09 410.20 281.20 121.50 774.04 172.63 710.85 81.64 230.23 60.60 99.241 42.27 21.415 1. 5 . 6 . 69.666 18.010 33.00 00.000 294.00 700.92 410.04 ŗ, • 9 • • с. • 13 **3202** 4-1-1-**32 U 6** 5568 5223 3223 1244 01 u 7 **J** 1 6 6 0100 0110 1110 2110 0113 22 U I 3203 0204 3205 3207 32 U S 0120 0221 3215 3215 0120 J227 3218 しってい
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100.02 1108.87 • 0 • 54.99 444 . 36 .16 72.00 39.00 34.00 274.04 1059.32 233.94 178.20 71.65 252.00 41.01 550.93 44.01 190.96 504.90 446.70 462.60 480.90 75.00 263.50 • 26 237 191 ٠ 126.96 198.90 46.26 120.19 . 88 136.71 64.12 **. 0**• ••• • 0 • • •0 • • 0 ٠ . . . ٠ ٠ ٠ . . 208. 0 9 0 0 ø 0 c 0 c 0 8 0 0 0 ŝ N 109.36 1414.55 117.36 902.72 1071.00 431.81 2282.16 60.68 246.38 54.00 Ś 1625.33 25.00 3730.00 664.20 487.22 771.75 1158.51 753.41 95.52 245.00 364.00 757.64 85.63 146.64 106.00 171.96 711.4 ÷ 'n • ٠ 0 24 30.84 33.34 5.19 • 25 0 29.78 ຸ ລ 103.68 4.1 49.21 75.01 0.0 0.0 0. ٠ . . . . . . . . . . ٠ . . . . ٠ 0 50 ........ 0 0 a 0 23 N 32.40 20.06 809.32 180.61 94.50 223.35 29.34 365.01 173.60 504.90 416.92 277.56 115.69 510.00 64.48 206.04 31.84 . 0. ••• • 0 ٠ 6 . ٠ 22 0 0 **D** 0 ວ ອ 0 3 71.65 210.60 Ъ 664.94 73.35 5 269.40 5 14 40 550.93 ۳ 350.03 7.3.00 11.00 351.64 536.70 317.49 71.65 73.32 81.00 04.00 291.15 3 223.21 41.01 341.00 606.5 511.5 07.5 2.99.2 657.2 191.0 224.2 126.0 э. 21 • 00 51.00 902.72 2054.02 132.00 3290.20 1135.20 096.60 J15.26 834.75 2313.29 164.04 132.03 1034.01 711.76 1794.10 1354.99 1/27.04 00.000 480 . 56 200.02 184.50 3/51.93 282.40 162.50 030.80 123.50 252.00 111.48 . 162, 5 20 225.58 200.62 53.64 207.10 074.24 3.0.75 91.65 54.63 225.58 693.90 91.00 2.9.25 1.13.51 29.34 523.11 6,2.30 3:2.47 **ú6**•68 103.02 3.16.63 44**.**00 043.27 40.50 11.65 275.20 12.50 175.12 100.50 • • 19 294.94 274.72 75.32 154.44 577.08 862.60 00.10 51.00 104.72 467.48 507.80 114.64 450.75 54.00 010.95 73.35 632.41 341.42 041.50 114.72 00.177 0.2.01 94.50 51.32 117.60 100.061 246.90 325.54 281.94 ч. 18 3308 3309 3312 3312 3312 3312 3314 3316 3316 3316 3316 3319 3219 5220 302 3302 3303 53U4 305 3336 33U7 9755 5321 3321 1102 4105 4107 3301 41 01 41 U 3 4104 4106

59.01 5 • U O 9 • U O 292.98 323.80 57.00 157.63 495.07 840.75 624.02 207.22 54.00 782.08 2106.64 183.82 316.08 47.01 14.00 1298.60 296.40 130 · ÚD 145.00 58.00 4 61.00 32.00 359.6 548.3 ٠ . ٠ ٠ 26 3 9 0 0 3 c 9 x 43.30 30.51 58.01 59.21 154.9 • • • 0 • • 0 • • .... . . 00 0 0 0 00 0 0 0 0 0 o 0 O 52 157.36 630.52 920.26 2015.36 5762.28 919.10 2212.50 1035.04 VC 1719.86 5134,00 1259.70 30.00 1037.40 894.36 793.51 398.50 183.00 130.00 16.00 40.04 308.0 125.3 99.7 • 0 • • • 0 . ٠ ٠ . Ð 0 0 c 118.56 0: 0. 0. 61.60 301.16 136.98 Q 212.10 413.00 35.12 0 03.85 4 51.34 103.21 285.7 .......... • ..... ٠ ٠ -----53 92.52. 64.76 32.00 U. 255.52 223.16 30.50 691.U4 2122.13 23.28 06.910 210.12 609-68 2506.00 207.48 146.25 24.00 55.71 • 0 ••• . . • 0 . . . . • • • . . ວ = 3 9 0 5 22 5.00 243•61 542•98 19.00 379.03 302.86 06.40 952.48 2895.65 226.24 1224.25 368.70 750.56 1736.50 374.50 102.50 09.34 431.20 617.62 01.00 3 372.37 47.01 43.55 43.01 85.51 246.5 . . • • • • • 21 135.28 1106.28 116.00 196.70 25.30 14.00 1147.20 u74.3U 1171.92 939.02 547.03 919.09 057.50 215.00 152.50 2737.28 7063.04 3171.25 172.37 14.00 2354.10 411.50 1141.14 \$57.50 95.60 009.00 242.2 • -. ٠ ÷ ð 20 **N** ŝ 2447.42 242.8U 973.5U 2ru.90 39.54 J2.84 31.3.24 1+3.40 04.80 736.00 2144.20 444.68 65.0V 109.40 200.62 709.12 () {:• < T 503.10 523.82 307.61 47.01 22.66 217.50 • ຄ • • 0 • 0 • 0 . • : • • 0 19 6.68 . 9 **.** 9 U 9.01 741.00 420.94 68.486 414.44 100.001 91.50 1263.36 3345.84 353.00 1489.75 491.08 7.3.35 14.60 945.64 234.69 530.52 14.292 3 ++++ 286.61 64.60 0 0 446.69 29.01 14.43 45.0 • • • • • • • 13 ~ 4109 4110 2 U Q 2 1 U 3 u 2 3 u 2 303 **3** J 5 306 3 u A 4112 2 0 2 205 204 2 u 5 206 2 U 7 2 ù ð 304 3 0 7 309 376 311 312 313 314 4111 2u1 5101 1 . 2 4108

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25	• 0	•0	0.	• 0	• 0	• 0	303.45	• 0	0.	59.44	• 0	• 0	• 0	• 0	• 0	<b>.</b>	61.92	• 0	105°06	16.92	• 0	•	65.00	149.50	• 0	• 0		• 0	• 0	• 0
24	395.46	• 0	63.32		30.26	1046.50	1820.70	9 •	1453.06	1768.90	• 7	402.00	560.82	106.54	249.59	568.80	1021.68	702.62	1558.00	253.80	900.00	576.46	1306.00	192.35	102.00	651.90	• 0	• •	258.56	570.15
23	0	• 0	•0	•0	00.52	89.7U	946.05	•0	2396.80	2942.28	•0	134.00	57.52	146.63	• 0	31.60	619.2U	• 0	124.64	2774.88	966.40	667.48	505.00	44.85	• • •	31.80	5626.50	•0	355.52	730.47
22	60.54	Û o	63.32	с. •	• 0	493.35	714.00	÷9	464.38	44.58	е. Э	67.00	23.76	• 0	• 0	ũ.	588.24	195.08	124.64	• ສ	407.70	546.12	564.75	269.10	102.00	127.20	• 0	• 0	225.24	220.06
21	593.19		63.32	<b>0</b> •	136.17	1061.45	10/1.00	• 0	803.82	951.04	<b>0</b> •	241.00	159.18	53.32	44.01	205.40	1000.20	457.52	482.98	846.00	961.50	561.29	660.25	40.3.65	00•43	349.80	1346.95	0	325.20	521.24
20	1525.201	13	209.94	• 0	287.47	02.1815	2620.50	• 0	3295.00	3700.14	0.	757.25	503.30	226.01	161.37	561.60	2167.20	1176.48	1/70.12	1:82.55	2295.20	1226.77	1003.75	1196.60	204.00	1224.50	1449.25	• 8	63u • 24	1503.20
١ċ	517.14	0	n3.32	• 0	<b>30.2</b> 0	403.45	701.85	•0	1016.64	3426.56	-	217.75	211.32	30.95	30.04	142.26	508.24	310.40	7 u 1 • 1 u	34.61	437.90	166.81	457.50	4 c 8 . 5 u	00.14	345.70	• 13	• ;;	96.96	268.54
18	502.77	ч.	63.32	ů.	10.01	1121.25	1249.56	• 0	960.05	945.02	а. В	204.75	215.70	60.00	73.35	266•00	1099.08	522.48	564 . 168	042.96	06.134	566.61	645.00	478.40	119.60	461.18	1227.60	۰ ٩	334.36	586.44
м	5103	5104	5105	5106	5107	5208	ちどい1	5202	5203	52 li 4	5361	5302	5503	, 5 J U 4	5305	<b>53U6</b>	5307	5 3 8 5	5309	5310	5311	5312	5313	5314	5315	5316	5317	5318	5319	9326

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25	•0	0.	• 0	<b>0</b>	15.23	•	90.78	258.88	•	ŋ.	• 0	114.94	• 0	• 0	0.	•	• 0	30.26	• 0	• 0	0.	0 0	0 • .	• 0	0.	• 0	•0	• 0	° o	• 0	
24	556.62	• 0	• 0	9 •	563.51	•	1573.52	614.84	10.63	• 0	735.75	1056.42	2529.60	33.20	10.00	0•	106.64	<b>333</b> .08	2481.60	• n	363.40	32.00	60.00	90.06	0.	193.50	224.00	20.00	225.00	• •	
÷2	0.	• 0	0.	<b>ں</b>	243.68	<b>.</b> 0	378.25	323.60	74.52	• 0	261.60	394.08	569.16	<b>33.2U</b>	<b>ں</b>	D.	0.	30.28	279.18	0.	0.	• 0	• 0	0• 0	• U	•0	• 0	•0	•0	• 0	
22	65.72	• a	ų •	• 0	472.13	ů.	741.37	226.52	74.52	• 0	130.60	394.08	1027.65	0•	u .	ч.	66.65	151.40	1070.19	• 0	145.36	<b>n</b>	150.00	• 0	Ú.	21.50	28.60	ų <b>.</b>	0•	• 0	
2,1	569.30	12.00	а. •	• =	491.67	. U	786.70	869.00	167.67	23.00	555.90	979.26	711.45	99.68	5.00	20.60	05.65	136.26	601.85	. 6	145.36	16.00	75.00	14.00	0.	43.6ט	112.00	۰ ۵	112.50	16.50	
20	190.001	72.00	ų s	۰ ۵	589.95	e 9	2405.67	1/95.98	484.38	46.00	1762.15	2294.36	2u3y.49	215.60	15.00	40.00	119.97	393.64	2080.24	20.06	363.40	10.00	210.00	07°70T	U .	150.50	252.00	65.00	525.00	30.00	
19	700.49	46.00	•	• 55	243.60	• 23	832.15	372.14	205.93	• 	456.50	925.36	822.12	16.61	5 . U U	•	39.99	121.12	977.15	• 0	127.19	16.00	15.08	<b>36.00</b>	. • U	04.50	98:86	13.90	42.94	• 0	•
18	20.424	12.10		- n -	517.82	• 12	1413.71	<b>559.90</b>	130.41	23.04	654.63	52.414	1059.27	132.60	10.00	24.00	52.52	227.10	992.64	• n	145.36	5 • J D	75.60	10.44	ų.	85.V(	112.00	2 v . i U	04.211	16.50	
<b>1</b>	5361	ちょくひ	5323	5324	ちうとら	5526	ちょくて	5328	9329	0054	5003	5352	ちょうろ	5304	5335	5401	5402	54 L 3	ちょしゅ	5405	ちんじん	55 U 1	5502	55u3	ちぃくぐ	ちょうく	0 N Ç Ç	5547	ちちょみ	55ug	

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5510	26.00	• U	52.00	00.24	* • e	• 0	• 3	• 0	2.6 - 0.0
1144	079.75	271.94	1141.98	135.04	1141.98	108.76	70694	<b>.</b>	4.3.50.4
りちょる	702.64	502.92	1549.34	644.25	020.36	<b>36 - 6</b> 8	1104.48	61.36	521.56
5144	704.56	517.48	1484.92	550.44	443.72	• 0	1200.96	3.3. 36	3.6.6., 96
ちちょう	464.40	2 6 2 . 2 U	38.300	337.00	741.40	0	202.20	0.*	3.377 • 0.0
0101	253.13	312.69	1012.52	357.36	• ೧	ŋ.	282.91	•	2:6.60.2
6102	410.00	336.00	1,20.06	512.00	80.00	• 0	144.00	0 <b>*</b>	1.9.6. 0.0
0103	130.00	178.75	115.06	162.50	• n	0	46.75	3:2 .5.0	1.9.5. 010
6104	365.15	5:5.20	1594.67	46 ⁴ .16	58.52	73.15	645.12	14.63	4 3.6 . 9'0
6105	850.14	650.84	2440.26	961.28	120.16	• 0	726.96	4 5 • 0 i6	871.16
6106	072.04	500.70	2482.60	736.92	128.16	96.12	945.13	8.0. 10	672 84
, 01U7	105.60	118.40	-114.40	118.40	e 0	44.40	2.60.40	0.•	13.320
6105	90.42	195.91	491.01	150.70	с. С	<b>0</b> •	2.86.33	0. •	19.5. 9.1
5119	360.41	206.39	b71.52	250.72	109.69	• 0	184.04	• 0	3.44 . 7 4
6110	490.05	311.52	1381.15	549.45	252.45	• 0	534.60	19:3.05	460.35
6111	1 U 2 J • U 9	3 3 6 - 3 10	2425.40	975.00	765.00	0.	00•484	60.00	690•00 ⁵
0112	774.72	419 64	1281.72	645.60	330.94	145.26	045.60	• 0	564.90
6113	862.26	501.66	2428.80	850.08	30.36	60.72	986.70	60.72	743.82
0114	062.04	512.04	1085.72	707.82	135.54	135.54	1506.00	30.12	490.98
0115	<b>801.36</b>	241.92	1 < 3 9 . 8 4	619.92	493.96	559.44	710.64	0.	496.96
6116	1435.28	716.64	3019.46	1348.49	432.97	164.23	1567.65	29.86	1119.75
6201	661.45	300.44	1300.95	495.60	123.90	• 0	745.40	• 0	413.00
6242	• n	0•	u .	• 0	• 0	0.	0 <b>•</b>	• 0	•
020 <b>3</b>	482.70	<b>32 • 1</b> ,8	52.17	547.00	402.25	04.30	32.18	96.54	370.07
6234	1066.74	94305	2411.76	881.22	1144.04	30.92	2164.40	• 0	602.94
6245	1024.00	8 . 2 . 9 8	2440.01	843.00	400.00	624.00	1232.00	• 0	650.00
6206	926.4U	360.038	2230.80	756.56	185.28	926.40	1775.60	• 0	555.84
62 u 7	h19.18	864.69	1972.10	576.46	606.00	121.36	2123.80	• 0	439.93
, 6 2 ሀ ዓ	120.01	7 4 5 • 6 4	1031.70	553.60	68.20	132.30	1249.50	• 0	396.90
(,209	ó14.ни	215.16	1196.66	319.62	184.44	y2.22	707.02	0.	384.25
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39.00 8.50 41.01 35.00 299.00 46.08 267.30 22.00 294.98 70.00 32,00 271.98 228.06 153.99 548.08 54.00 33.99 49.50 380.88 151.02 170.04 432.04 64.01 90.00 41.01 29.00 48.00 784.89 125.01 • 0 • 26 33.22 30.22 81.45 29.70 ••• • 0 • **с**. • • 25 .......... 0 0 Ö 0 0 a C 0 0 0 479.08 468.00 396.00 1220.16 637.20 016.14 1419.56 78.00 180.00 979.99 96.00 634.62 796.21 2770.20 1869.92 135.96 604.08 888.96 27.34 372.75 138.00 ŝ 54.68 86.00 116.00 224.00 519.7 • • • • 5 : • 24 97.74 30.78 60.44 103.68 14.95 29.34 118.80 32.00 23.44 **0** • • • • 0 • 0 • • 0 • • • • 5 • . • ٠ • 0 0 0 0 0 33 569.43 596.44 72.00 540.05 269.76 20.00 120.68 550.56 100.68 35.00 416.00 264.06 200.35 564°30 228.06 16.00 • 1 • 0 **.**0 • 0 • 0 ч. Ч • • • • ••• • 5 • 0 • 0 • 0 • 22 134.58 152.79 3 8 2 • 0 5 48.0U . 52.00 458.19 309.51 153.99 1077.34 789.38 90.06 53.99 49.50 461.28 70.60 284.05 278.75 678.92 39.00 13.67 223.65 123.00 31.50 297.04 22.00 29.00 64.00 41.01 **0** • • 0 • • 21 92.984 513.93 136.50 149.94 64.00 2003.25 2063.36 252.00 247.50 1547.52 207.30 07.50 216.95 733.50 82.02 70.144 17.00 2 8 5 . 6 0 046.45 123.03 141.50 224.00 129.911 182.00 1012.07 961.11 427.75 113.30 10.00 • • د د 20 43.54 548.15 42.06 271.90 358.34 102.60 046.45 741.52 90**.**02 22 • 6 6 123.72 201.30 418.60 233.40 509.19 236.13 0.0.60 105.00 46.00 237.60 580.32 13.67 27.34 00.00 44.00 178.9, • • 0 • • **0 .** 19 32.05 72.50 99.00 7 11 - 6 9 536.20 410.76 642.30 194.46 34.00 283.29 3.50 415.25 112.00 434.19 358.3H 962.72 120000 50.05 054.72 234.92 00.241 00.69 100.95 222.43 492.83 41.01 22.06 59.00 41.01 • 1 • ŋ 18 6316 6317 0320 0 J U 5 0313 0 315 8750 0319 6445 0210 6301 6302 0303 0304 cjub o 3 u 7 e 3 U B 6319 0310 6311 0312 0314 6321 0402 6403 64 U 6 64 U 7 0211 6401 ひそいろ 5408

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93.00 183.96 51.99 111.00 396.00 331.80 698 • 85 N 62.00 65 3 96.91 56.00 35.01 42.00 0 9 9 253.05 34.09 65.60 847.28 102.36 135.9 152.0 260.9 259.5 290.0 409.5 • 9 • 26 66+30 124.24 152.91 65.21 22 + 71 ° 0 • 0 • • • • • ° 0 •0 • 0 • 0 . a • 0 9. 0 **.**0 å • ••• • 6 • • • • • 0 25 111.60 306.60 2577.98 93.00 832.15 796.25 28.00 1028.58 93.36 33.98 244.65 447.02 173.30 452.16 127,50 276.25 182.40 320.53 02.9.610 1031.94 09.69 ÷. H ۰, 0 ° • 0 • • • • c 34 ţ 0.60 266.00 06.30 261.89 N 5.5 ° • 0 0 ° •• • 0 • • • • . . - 0 **.** • **0** ••• • o 50 o e 0 0 o Ċ 3 74.00 26.00 32.02 332.86 102.00 487.50 240.05 111.60 95.00 106.00 30.06 490.96 119.20 32.76 28.34 32.80 • 0 • • ••• ч • Л • ;; • • 8 . * 5 • 5 • 1 * 3 • 0 • -S 22 257.21 85.38 17.00 29.00 93.00 69.32 84.78 63.75 06.25 111.00 36.25 56.00 381.57 93.00 260.61 978.39 23.34 42.00 105.92 121.60 34.0U 403.76 269.92 85.62 342.70 179.41 475.02 52.0C • • 0 21 201.00 277.50 1094.56 191.25 1128.12 241.30 76.194 2956.70 93.36 139.50 255 . 40 419 . 77 59.00 462.50 84.00 112.00 373.78 395.20 102.00 152.66 877.24 170.04 068.11 966.50 1425.06 147.0 • 3 • 5 20 17.06 97.86 15.50 900.32 157.91 28.00 95.36 16.40 d5.96 103.09 132.50 90.345 398.16 67.96 22.99 63.75 3226.37 46.65 91,20 346.08 2 2 2 . 4 4 387.40 5/3.30 • 0 ° 0 ° ů • • 0 • 0 • ¢ 19 42.00 51.00 270.94 95.40 24.00 547.99 103.95 169.56 89.25 29.00 74.5U 166.50 55.00 301.57 ¥3.8U 1149.22 25.34 130.92 130.69 389.69 374.92 343.06 136.43 82.00 582.00 42.51 372.50 524.16 • n • • 18 6417 0425 6438 6410 0412 0413 0414 0415 0110 6418 6119 0420 0422 6423 0424 6425 0423 6433 1140 6421 0427 0423 6400 5431 6432 0435 6436 6437 6059 6434

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58.00 199.78 60.00 100.98 39.00 253.95 53.00 533.40 339.57 338.10 326.97 37.50 27.00 ø 44.25 127.62 350.06 86.65 26.00 359.04 63.00 45.00 51.20 57.99 57.99 33.00 45°99 85.02 48.13 7.05 177.2 0 26 50.64 45.60 34.60 80.85 99.66 113.44 • 0 • 0 • • 0 ••• • 0 • 5 . . . ų · • . . . . . . . • . **a** ō ō 0 Θ 0 0 0 0 9 C c 0 • c 0 o 25 214.05 554.88 59.00 644.00 287.81 700.12 34.66 C 2 0 095.51 201.00 996.48 0 540.00 102.40 54.64 ŝ 0 22.00 155.50 170.04 134.64 014.57 50.64 53.00 87.00 56.2! 42.01 1188.7 169.0 • 0 • • • 9 • • • 24 228.60 76.10 • • • ••• ••••• • • • • •0 • 23 33.06 57.99 45.72 226.38 273.70 293.76 365.40 284.26 25 • 60 39.60 575.62 354.84 613.61 27.00 212.55 232.54 02.50 • 0 • • • • ° n ; • • • • • • n • = • • 5 • 9 23 ĊJ 37.53 27.06 7.00 242.59 66.00 29.50 113.44 33.60 39.00 3 4 4 . 7 4 354.84 20.16 53.00 762.00 26.00 371.91 466.90 156.96 113.40 482.67 43.50 75.00 51.20 90.06 19.33 76.65 99.19 48.47 111.28 • 0 • 5 0 145.75 2241.28 1002.54 1224.00 212.63 115.98 54.60 73.75 252.45 06.86 161.85 1004.52 173.58 162.00 **996.20** 513.72 226.80 1410.37 285.68 166.40 42.00 122.04 226.72 115.50 UC.120 203.00 112.50 99.00 561.54 206.40 • Reproduced from best available copy. 'n 20 237.02 243.52 17.33 128.43 77.32 806.58 269-86 212.10 8.75 13.25 104.00 226.38 75.03 667.23 21.00 14.75 28.33 41.10 43.54 130.001 51.20 11.00 30.60 28.01 101.01 25.32 . • 0 • ;; • 0 • 0 • • ----19 75.03 372.46 830.26 39.00 527.44 574.08 522.54 230.60 407.10 102.40 38.60 44.00 66.00 44.25 113.44 טל.טל 141.58 103.98 39.75 325.21 1-1-50 77.32 56.25 4 u • 5 0 67.32 1.00 75.05 127.53 262.56 514.91 е в 81 0442 0443 6440 6447 6449 6423 0444 0445 6448 9479 0451 0422 6424 6425 0456 6501 5950 6503 6564 6505 ሰ 5 ሀ 6 65 U 7 6 5 J B 6510 6513 0441 1744 0433 c 6049 6441

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Тò	53.63	142.09	205.58	50.68	29.34	• 0	234.72	• 0	44.01
20 2	26.70	54.61	5:55.39	136.02	• 3	• 0	226.70	• 0	130.02
21 2	01.52	75.99	253.30	126.65	0.	•0	303.96	• 0	75.99
22 1	30.00	1<2.40	272.00	122.40	81.60	54.40	571.20	0• .	68.00
<b>23 1</b> .	33.68	99 <b>4</b> ù	284.00	127.50	23.40	<b>.</b> 0	241.40	• 0	71.00
24	45.75	15.25	91.50	<b>3</b> 9.50	• ŋ	• 0	34.50	0.	45.75
25 I.	99.94	16.90	415.26	107.66	• 0	• 0	138.42	0.	123.04
25	73.00	24.75	237.25	54.75	•0	0.	109.50	• 0	73.00
27	58.50	78.04	195.00	58.56	97.50	<b>0</b>	273.00	• 0	39.00
28	51.00	46•66	162.00	32.40	• 0	• 0	97.20	32.40	64.80
29 3.	3 0 0	396.60	1 . 2	195.00	150.00	•0	045.00	30.00	315.00
<b>30 2</b>	23.62	129.30	551.55	2 . 7 . 0 9	31.86	•0	334.53	• 0	223.02
31	64,50	64.50	182.15	64.58	107.50	• 0	225.75	• 0	43.00
32 1	02.00	34.01	221.00	17.00	• 0	<b>0</b>	136.00	0.	68.00
	94.44	42.75	156.75	20.50	• 0	• 0	85.50	• 0	57.00
54	70.00	117.00	<b>351.00</b>	56.50	97.50	• 0	234.00	• 0	78.00
55	94.19	122.00	244.00	61.00	. 91.50	• 0	244.00	0.	61.00
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62 21	27.34	203.61	1028.95	511.83	403.26	0.	62 • U 4	93.06	682.44
r3 0.	10.01	109.45	90v e U 3	315.30	• 0	0	268.43	• 0	284.22
4 S	92.60	321.36	922.32	263.52	• 3	0.	245.88	•	278.16
u5 2	92.20	147.60	010.01	246.00	<b>.</b> 0	• •	147.00	98.40	229.60
u 6 2	93.69	279.11	1087.06	425.01.	0.	• 6	224.35	• 0	337.87
u7 3.	14.47	103.17	197.12	293.06	199.43	•	54.59	• 0	290.08
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179 i ŧ 777.75 70.02 266.05 398.72 679.88 346.94 915.00 220.00 988.80 39.99 509.19 663.06 604.89 560.38 265.32 005.18 617.05 344.08 679.80 205.94 215.60 519.84 927.81 371.04 807.84 -78.00 133.91 544.00 149.04 52.50 22.00 ۱ 26 • -45.15-259.25 29.52 198.25 152.50 386.25 57.76 215.86 91.26 124.08 ۍ 229.65 46.92 125.20 30.90 28.48 ¢ 262.31 Ś 103.46 58.9 335.0 **0** • 0 • • • . . 0 0 0 C 0 0 25 ł ŝ \$ 1657.89 1082.20 2054.85 385.75 863.52 1682.75 1077.48 412.72 1989.68 109.48 1799.50 8 û y . 25 39.99 400.40 231.04 3685.66 1941.45 0 ŝ 480.01 273.00 1791.27 328.00 298.08 1467 ; 7 281.7 • 5 • 9 **3** 1 24 22.48 58.35 45.75 200.99 140.70 4 29.42 63.08 9 45.63 155.10 86.56 ω 52.30 3 01.01 64.01 56.6 418.8 • • 0 • 0 • 0 • •••• • • . . . ٠ ċ 0000 33 ł 31.28 62.60 432.60 39.99 138.60 231.45 274.36 524.28 330.25 976.00 50.92 587.48 216.30 0.98.00 701.50 Ś 520.54 976.25 83.60 105.00 213.60 U12.90 189.24 1/0.01 715.61 230.00 132.48 1 265.94 463.7 • 3 е П ÷, 22 • 46 941.25 .10 379.36 53.35 391.25 648.90 427.20 176.52 346.94 113.25 223.00 174.20 39.99 246.40 410.61 369.98 693.90 003.86 666.93 605.10 260.00 479.26 151.92 91.00 152.48 1149.25 7 . 4 . 0 . 8 H 7 . 95 22.00 .00 842 2 'n 21 3 ì 3036.86. 970.50 946.70 984.48 1040.82 ÷ ŝ 476.25 0 1172.68 0 Θ 2119.75 1712.16 3 4 285.00 3929.34 3006.20 985.32 216.05 1167.68 2045.02 93.31 2750.01 104.47 u16.00 2362.85 114.00 496.0.0 87.51 2714.5 1227.4 3004.2 206.2 1634.9 610°7 1298.6 20 1325.47 250.56 324.60 2109.75 214.96 23.34 219.10 556.20 409.92 116.52 0 05 0 3 263.86 27.775 716.75 158.75 13.33 123.20 107.72 447.10 609.24 31.0.20 274 .50 947.36 117.00 149.04 425.04 736.00 82.60 • • 5 1357.25 32.00 741.60 457.33 723.24 7 ... . 2 60.475 250.07 \$10.36 04.115 50.32 231.00 540.053 462.08 561.84 113.46 976.03 368.50 91.16 2 130.00 439.14 00.000 212.28 5 J 0 . 64 184.16 232.01 644.84 りく・ぐくり 44.60 341.5 38 205-7113 7121 7122 7123 7241 7242 207 7109 0117 7112 114 115 116 7117 7113 6712 7120 2 L 4 205 203 2 U 9 210 212 213 7111 211 214 3 61 302

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26	25.00	40.00	349.02	980.10	296.0-0	22.00	4 8 • 0 0 0	59.00	4 4 . 0 0	51.99	61.60	132.00	193.96	387.00	•	210.60	169.95	122.00	8.00	•	9 0 0 0 ·	261.97	486.91	7 0 . 0 0	•	610.00	47.00	58.00	32.00	24.00
25	•	•0	• 0	• 0	88.80-	<b>0</b>	• 0	•••	• •	о О	• 0	• 0	• 0	• 0•		•	• 0	ا	•	• 0	• 0 •	• 0	•	.0.	• 0	• 0	0.	• 0	0.	•
24	•	• 0	1196.64	-2946.50	. 00•484	8 H • U 0	396.00	162.25	72.00	225.29	164.80	1134.50	-999.64	1099.08	с •	606.48	571.65	488.00	32.00	( • f)	• 0	· 708.86	1561.47	631.00	<b>9</b> •	1692.75	0 •	406.00	64.00	192.00
23	•	• 0	66.48	29.70	02.94	• 0	• 0	• 0	• 0	• 0	• 0	• • 0	119.20	30.96	• 0	• 0	30.90	•	• <b>0</b> •	0	• 0	• 0	• 0	122.50	• • 0	137.25	0.	• 0	• 0	•
22	• • •	0	166.20	1232.55	296.90	• 0	61.00	54.40	• •	121.31	<b>51.00</b>	97.60	373.40	232.20	•	505.40	262.65	91.50	. J	0.	0.	30.62	738.76	• 0	• •	899.75	• 0	• 0	. J	•
21	37.50	40.00	365.64 -	1316.80	444.00	22.0U	- 44.06	73.75	4 8- 00	66.65	72.46	23.1.00	238.72	557.28	• •	245.48	216.30	163.94	16.60	• • 0	13.00	154.10	665.39	122.50	• 0	701.50	47.00	2.00	16.00	4 4 • [] U
20	62.0	50.00	1163.40	3053.10	1095.20	6 6 7 0 0	240.00	191.15	144.00	207.96	523.40	043.50	760.92	1400.68	• 11	020.V2	256.20	513.25	32.00	• 0	14.00	523.94	1961.22	04.160	• ت	1891.00	117.50	232.00	112.00	144.00
19	<b>.</b> О	- - -	448.74	1009-20	325.60	22.00	96.08	23.75	24.00.	36.65	92.4u	313.54	203.48	4 . 2 . 4 8	•0	1/3.28	139.05	107.75	16.0Û	• 0	• 0 •	2 . 2 . 7 9	671.60	157.50	• 0	579.50	• 0	116.30	02.00	y 6 • U U
18	- 37.50	4 4 • 6 4	493.00	1782.00	910.014	- 22.00	129.00	83.50	160.00	121.31	123.20	231.40	343.16	758.52.	•	418.76	<b>309.00</b>	244 0	6 • n O	• 0	9.00	292.79	605 • 92	165.00		1052.25	47.00	04.101	32.06	18.00
; •4	7303	1304	- 7345	1306	1307	7308	7509	1310-	7311	1312	7313	1314	7315	7316	7317	1318-	7319	1320	7321	7322	. 7323	7324	7325	1326	1327	7328	7401	7402	1403	7464

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26	64.00	207.96	72.00	62.00	215.85	984.32	418.04	25.00	27.00	803.52	10.00	• 0	•	471.04	32.50	177.96	1307.61	545.04	266.39	135.00	- 41 • •	434.13	•••	•	451.80	295.20	985.38	229.65	458.18.	388.9.6	
25	• •	17.33	• 0	• 0	57.56	46.14	209.02	50.00	• 0	59.52	• 0	• 0	•0	• 0	• 0	• 0	• 0	0.	• 0	0.	• 0	• 0	• 0	• 0	90.36	• D	119.44	• 0	• •	• 0	
24	128.00	69.32	• 8	272.80	57.56	1107.36	701.71	•	с.	744.00	• 0	• 0	• 0	1236.48	• •	504.22	5906.79	5404.98	1065.56	40.50	• 0	598.80	6 •	Е	707.82	428.04	2821.77	321.51	1995.50	792.88	**
. 23	0	• 0	0• 0	24.80	•	• 0	• 0	• 0	• 0	342.24	•	• 0	• 0	• 0	• 0	•0	60.12	• 0	0	ŋ.	• 0	0	0.	• 0	• 0	• 0	119.44	• 0	0.	74.80	•
22	32.00	69.32	Ú.	• 3	• 0	569.06	119.44.	81.50	• 7	410.64	9	0.	• 0	279.68	• 5	59.32	285.57	242.24	62.08	594 • U 0	• 7	134.73	<b>0</b> •	• 0	421.68	428.64	1433.28	415.57	1359.76	553.52	,
21	43.06	190.63	72.00	66.80	172.68	958.18	417.70	25.00	40.50	714.24	.0	0•	9 •	412.16	32 • 5 U	155.47	279.54	404.70	78.35	256.56	• 0	449.10	• 0	• ()	311.26	236.16	1119.61	201.27	541.20	364.96	•
20	192.00	74.304	144.08	265.20	561.21	2245.48	1>22.66	04.78	40.50	2048.04	14:00	с.	• 0	1363.96	46.75	454.73	2091.37	2494.10	1126.24	376.00	• 0	1062.87	ور •	• N	1144.56	674.84	5239.61	073.64	1019.42	1032.24	
19	6.4 . 9.0	.4.6U	• 0	136.40	115.12	753.62	4 5 2 . 9 7	• 0	, 0 0	649.34	• 0	• 0	• •	529.92	• 0	192.79	2134.20	1621-20	10v2.8n	46.50		329.34	• 0	• 3	2 < 5 . 9 U	221.4U	1000.01/	107.79	344.23	254.32	·
18	45.60	294.61	72.50	80 <b>.</b> 00	40.34	553.68	471.76	37.50	4 4 • 2 4	54.549	1 0 0 0 0	0 °	() •	524.92	32.50	11.563	255.51	157.00	62.08	162.96	• R	329.34	• •	• 3	790.18	561.84	1761.74	164.92	124.22	763.12	
1	7405	74 U 6	1407	7408	HIU1	6142	5163	8104	6105	9166	81 U 7	81 N 8	2109	6110	8111	6112 V	6113	0114	6115	6116 5116	2110	6115	6119	0120	52 U 1	0202	<b>5203</b>	82 U 4	02 U 5	82V6	

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.25	69.82 0.	424.76	• 0	• 0	• 0	• 0	0.1	943.11	• 0	169.73	• 0	• 0	572.00	<b>0</b>	104.82	0.	97.56	• 0	•	45.36	103.04	•	• 0	• 0	• 0	259.74	•	•	0.1
24	: 1592.21 3534.40	2032.78	121.12	• 0	159.96	1580.00	38 H. 75	973.05	205.56	1789.88	661.20	1066.10	414.70	1166.10	296.99	561.74	1205.24	3210.24	232.48	2026.08	723.28	1151.44	0	•	779.52	919.09	1373.27	519.75	1390.12
23	29.94 180-48	166.87	• 0	• 0	26.66	• 0	264.35	• 0	• 0	154.30	66.12	106.61	• 0	29.90	1:0.76	• 0	146.34	01.44	• 0	•	147.20	62.24	• 0	• 0	• 0	• 0	, c,	• 0	75.55
22	, , , , , , , , , , , , , , , , , , ,	1010.39	56U.18	0 •	519.92	948.00	85.658	464.07	274.08	079.51	958.74	1691.53	686.40	403.65	139.76	290.52	1186.98	1766.40	270.07	589.68	. 235.52	171.16	<b>u</b> .	• ຄ	1201.75	1082.25	1033.61	141.75	800.83
21	568.80 962.56	7 6 3 . 8 4	242.24	<b>.</b> 1	106.62	577.60	1026.36	464.19	445.35	641.77	925.65	1020.41	343°20	598.60	419.25	145.20	654.40	1050.50 SOL	365.13	1013.04	347.44	542.32	e 0	21,00	747.04	543.39	324.05	214.75	951.93
20	1691.51 3919.36	24/2.71	757.40	105.00	500.04	1/02.40	2033.70	1362.27	1113.45	1743.59	2240.08	1495.13	936.10	1299.65	764.55	545.76	1723.56	3050004	595.73	2751.04	1006.96	964.72	() •	42.00	1965.34	1601.13	1011.55	704.15	2765.13
19	589.22 1488.90	0.5.05	60.5 <i>à</i>	<b>°</b> 6	93.JI	532.03	217.70	329.34	137.04	6.1.17	402.84	517.82	243.16	45.345	174.78	274.38	1 2 7 . 3 U	1228.80	161.71	d16.48	369.12	3:7.86	0.	• 0	329.76	315.18	555.48	236.25	10.926
18	778.44	161.90	317.94	4 j . u Q	330.25	921.20	1254.55	536.92	565.29	771.50	1200.69	1005.18	471.90	717.60	364.54	193.08	975.60	1469.92	334.19	1239.64	<b>33</b> 4.56	326.76	• 0	21.60	1055.60	894.66	224.62	336.75	1.17 5 8
r	v2v7 v2v8	0 C U G	. 8210	<b>5211</b>	-212	u213	1214	0215	c215	0217	[ 6218	5219	, 6220	6221	\$252	±223	b224	.0225	、 <b>6226</b>	5227	. 8228	6229	2236	¢2 <b>31</b>	6232	, <b>ù 2 3</b> 3	2231	8235	0236

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0	26	127.98	770.88	706.08	418.04	202.02	• 0	• 0	420.42	589.68	333.06	25.00	60.00	367.50	176.00	63.00	273.96	260.16		326.00	015.72	333.07	• •	• •	215.04	138.96	224.96	190.96	760.95	665 • 6 <del>4</del>			
	25	•	298.80	147.10	•	•	• 0	• 0	•	•	112.36	100.00	•0	279.30	•	•	•		•	•••	0.	0.	• 0	•	•	• •	84.36	40.92	° 0	913.52			
、 [•] • [•] •,	24	483.48	956616	2147.66	012.13	388.50		°. Ú	2150.61	2,6 8 0 . 6 4	1966.64	200.00	135.00	1293.60	666.80	252.00	424.476	2400.48 1404 70	1501.76	796.70	2580.16	1227.10	• 0	0.	629.76	617.60	203-00	463.76	1572.63	2074.32		•*	
1	23	• 0	119.52	58.34	•	•	•	•	•0	· • •	•0•	• 0	• 0	•	•	• • •	28.2/ , r	07.U4	57.75	32.60	•0	• 0	•	•••	50 • 7 Z	•	• •	08.20	• 0	<b>0</b> •			
) .	22	142.20	1015.92	809.65	149.58	186.48		• 1	594.29	362.68	412+36	87.50	60.00	499.80	193.60	•	04001 1000	308.94 1750 77	722.000	580.00	1275.42	350.60	• •	•••	09.7.64	617•60 n-	253.68	477.40	1046.42	<b>804.96</b>			
	21	164.86	821.46	832.64	410.04	264.15	• 0	• 0	420.42	756.00	364.76	37.54	45.00	455.70	1/6.00	10.61	2/3.00	20.072	361.80	440.16	671.36	350.60	0.	•	201.12	138.96 A	319.32	190.96	777.86	743.04	i		
·	20	390.16	1942.20	2010.38	1254.12	u 8 J • 7 6	e 1)	•	1519.98	2177.28	1:79.62	87.50	195.00	1440.60	774.40	02.112	10.410	1.007 • 04 2100 • 58	1031.72	1255.10	2242.98	1174.51	• 0	• 3	116.50	401.44	801-42	011.10	2470.16	2492.28	•		
	19	113.76	268.92	807.89	66.622	264.18	.• 0	•	620.65	8 <b>31.6</b> U	618.54	37.50	00.00	455.75	359.60	110.40	CC•/22	0 7 7 • 1 8 5 - 1 4 - 1 3	720-022	417.50	718.34	202.95	•	• •	n. +	123.52	154.66	190.04	1014.68	634 <b>.</b> 68	•		
	18	184 . 86	1040.60	1 185.54	04 • 10 ú v : v : v : v	299.20	• 1	<b>0</b>	954.03	1149.12	681.98	87.50	7 0	617.40	552.0U		50° 50°	1400,50	00°°660	619.40	1187.16	595.02	• 0	0 •	00.000	2/06/2	432.86	513.72	1290.61	1037.16			•
	П	3237	11 Z J B	8778 1979 1979	0 4 7 0	1629	8242 8	b243' -	6301	K3u2	343	K 3 U 4	U3U5	83U6	83U7	8968	5 0 C 2	0100	5312 5312	8513	8314	<b>d</b> 315	<b>5316</b>	6317	BICS	0.7 CO	8321	c 3 2 2	<b>6523</b>	6324			

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26	130.00	78.35	66.00	240.90	363.84	540.20	434.08	146.40	0.	392.86	350.29	801.36	109.04	684.80	638.98	• 0	• 0	• 0	16.00	463.14	• 0	199.94	68.00	201-03	80.85	531.00	932.48	45.99	261.90	100.50	100.47
25	17.0.00	297.73	• 0	• 0	<b>0</b> •	175.20	930.32	• 0	0.	• 0	45.69	207.76	• 0	88.80	89.16	• 0	•0	• 0	•0	•	•0	• 0	0.	• 0	• 0	•0•	360.96	0.	• 0	0.	C
24	527.00	282.06	352.00	754.82	651.88	949.00	1491.72	. 351.36	• 0	498.63	228.45	563.92	122.67	1258.00	1.067.12	0.	• 0	u.	ů.	1329.66	ů.	61.52	• 0	e •	0.	1637.25	1398.72	30.66	974.85	<b>.</b> 0	11 2611
23	• 0	0.	0 •	32.12	•0	292.00		• 0	•0	106.21	121.84	89.04	• 0	• 0 •	89.16	. 0	<b>0</b>	•0	• 0	29.88	• 0	• 0	•	\$1.74	• 0	118.00	•0	0.	72.75	<b>.</b>	c
22	255.00	78.35	• 6	192.72	95 . 5 6	458.00	368.92.	58.56	• 0	120.88	456.90	00.100	1.56.30	754.80	653.64	<b>ں</b> .	• 0	•0•	• ŋ	74.70	• 0	92.28	64.00	45.87	• 0	87u.25	315.84	u .	87.30	6.	:
21	130.00	76.35	132.00	305.14	569.28	715.40	545.36	190.32	0.	4 u 7 . 97	274.14	965.24	149.93	695.60	743.00	ŋ.	Ð.	<b>0</b> •	16.00	597.60	• 0	199.94	34.96	168.19	48.51	649.00	1057.76	45.99	363.75	<b>50.25</b>	<b></b>
20	040.60	235.05	242.00	<b>583.30</b>	1006.9001	1/00.20	1299.24	439.20	Ú.	1269.24	o52.88	1940-56	346.75	1909.20	2020.76		• 5	с. Ч	32.00	1248.58	• a	492.16	119.00	214.06	145.53	1562.99	2947.54	224.95	1050.0501	167.90	720 46
19 '	107.00	02.63	110.011	323.32	212.24	305.01	3-26-84	73.20	• ພ	407.97	1.07.07	290.80	08.15	516.00	504.96	0.	0.	0 •	<b>0</b> •	410.32	• 0	ó1.52	• 0	15.29	. • n	39% . 25	691。84	61.32	392.85	0.	10 220
18	187.00	127.36	110.00	461.40	545.7č	758.48	073.68	246.68	0.	460.41	472.13	593 e 23	177.19	1030.00	876.74	ų •	ù.	• 3	16.00	657.24	•	251.46	60.00	137.61	115.19	611.25	1184.16	76.05	421.45	134.60	50120R
	325	326	327	1368	201	12 02	1213	1204	205	7205	207	, 2 U B	1219	1210	-211	212	213	214	215	216	,217	1218	,219	1220	1221	222	301	362	503	1004	515

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97	23.00	451.36	357.42	405.08	273.02	58.00	177.32	. 0	• 0	14.00	638.44	491.04	533.16	557.46	17.00	229.06	405.11	167.04	210.99	60.00	665.62	330.74	183.96	37.00	232.95	416.00	•••	161.00	66.00	51.00	4.00
25	• 0	276.64	•0	0°	<b>0</b>	• •>	°. O	• 0	• 0	•	72.55	• 0	29.062	• 0	• 0	• 0	179.16	• 0	9 •	0.	376.22	• 0	• 0	• 0	<b>.</b> 9	80.00	• 0	• 0	0.	•0	43.39
24	115.00	1179:36	295.26	1121.76	995.72	56,00	27.28	•0	•0	42.00	2553.76	1130.88	725.69	1804,41	- - -	317.16	283.67	320,16	1087.41	120.00	1447.00	1524.28	306:60	; • 9	667.19	1166.00	9.	595.70	409.20	255.00	32.00
23	•0	0.	• •	124.64	• 0	• 0	•0	•0	• 0	•	•	•0	• 0	• 0	0 0	• 0	• 0	° 0	• 0	•	• 0	• 0	• 0	•0	• 0	• 0	• 0	• 0	•	• 0	
- 22	92.60	110.48	93.24	654.30	337.26	29.00	27.28	• ח	<b>.</b> .	49.00	783.54	729.12	784,93	865.53	136.00	140.96	164.23	190.96	162.30	• 0	920.08	80.28	444.57	• •	450.37	608.90	• 0	338.10	• 7	221.00	• 0
12	23.00	555.28	295.26	514.14	323.32	130,50	177.32	• 0	<b>9</b> •	. 23.00	812.56	729.12	690.07	733.50	17.00	229.00	477.76	235.64	253.66	60.00	868:20	503.30	275.94	55.50	217.42	576.00	J.	161-00	66.00	85.00	4.00
20	92.00	1426 - 85	1041.18	1.3.7.88	067.24	246.50	00.060	• 2	<b>.</b> .	63.00	2495.72	1740.96	1703.15	2068.47	34.00	051.94	1269.05	550.30	795.27	195.00	2u25.ä0	1279.32	491.56	111.00	714.38	1000.00	<b>6</b> .	90.974	277.20	204.00	12.00
61	46.00	4 U 7 . 6 U	202.02	405.06	240.90	07 • 11 U	24.50	. 0	t) • ()	21.00	870.64	529.80	201.39	572.13	0.	176.20	223.95	139.20	292.14	<i><b>3</b> 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</i>	403.04	445.78	76.65	<b>9</b> •	201.84	4 u ú • U O	• 0	193.20	92.40	102.00	4.00
18	40.00	557.84	4.5.12	741.14	64.14.6	101.50	177.32		, • D	23.60	111/.27	9117.68	b14.55	1626.90	17.00	240.08	041.99	251.56	324 • 6 U	9 υ • ሀ θ	1012.90	603.96	242.28	55.53	320.13	683.60	• 0	225.40	92.40	60.00	<b>U u e u l</b> l
	9300	9387	9305	. 4349	9310	9311	9312	9313	4725	43 <b>1</b> 5	9310	9317	9319		9320	9321	4322	9323	9324	9325	9325	9327	9328	9329	9.5.0	4301	9332	5495	5334	そらいう	9005

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## APPENDIX H

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LISTING OF ZONES USED TO DEVELOP THE SIXTEEN TRIPEND EQUATIONS

KEY TO COLUMN NUMBERS

- Home Based Trip Productions
- Home Work Trip Productions
- Home Personal Business Trip Productions
  - Home Shopping Trip Productions
- Home Social Recreational Trip Productions
  - Home School Trip Productions ۵
- All Other Home Based Trip Productions
  - All Home Based Trip Productions ω

    - Home Based Trip Attractions
      - Home Work Trip Attractions 0
- Home Personal Business Trip Attractions
  - Home Shopping Trip Attractions 2
- Home Social Recreational Trip Attractions 3

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- Home School Trip Attractions 14
- All Other Home Based Trip Attractions 15
  - All Home Based Trip Attractions 16

Note: 0000 indicates that there are no further significant zones for the particular trip purposes.

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16	1203	7244	7245	7210	7211	7347	31u6	6243	1247	1:219	6217	8222	8228	r 2 2 B	v 2 3 8	1239	\$7.7 X	9202	9207	9636	9211	ŧ
15	7244	1205	122.0	7211	7395	0110	6245	8241	9209	1128	8228	4224	522 H	8233	6239	9202	9201	92026	9211	0630	010	
14	11111	הוחי	0 11 11 12	មេប្រព្	ំពេ ម ព	0000	0 11 11 0	ប្រជុំថ្នំ	ប្រព្រ ព្រ	8499	uìlid	0000	ប់ប្រហៀ	11 11 11	0 11 10 10	0000	UduD	a ų į, a	የ በ የ ሀ	0000	0 " 0 "	
13	1213	7204	1245	1214	7211	7387	01178	3200	8201	6 # 2 8	321/	3228	8224	ういいてい	8234	32.34	0022	32026	42 U 7	9203	9211	
12	6238	8239	1522	42 H Z	9247	9211	0000	ធំពេខឲ្	លកល	លប្រលួ	0000	000	6000	0000	0 7 7 1	0001	ti U u O	6004	000	0000	ព្រព្	
11	7245	7204	7205	7210	7211	7.007	0110	0203	4247	8244	8217	5228	8224	8228	6236	8239	8322	42UZ	5207	9208	9211	*
10	7 2 ii 5	1239	1221	1347	0115	62 4.5	0247	0.420	12126	0222	6220	6223	いてい	1239	3256	9202	7926	y 2 t 3	721L	6008	U II II U	
6	72113	1671	2622	1210	1127	1001	3196	3203	1029	8209	8217	8122	3224	6228	もんうじ	8259	8322	2026	1426	9268	1126	
ø	7 2 4 3	12:44	61 61	1264	1211	7.36.7	a La Ġ	5.2.	1.2.1	5129	1220	1222	1224	のここの	62JÀ	1.2.09	ト ジ < 2	5.5.5	5020	5718	1120	
2	フィル・	2637	1224	7766	7601	3100	2743	1120	1020	1148	ところさ	3624	022R	6233	ひにいび	9282	1026	0200	923 L	<b>ຜູ້ນ</b> ີ່ ເບ	U [- I [I	•
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5	7 6 4.5	いいろん	7235	7 61.6	1211	1221	4145	0420	1028	りとりい	3211	5226	0224	5220	いじろい	さんらび	3522	そりてん	9261	9263	9611	
4	0020	\$365	21.24	9601	ソント	ù ² € 1,	ા હુવુ	5 Å 5 J	N P &	0 11 6 3	6969	0.40.4	いこうい	0 0 0 0	ا، ز، ۱۱	6 8 7 0	0101	3060		0 6 1 1 1	0 11 11 11	
ŝ	7230	7244	76.35	7214	7212	7.007	1140	Ciuj	0237	8214	1123	5228	4238	62210	8256	2232	8022	9292	1026	9235	9231	
2	1200	121 #	1211	1367	:1c2		1 1 2 1	~~~~	6217	5254	よいいい	12 Z B	0620	4c2n	0322	2924	5020	22 U S	9211	ניטטט	5 Ú U J	, , , ,
Ч	6421	120-	6126	1211	1121	1001	1 1 1 1	0120	1076	1120	5120	とくこく	かいひょ	いくこい	0520	ろいん	2220	7292	1526	920-5	4612	، ا ا ا ا ا ا ا ا ا ا ا ا ا ا ا ا ا ا ا

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## **BIOGRAPHICAL SKETCHES OF THE AUTHORS**

ALL ST LAND ALL ST AN

Captain John M. Barry, USAF, is a native of New York. He entered the U.S. Navy Reserve in 1964 and transferred to the Air Force in 1967. He received a Bachelor of Science degree in Multiple Science at LeMoyne College in 1967. He was commissioned through Officer Training School and attended the Aircraft Maintenance Officer Course at Chanute AFB, Illinois. He was initially assigned to the 41st Aerospace Rescue and Recovery Squadron at Hamilton AFB, California as the Staff Maintenance Officer. He received a Master of Arts in Aerospace Operations Management in 1970 from the University of Southern California through the Air Force's Operation Bootstrap. His next assignment was with the Western Aerospace Rescue and Recovery Center as Assistant Chief of Maintenance. Upon completion of AFIT, Captain Barry is being assigned as a system program officer in the Titan III System Program Office at the Systems and Missile Space Organization, Los Angeles AFS, California.

Captain Philip D. Bown, USAF, was born in Chariton, Iowa. He received his Bachelor of Science degree in Marketing from Drake University in 1968. Commissioned through Air Force ROTC, he entered the Air Force in June of that year. His first assignment was as a student, Supply Officer Course, Lowry AFB, Colorado. His

subsequent assignment was at L. G. Hanscom Field, Massachusetts, as a supply officer in the 3245th Air Base Group. During this assignment he served six months temporary duty with the 3247th Special Activities Squadron at Grenier Field, New Hampshire. One year prior to entering AFIT he served in the Support Management Division of the 416 M/L System Program Office again at Hanscom Field. His next assignment is to the 635th Supply Squadron, U-Tapao Airfield, Thailand.

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