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16. Abstract This report presents the principal results of the compilation of the data that were collected in travel surveys conducted in Amarillo, San Antonio, Brownsville, Sherman-Denison, and Tyler, Texas, during 1990 and 1991. The data from those surveys were edited and corrected prior to being compiled into a form usable in travel demand modeling. Data included in this report include recommended household trip production rates by trip purpose, recommended employee attraction rates by trip purpose, recommended employee attraction rates for selected special generators, commercial vehicle trip rates, and data on the travel characteristics of external travel for those surveyed urban areas. Where appropriate, comparisons were made between the urban areas surveyed to examine the transferability of the survey data. Household trip production rates for small urban areas were found to be transferable. Attraction rates required extensive adjustment to produce reasonable rates and problems were identified in those surveys which indicate a need for extensive research in those surveys and their methods. Most of the special generators surveyed were found to have significantly different attraction rates which warranted their treatment as special generators. Some were found to be marginal and did not necessarily warrant such treatment. The commercial vehicle trip rates produced by the commercial vehicle surveys appear reasonable. There was an unresolved issue concerning the number of those vehicles operating within urban areas, and total truck trips were not estimated. The results from the external station surveys indicate that external trips comprise a significant proportion of urban travel and more research is needed in the understanding of those trips for travel demand modeling.					
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**URBAN TRAVEL IN TEXAS:
AN EVALUATION OF TRAVEL SURVEYS**

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IMPLEMENTATION STATEMENT

This report presents the principal results of the travel surveys conducted in five urban areas in Texas in 1990-91. Results are presented for household, workplace, special generator, commercial vehicle, and external station surveys. Recommended trip production rates, attraction rates, special generator attraction rates, and truck trip rates with data for use in the estimation of external travel are presented as part of this report. These data may be used immediately by the Texas Department of Transportation in travel demand modeling efforts in urban areas throughout Texas.

This report has not been converted to metric units because the trip length information output information from the Texas Package software is in English units. Input data to the Texas Package must be in English units; the use of metric units would produce output errors.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration or the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation. Additionally, this report is not intended for construction, bidding, or permit purposes. David F. Pearson (Texas P.E. #45457) was the principal investigator for this project.

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SUMMARY

Comprehensive travel surveys were conducted in five urban areas in Texas in 1990 and 1991. The urban areas were Amarillo, Brownsville, San Antonio, Sherman-Denison, and Tyler. This report presents documentation on the data that were collected, the corrections that were made to the data, the methodology used to compile the data into a format for use in travel demand modeling, and general observations relative to the data. The comprehensive surveys included households, workplaces, special generators (in all but two of the areas), commercial vehicles, and external stations. An extensive amount of data and information was compiled in the conduction of these surveys which provides a comprehensive data base for use by the Texas Department of Transportation in their travel demand models. The following sections present brief summaries of each of the surveys which were compiled during this project.

HOUSEHOLD SURVEYS

Household surveys were conducted in all five of the urban areas. These data were used to develop trip production rates by trip purpose for use in trip generation models. In addition, information was developed on the average trip lengths and trip length frequency distributions by trip purpose for use in trip distribution models. Trip production rates for home based work, home based non-work, and non-home based trips were developed for each urban area surveyed for households stratified by household size and household income. The analysis performed to determine the recommended stratifications is also documented. The survey trip production rates were smoothed using a methodology developed for this project, which is documented in this report. Comparisons of stratified trip rates between the urban areas indicated trip rates are transferable for small urban areas. Trip rates for all of the urban areas were found to be fairly comparable. The accuracy of the estimates of trip productions developed based on the sample data was examined and found to be between 10 and 13 percent for person trips and between 10 and 15 percent for auto driver trips. These errors increase significantly when trips are segregated by trip purpose. Trip rates per person by age group and gender were also examined and used to adjust the trip rates to account for bias in the survey of persons by age group and gender. Estimates of the total number of trips being produced and the total internal vehicle miles of travel (VMT) were developed by trip purpose for each urban area. The average number of trips per person for

persons five years of age and older ranged from 3.5 to 4.1. The majority of trips in all of the urban areas were made by automobile.

WORKPLACE SURVEYS

Workplace surveys were conducted in all five of the urban areas. These data were used to develop trip attraction rates by trip purpose for use in trip generation models. Recommended trip attraction rates by trip purpose were developed for establishments stratified by employment type, households, and area type. The rates from the surveys required extensive adjustment to produce results that were comparable to the results from the household surveys. The reasons for these adjustments were determined to be the methodology used in the workplace surveys and the failure to geocode the survey data to allow the identification of the external related trips. A comparative evaluation of the attraction rates between the urban areas was not done due to the problems identified with the surveys.

SPECIAL GENERATOR SURVEYS

Special generator surveys were conducted in three of the urban areas, San Antonio, Amarillo, and Tyler. Ten sites were surveyed in San Antonio, six in Amarillo, and five in Tyler. The evaluation in this report includes development of trip attraction rates by trip purpose for each site, comparisons of attraction rates between similar sites in terms of employment and standard industrial classification, evaluation of the uniqueness of the sites surveyed, and development of recommended rates for use in other urban areas. In general, most of the sites surveyed were found to have significantly different attraction rates from similar sites surveyed in the workplace surveys and between similar special generator sites. Some sites were found to be marginally unique and estimates of the attractions for those sites could have been developed using data from the regular workplace survey. Recommended attraction rates for general categories of special generators were developed and are included in this report.

COMMERCIAL VEHICLE SURVEYS

Commercial vehicle surveys were conducted in all five of the urban areas. These data were used to develop average trips per commercial vehicle (i.e., truck) for each of the urban area and average trip length estimates for commercial vehicles. The average trip rates were found to be

comparable for several of the urban areas. These rates were found to range between six and eleven trips per vehicle. The rates for internal travel only ranged from three to just under nine trips per vehicle. Average internal trip length for commercial vehicles ranged from 2.7 miles to 5.6 miles. The data were found to vary significantly between the urban areas, and part of this variation was felt to be due to the urban form and location of the study area boundary. The data were not expanded because no information was known about the population of vehicles from which the samples were drawn. One of the recommendations for future commercial vehicle surveys was to standardize the definition of what was considered a commercial vehicle. The definition recommended was a vehicle with six or more wheels on the ground, with a gross vehicle weight of 6,000 pounds or more, and used for commercial purposes be considered a commercial vehicle.

EXTERNAL STATION SURVEYS

External station surveys were conducted in all five urban areas. These data were used to develop estimates of the total external-local and external-external trip movements for each area. In addition, total estimates of VMT in each urban area due to the external trips were developed. External travel was found to comprise a significant amount of the overall travel within the urban areas, especially in terms of VMT. In Tyler, for example, it was found that the total VMT due to external travel was greater than the VMT due to auto driver trips as estimated from the household survey. The location of the study area boundary in relation to satellite cities and major highways can be a significant factor in the number and impact of external travel within the urban areas. It was determined that a significant potential exists for the underestimation of travel demand within urban areas due to the lack of information concerning external travel. A need exists for additional research and analysis in this area of travel demand modeling.

I. INTRODUCTION

In 1990 and 1991, the Texas Department of Transportation (TxDOT) funded comprehensive travel surveys in five urban areas in Texas. Prior to that initiative, travel surveys had been conducted in the Dallas-Fort Worth area in 1984, in the Houston-Galveston region in 1984, and in Texarkana in 1989. Findings from those surveys indicated a need to begin a comprehensive program of data collection to update the origin-destination (O-D) travel data collected in the 1960s and early 1970s in nearly all major urban areas in Texas (as well as other parts of the nation). These data were needed to provide information for updating travel demand models being used for transportation planning and to gain a better understanding of the changes that had occurred over time in travel patterns and behavior. One issue of particular interest to TxDOT was transferability of travel demand modeling data between urban areas and the question of trip rate stability over time.

The travel surveys initiated in 1990 and 1991 were significant because a great deal of consistency was maintained between the urban areas in the methodologies and survey instruments used in the surveys. This provided a basis for comparing travel patterns between urban areas not normally found in other surveys.

The urban areas surveyed in 1990 and 1991 were San Antonio, Amarillo, Brownsville, Tyler, and Sherman-Denison. A typical travel survey in Texas generally consists of five distinct and independent surveys: a household survey, a workplace survey, a special generator survey, a commercial vehicle (e.g., truck) survey, and an external station survey. Funding limitations, however, prevented all five surveys being done in each of those urban areas. Table 1 presents the surveys which were done in each of the urban areas.

The Texas Transportation Institute was contracted to evaluate the data from the travel surveys; examine the survey methodologies, instruments, data elements, etc., and provide TxDOT with recommendations concerning the data input to the travel demand models and the continuation of the travel surveys in other urban areas. Subsequent to the completion of those initial surveys in 1990 and 1991, a number of recommendations have been made and additional surveys were initiated in Beaumont-Port Arthur and El Paso. This report provides documentation of the examination of the data from the travel surveys, the results of the analyses undertaken on those data, and recommendations with respect to the individual surveys. Since one of the issues of concern was

changes of travel characteristics over time and transferability of travel survey results between urban areas, the section of this report following the introduction presents some background and an overview of previous research on temporal and transferability issues. This is followed by individual chapters on each of the five surveys. These chapters present background information on the survey, the areas surveyed, the survey methodology, the data collected, efforts to edit and correct the data, results of the data analysis, and specific areas of analysis accomplished depending on the type of survey. Each chapter also contains a summary of the findings and recommendations for the survey. Following those five chapters, Chapter 6 discusses the results of comparisons of specific data elements over time. Where found feasible, similar data elements from earlier O-D surveys were compiled and compared with the results from the surveys in 1990 and 1991. The final chapter presents a general summary of the findings of this research.

Table 1
Completed Surveys

Urban Area	Survey				
	Household	Workplace	Special Generator	Commercial Vehicle	External Station
San Antonio	Yes	Yes	Yes	Yes	Yes
Amarillo	Yes	Yes	Yes	Yes	Yes
Brownsville	Yes	Yes	No	Yes	Yes
Tyler	Yes	Yes	Yes	Yes	Yes
Sherman-Denison	Yes	Yes	No	Yes	Yes

BACKGROUND/PREVIOUS RESEARCH

Historically, travel surveys have provided the information necessary to develop and update travel demand models. These models form the basis for estimating existing and forecasting future travel demand in urban areas. They are the tools used to evaluate alternative transportation systems, proposed projects, and relative impacts of transportation on air quality. While travel surveys were

initiated in the 1950s, the major efforts in this field were conducted in the 1960s and early 1970s. These surveys were referred to as O-D surveys. The effort involved in these early surveys was substantial with thousands of households being surveyed using the home interview technique where the members of each surveyed household were personally interviewed in the home. Data from these surveys were used to develop and calibrate numerous travel demand models. While the data are and have been used in all phases of travel demand modeling, the data's primary use has been in the trip generation model development and calibration. Due to the cost and time requirements to conduct and complete these surveys, the issues of whether the results of one survey may be used in another (unsurveyed) urban area and whether the results are stable over time have often been raised.

Temporal Stability

The question of temporal stability relates to the trip characteristics observed in a travel survey, primarily the household survey. One of the basic questions is whether the average trip rates observed in a household survey are stable over time. The importance of this issue lies in the fact that the projection of travel in the future assumes that households with similar characteristics will generate the same number of trips (by trip purpose) as those observed in the household survey.

In the early 1970s, Ashford and Holloway (1) examined the time validity of cross-classification models for home based work (HBW) to total trip productions in the Pittsburgh area. Data from travel surveys done in that area in 1958 and 1967 were examined using the same zone system. Their study concluded that the assumption of constant trip generation models over time was questionable. They suggested that reliance on trip generation models be for short time periods only with constant reevaluation and updating. The study found that over a conventional planning period of 20 years, both the regression and cross-classification model may be unreliable for anything other than gross estimates of trip productions.

In a study evaluating trip rate temporal stability in Texas, Christiansen and Stover (2) found that internal person trips per person had been increasing historically and were expected to increase in the future. That study was based on an analysis of O-D surveys done in the 1960s and 1970 in combination with other measures such as vehicle ownership and vehicle miles of travel.

Yunker (3) developed linear regression trip generation models using 1963 (O-D) survey data. These models were then applied to data from a 1972 O-D survey to measure the ability of the models

to replicate the data from the survey. The study found that the overall estimates of trip productions were within 2.5 percent. Estimates of the trip productions by trip purpose varied from -10.0 percent for non-home based trips to over 13 percent for home based shopping trips. The author felt that the zonal and regional estimates were reasonable.

Kollo and Purvis (4) conducted a study in the early 1980s to evaluate the changes in travel characteristics in the San Francisco Bay area. Using data from household travel surveys done in 1960 and 1981, they found that total household trip rates were stable over long periods of time but significant shifts in the frequency of trip making by trip purpose had occurred. While some trip rates for households stratified by socioeconomic characteristics had changed significantly over time, the overall effect on the aggregate regional trip rates was tempered by shifts in the household distribution for the same stratification. Summary statistics indicated that the total trips per household and total HBW trips per household had not changed significantly between 1960 and 1981. Trips per household for other trip purposes such as shopping, social-recreation, school, etc., had changed significantly. These findings were similar to those reported in a comparison of trip rates between the 1964 and 1984 surveys done in the Dallas-Fort Worth area (5).

In a study to evaluate the long-range temporal stability of trip generation rates in the Delaware Valley Region, Walker and Peng (6) found that the selection of variables for the stratification of households impacted the temporal stability of the model. The models being used were cross-classification models. Trip rates from households stratified by household size were generally not stable over time. Rates for households stratified by household income were more stable, and those stratified by auto ownership were the most stable.

In general, it appears that previous research indicates that overall travel per household has been found to be fairly stable in some instances and unstable in others. The influence of the variables used to stratify households in the computation of trip rates in combination with the changes in overall distributions of households has not been adequately investigated. A general consensus in the research reviewed was that the travel patterns as indicated by the frequency of trips by trip purpose have changed significantly over time. This could have serious implications relative to the assumptions of stability in the trip rates by trip purpose for forecasting future travel demand.

Transferability of Trip Rates

The total cost and time requirements for conducting travel surveys is significant. If it is possible to use the data for modeling purposes from one travel survey in another urban area that has not been surveyed, a significant savings in cost and time may be achieved. In Texas, 26 urban areas have Metropolitan Planning Organizations and subsequent travel demand modeling needs. This number precludes having travel surveys done in all of the urban areas within a reasonable time frame. In interim, the issue of transferability is particularly relevant to the needs of TxDOT.

In a study on the transferability of trip generation parameters for small urban areas in Indiana, Mahmassami and Sinha (7) found that the distribution of trips by trip purpose (e.g., home based work, home based non-work, etc.) was different between urban areas. Their analysis was based on survey data from seven urban areas. They proposed that, since the trip distribution by purpose was significantly different for each socioeconomic group, it was reasonable to assume that the overall (areawide) trip distribution by purpose in two different urban areas would be the same if the socioeconomic mix in those areas were similar. The factors examined relative to areawide travel frequency included urban form (the shape of the urban area, spatial distribution of land uses, urban area size, transportation network layout and characteristics) and the socioeconomic characteristics of the residents. Urban form was not found to be a significantly differentiating factor between small and medium sized urban areas relative to trip frequency. The study found that transferring aggregate trip frequency parameters between urban areas for gross areawide estimations was feasible, if the socioeconomic characteristics were roughly similar. More accurate areawide predictions would require more detailed and careful comparisons of the socioeconomic characteristics of the areas from and to which parameters were being transferred.

Grecco, Wegmann, et.al. (8) found that the savings in terms of time and cost due to the use of borrowed models were significant when using simplified procedures. The disadvantage was the potential for less accuracy. A case study using synthetically developed trip generation models for various trip purposes and models based wholly on O-D data found that all of the models were subject to considerable error in duplicating traffic volumes on the transportation network. Disaggregate household models were recommended for use in estimating trip productions because of the advantages in terms of data requirements and adaptability to varying zonal schemes and behavioral modal split analysis. The criteria for selecting apparent city from which travel models could be

borrowed for a particular urban area were not clearly known. Characteristics of population size and nature of the economic base were useful indicators but did not guarantee similarity in travel characteristics. It was recommended that, if feasible, a small sample home interview survey be conducted to derive trip rates and that a detailed breakdown of trip purposes was not necessary for small urban areas. The three trip purpose categories, home based work, home based other, and non-home based, were found to be satisfactory.

In another study of the transferability of trip generation models between urban areas, Goode and Heimbach (9) developed composite cross-classification models for trip production from O-D survey data for three urban areas in North Carolina and regression based attraction models from one of the urban areas. These models were used to perform trip generation for the Fayetteville, North Carolina, urban area. In addition, models for Fayetteville were developed using O-D survey data from that urban areas and used to perform trip generation. The estimated trips from both sets of models were distributed and assigned and the results compared with four screen line counts and over 800 traffic counts. The study concluded that the synthesized models (i.e., the composite models) closely approximated the results from the O-D trip generation model and adequately duplicated the traffic volumes. The result was the finding that trip generation models were transferable from one urban area to another of similar size.

Ou and Yu (10), in examining the effects of urban character on transferability, found that the transferability of models depended on the type of demand measure and explanatory variable as well as the number of explanatory variables included in the model. Their study concluded that no models were perfectly transferable but with careful selection, the transfer of a model from one urban area to another was possible.

In general, previous research has implied that trip generation models are most likely transferable between urban areas in certain situations. There is no clear criterion for when and when not to transfer modeling data. The potential for using transferable data is favorable, and significant benefits may be attained in terms of cost and time savings. It is an area which needs additional study and justification for identifying where transferred data and models may be used.

Previous Research

The data collected in the travel surveys in 1990 and 1991 have undergone extensive analysis as a part of this research effort and other projects as well. An overview of the findings of the survey analyses was published in 1993 as an Executive Summary (11). That report documented the findings of the survey analyses relative to general changes in travel characteristics over time and the relationships of travel between small and large urban areas. The reader is referred to that document for a general overview of the travel surveys.

Other projects have also evaluated the survey methodologies and detailed documentation of that analyses, and the results are presented in Reference 12. A number of unpublished technical notes have also been produced and will be presented in this report in part or in whole where appropriate. While every effort has been made to avoid duplication of other published material, some of the analyses and results from these earlier publications will be reproduced and referenced in this report for purposes of continuity.

II. HOUSEHOLD SURVEYS

Household travel surveys provide a significant portion of the information on travel behavior within urban areas. In 1990 and 1991, household surveys were conducted in five urban areas, San Antonio, Amarillo, Brownsville, Tyler, and Sherman-Denison. Table 2 presents data on each of the urban areas surveyed relative to their size and socioeconomic characteristics. The data in Table 2 were compiled from the 1990 census for areas as similar to the defined study areas as possible. Data from the 1990 census were used to expand the survey data, even if the actual survey was conducted in 1991.

Table 2
Urban Areas Surveyed in 1990-1991

Element	Urban Area				
	San Antonio	Amarillo	Brownsville	Tyler	Sherman-Denison
Year of Survey	1990	1990	1991	1991	1991
1990 Population*	1,185,394	187,547	98,962	151,309	95,021
1990 Households*	409,606	72,252	26,519	56,807	36,799
Persons/Household	2.89	2.60	3.73	2.66	2.58
Household Income*	\$ 33,648	\$ 32,665	\$ 23,219	\$ 33,615	\$ 31,319

* Source: 1990 Census

SAMPLE SIZES

The sample sizes as specified in the requests for proposals (RFP) in each of the urban areas surveyed varied. In all five surveys, the sampled households were to be stratified by household size and vehicle availability. Tables 3 through 7 present the sampling goals for each of the urban areas as established in the RFPs. The survey designs were intended to provide data for estimating trip rates which would yield an overall accuracy of ± 5 percent at a confidence level of 90 percent. An analysis of the data from the surveys found that the desired level of accuracy was not achieved (12). Tables 8 through 12 present the number of usable surveys as determined from this project. These numbers represent the most recent evaluation of the number of usable household surveys for each of the areas

surveyed. Percent values in excess of 100 in Tables 8 through 12 represent cells where more households were surveyed than originally planned. Values less than 100 represent the opposite.

Table 3
Household Sampling Goals
San Antonio Household Survey

Persons per Household	Cars per Household				Total
	0	1	2	3+	
One Person	199	264	100	--	563
Two Persons	78	357	244	100	779
Three Persons	43	284	146	159	632
Four or More Persons	70	250	151	157	628
Total	390 ¹	1156	641	415	2602

¹Column total was only requirement in terms of sample size.

Note: Shaded cells had no minimum number of samples.

Source: Reference 13

Table 4
Amarillo Household Initial Sampling Goals

Persons per Household	Cars per Household				Total
	0	1	2	3+	
One Person	-	144	99	--	243
Two Persons	-	173	99	99	371
Three Persons	-	133	102	99	334
Four or More Persons	-	155	99	102	356
Total	163 ¹	605	399	300	1467

¹Column total was only requirement in terms of sample size.

Note: Shaded cells had no minimum number of samples.

Source: Reference 14

**Table 5
Brownsville Household Initial Sampling Goals**

Persons per Household	Vehicles Available				Total
	0	1	2	3+	
One Person	-	144	99	--	243
Two Persons	-	173	99	99	371
Three Persons	-	133	102	99	334
Four or More Persons	-	155	99	102	356
Total	163 ¹	605	399	300	1467

¹Column total was only requirement in terms of sample size.

Note: Shaded cells had no minimum number of samples.

Source: Reference 15

**Table 6
Household Response Matrix for Recommended Usable Surveys
Tyler Household Survey**

Vehicles Available	Persons in Households				Total
	1	2	3	4+	
0	218	120			120
1		264	204	415	883
2		259	239	188	686
3+		218	209	191	618
Total	218	741	652	794	2525

Source: Reference 16

Table 7
Household Response Matrix for Recommended Usable Surveys
Sherman-Denison Household Survey

Vehicles Available	Persons in Households				Total
	1	2	3	4+	
0	299	110			110
1		249	168	228	645
2		260	235	184	419
3+			198	183	641
Total	299	509	601	595	2114

Source: Reference 17

Table 8
Number of Usable Household Surveys
in the 1990 San Antonio Household Survey

Persons per Household	Item	Available Vehicles				Totals
		0	1	2	3+	
One Person	Number	169	343	37	7	556
	Percent ¹	84.9	129.9	37.0	N.A.	98.6
Two Persons	Number	76	244	374	78	772
	Percent	97.4	68.3	153.3	78.0	99.1
Three Persons	Number	44	147	180	121	492
	Percent	102.3	51.8	123.3	76.1	77.8
Four or More Persons	Number	61	249	337	184	831
	Percent	87.1	99.6	223.2	117.2	132.3
Totals	Number	350	983	928	390	2651
	Percent	89.7	85.0	144.8	94.0	101.9

¹"Percent" is the percentage of the desired number of households surveyed.

Table 9
Number of Usable Household Surveys
in the 1990 Amarillo Household Survey

Persons per Household	Item	Available Vehicles				Totals
		0	1	2	3+	
One Person	Number	71	440	49	13	573
	Percent ¹	NA	305.6	49.5	N.A.	235.8
Two Persons	Number	26	202	488	175	891
	Percent	NA	116.8	492.9	176.8	240.2
Three Persons	Number	6	95	225	174	500
	Percent	NA	71.4	220.6	175.8	149.7
Four or More Persons	Number	8	102	352	227	689
	Percent	NA	65.8	355.6	222.5	193.5
Totals	Number	111	839	1114	589	2653
	Percent	68.1	138.7	279.2	196.3	180.8

¹"Percent" is the percentage of the desired number of households surveyed.

Table 10
Number of Usable Household Surveys
in the 1991 Brownsville Household Survey

Persons per Household	Item	Vehicles Available				Totals
		0	1	2	3+	
One Person	Number	55	137	10	3	205
	Percent ¹	NA	95.1	10.1	N.A.	84.4
Two Persons	Number	48	154	132	21	355
	Percent	NA	89.0	133.3	21.1	95.7
Three Persons	Number	35	138	86	56	315
	Percent	NA	103.8	84.3	56.6	94.3
Four or More Persons	Number	52	177	193	114	536
	Percent	NA	114.2	194.9	11.86	150.6
Totals	Number	190	606	421	194	1411
	Percent	116.6	100.2	105.5	64.7	96.2

¹"Percent" is the percentage of the desired number of households surveyed.

Table 11
Number of Usable Household Surveys
in the 1991 Tyler Household Survey

Persons per Household	Item	Available Vehicles				Totals
		0	1	2	3+	
One Person	Number	129	432	66	12	639
	Percent ¹	NA	NA	NA	N.A.	293.1
Two Persons	Number	27	200	551	164	942
	Percent	NA	75.8	212.7	75.2	127.1
Three Persons	Number	5	52	174	161	392
	Percent	NA	25.5	72.8	77.08	60.1
Four or More Persons	Number	7	56	269	187	519
	Percent	NA	13.5	143.1	97.9	65.4
Totals	Number	168	740	1060	524	2492
	Percent	140.0	83.8	154.5	84.8	98.7

¹"Percent" is the percentage of the desired number of households surveyed.

Table 12
Number of Usable Household Surveys
in the 1991 Sherman-Denison Household Survey

Persons per Household	Item	Vehicles Available				Totals
		0	1	2	3+	
One Person	Number	174	415	67	17	673
	Percent ¹	NA	NA	NA	N.A.	225.1
Two Persons	Number	25	218	211	170	624
	Percent	NA	87.6	NA	NA	122.6
Three Persons	Number	9	90	164	168	431
	Percent	NA	53.8	69.8	84.8	71.7
Four or More Persons	Number	1	60	268	222	551
	Percent	NA	26.3	145.7	121.3	92.6
Totals	Number	209	783	710	577	2279
	Percent	190.0	121.4	169.5	90.0	107.8

¹"Percent" is the percentage of the desired number of households surveyed.

SURVEY METHODOLOGY

San Antonio, Amarillo, and Brownsville were all surveyed using the same methodology and survey instruments. Households were randomly selected, contacted by phone, and asked to participate in the survey. Those agreeing to participate were assigned a travel day and mailed a packet containing travel diaries for every person in the household over 5 years of age. Each member of the household was asked to record all trips on the survey day assigned. The household was reminded by phone prior to the travel day to complete the diaries and then contacted by phone after their travel day to retrieve the information on the travel diaries. The households were also asked to return the travel diaries for documentation purposes. Detailed descriptions of the survey methodologies are contained in References 13, 14, and 15. The survey methodology in Tyler and Sherman-Denison was the same as that in the other three urban areas except for the data retrieval. The households in Tyler and Sherman-Denison were requested to mail back the completed travel

diaries, and the data were not retrieved by phone. Detailed descriptions of those survey methodologies may be found in References 16 and 17.

A comprehensive analysis of the survey methodologies and survey instruments was performed and is documented in Reference 12. That analysis examined the sample sizes, sample selection methods, the data collection methodology, and the data actually collected. That report offers a more complete discussion of those elements of the survey.

HOUSEHOLD SURVEY DATA

As previously discussed, the purpose of the household survey was to collect information on the characteristics of the household and the individual trips made during a 24-hour period by each member of the household over 5 years of age. The data collected included information on the household, information on the individuals in the household (those over 5 years of age), and information on the trips each person in the household made over a 24-hour period.

The following household information was collected:

1. Address of the household.
2. Whether the residence was single family or multi-unit (apartment, condo, townhouse).
3. The number of persons living at that address.
4. The number of persons living at that address that were 5 years of age or older.
5. The number of persons in the household that were employed.
6. The number of cars, vans, and light trucks available for use by members of the households.

The information gathered on each person 5 years of age and older in the household consisted of the following:

1. Sex.
2. Age.
3. Whether or not they were a licensed driver.
4. The person's relationship to the head of the household (e.g., spouse, child, relative, etc.)
5. Whether the person was or was not employed.
6. Whether the person did or did not travel on their designated travel day.

The information obtained on each trip for each person consisted of the following:

1. The beginning and ending location for each trip including the address or nearest intersecting streets.
2. The arrival and departure time for each trip.
3. The purpose of each trip. The trip purposes listed on the survey instrument included return home, go to work or work related, school, social/recreation, pick up/drop off passenger, change travel mode, and other (a blank was provided for individuals to write in their purpose).
4. The mode of transportation. The modes listed on the survey instrument included driver, passenger, walk, bicycle, bus, school bus, taxi, commercial vehicle (over 1 ton), and other (a blank was provided for individuals to record their mode).
5. The total number of people in the car/truck/van including the person completing the survey.
6. The amount paid for parking, if they paid for parking.
7. If the trip was made by bus, the fare paid and how the person got to the bus stop. The options given for getting to the bus stop were drove auto and parked, dropped off, walked, carpoled with bus riders, and other (a blank was provided for individuals to record their means for getting to the bus stop).

A more complete description of the data elements collected and the survey instruments used may be found in Reference 12. It should be noted that revisions were made in the survey instruments for the household surveys in Beaumont-Port Arthur and El Paso to clarify information and collect additional data. Those revisions are discussed in detail in Reference 12.

DATA EDITING

A tremendous amount of data is collected in a household survey. As such, the data collection, compilation, and coding provide numerous opportunities for error. In the case of the household surveys done in 1990 and 1991, the consultants were left on their own to collect, compile, and code the data in a form for use in their internal analyses. TxDOT contracted with TTI to analyze the data to ensure consistency in the analysis between the different urban areas, identify needed improvements in the surveys, and perform a comparative analysis between the areas surveyed and the earlier O-D surveys. In order to accomplish these tasks, it was necessary to reformat the data

files, correct errors found in the data, and develop computer programs to process and analyze the data.

The amount of editing to correct the household survey data files was more than originally programmed. Since the household survey is a small sample, each sampled household represents a large number of unsampled households. When expanded, small errors may become significant. For this reason, it was considered essential to attempt to correct as many errors as possible. For purposes of brevity, only the corrections made to the San Antonio household survey are discussed in the following paragraphs. The purpose is only to illustrate the types of errors found and the effort expended to correct them.

The data from the San Antonio household survey consisted of three files, a household file, a person file, and a trip file. Initial editing was done on the household file and the trip file. Records in the individual files were identified by unique sample numbers being assigned to each household. Person numbers were assigned to each person in each household and the same number was used in the trip file to identify the trips made by each person. Initially, 123 samples were found in the trip file which had 196 occurrences of nonsequential trip numbers. Each trip (for each person within each sampled household) was numbered sequentially beginning with zero. In the raw trip records, each record actually represented an entry in the trip diary containing the destination location, address, time of arrival and departure, purpose of trip to that destination, mode of travel to that destination, etc. Nonsequential trip entries implied a number of possible errors. Review of the questionable records revealed the following types of problems:

1. Wrong sample number recorded. In most cases, this was simply a data entry error.
2. Incorrect person number or trip number. Most cases this was also a data entry error.
3. Missing trip numbers or duplicate trip numbers. These were found to be data entry errors in some cases and in others, it appeared that there were missing trips.
4. No household record with a corresponding sample number.
5. Duplicate trip record.

The first steps were to identify and correct the data entry errors. This was done using the arrival and departure times indicated on the records as compared to trip records before and after locations where a trip was apparently missing. Table 13 shows an example of unedited raw trip records for sample number 246. Table 14 shows the edited data for the same sample.

The second set of corrections dealt with the trip records that had no corresponding household

records. Through a process of elimination and review of missing trips records, most of these were found to be data entry errors. Table 15 presents an example of the unedited trip records for sample 192 which did not have a corresponding household record. Table 15 also shows the unedited trip records for sample 1982. The apparent cause in this example was that sample number 192 should have been 1982 as indicated by the fact that the trip record for 192 “fits” the travel times, person and trip number for the missing trip record in sample 1982.

Table 13
Unedited Raw Trip Data for Sample 246
San Antonio Household Survey

SAMPLE	PERSON	TRIP	PURPOSE	MODE	OCCUP	ARRIVE	DEPART	ZONE	LOCATION
246	1	0	1	0	0	0:00	8:13	214	Home
246	1	1	4	1	1	8:18	8:25	214	Diamond Shamrock
246	1	2	3	1	1	8:40	9:57	259	San Antonio College
* 246	1	3	1	1	1	10:15	10:36	214	Home
* 246	1	3	4	2	3	16:33	17:26	183	Mothers House
* 246	1	4	4	1	2	10:43	11:01	225	HEB
* 246	1	4	1	1	1	7:54	12:15	214	Home
246	1	5	5	1	2	11:09	11:10	517	Church's Of Today
246	1	6	4	1	1	11:12	11:20	223	Chevron
246	1	7	4	1	1	11:37	11:52	267	Sasa Bank
246	1	8	2	1	1	11:59	13:50	259	San Antonio College
246	1	9	1	1	1	14:07	16:25	214	Home
246	1	10	2	1	1	16:42	19:00	23	Mariachi Bar
* 246	1	11	5	1	2	20:47	22:27	227	Girl Friends house
* 246	1	11	1	1	1	16:42	19:00	214	Home
246	1	12	5	1	1	19:37	19:39	227	Friends House
246	1	13	0	0	0	19:48	0:00	214	Home
246	2	0	1	0	0	0:00	10:37	214	Home
246	2	1	4	2	2	10:43	11:01	225	HEB
246	2	2	4	2	2	11:09	13:15	517	Church's Of Today
246	2	3	4	2	2	13:20	13:27	223	Chevron

246	2	5	4	4	1	16:33	17:26	183	Mothers House
* 246	2	6	1	1	3	17:33	18:20	214	Home
* 246	2	6	1	2	2	13:41	16:30	214	Home
246	2	7	4	1	2	18:35	21:50	517	Church's Of Today
246	2	8	0	0	0	22:15	0:00	214	Home
246	3	0	1	0	0	0:00	7:40	214	Home
246	3	1	5	1	2	7:44	7:45	215	Roosevelt School
246	3	2	5	1	2	7:48	7:45	214	Home
246	3	3	5	1	2	7:51	7:52	214	Memorial School

246	3	5	4	1	1	12:35	12:55	529	Friend's House
246	3	6	5	1	1	13:05	13:15	517	Church's Of Today
246	3	7	4	1	2	13:41	15:00	223	Chevron
246	3	8	5	1	1	15:02	15:03	214	Home
246	3	9	5	1	1	15:02	15:03	215	Roosevelt School
246	3	10	1	1	2	15:06	20:42	214	Home

246	3	12	0	0	0	22:35	0:00	214	Home
246	4	0	1	0	0	0:00	7:40	214	home
246	4	1	3	2	2	7:51	15:43	214	Memorial School
246	4	2	1	2	3	16:00	17:26	214	Home
246	4	3	1	2	3	16:35	17:26	183	Costurera
246	4	4	0	0	0	17:33	0:00	214	Home
246	5	0	1	0	0	0:00	7:40	214	Home
246	5	1	3	2	2	7:44	15:00	215	Roosevelt School
246	5	2	1	2	2	15:06	16:30	214	Home

246	5	4	1	2	3	17:33	18:20	214	Home
246	5	5	4	2	2	18:35	21:50	517	Church's Of Today
246	5	6	0	0	0	22:14	0:00	214	Home

*Additional Trip

***Missing Trip

Table 14
Edited Raw Trip Data for Sample 246
San Antonio Household Survey

SAMPLE	PERSON	TRIP	PURPOSE	MODE	OCCUP	ARRIVE	DEPART	ZONE	LOCATION
246	1	0	1	0	0	0:00	8:13	214	Home
246	1	1	4	1	1	8:18	8:25	214	Diamond Shamrock
246	1	2	3	1	1	8:40	9:57	259	San Antonio College
246	1	3	1	1	1	10:15	10:36	214	Home
246	1	4	4	1	2	10:43	11:01	225	HEB
246	1	5	5	1	2	11:09	11:10	517	Church's Of Today
246	1	6	4	1	1	11:12	11:20	223	Chevron
246	1	7	4	1	1	11:37	11:52	267	Sasa Bank
246	1	8	2	1	1	11:59	13:50	259	San Antonio College
246	1	9	1	1	1	14:07	16:25	214	Home
246	1	10	2	1	1	16:42	19:00	23	Mariachi Bar
246	1	11	1	1	1	16:42	19:00	214	Home
246	1	12	5	1	1	19:37	19:39	227	Friends House
246	1	13	0	0	0	19:48	0:00	214	Home
246	2	0	1	0	0	0:00	10:37	214	Home
246	2	1	4	2	2	10:43	11:01	225	HEB
246	2	2	4	2	2	11:09	13:15	517	Church's Of Today
246	2	3	4	2	2	13:20	13:27	223	Chevron
246	2	4	1	2	2	13:41	16:30	214	Home
246	2	5	4	4	1	16:33	17:26	183	Mothers House
246	2	6	1	1	3	17:33	18:20	214	Home
246	2	7	4	1	2	18:35	21:50	517	Church's Of Today
246	2	8	0	0	0	22:15	0:00	214	Home
246	3	0	1	0	0	0:00	7:40	214	Home
246	3	1	5	1	2	7:44	7:45	215	Roosevelt School
246	3	2	5	1	2	7:48	7:45	214	Home
246	3	3	5	1	2	7:51	7:52	214	Memorial School
246	3	4	1	1	1	7:54	12:15	214	Home
246	3	5	4	1	1	12:35	12:55	529	Friend's House
246	3	6	5	1	1	13:05	13:15	517	Church's Of Today
246	3	7	4	1	2	13:41	15:00	223	Chevron
246	3	8	5	1	1	15:02	15:03	214	Home
246	3	9	5	1	1	15:02	15:03	215	Roosevelt School
246	3	10	1	1	2	15:06	20:42	214	Home
246	3	11	5	1	2	20:47	22:27	227	Girl Friends house
246	3	12	0	0	0	22:35	0:00	214	Home
246	4	0	1	0	0	0:00	7:40	214	home
246	4	1	3	2	2	7:51	15:43	214	Memorial School
246	4	2	1	2	3	16:00	17:26	214	Home
246	4	3	1	2	3	16:35	17:26	183	Costurera
246	4	4	0	0	0	17:33	0:00	214	Home
246	5	0	1	0	0	0:00	7:40	214	Home
246	5	1	3	2	2	7:44	15:00	215	Roosevelt School
246	5	2	1	2	2	15:06	16:30	214	Home
246	5	3	4	2	3	16:33	17:26	183	Mothers House
246	5	4	1	2	3	17:33	18:20	214	Home
246	5	5	4	2	2	18:35	21:50	517	Church's Of Today
246	5	6	0	0	0	22:14	0:00	214	Home

Table 15
Unedited Raw Trip Records for Samples 192 & 1982
San Antonio Household Survey

SAMPLE	PERSON	TRIP	PURPOSE	MODE	OCCUP	ARRIVE	DEPART	ZONE	LOCATION
192	1	2	4	1	1	11:40	12:13	86	Lupita's
1982	1	0	0	0	0	0:00	8:45	126	Home
1982	1	1	4	1	1	9:15	11:30	89	Dr. Freeburger
1982	1	3	4	1	1	12:30	13:00	97	San Antonio Hosp
1982	1	4	1	1	1	13:30	16:00	126	Home
1982	1	5	4	1	1	16:45	21:30	225	Broadview Apts
1982	1	6	4	1	1	21:50	21:55	224	Stop N Go
1982	1	7	1	1	1	13:30	0:00	126	Home
1982	2	0	0	0	0	0:00	15:30	126	Home
1982	2	1	2	1	1	16:15	24:00	17	LaMasion Hotel
1982	2	2	1	1	1	24:30	0:00	126	Home
1982	3	0	0	0	0	0:00	0:00	126	Home

The third elements corrected were the wrong sample numbers that were entered. This was done by identifying where a trip record fit in other samples that were missing a trip. Table 16 presents an example of this for sample numbers 455 and 4555. In this example, sample 455 had one too many number 4 trips for person 2, and sample 4555 had one missing number 4 trip for person number 2. Because the arrival and departure times for the trip record “fit” the times shown on the before and after trips, it was concluded that the sample number had been incorrectly entered for sample 455, person 2, trip number 4.

The fourth area of correction was duplicate trip records. These had to be identified and then removed. Table 17 presents an example of the unedited trip records for sample 321. In this example, person 1 has two number 2 trip records, both of which appear to be identical. In this case, the only difference was that the transit fare cost (which was 0.00) was not coded on one of the two and the zip code was coded as unknown (indicated by 999999999). The zone number, trip purpose, mode, occupancy, arrival and departure times, and the remaining information in the record were all identical. As a result, the indicated trip record was deleted from the file.

The fifth set of corrections were missing trips. These corrections involved using logic and professional judgment with a limited number of assumptions. In many cases, the missing trips for a sample involved the beginning trip (i.e., trip number 0). Since these trips typically begin at home (with very few exceptions), a trip record was assumed and inserted into the file with the origin

Table 16
Unedited Raw Trip Records for Samples 455 & 4555
San Antonio Household Survey

SAMPLE	PERSON	TRIP	PURPOSE	MODE	OCCUP	ARRIVE	DEPART	ZONE	LOCATION
455	1	0	1	0	0	0:00	7:30	166	Home
455	1	1	5	1	3	7:35	7:37	166	Indian Creek Elem.
455	1	2	5	1	2	7:45	9:45	133	Palo Alto College
455	1	3	8	1	1	9:50	9:56	147	San Antonio Teach CU
455	1	4	8	1	1	10:01	10:10	146	Bank One South
455	1	5	8	1	1	10:15	10:30	147	SA Teach CU
455	1	6	4	1	1	10:37	10:50	145	Trade Wind Auto
455	1	7	8	1	1	11:05	11:15	171	Valley High Post Off
455	1	8	1	1	1	11:25	11:52	166	Home
455	1	9	5	1	1	12:05	12:10	133	Palo Alto College
455	1	10	4	1	1	12:15	12:50	128	Fisherman's Grill
455	1	11	5	1	2	13:00	13:03	133	Palo Alto College
455	1	12	4	1	1	13:27	14:10	8888	Mother's House
455	1	13	4	1	1	14:14	14:22	8888	Sister's House
455	1	14	1	1	1	14:38	14:57	166	Home
455	1	15	5	1	1	15:02	15:05	166	Indian Creek Elem.
455	1	16	1	1	2	15:15	16:50	166	Home
455	1	17	5	1	4	17:05	17:15	133	Palo Alto College
455	1	18	1	1	5	17:25	19:30	166	Home
455	2	0	1	0	0	0:00	7:30	166	Home
455	2	1	5	2	3	7:35	7:37	166	Indian Creek Elem.
455	2	2	2	2	2	7:45	12:10	133	Palo Alto College
455	2	3	4	2	2	12:15	12:50	128	Fisherman's Grill
* 455	2	4	2	2	2	13:00	17:15	133	Palo Alto College
* 455	2	4	5	1	2	14:40	14:43	518	Nobhill Apartments
455	2	5	1	2	5	17:25	19:30	166	Home
455	2	6	4	2	2	19:40	20:40	171	HEB
455	2	7	1	2	2	20:50	0:00	166	Home
455	3	0	1	0	0	0:00	7:00	166	Home
455	3	1	3	6	0	7:20	15:30	458	SW Jr. High School
455	3	2	1	6	0	16:00	0:00	166	Home
455	4	0	1	0	0	0:00	7:00	166	Home
455	4	1	3	6	0	7:20	15:30	458	SW Middle School
455	4	2	1	6	0	16:00	0:00	166	Home
455	5	0	1	0	0	0:00	7:30	166	Home
455	5	1	3	2	3	7:35	15:05	166	Indian Creek Elem.
455	5	2	1	2	2	15:15	0:00	166	Home
4555	1	0	1	0	0	0:00	9:20	572	Home
4555	1	1	2	1	1	9:40	10:20	546	Rental House
4555	1	2	2	1	1	10:35	17:25	508	Single Family Mngmt
4555	1	3	2	1	1	17:45	18:15	539	Rental House
4555	1	4	4	1	1	18:25	18:50	318	Jim's Restaurant
4555	1	5	2	1	1	18:55	19:05	319	Rental House
4555	1	6	1	1	1	19:25	19:55	572	Home
4555	1	7	8	1	1	20:02	20:03	589	Post Office
4555	1	8	1	1	1	20:08	0:00	572	Home
4555	2	0	1	0	0	0:00	9:45	572	Home
4555	2	1	4	1	1	10:10	12:45	164	Kelly AFB
4555	2	2	5	1	2	13:40	13:56	518	Nobhill Apartments
4555	2	3	8	1	2	14:05	14:24	293	Eye Masters

4555	2	5	1	1	1	15:05	18:10	572	Home
4555	2	6	4	1	3	18:30	21:45	554	Alzafar Shrine Templ
4555	2	7	1	1	3	22:50	0:00	572	Home

* - Additional Trip

*** - Missing Trip

Table 17
Unedited Raw Trip Records for Sample 321
San Antonio Household Survey

SAMPLE	PERSON	TRIP	PURPOSE	MODE	OCCUP	ARRIVE	DEPART	ZONE	LOCATION
321	1	0	1	0	0	0:00	8:00	564	Home
321	1	1	2	1	1	8:15	12:30	566	Banc Plus Mortgage
* 321	1	2	4	1	3	12:40	14:00	274	La Sogata
* 321	1	2	4	1	3	12:40	14:00	274	LA SOGATA
321	1	3	2	1	3	14:15	18:15	566	Banc Plus Mortgage
321	1	4	1	1	1	18:25	20:00	564	Home
321	1	5	4	1	2	20:20	21:05	246	Builders Square
321	1	6	1	1	2	22:00	0:00	564	Home
321	2	0	1	0	0	0:00	8:15	564	Home
321	2	1	4	1	1	8:30	8:35	545	Comet Cleaners
321	2	2	4	1	1	8:40	9:00	540	finish Line Car Wash
321	2	3	2	1	1	9:15	12:15	311	Siemens Electric
321	2	4	4	1	3	12:20	13:15	311	China Town Cafe
321	2	5	2	1	3	13:20	15:15	311	Siemens Electric
321	2	6	4	1	1	15:20	15:45	530	Celluar One
321	2	7	4	1	1	15:55	16:20	539	Hair Gallery
321	2	8	4	1	1	16:45	16:50	308	Central Shoe Repair
321	2	9	4	1	1	17:10	17:20	336	Builders Square
321	2	10	1	1	1	17:45	20:00	564	Home
321	2	11	4	2	2	20:20	21:05	246	Builders Square
321	2	12	1	2	2	22:00	0:00	564	Home

* - Additional Trip

assumed to be the home zone (identified from the other trip records). Since the trip purpose, mode, and occupancy were determined from the destination end record, this information was not needed. The difficult information to derive was the departure time. Where estimates of those times could be reasonably derived, a trip record was inserted. Where this was not possible, it was left as it was. The departure time was estimated based on the travel times of the succeeding trips. For example, if the first trip record showed an arrival time of 8:00 and a departure time of 8:10 and the second trip record showed an arrival time of 8:30, a departure time of 9:00 and was a return to home, the departure time of the first trip from home was set to 7:40. An example of this is shown in Table 18 for sample number 1393.

In another sample, the missing trip occurred in the middle of the trip records for an individual. In some of these cases, it was possible to identify another person (in the same household) traveling with that individual (indicated by identical information). In those situations, a trip record was inserted that corresponded with that of the traveling companion.

Table 18
Unedited and Corrected Raw Trip Records for Sample 1393
San Antonio Household Survey

SAMPLE	PERSON	TRIP	PURPOSE	MODE	OCCUP	ARRIVE	DEPART	ZONE	LOCATION

1393	1	1	2	1	1	7:20	16:00	230	St. Mary's Universit
1393	1	2	0	0	0	16:30	0:00	121	Home

1393	2	1	5	1	3	7:35	7:36	41	Brackenridge H.S.
1393	2	2	5	1	2	7:45	7:46	51	Page Middle School
1393	2	3	1	1	1	8:02	8:35	121	Home
1393	2	4	3	1	1	9:05	11:02	200	Johnson Admin. Cente
1393	2	5	4	1	1	11:25	13:00	40	B.K. Johnson Home
1393	2	6	8	1	1	13:20	13:52	107	Riverside Park Elem
1393	2	7	1	1	1	14:04	17:01	121	Home
1393	2	8	5	1	1	17:25	17:26	201	Natatorium
1393	2	9	1	1	2	17:45	18:45	121	Home
1393	2	10	5	1	4	70:10	70:11	21	The Carnival
1393	2	11	1	1	1	19:40	22:10	121	HOME
1393	2	12	5	1	1	22:30	22:31	21	The Carnival
1393	2	13	1	1	4	22:50	0:00	121	Home

1393	3	1	3	2	3	7:35	15:00	41	Breckenridge H.S.
1393	3	2	4	2	6	15:20	17:25	201	Natatorium
1393	3	3	1	2	2	17:45	18:45	121	Home
1393	3	4	4	2	4	19:10	22:31	8888	Carnival
1393	3	5	1	2	4	22:50	0:00	121	Home

1393	4	1	8	2	3	7:35	7:36	41	Breckenridge H.S.
1393	4	2	3	2	2	7:45	15:15	51	Page Middle School
1393	4	3	1	3	0	16:10	17:15	121	Home
1393	4	4	4	3	0	17:19	18:30	121	Mark Diams (friend)
1393	4	5	1	3	0	18:34	18:45	121	Home
1393	4	6	4	2	4	19:10	22:31	21	The Carnival
1393	4	7	1	2	4	22:50	0:00	121	Home
** Corrected Records **									
1393	1	0	1	0	0	0:00	6:50	121	Home
1393	1	1	2	1	1	7:20	16:00	230	St. Mary's Universit
1393	1	2	0	0	0	16:30	0:00	121	Home
1393	2	0	1	0	0	0:00	7:20	121	Home
1393	2	1	5	1	3	7:35	7:36	41	Brackenridge H.S.
1393	2	2	5	1	2	7:45	7:46	51	Page Middle School
1393	2	3	1	1	1	8:02	8:35	121	Home
1393	2	4	3	1	1	9:05	11:02	200	Johnson Admin. Cente
1393	2	5	4	1	1	11:25	13:00	40	B.K. Johnson Home
1393	2	6	8	1	1	13:20	13:52	107	Riverside Park Elem
1393	2	7	1	1	1	14:04	17:01	121	Home
1393	2	8	5	1	1	17:25	17:26	201	Natatorium
1393	2	9	1	1	2	17:45	18:45	121	Home
1393	2	10	5	1	4	70:10	70:11	21	The Carnival
1393	2	11	1	1	1	19:40	22:10	121	HOME
1393	2	12	5	1	1	22:30	22:31	21	The Carnival
1393	2	13	1	1	4	22:50	0:00	121	Home
1393	3	0	1	0	0	0:00	7:20	121	Home
1393	3	1	3	2	3	7:35	15:00	41	Breckenridge H.S.
1393	3	2	4	2	6	15:20	17:25	201	Natatorium
1393	3	3	1	2	2	17:45	18:45	121	Home
1393	3	4	4	2	4	19:10	22:31	8888	Carnival
1393	3	5	1	2	4	22:50	0:00	121	Home
1393	4	0	1	0	0	0:00	7:20	121	Home
1393	4	1	8	2	3	7:35	7:36	41	Breckenridge H.S.
1393	4	2	3	2	2	7:45	15:15	51	Page Middle School
1393	4	3	1	3	0	16:10	17:15	121	Home
1393	4	4	4	3	0	17:19	18:30	121	Mark Diams (friend)
1393	4	5	1	3	0	18:34	18:45	121	Home
1393	4	6	4	2	4	19:10	22:31	21	The Carnival
1393	4	7	1	2	4	22:50	0:00	121	Home

*** Missing Trip

Another situation where missing trips were encountered was the last trip for an individual. This was found when the last trip in the trip records had both an arrival time and a departure time, implying another trip record should have followed. Additional verification was possible by comparing the number of total trips in the trip record file with the total recorded on the household record. Where the addition of a trip in the trip records would result in the same number of trips as recorded in the household record, the trip was added and the assumption made that it was a return to home trip. In some cases, several individuals in the household were traveling together, and it was possible to get the missing information from those trip records. An example of this type of correction is shown in Table 19 for sample 466.

Table 19
Unedited and Corrected Raw Trip Records for Sample 466
San Antonio Household Survey

SAMPLE	PERSON	TRIP	PURPOSE	MODE	OCCUP	ARRIVE	DEPART	ZONE	LOCATION
466	1	0	1	0	0	0:00	8:00	228	Home
466	1	1	5	1	2	8:05	8:08	0	Babysitter's
466	1	2	2	1	1	8:30	12:40	204	H&H Business Prod.
466	1	3	4	2	2	13:00	13:20	259	Bill Miller's BBQ
466	1	4	2	2	2	13:35	17:30	204	H&H Business Prod.
466	1	5	5	1	1	18:00	18:15	0	Babysitter's
466	1	6	4	1	2	18:35	19:00	227	Gilbert Garza Field
466	1	7	4	1	2	19:10	19:20	227	Circle K Store
466	1	8	1	1	2	19:35	0:00	228	Home
466	2	0	1	0	0	0:00	8:00	228	Home
466	2	1	8	2	2	8:05	18:15	0	Babysitter's
466	2	2	4	2	2	18:35	19:00	227	Gilbert Garza Field
466	2	3	4	2	2	19:10	19:20	227	Circle K

** Corrected Records **									
466	1	0	1	0	0	0:00	8:00	228	Home
466	1	1	5	1	2	8:05	8:08	0	Babysitter's
466	1	2	2	1	1	8:30	12:40	204	H&H Business Prod.
466	1	3	4	2	2	13:00	13:20	259	Bill Miller's BBQ
466	1	4	2	2	2	13:35	17:30	204	H&H Business Prod.
466	1	5	5	1	1	18:00	18:15	0	Babysitter's
466	1	6	4	1	2	18:35	19:00	227	Gilbert Garza Field
466	1	7	4	1	2	19:10	19:20	227	Circle K Store
466	1	8	1	1	2	19:35	0:00	228	Home
466	2	0	1	0	0	0:00	8:00	228	Home
466	2	1	8	2	2	8:05	18:15	0	Babysitter's
466	2	2	4	2	2	18:35	19:00	227	Gilbert Garza Field
466	2	3	4	2	2	19:10	19:20	227	Circle K
466	2	4	1	2	2	19:35	0:00	228	Home

***Missing Trip

In examining the household data file, 20 records were found with duplicate sample numbers. This necessitated looking at the trip records for those sample numbers to determine if it was a case of duplicate information or if two separate sets of trip records existed for the same sample number. For the two household records with sample number 89, it appeared both records were complete and involved two separate households in different zones. In reviewing the trip records for sample 89, it appeared that two sets of trips had been recorded for the same sample number. Beginning with the home zone numbers and following the arrival and departure times, it was possible to construct two sets of trips records, each of which corresponded to one of the two household records. One of the household records and corresponding trip records sample numbers was changed. The same modification was done for five of the other duplicate sample numbers. The remaining duplicate sample numbers were found to be duplicate records, one of which was removed. Table 20 presents an example of the household records with duplicate sample numbers. Table 21 presents the unedited records for sample 89 and the corrected records which included the new sample 88.

The household data file was also reviewed to identify those household records with no trip records, and the trip data file was reviewed to identify those trips which had no corresponding household record. Five household samples were found that had no corresponding trip records. Trip records were found for 15 sample numbers that had no corresponding household record. Four of the five household records with no trip records were removed from the data file, because even zero trip households had a single trip record for each person indicating no trips were made. A data entry error was found in the other household record, which was then corrected and corresponded to one set of trip records in the trip file. Of the remaining trips with sample numbers that did not correspond to any household record sample numbers, data entry errors were identified in four of the sample numbers which were corrected. The remaining records were removed from the trip records. The number of trips removed equated to 60 unlinked trips.

The remaining samples with missing trips were examined, and it was determined that no reasonable corrections could be made. This involved 23 sample numbers with approximately 357 unlinked trips. These were subsequently removed from the data file.

Data checks were also done on the recorded times for the trips and the trip purposes. Errors were found in 264 samples. Examination of these errors revealed most to be simple data entry errors. Where possible, these were corrected.

The person data file was also examined. It was subsequently merged with the household data

records for later processing. Errors found in those records included duplicate records, missing persons where the household record indicated more or fewer members than person records found, missing data elements such as age and sex, and persons with sample numbers that did not match any household record sample number. The process of correcting these was similar to that followed for the household and trip data files. It consisted of reviewing individual records and determining to the extent possible where records belonged and which ones should be removed. In some cases, records were created for missing persons to allow subsequent programs to process the data. Missing information not termed critical was noted in the subsequent analyses.

Examination of the household records also revealed some households whose location was coded as outside the study area. External locations were to have their zone number coded as 9999. Further review of the trips for these households found the majority were external related. Since all surveyed households were supposed to be within the study area, those coded as being outside the study area were not included in the data analysis.

While only examples of the data editing for San Antonio are discussed, it should be noted that similar efforts were accomplished for the other four household surveys. The level of effort in correcting those surveys varied depending on the errors in the data and the data actually provided by the consultant. For example, in Tyler and Sherman-Denison the consultant did not code as a part of the trip record the location description. This made it virtually impossible to perform some of the data corrections that were done to the other surveys. It should also be noted that there are still errors in the data which could not be corrected. In most cases, this involves data which are not considered critical for analysis purposes.

PROCESSING THE HOUSEHOLD SURVEY DATA

After the data files were edited, the next step was to process the data to prepare them for analysis. Data analysis was not possible until additional processing had been accomplished to organize the raw data into a format adaptable for subsequent analysis. For example, the raw trip data were first processed to build individual trips for each person in the household. This step was accomplished by developing a computer program to input the raw survey data, convert the recorded arrival and departure times to military time, and build a new trip file. The format for this new trip file is shown in Table 22. The advantage to this format is each record consists of an individual trip with origin and destination information, trip purpose (both from and to), mode, occupancy, etc.

Conversely, in the raw data format, each record actually represented one end of a trip and to evaluate a complete trip, two records had to be processed.

Table 20
San Antonio Duplicate Household Records

SAMPLE	ZONE	PERSON	EMPLOYED	AUTOS	INCOME	TOT TRIPS
89	96	2	1	1	3	8
89	88	3	3	3	9	14
96	96	4	3	2	3	9
96	80	2	0	1	2	4
377	188	3	1	1	3	10
377	101	2	1	1	3	18
672	486	5	1	2	4	17
672	216	6	2	1	7	25
1555	353	0	0	0	0	0
1555	353	5	2	3	99	33
1555	8888	0	0	0	0	0
2278	293	0	0	0	0	0
2278	540	3	1	1	5	19
2314	4	0	0	0	0	0
2314	564	1	1	1	99	8
2749	529	2	1	3	10	18
2749	529	2	1	3	10	19
3160	293	6	2	1	99	39
3160	293	6	2	1	99	39
3529	573	5	4	2	1	11
3529	573	5	4	2	1	15
7997	339	4	2	3	6	24
7997	197	0	0	0	0	0
9127	293	1	0	1	4	0
9127	293	2	2	2	10	0
11170	64	1	0	1	2	0
11170	64	1	1	1	6	0
15681	210	4	3	1	4	13
15681	210	4	3	1	6	14
15687	216	2	0	0	2	0
15687	216	2	0	0	1	0
15757	187	2	1	0	1	0
15757	187	2	0	0	99	0
15819	564	5	2	2	99	27
15819	564	0	0	0	0	0
15935	563	2	1	2	10	2
15935	563	2	1	2	9	0
16212	121	2	1	1	3	4
16212	121	3	1	2	3	4
16567	339	2	2	3	10	4
16567	339	0	0	0	0	0

Table 21
Unedited and Corrected Raw Trip Records for Sample 89
San Antonio Household Survey

SAMPLE	PERSON	TRIP	PURPOSE	MODE	OCCUP	ARRIVE	DEPART	ZONE	LOCATION
89	1	0	0	0	0	0:00	5:30	96	Home
89	1	0	1	0	0	0:00	7:40	88	Home
89	1	1	2	1	1	7:55	12:01	427	Zipprint
89	1	1	2	1	1	5:50	18:05	61	Cessing Stores Foods
89	1	2	5	1	2	18:20	18:25	51	Residence
89	1	2	4	1	1	12:15	12:40	118	McDonalds
89	1	3	4	1	1	18:30	18:40	33	Rio Grande Grocery
89	1	3	2	1	1	12:55	17:00	427	Zipprint
89	1	4	1	1	1	17:15	18:30	88	Home
89	1	4	1	1	1	19:00	19:15	96	Home
89	1	5	4	1	2	19:30	20:05	115	Kroger
89	1	5	4	1	1	18:35	18:45	88	Kentucky Fried Chick
89	1	6	1	1	2	20:20	0:00	96	Home
89	1	6	1	1	1	18:50	0:00	88	Home
89	2	0	1	0	0	0:00	7:25	88	Home
89	2	0	1	0	0	0:00	19:15	96	Home
89	2	1	4	2	2	19:30	20:05	115	Kroger
89	2	1	2	1	1	7:35	12:01	380	Detco
89	2	2	4	1	1	12:10	12:25	76	Fajita Junction
89	2	2	1	2	2	20:20	0:00	96	Home
89	2	3	1	1	1	12:35	17:00	380	Detco
89	2	4	1	1	1	17:15	0:00	88	Home
89	3	0	1	0	0	0:00	9:00	88	Home
89	3	1	2	1	1	9:40	13:30	335	NCDA Ins.
89	3	2	4	1	1	13:40	14:10	568	Ponchito's
89	3	3	2	1	1	14:30	19:00	335	NCDA
89	3	4	1	1	1	19:15	0:00	88	Home
** Corrected Records **									
88	1	0	0	0	0	0:00	5:30	96	Home
88	1	1	2	1	1	5:50	18:05	61	Cessing Stores Foods
88	1	2	5	1	2	18:20	18:25	51	Residence
88	1	3	4	1	1	18:30	18:40	33	Rio Grande Grocery
88	1	4	1	1	1	19:00	19:15	96	Home
88	1	5	4	1	2	19:30	20:05	115	Kroger
88	1	6	1	1	2	20:20	0:00	96	Home
88	2	0	1	0	0	0:00	19:15	96	Home
88	2	1	4	2	2	19:30	20:05	115	Kroger
88	2	2	1	2	2	20:20	0:00	96	Home
89	1	0	1	0	0	0:00	7:40	88	Home
89	1	1	2	1	1	7:55	12:01	427	Zipprint
89	1	2	4	1	1	12:15	12:40	118	McDonalds
89	1	3	2	1	1	12:55	17:00	427	Zipprint
89	1	4	1	1	1	17:15	18:30	88	Home
89	1	5	4	1	1	18:35	18:45	88	Kentucky Fried Chick
89	1	6	1	1	1	18:50	0:00	88	Home
89	2	0	1	0	0	0:00	7:25	88	Home
89	2	1	2	1	1	7:35	12:01	380	Detco
89	2	2	4	1	1	12:10	12:25	76	Fajita Junction
89	2	3	1	1	1	12:35	17:00	380	Detco
89	2	4	1	1	1	17:15	0:00	88	Home
89	3	0	1	0	0	0:00	9:00	88	Home
89	3	1	2	1	1	9:40	13:30	335	NCDA Ins.
89	3	2	4	1	1	13:40	14:10	568	Ponchito's
89	3	3	2	1	1	14:30	19:00	335	NCDA
89	3	4	1	1	1	19:15	0:00	88	Home

Table 22
Household Survey Trip Record Format

Variable	Format	Sum	Description
ISN	I6	6	Sample Number
IPN	I3	9	Person Number
ITP2	I2	11	Trip Number
IHRD	I2	13	Hour That Trip Began
	A1	14	":" to Separate Hour and Minutes of Time
IMD	I2	16	Minute that Trip Began
IHRA2	I2	18	Hour That Trip Ended
	A1	19	":" to Separate Hour and Minutes of Time
IMA2	I2	21	Minute That Trip Ended
IPURP	I1	22	Purpose of Trip From
IPURP2	I1	23	Purpose of Trip To
IMODE2	I2	25	Mode of Trip
IOCC2	I2	27	Vehicle Occupancy of Trip
PC2	F6.2	33	Parking Cost
F2	F6.2	39	Fare Cost if Trip by Transit
IRM2	I1	40	Arrival Mode if Trip by Transit
ANAME	A21	61	Location Where Trip Began
BNAME	A21	82	Location Where Trip Ended
IZN	I4	86	Zone Where Trip Began
IZN2	I4	90	Zone Where Trip Ended
Code Definitions			
<i>Trip Purpose</i>		<i>Mode of Trip</i>	
1 - Return home or home		1 - Driver (car/truck/van/motorcycle)	
2 - Go to work or work related		2 - Passenger (car/truck/van/motorcycle)	
3 - School		3 - Walk	
4 - Social/Recreation/Shop/Eat		4 - Bicycle	
5 - Pick up/drop off passenger		5 - Bus	
6 - Change travel mode		6 - School Bus	
7 - Other		7 - Taxi	
8 - Refused/unknown		8 - Commercial Vehicle (over 1 ton)	
		9 - Other	
		99- Refused/unknown	

The second step in processing the data for analysis purposes was trip linking. Trip linking is defined as combining two or more trips involving home and work into a single trip that represents the true purpose of the trip. In application, the process consists of identifying those trips which occur between home and work (either direction) which involved either a serve passenger trip purpose or a change mode trip purpose. For example, if the first trip made by a person was coded as a home to

serve passenger (e.g., father took child to school) and the second trip was coded as serve passenger to work (e.g., father went to work after dropping child off), these two trips would be combined into a single home to work trip. A computer program was developed to input the trip records and link those serve passenger and change mode of travel trips which occurred between home and work (either direction). Since the intent is to build trips that actually represent the true purpose of the individual, a limiting factor was included in the program to prevent linking serve passenger trips which involved a dwell time of over 20 minutes. The logic was that a high dwell time implied the purpose of the trip was more than just serving a passenger (i.e., dropping off or picking up someone). This actually occurred in the trip data where a person went from work to a school to pick up someone and was at the school for several hours. In such a case, it is assumed that an additional activity is occurring besides serving a passenger. The process of linking trips does reduce the total number of trips for an urban area. Table 23 presents the final totals for the household survey data for each of the urban areas surveyed and the results of the trip linking process. Trip linking reduced the total number of trips between 1.6 percent to 2.5 percent.

After linking, the next step was to process the trip files, identify those trips which had one or both trip ends outside the study area (i.e., were external trips), and add the travel time and distance as determined from the transportation network to each trip record. Separation matrices containing the zone to zone travel times and distances were developed from the transportation networks for each of the urban areas. The computer program was modified to input the trip records from the survey and locate the zone to zone travel time and distance from the separation matrices and add those values to the trip record. In addition, the reported travel time was also computed and added to the trip record. The reported travel time was based on the beginning and ending times for each trip. Trips identified as external were given travel times and distances of zero. Since a number of trips had one or both trip ends defined as unknown, a method was developed to estimate the travel time and travel distance. Trips originating or terminating in an unknown zone had the unknown zone number coded as 8888. Table 24 shows the number of total external trips found in each survey and the number of internal trips which were not geocoded (i.e., the zone number where the trip originated or ended could not be determined from the information gathered in the survey).

Table 23
Edited Household Survey Totals

Urban Area	Total Households	Total Unlinked Trips*	Total Linked Trips*	Total Persons 5 and Older
San Antonio	2,651	24,389	23,841	6,854
Amarillo	2,653	28,862	28,150	6,428
Brownsville	1,411	15,295	15,001	4,205
Tyler	2,492	23,022	22,688	5,600
Sherman-Denison	2,279	22,761	22,406	5,287

*Total trips includes external and internal trips

Table 24
Trips with an External or Unknown Trip End

Urban Area	Total Linked Trips	External Trips		Internal Trips		Unknown Trip Ends	
		No.	%	No.	%	No.	%
San Antonio	23,841	281	1.2	23,560	98.8	1,321	5.6
Amarillo	28,150	1,070	3.8	27,080	96.2	621	2.3
Brownsville	15,001	566	3.8	14,435	96.2	192	1.3
Tyler	22,688	2,251	9.9	20,437	90.1	67	0.3
Sherman-Denison	22,406	2,036	9.1	20,370	90.9	79	0.4

The data in Table 24 indicate a high percentage of the total trips were geocoded. Those trips that were not geocoded did not have valid zone numbers for use in identifying the network travel time and distance for the trip. A method for estimating those quantities was developed and incorporated into the computer program. The methods for estimating comparable network distance and time for those trips with unknown zones were based on the reported travel times for those trips that had been successfully geocoded. Basically, the program first obtained the network travel time and distance for all trips with known origin and destination zones. The reported travel time (based

on the beginning and ending times for each trip) and network distance (in miles) were summed into seven time groups. The time groups used were 0 to 7 minutes, 7 to 12 minutes, 12 to 17 minutes, 17 to 22 minutes, 22 to 27 minutes, 27 to 32 minutes, and over 32 minutes. These groupings of time were developed through trial and error to achieve a reasonable estimate. The average speed for each time group was computed by dividing the total reported time by the total distance within each group. Table 25 presents the values as computed for the San Antonio survey. For those trips with unknown origin or destination zones, an estimate of the network distance for the trip was obtained by identifying the time group the trip fell within and multiplying the reported travel time by the average speed for that time group.

Table 25
Average Speed by Reported Time

Time Interval (min)	Total Reported Time (hours)	Total Network Distance	Average Speed (mph)
0 to 7	256.67	9,512.00	37.06
7 to 12	622.18	13,574.35	21.82
12 to 17	1,090.83	22,027.60	20.19
17 to 22	804.25	16,869.72	20.98
22 to 27	476.23	9,418.38	19.78
27 to 32	1,324.43	23,606.34	17.82
32 +	1,726.20	20,046.21	11.61

A similar procedure was used for developing estimates of network travel time, except distance groupings were used and average network travel time computed for each distance group. There were 21 distance intervals used, each representing a one-mile increment. For those trips with known origin and destination zones, the number of trips and the network travel time were summed for each distance interval. An average network travel time was computed for each interval by dividing the total time by the total number of trips. Table 26 presents the results for San Antonio. An estimate of the network travel time for those trips with unknown origin or destination zones was computed by identifying the interval that the estimated network distance fell within and setting the network travel time equal to the average travel time for that distance interval.

Table 26
Average Travel Time by Estimated Trip Distance

Distance Interval (miles)	Total Travel Time (min)	Number of Trips	Average Travel Time (min)
0 to 0.99	3,500.23	1,361	2.57
1.0 to 1.99	11,641.06	2,723	4.28
2.0 to 2.99	17,341.29	2,801	6.19
3.0 to 3.99	17,504.84	2,218	7.89
4.0 to 4.99	15,739.89	1,612	9.76
5.0 to 5.99	17,226.92	1,505	11.45
6.0 to 6.99	15,296.81	1,154	13.26
7.0 to 7.99	14,892.46	1,010	14.75
8.0 to 8.99	15,784.78	972	16.24
9.0 to 9.99	14,218.99	794	17.91
10.0 to 10.99	11,543.29	596	19.37
11.0 to 11.99	12,021.17	572	21.02
12.0 to 12.99	11,884.63	535	22.21
13.0 to 13.99	6,882.07	290	23.73
14.0 to 14.99	7,274.41	287	25.35
15.0 to 15.99	8,143.74	302	26.97
16.0 to 16.99	5,381.67	192	28.03
17.0 to 17.99	4,804.79	160	30.03
18.0 to 18.99	3,936.56	126	31.24
19.0 to 19.99	2,541.05	77	33.00
20.0 Plus	12,072.81	323	37.38

Travel time and distance were not estimated for those trips identified as having one or both ends outside the study area (i.e., external) and for those trips where it was not possible to compute a reported travel time. Those trip records with estimated network travel time and distance were

marked to indicate that the values were estimates. Travel time and distance were estimated for intrazonal trips. Subsequent analyses present the data on trip length for trips where the origin and destination zones were known and also with those trips using estimated values for the trip length.

The next step in processing the data was selecting the method for expanding the survey data. Several options were possible. Since the survey data represent information for only a small proportion of the population, it is necessary to expand the data to develop overall estimates for each urban area. This may be accomplished in a number of ways. For example, in San Antonio 2,651 households were surveyed. The 1990 census estimate of households in the San Antonio study area was 409,606. The household survey data could be expanded simply by dividing the total households by the number of households surveyed and multiplying the survey data by the result. In this example, the expansion factor would be 154.51. This method, however, gives equal weight to each household surveyed when it is generally accepted that households with different characteristics have different travel patterns. The use of a single expansion factor could then produce erroneous results in the travel estimation. The decision was made to stratify the surveyed households in terms of their socioeconomic characteristics and compute expansion factors for each stratification cell. Since the survey design had selected households for sampling based on a stratification of household size and vehicle availability, this stratification seemed the most logical. Previous research (18), however, had recommended that trip rates for trip production modeling be developed for households stratified by household size and household income. The decision was made to use the same stratification for expansion of the data as would be used in the development of the trip rates for modeling trip productions. The next step was to determine the appropriate levels of stratification for household size and household income. Appendices A and B contain the results of the preliminary analysis to develop a recommended stratification for the development of trip rates and subsequent comparative analysis of travel characteristics. Careful examination of the data presented in Appendices A and B will reveal slight variations in the data values relative to those presented in the main body of this report. The analyses presented in the appendices were done early in the project and subsequent corrections to the survey data resulted in minor changes in some data values. These changes would not have affected the results of the analyses presented. The recommended stratification of surveyed households is shown in Table 27.

Table 27
Recommended Household Stratifications

Household Income (1990 Dollars)	Household Size				
	1	2	3	4	5+
\$ 0 - \$ 4,999					
\$ 5,000 - \$ 9,999					
\$ 10,000 - \$ 19,999					
\$ 20,000 - \$ 34,999					
\$ 35,000 Plus					

The next step was to compile estimates of the number of households stratified by the levels shown in Table 27 for each of the urban areas surveyed. These estimates were developed using data from the 1990 census and are shown in Tables 28 through 32.

Table 28
1990 Regional Distribution of Households
San Antonio-Bexar County

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	14,949	6,225	5,488	4,423	4,587	35,672
\$ 5,000 to \$ 9,999	15,809	9,256	5,283	3,809	4,751	38,908
\$ 10,000 to \$ 19,999	26,622	23,018	13,024	11,263	11,509	85,436
\$ 20,000 to \$ 34,999	24,000	31,496	18,308	15,932	16,505	106,241
\$ 35,000 Plus	12,615	46,527	30,144	30,226	23,837	143,349
Totals	93,995	116,522	72,247	65,653	61,189	409,606

Table 29
1990 Regional Distribution of Households
Amarillo, Texas

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	2,666	1,221	744	376	347	5,354
\$ 5,000 to \$ 9,999	4,270	1,907	780	448	405	7,810
\$ 10,000 to \$ 19,999	6,033	4,870	2,117	1,546	1,091	15,657
\$ 20,000 to \$ 34,999	4,342	6,127	3,483	2,948	2,319	19,219
\$ 35,000 Plus	1,951	8,872	5,065	5,737	2,587	24,212
Totals	19,262	22,997	12,189	11,055	6,749	72,252

Table 30
1990 Regional Distribution of Households
Brownsville, Texas

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	1,302	724	536	483	801	3,846
\$ 5,000 to \$ 9,999	878	923	557	528	963	3,849
\$ 10,000 to \$ 19,999	880	1,602	1,005	1,183	2,318	6,988
\$ 20,000 to \$ 34,999	668	1,482	931	939	1,869	5,889
\$ 35,000 Plus	400	1,816	984	1,254	1,493	5,947
Totals	4,128	6,547	4,013	4,387	7,444	26,519

Table 31
1990 Regional Distribution of Households
Tyler, Texas

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	2,812	1,023	494	256	466	5,051
\$ 5,000 to \$ 9,999	3,232	1,170	432	381	511	5,726
\$ 10,000 to \$ 19,999	3,465	4,505	1,909	1,091	1,130	12,100
\$ 20,000 to \$ 34,999	3,147	5,425	2,710	2,039	1,380	14,701
\$ 35,000 Plus	1,040	6,720	4,465	4,442	2,562	19,229
Totals	13,696	18,843	10,010	8,209	6,049	56,807

Table 32
1990 Regional Distribution of Households
Sherman-Denison

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	2,263	677	298	250	77	3,565
\$ 5,000 to \$ 9,999	2,355	1,388	320	258	173	4,494
\$ 10,000 to \$ 19,999	2,079	2,893	1,112	736	593	7,413
\$ 20,000 to \$ 34,999	1,653	3,691	1,741	1,590	1,181	9,856
\$ 35,000 Plus	780	3,982	2,628	2,642	1,439	11,471
Totals	9,130	12,631	6,099	5,476	3,463	36,799

One of the early concerns expressed in the household survey was that of nonresponse to selected data items particularly with regard to household income. As expected, a number of households refused to answer the household income question in the survey. The number of households not reporting income was not significant except in the Tyler survey. Table 33 presents the number of households that did not report income as well as the number of households which reported zero trips.

Expansion factors for each of the surveys were computed using the number of households within each stratification cell divided by the number of surveyed households in each cell. Tables 34 through 38 present the number of surveyed households for each urban area stratified by household size and income. The computed expansion factors for each cell within each area are shown in Tables 39 through 43. Households which did not report income were left in the data file but the expansion factor for those households was zero.

Table 33
Comparison of Zero Trip Households
and Households Not Reporting Income

Data Collection Method	Urban Area Surveyed	Year Surveyed	Percentage of Households With Zero Trips	Percentage of Households Not Reporting Income
Telephone	San Antonio	1990	8.25	7.54
Telephone	Amarillo	1990	6.24	3.00
Telephone	Brownsville	1990	7.44	3.12
Mail	Sherman-Denison	1991	11.95	0.55
Mail	Tyler	1991	11.01	23.54

Source: Reference 12

Table 34
Surveyed Households
1990 San Antonio Household Travel Survey

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4999	129	67	40	29	33	298
\$ 5000 to \$ 9999	77	74	46	35	49	281
\$ 10000 to \$ 19999	137	144	83	81	105	550
\$ 20000 to \$ 34999	117	173	122	119	85	616
\$ 35000 Plus	51	243	169	151	91	705
Totals	511	701	460	415	363	2450

Table 35
Surveyed Households
1990 Amarillo Household Travel Survey

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	66	28	14	5	8	121
\$ 5,000 to \$ 9,999	113	54	28	15	13	223
\$ 10,000 to \$ 19,999	179	147	80	52	34	492
\$ 20,000 to \$ 34,999	131	275	160	129	78	773
\$ 35,000 Plus	56	348	199	219	115	937
Totals	545	852	481	420	248	2546

Table 36
Surveyed Households
1991 Brownsville Household Travel Survey

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	48	61	58	27	62	256
\$ 5,000 to \$ 9,999	32	60	59	33	53	237
\$ 10,000 to \$ 19,999	42	71	55	58	77	303
\$ 20,000 to \$ 34,999	59	72	70	51	51	319
\$ 35,000 Plus	19	71	66	50	46	252
Totals	200	335	308	219	305	1367

Table 37
Surveyed Households
1991 Tyler Household Travel Survey

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	108	25	12	2	4	151
\$ 5,000 to \$ 9,999	107	43	19	6	9	184
\$ 10,000 to \$ 19,999	138	149	32	25	17	361
\$ 20,000 to \$ 34,999	117	219	87	84	42	549
\$ 35,000 Plus	38	282	149	151	49	669
Totals	508	718	299	268	121	1914

Table 38
Surveyed Households
1991 Sherman-Denison Household Travel Survey

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	140	29	15	4	3	191
\$ 5,000 to \$ 9,999	185	64	23	8	2	282
\$ 10,000 to \$ 19,999	147	153	64	39	25	428
\$ 20,000 to \$ 34,999	142	190	162	132	62	688
\$ 35,000 Plus	59	188	165	179	91	682
Totals	673	624	429	362	183	2271

Table 39
Sample Expansion Factors
1990 San Antonio Household Travel Survey

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	115.88	92.92	137.20	152.53	139.00	NA
\$ 5,000 to \$ 9,999	205.31	125.08	114.86	108.83	96.96	NA
\$ 10,000 to \$ 19,999	194.32	159.84	156.92	139.05	109.61	NA
\$ 20,000 to \$ 34,999	205.13	182.06	150.06	133.88	194.18	NA
\$ 35,000 Plus	247.35	191.47	178.37	200.17	261.94	NA
Totals	NA	NA	NA	NA	NA	NA

Table 40
Sample Expansion Factors
1990 Amarillo Household Travel Survey

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	40.40	43.61	53.16	75.14	43.35	NA
\$ 5,000 to \$ 9,999	37.79	35.32	27.87	29.86	31.12	NA
\$ 10,000 to \$ 19,999	33.70	33.13	26.46	29.73	32.09	NA
\$ 20,000 to \$ 34,999	33.15	22.28	21.77	22.85	29.73	NA
\$ 35,000 Plus	34.84	25.50	25.45	26.20	22.49	NA
Totals	NA	NA	NA	NA	NA	NA

Table 41
Sample Expansion Factors
1991 Brownsville Household Travel Survey

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	27.13	11.87	9.24	17.88	12.92	NA
\$ 5,000 to \$ 9,999	27.43	15.38	9.44	15.99	18.16	NA
\$ 10,000 to \$ 19,999	20.96	22.56	18.27	20.39	30.10	NA
\$ 20,000 to \$ 34,999	11.33	20.59	13.30	18.41	27.90	NA
\$ 35,000 Plus	21.08	25.59	14.91	25.09	32.46	NA
Totals	NA	NA	NA	NA	NA	NA

Table 42
Sample Expansion Factors
1991 Tyler Household Travel Survey

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	26.04	40.90	41.19	127.82	116.45	NA
\$ 5,000 to \$ 9,999	30.21	27.21	22.72	63.43	56.81	NA
\$ 10,000 to \$ 19,999	25.11	30.23	59.65	43.63	66.50	NA
\$ 20,000 to \$ 34,999	26.90	24.77	31.15	24.28	32.87	NA
\$ 35,000 Plus	27.36	23.83	29.97	29.42	52.29	NA
Totals	NA	NA	NA	NA	NA	NA

Table 43
Sample Expansion Factors
1991 Sherman-Denison Household Travel Survey

Household Income Range	Household Size					Totals
	1	2	3	4	5 +	
\$ 0 to \$ 4,999	16.17	23.35	19.87	62.56	25.76	NA
\$ 5,000 to \$ 9,999	12.73	21.68	13.92	32.20	86.49	NA
\$ 10,000 to \$ 19,999	14.15	18.91	17.37	18.87	23.70	NA
\$ 20,000 to \$ 34,999	11.64	19.43	10.75	12.04	19.05	NA
\$ 35,000 Plus	13.22	21.18	15.93	14.76	15.81	NA
Totals	NA	NA	NA	NA	NA	NA

The previous steps in processing the household survey data were accomplished in a computer program written to prepare a composite data file with all of the relevant survey information. This file could then be input to any number of subsequent analysis programs to process and analyze the survey data. Appendix C presents the data file format for the records in this composite file. As part

of this project, a comprehensive analysis program was developed for the purpose of analyzing the survey data. The program was designed to provide as much flexibility as possible in examining the survey data. The following lists some of the capabilities of the program:

- Allows user to select one-, two-, or three-way stratifications for developing trip production rates.
- Allows the user to select household size, household income, vehicles available, number employed (in the household), age of the head of household, and/or number of licensed drivers as the variables to be used in the household stratification.
- Allows the user to select the numerical ranges for the selected variables in the household stratification.
- Allows the user to select time periods for the compilation of the results. For example, the user may have the total trips (by trip purpose), the stratified trip rates, the trip length frequency distribution for all trips which began during the period 7:00 am to 8:30 am compiled and printed.
- Allows the user to specify (from three options) the trip purposes to be used in compiling the survey data. For example, the first option is the trip purposes home based work, home based non-work, and non-home based. The maximum number of trip purposes which may be selected is ten.
- Allows the user to specify the mode(s) of travel for the trip compilation and related statistics. Single or multiple options may be selected for up to eight modes of travel.
- Allows the user to select certain statistics to be output for the stratified trip rates. The options provided are the coefficient of variation, sample variance, sample standard deviation, variance of the mean, and standard deviation of the mean. The selected statistics are produced for each cell in the stratification.

The user is given flexibility in selecting how the survey data are stratified; and depending on the choices, a large amount of output may be generated. The output from the program generally consists of the following tables for each trip purpose and travel mode:

1. Household trip summary which lists the surveyed and expanded trips for each mode of travel and for external trips. The surveyed and expanded households and persons are also listed. In addition, the number of auto driver trips reporting a parking cost is output with the average parking cost paid. The total transit trips that reported a

- transit fare is output with the average transit fare paid.
2. Trip length frequency distributions for travel distance (miles) and time (minutes). For auto driver trips (all purposes combined) the trip length frequency distribution for reported travel time is also produced.
 3. Trips per person summaries which include the sampled and expanded trips for persons in 15 age groups. The data for each age group include the number of persons observed, the number of persons that made trips, the number of persons that reported no trips, the number of persons (reporting no trips) that came from zero trip households, the total person trips reported, the mean and variance for person trips per person, and the mean and variance for person trips per person for only those persons making trips. The same data are output for auto driver trips. This information is also output for persons by sex.
 4. Person trip length summaries for sampled and expanded trips. For each of 15 age groups, for person and auto driver trips, the average trip length in reported time, network travel time, and network travel distance is output.
 5. For the trip purposes, modes of travel, variables, and stratification levels selected, tables with the following data are output:
 - a. Sampled and expanded number of households surveyed.
 - b. Expanded number of trips.
 - c. Average trips per household.
 6. For auto driver trips, the average reported vehicle occupancy and factors for converting person trips to vehicle trips are output for each trip purpose, and selected variables and stratification levels.
 7. For each trip purpose and mode of travel, the trip length frequency distribution is output for travel distance (miles) and travel time (minutes). These distributions are produced for sampled trips only, sampled plus estimated trips, expanded sample trips only, and expanded sampled plus estimated trips. The estimated trips are those for which the travel distance and/or time were estimated based on the methodology previously discussed.
 8. For each trip purpose and mode of travel, the average distance traveled in miles and minutes are output for households stratified by the selected variables. This is

produced both with and without those trips with estimated values of travel time and distance.

The data from that analysis program were the basis for the analysis results discussed in the next section.

HOUSEHOLD SURVEY DATA ANALYSIS

The data from the household survey were extensive and offered a variety of options by which they could be stratified, examined, and analyzed. For brevity, most of the analyses presented in this report center on household trip production rates for households stratified by five categories of household size and five categories of household income. In addition, the trip purposes discussed are home based work, home based non-work, non-home based, and all purposes combined. Most of the data analyzed and presented in this report are for two types of trips, person trips and auto driver trips. Person trips are all trips reported regardless of mode. They include walk trips, bicycle trips, auto passenger trips, commercial vehicle trips, etc. Auto driver trips are only those trips where the individual reported the mode of the trip as driver of the vehicle.

Tables 44 through 47 present summary results in the form of sampled and expanded trips for each trip purpose for the five urban areas surveyed. The sampled data reflect data for all of the households surveyed, while the expanded data reflect the expanded trips for households stratified by household size and household income. Also shown in those tables are ratios of person trips per capita, person trips per household, auto driver trips per capita, and auto driver trips per household. Care should be taken in evaluating these values, since differences between urban areas may not be differences in trip rates but differences in the distributions of households by socioeconomic characteristics.

The surveyed households were then stratified by the five categories of household size and household income. Tables 34 through 38 presented the number of surveyed households stratified by household size and income. Trips were summed for each trip purpose and for each mode. The average trips per household for each stratification cell were computed by dividing the total trips in each cell by the number of surveyed households in each cell. The raw trip rates are presented in Tables 48 through 52. The sample coefficients of variation are presented in Appendix H for each urban area. These are stratified by household size and income and may be used to examine the sample trip rate errors and to estimate sample size requirements for future surveys.

Trip Rate Comparisons

Since the 1990 and 1991 surveys utilized the same survey instruments and basic methodologies, the raw trip rates were compared to determine their similarity and/or difference statistically. The comparison test was a test statistic called the z test. The computational formula for this statistic is shown in Appendix B. In essence, the stratified person and auto driver trip rates for each trip purpose for each urban area were compared with the same rate for each of the other urban areas. Another method for comparing trip rates is to compute a correlation coefficient for each set of trip rates, i.e., the set of home based work person trip rates for one urban area would be compared to the set of the same rates in another urban area. The correlation is an approximate measure of how well the rates match.

Table 44
Household Survey Summary Results
Home Based Work Trips

Trips	San Antonio		Amarillo		Brownsville		Tyler		Sherman-Denison	
	Sampled	Expanded	Sampled	Expanded	Sample	Expanded	Sampled	Expanded	Sampled	Expanded
Person	4,817	787,401	4,961	127,152	2,205	44,633	3,980	95,539	3,334	53,120
Auto Driver	3,959	662,770	4,567	116,468	1,765	36,272	3,731	89,210	3,079	48,962
Auto Passenger	463	69,495	308	8,176	334	6,400	213	5,350	217	3,535
Public Transit	249	33,428	36	1,070	29	542	1	0	5	92
Walk	86	12,535	31	955	58	1,069	22	710	20	339
Bicycle	6	917	11	294	10	168	2	25	3	37
School Bus	4	730	0	0	2	30	1	25	2	21
Taxi	2	300	2	76	6	139	3	78	0	0
Commercial Vehicle	1	134	3	69	0	0	7	141	5	82
Other Mode	7	1,002	2	23	0	0	0	0	3	50
Unknown	40	6,088	1	22	1	13	0	0	0	0
External	70	12,003	296	7,289	159	3,158	445	11,011	403	6,292
Person/Capita	0.70	0.75	0.77	0.76	0.52	0.54	0.71	0.70	0.63	0.61
Person/House.	1.82	1.92	1.87	1.76	1.56	1.68	1.60	1.68	1.46	1.44
A-D/Capita	0.58	0.63	0.71	0.69	0.42	0.44	0.67	0.66	0.58	0.57
A-D/House.	1.49	1.62	1.72	1.61	1.25	1.37	1.50	1.57	1.35	1.33

Table 45
Household Survey Summary Results
Home Based Non-Work Trips

Trips	San Antonio		Amarillo		Brownsville		Tyler		Sherman-Denison	
	Sampled	Expanded	Sampled	Expanded	Sample	Expanded	Sampled	Expanded	Sampled	Expanded
Person	12,353	1,949,864	13,284	348,558	8,334	167,622	9,961	248,660	10,203	166,500
Auto Driver	6,311	1,032,420	8,284	217,448	4,431	87,678	6,800	161,595	6,428	104,689
Auto Passenger	3,693	579,523	4,469	116,574	2,922	60,789	2,717	73,084	2,884	46,823
Public Transit	484	66,534	60	2,141	217	3,571	26	574	108	1,684
Walk	1,057	141,364	194	5,251	58	1,061	173	5,314	373	6,482
Bicycle	61	9,224	24	582	3	67	42	1,268	55	830
School Bus	604	98,612	231	5,974	682	13,982	191	6,561	309	5,288
Taxi	4	272	7	151	11	253	7	197	41	631
Commercial Vehicle	0	0	0	0	0	0	0	0	1	19
Other Mode	17	2,190	10	303	8	178	5	72	3	43
Unknown	122	19,750	5	143	2	43	0	0	1	11
External	134	20,540	502	12,927	241	5,008	840	20,378	713	11,554
Person/Capita	1.80	1.86	2.07	2.07	1.98	2.02	1.78	1.83	1.93	1.92
Person/House.	4.66	4.76	5.01	4.82	5.91	6.32	4.00	4.38	4.48	4.52
A-D/Capita	0.92	0.99	1.29	1.29	1.05	1.06	1.21	1.19	1.22	1.21
A-D/House.	2.38	2.52	3.12	3.01	3.14	3.31	2.73	2.84	2.82	2.84

Table 46
Household Survey Summary Results
Non-Home Based Trips

Trips	San Antonio		Amarillo		Brownsville		Tyler		Sherman-Denison	
	Sampled	Expanded	Sampled	Expanded	Sample	Expanded	Sampled	Expanded	Sampled	Expanded
Person	6,390	1,065,255	8,835	228,425	3,896	80,739	6,496	162,067	6,833	111,639
Auto Driver	4,543	768,052	6,667	172,251	2,776	57,670	5,123	125,530	5,206	84,788
Auto Passenger	1,384	227,414	2,032	52,629	1,039	21,320	1,271	33,528	1,359	22,584
Public Transit	126	17,875	10	291	31	545	1	52	46	723
Walk	219	32,714	49	1,338	11	259	34	1,001	86	1,379
Bicycle	6	861	7	192	0	0	4	75	6	83
School Bus	67	10,785	58	1,442	36	902	39	1,297	81	1,248
Taxi	0	0	1	38	2	18	1	26	6	93
Commercial Vehicle	38	6,411	7	153	0	0	20	497	36	620
Other Mode	6	986	4	97	1	25	2	31	7	121
Unknown	1	157	0	0	0	0	0	0	0	0
External	77	13,164	272	6,997	166	3,411	966	22,575	920	14,730
Person/Capita	0.93	1.02	1.37	1.36	0.93	0.98	1.16	1.19	1.29	1.29
Person/House.	2.41	2.60	3.33	3.16	2.76	3.04	2.61	2.85	3.00	3.03
A-D/Capita	0.66	0.73	1.04	1.02	0.66	0.70	0.91	0.92	0.98	0.98
A-D/House.	1.71	1.88	2.51	2.38	1.97	2.17	2.06	2.21	2.28	2.30

Table 47
Household Survey Summary Results
All Trip Purposes

Trips	San Antonio		Amarillo		Brownsville		Tyler		Sherman-Denison	
	Sampled	Expanded	Sampled	Expanded	Sample	Expanded	Sampled	Expanded	Sampled	Expanded
Person	23,560	3,802,409	27,080	704,097	14,435	292,996	20,437	506,318	20,370	331,232
Auto Driver	14,813	2,463,204	19,518	506,144	8,972	181,620	15,654	376,338	14,713	238,433
Auto Passenger	5,540	876,440	6,809	177,376	4,295	88,508	4,201	111,962	4,460	72,943
Public Transit	859	117,837	106	3,501	277	4,658	28	626	159	2,498
Walk	1,362	186,613	274	7,543	127	2,389	229	7,024	479	8,200
Bicycle	73	11,002	42	1,068	13	235	48	1,368	64	950
School Bus	675	110,127	289	7,416	720	14,914	231	7,883	392	6,557
Taxi	6	572	10	265	19	411	11	301	47	724
Commercial Vehicle	39	6,545	10	222	0	0	27	639	42	721
Other Mode	30	4,179	16	423	9	203	7	103	13	214
Unknown	163	25,994	6	166	3	56	0	0	1	11
External	281	45,707	1,070	27,213	566	11,577	2,251	53,965	2,036	32,575
Person/Capita	3.44	3.63	4.21	4.18	3.43	3.54	3.65	3.73	3.85	3.82
Person/House.	8.89	9.28	10.21	9.75	10.23	11.05	8.20	8.91	8.94	9.00
A-D/Capita	2.16	2.35	3.04	3.01	2.13	2.19	2.80	2.77	2.78	2.75
A-D/House.	5.59	6.01	7.36	7.01	6.36	6.85	6.28	6.62	6.46	6.48

Table 48
Raw Trip Production Rates by Trip Purpose
1990 San Antonio Household Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.19	0.51	0.78	1.45	1.27	0.05	0.31	0.58	0.55	0.82
\$ 5,000 - \$ 9,999	0.46	1.04	1.39	1.54	1.74	0.29	0.60	0.76	0.60	1.06
\$ 10,000 - \$ 19,999	1.08	1.29	2.01	1.89	2.37	0.90	0.94	1.54	1.31	1.55
\$ 20,000 - \$ 34,999	1.09	1.88	2.48	2.69	2.17	0.95	1.55	2.12	2.40	1.66
\$ 35,000 Plus	1.22	2.36	2.83	3.04	3.43	1.22	2.24	2.65	2.79	3.00

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.33	2.19	5.50	6.07	7.61	0.40	0.87	1.60	1.14	1.76
\$ 5,000 - \$ 9,999	1.65	2.57	4.24	5.40	8.94	0.94	1.43	1.41	2.03	2.55
\$ 10,000 - \$ 19,999	1.68	3.71	4.88	7.38	9.93	1.39	2.43	2.19	2.94	3.19
\$ 20,000 - \$ 34,999	1.83	3.41	4.76	6.61	10.41	1.65	2.56	2.67	3.30	4.38
\$ 35,000 Plus	1.75	2.82	4.37	7.70	11.11	1.63	2.28	3.11	4.14	4.75

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.40	0.63	1.05	1.21	0.91	0.19	0.39	0.38	0.45	0.42
\$ 5,000 - \$ 9,999	1.43	0.97	0.76	1.60	2.10	1.08	0.64	0.33	0.86	0.82
\$ 10,000 - \$ 19,999	1.56	2.14	2.72	3.62	3.41	1.39	1.42	1.47	1.84	2.01
\$ 20,000 - \$ 34,999	1.68	2.36	2.34	2.99	4.14	1.43	1.90	1.84	2.05	2.31
\$ 35,000 Plus	1.77	3.06	3.52	4.12	4.76	1.63	2.70	2.87	3.12	2.81

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.92	3.33	7.33	8.73	9.79	0.64	1.57	2.56	2.14	3.00
\$ 5,000 - \$ 9,999	3.54	4.58	6.39	8.54	12.78	2.31	2.67	2.50	3.49	4.43
\$ 10,000 - \$ 19,999	4.32	7.14	9.61	12.89	15.71	3.68	4.79	5.20	6.09	6.75
\$ 20,000 - \$ 34,999	4.60	7.65	9.58	12.29	16.72	4.03	6.01	6.63	7.75	8.35
\$ 35,000 Plus	4.74	8.24	10.72	14.86	19.30	4.48	7.22	8.63	10.05	10.56

Table 49
Raw Trip Production Rates by Trip Purpose
1990 Amarillo Household Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.32	0.71	0.79	0.80	1.00	0.18	0.39	0.64	0.40	0.75
\$ 5,000 - \$ 9,999	0.42	1.04	1.29	1.33	1.69	0.37	0.85	1.00	1.27	1.31
\$ 10,000 - \$ 19,999	0.72	1.19	1.84	2.19	1.85	0.69	1.10	1.54	1.89	1.12
\$ 20,000 - \$ 34,999	1.21	1.63	2.29	2.52	3.10	1.14	1.52	2.08	2.26	2.74
\$ 35,000 Plus	1.11	2.27	2.74	2.85	3.23	1.02	2.18	2.68	2.69	3.01

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.89	2.82	5.07	8.79	10.37	1.29	1.54	2.36	6.00	3.50
\$ 5,000 - \$ 9,999	1.66	3.82	4.90	8.47	11.22	1.41	2.39	2.54	4.67	5.00
\$ 10,000 - \$ 19,999	1.99	3.36	4.60	6.54	10.50	1.77	2.33	2.54	3.65	5.09
\$ 20,000 - \$ 34,999	1.65	3.47	4.89	7.82	12.16	1.47	2.67	3.24	3.82	5.42
\$ 35,000 Plus	1.91	3.77	5.35	8.88	12.12	1.83	3.05	3.79	4.92	6.10

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.76	1.46	2.57	0.40	2.38	0.62	1.04	1.36	0.00	1.50
\$ 5,000 - \$ 9,999	1.04	2.04	2.79	4.07	2.15	0.95	1.48	2.04	2.33	0.92
\$ 10,000 - \$ 19,999	1.71	2.48	2.49	3.14	4.82	1.64	1.82	1.48	2.06	2.76
\$ 20,000 - \$ 34,999	1.63	3.22	3.55	3.74	5.54	1.47	2.68	2.73	2.30	3.22
\$ 35,000 Plus	2.20	3.37	4.14	6.02	6.98	2.06	2.93	3.49	4.16	4.51

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	2.97	4.99	8.43	9.99	13.75	2.09	2.97	4.36	6.40	5.75
\$ 5,000 - \$ 9,999	3.12	6.90	8.98	13.87	15.06	2.73	4.72	5.58	8.27	7.23
\$ 10,000 - \$ 19,999	4.42	7.03	8.93	11.87	17.17	4.10	5.25	5.56	7.60	8.97
\$ 20,000 - \$ 34,999	4.49	8.32	10.73	14.08	20.80	4.08	6.87	8.05	8.38	11.38
\$ 35,000 Plus	5.22	9.41	12.23	17.75	22.33	4.91	8.16	9.96	11.77	13.62

Table 50
Raw Trip Production Rates by Trip Purpose
1991 Brownsville Household Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.15	0.23	0.88	0.85	1.00	0.10	0.18	0.45	0.33	0.61
\$ 5,000 - \$ 9,999	0.53	0.82	1.46	1.21	1.55	0.41	0.52	0.95	0.94	1.00
\$ 10,000 - \$ 19,999	0.55	1.10	1.51	1.83	1.75	0.55	0.87	1.24	1.19	1.27
\$ 20,000 - \$ 34,999	1.09	1.28	1.93	2.53	3.26	1.02	1.07	1.54	2.34	2.49
\$ 35,000 Plus	0.79	2.13	2.50	3.40	3.13	0.79	1.90	2.24	3.06	2.98

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.27	3.23	5.30	6.60	9.82	0.48	1.49	2.52	2.78	2.87
\$ 5,000 - \$ 9,999	1.72	3.14	4.45	7.59	9.87	1.06	1.90	2.26	4.25	4.34
\$ 10,000 - \$ 19,999	2.07	3.65	4.22	8.59	11.06	2.03	2.28	2.46	4.24	4.40
\$ 20,000 - \$ 34,999	2.34	4.38	5.10	6.65	11.18	2.14	3.18	3.69	3.02	5.36
\$ 35,000 Plus	3.06	3.96	5.67	8.44	11.52	2.95	3.13	4.03	4.74	5.57

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.40	0.92	1.61	1.08	1.55	0.23	0.62	0.88	0.48	0.73
\$ 5,000 - \$ 9,999	0.53	1.20	2.28	2.91	1.81	0.31	0.87	1.26	1.97	1.13
\$ 10,000 - \$ 19,999	1.64	2.71	2.06	3.05	2.73	1.64	1.93	1.44	1.64	1.73
\$ 20,000 - \$ 34,999	1.93	2.35	3.10	3.95	5.39	1.81	1.86	2.36	2.89	3.72
\$ 35,000 Plus	2.06	5.17	4.63	5.50	6.67	2.06	4.28	3.56	4.02	4.59

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.82	4.38	7.79	8.53	12.37	0.81	2.29	3.85	3.59	4.21
\$ 5,000 - \$ 9,999	2.78	5.16	8.19	11.71	13.23	1.78	3.29	4.47	7.16	6.47
\$ 10,000 - \$ 19,999	4.26	7.46	7.79	13.47	15.54	4.22	5.08	5.14	7.07	7.40
\$ 20,000 - \$ 34,999	5.36	8.01	10.13	13.13	19.83	4.97	6.11	7.59	8.25	11.57
\$ 35,000 Plus	5.91	11.26	12.80	17.34	21.32	5.80	9.31	9.83	11.82	13.14

Table 51
Raw Trip Production Rates by Trip Purpose
1991 Tyler Household Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.17	0.64	1.00	2.00	0.75	0.16	0.60	0.67	1.00	0.75
\$ 5,000 - \$ 9,999	0.37	0.44	1.32	1.50	1.44	0.36	0.37	1.10	1.17	0.67
\$ 10,000 - \$ 19,999	0.57	1.00	1.41	1.96	2.06	0.52	0.95	1.41	1.72	1.59
\$ 20,000 - \$ 34,999	1.05	1.40	2.30	2.55	2.43	1.02	1.33	2.23	2.43	2.19
\$ 35,000 Plus	0.87	1.88	2.91	3.07	3.90	0.87	1.81	2.73	2.82	3.80

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.07	2.56	3.75	5.99	7.25	0.67	1.56	2.25	3.00	2.25
\$ 5,000 - \$ 9,999	1.33	1.63	4.37	11.16	7.23	1.13	1.19	2.74	3.50	2.22
\$ 10,000 - \$ 19,999	1.86	3.09	4.28	6.12	8.95	1.60	2.33	2.84	3.44	3.65
\$ 20,000 - \$ 34,999	1.65	3.30	3.99	6.82	9.24	1.55	2.74	2.87	3.62	3.76
\$ 35,000 Plus	1.97	3.51	4.90	8.22	11.84	1.76	3.08	3.76	4.70	6.57

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.50	1.12	1.92	1.50	1.50	0.34	0.76	1.59	0.50	1.00
\$ 5,000 - \$ 9,999	0.91	0.93	2.37	4.16	2.89	0.65	0.84	1.84	3.66	1.44
\$ 10,000 - \$ 19,999	1.25	1.91	2.75	2.60	4.53	1.14	1.44	2.16	2.12	2.59
\$ 20,000 - \$ 34,999	1.94	2.35	3.20	4.33	4.22	1.74	1.83	2.63	3.12	2.19
\$ 35,000 Plus	1.74	2.87	3.77	5.46	7.37	1.66	2.62	3.19	4.09	5.08

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.74	4.32	6.67	9.49	9.50	1.17	2.92	4.51	4.50	4.00
\$ 5,000 - \$ 9,999	2.61	3.00	8.06	16.82	11.56	2.14	2.40	5.68	8.33	4.33
\$ 10,000 - \$ 19,999	3.68	6.00	8.44	10.68	15.54	3.26	4.72	6.41	7.28	7.83
\$ 20,000 - \$ 34,999	4.64	7.05	9.49	13.70	15.89	4.31	5.90	7.73	9.17	8.14
\$ 35,000 Plus	4.58	8.26	11.58	16.75	23.11	4.29	7.51	9.68	11.61	15.45

Table 52
Raw Trip Production Rates by Trip Purpose
1991 Sherman-Denison Household Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.08	0.35	0.87	0.00	0.34	0.07	0.17	0.74	0.00	0.34
\$ 5,000 - \$ 9,999	0.12	0.33	0.91	2.12	3.00	0.12	0.20	0.78	1.37	3.00
\$ 10,000 - \$ 19,999	0.61	0.71	0.99	2.21	1.52	0.59	0.60	0.73	1.92	1.24
\$ 20,000 - \$ 34,999	0.99	1.07	2.15	2.62	2.63	0.96	0.99	1.95	2.39	2.40
\$ 35,000 Plus	1.15	1.95	2.81	2.73	2.47	1.05	1.87	2.73	2.53	2.40

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.85	2.76	6.40	4.50	3.68	0.26	1.93	3.74	2.50	1.68
\$ 5,000 - \$ 9,999	1.42	2.70	3.65	9.11	4.50	1.06	1.94	2.22	3.62	3.00
\$ 10,000 - \$ 19,999	1.96	3.59	4.88	7.08	10.19	1.74	2.63	2.94	4.15	4.44
\$ 20,000 - \$ 34,999	1.91	4.19	4.91	7.01	10.26	1.80	3.13	3.12	3.89	4.15
\$ 35,000 Plus	2.00	2.96	5.44	8.69	11.00	1.78	2.47	4.08	4.81	5.33

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.29	1.66	4.60	1.75	1.34	0.19	1.07	3.34	1.25	1.34
\$ 5,000 - \$ 9,999	0.76	1.56	1.39	5.62	0.00	0.58	1.14	0.87	4.12	0.00
\$ 10,000 - \$ 19,999	1.52	1.92	2.61	4.44	5.68	1.43	1.50	1.50	3.13	3.32
\$ 20,000 - \$ 34,999	1.71	3.10	3.41	4.17	5.73	1.54	2.46	2.62	2.89	3.47
\$ 35,000 Plus	1.85	3.54	4.19	5.69	6.02	1.66	3.02	3.57	4.22	4.13

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.22	4.77	11.87	6.25	5.36	0.52	3.17	7.82	3.75	3.36
\$ 5,000 - \$ 9,999	2.30	4.59	5.95	16.85	7.50	1.76	3.28	3.87	9.11	6.00
\$ 10,000 - \$ 19,999	4.09	7.40	8.48	13.73	17.39	3.76	4.73	5.17	9.20	9.00
\$ 20,000 - \$ 34,999	4.61	8.36	10.47	13.80	18.62	4.30	6.58	7.69	9.17	10.02
\$ 35,000 Plus	5.00	8.45	12.44	17.11	19.49	4.49	7.36	10.38	11.56	11.86

The z statistic was computed for each pair of trip rates. Tables 53 and 54 present the number and percentage of trip rates that were found to be significantly different with a confidence level of 95 percent. These comparisons indicate that the urban areas of Brownsville and Tyler have the most similar trip rates. Of 200 pairs of rates, only 15 (7.5 percent) were found to be significantly different. San Antonio has the most significantly different trip rates. Of the 800 comparisons done against the San Antonio rates, 197 (nearly 25 percent) were found to be significantly different. Table 55 shows a summary of the total trip rates compared for each pair of urban areas, and Table 56 shows the correlation coefficients computed for all sets of the trip rates. If San Antonio is not included in the comparisons the percentage of trip rates is significantly different for the remaining four urban areas ranges from 11 percent to nearly 16 percent. The comparison of individual trip rates implies that the trip rates for the large urban area, San Antonio, are different from those for the smaller urban areas. This may, in fact, be the case; however, there appears to be significant correlation between the trip rates for all of the urban areas surveyed as indicated by the high correlation coefficients shown in Table 56.

The data in Table 56 indicate that the majority of the differences between urban areas occurs between trip purposes, not total trips. Table 57 shows the percentage of total trips for each trip purpose within each urban area for both person and auto driver trips. With the exception of Brownsville, the percentage distribution of trips by trip purpose was consistent for the four small urban areas. All were different from San Antonio. The data here indicate that in large urban areas, there is a higher percentage of HBW trips. This was consistent with the survey findings in the 1984 Dallas-Fort Worth region where HBW person trips accounted for 27 percent of the total trips in the region (5).

Table 53
Number and Percentage of
Significantly Different
Person Trip Rates

Home Based Work

Urban Area	Brownsville		San Antonio		Sherman- Denison		Tyler	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Amarillo	1	4.0	2	8.0	7	28.0	2	8.0
Brownsville			6	24.0	7	28.0	1	4.0
San Antonio					9	36.0	6	24.0
Sherman-Denison							3	12.0

Home Based Non-Work

Urban Area	Brownsville		San Antonio		Sherman-Denison		Tyler	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Amarillo	3	12.0	5	20.0	5	20.0	4	16.0
Brownsville			3	12.0	3	12.0	4	16.0
San Antonio					5	20.0	3	12.0
Sherman-Denison							4	16.0

Non-Home Based

Urban Area	Brownsville		San Antonio		Sherman-Denison		Tyler	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Amarillo	4	16.0	10	40.0	2	8.0	4	16.0
Brownsville			3	12.0	5	20.0	1	4.0
San Antonio					7	28.0	3	12.0
Sherman-Denison							3	12.0

Total Person Trips

Urban Area	Brownsville		San Antonio		Sherman-Denison		Tyler	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Amarillo	3	12.0	8	32.0	6	24.0	6	24.0
Brownsville			4	16.0	3	12.0	3	12.0
San Antonio					6	24.0	4	16.0
Sherman-Denison							2	8.0

Table 54
Number and Percentage of
Significantly Different
Auto Driver Trip Rates

Home Based Work

Urban Area	Brownsville		San Antonio		Sherman-Denison		Tyler	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Amarillo	3	12.0	3	12.0	8	32.0	2	8.0
Brownsville			4	16.0	4	16.0	1	4.0
San Antonio					11	44.0	2	8.0
Sherman-Denison							6	24.0

Home Based Non-Work

Urban Area	Brownsville		San Antonio		Sherman-Denison		Tyler	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Amarillo	1	4.0	11	44.0	3	12.0	4	16.0
Brownsville			10	40.0	1	4.0	2	8.0
San Antonio					5	20.0	3	12.0
Sherman-Denison							3	12.0

Non-Home Based

Urban Area	Brownsville		San Antonio		Sherman-Denison		Tyler	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Amarillo	5	20.0	11	44.0	4	16.0	3	12.0
Brownsville			8	40.0	5	20.0	2	8.0
San Antonio					11	44.0	6	24.0
Sherman-Denison							3	12.0

Total Auto Driver Trips

Urban Area	Brownsville		San Antonio		Sherman-Denison		Tyler	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Amarillo	2	8.0	14	56.0	3	12.0	5	20.0
Brownsville			5	20.0	2	8.0	2	8.0
San Antonio					6	24.0	5	20.0
Sherman-Denison							2	8.0

Table 55
Significantly Different Trip Rates
Summary

Urban Areas	Trip Rates Compared	Number Different	Percentage Different
Amarillo vs. Brownsville	200	22	11.0
Amarillo vs. San Antonio	200	64	32.0
Amarillo vs. Sherman-Denison	200	38	19.0
Amarillo vs. Tyler	200	30	15.0
Brownsville vs. San Antonio	200	43	21.5
Brownsville vs. Sherman-Denison	200	30	15.0
Brownsville vs. Tyler	200	15	7.5
San Antonio vs. Sherman-Denison	200	60	30.0
San Antonio vs. Tyler	200	30	15.0
Sherman-Denison vs. Tyler	200	26	13.0

Table 56
Trip Rate Comparison Correlation Coefficients

Urban Areas	Trip Type	Correlation Coefficients			
		HBW	HBNW	NHB	All
Amarillo vs. Brownsville	Person	0.97	0.97	0.90	0.98
	Auto Driver	0.96	0.84	0.91	0.96
Amarillo vs. San Antonio	Person	0.94	0.96	0.84	0.96
	Auto Driver	0.93	0.70	0.86	0.90
Amarillo vs. Sherman-Denison	Person	0.87	0.81	0.87	0.88
	Auto Driver	0.87	0.75	0.81	0.91
Amarillo vs. Tyler	Person	0.91	0.92	0.94	0.95
	Auto Driver	0.93	0.80	0.88	0.94
Brownsville vs. San Antonio	Person	0.92	0.98	0.88	0.97
	Auto Driver	0.94	0.89	0.91	0.95
Brownsville vs. Sherman-Denison	Person	0.85	0.85	0.77	0.89
	Auto Driver	0.83	0.88	0.75	0.92
Brownsville vs. Tyler	Person	0.91	0.92	0.88	0.94
	Auto Driver	0.94	0.85	0.84	0.93
San Antonio vs. Sherman-Denison	Person	0.81	0.87	0.75	0.88
	Auto Driver	0.80	0.89	0.71	0.88
San Antonio vs. Tyler	Person	0.94	0.89	0.84	0.92
	Auto Driver	0.94	0.87	0.76	0.90
Sherman-Denison vs. Tyler	Person	0.78	0.90	0.82	0.92
	Auto Driver	0.76	0.90	0.84	0.91

Table 57
Percentage of Trips by Trip Purpose

Urban Areas	Trip Type	Percentage of Total Trips*			
		HBW	HBNW	NHB	Total
San Antonio	Person	20.71	51.28	28.01	100.00
Amarillo	Person	18.06	49.50	32.44	100.00
Brownsville	Person	15.23	57.21	27.56	100.00
Tyler	Person	18.87	49.12	32.01	100.00
Sherman-Denison	Person	16.04	50.26	33.70	100.00
San Antonio	Auto Driver	26.91	41.91	31.18	100.00
Amarillo	Auto Driver	23.01	42.96	34.03	100.00
Brownsville	Auto Driver	19.97	48.28	31.75	100.00
Tyler	Auto Driver	23.70	42.94	33.36	100.00
Sherman-Denison	Auto Driver	20.53	43.91	35.56	100.00

*Expanded trips

Trip Rate Error

Using the observed mean trips per household for each stratification cell and the computed variance of the household observations within each cell, it is possible to compute the error in the average trips per household at a specified confidence level. Mathematically, the computation uses the following equation (19):

$$E = \frac{t * \sigma}{\sqrt{n}}$$

where:

E = Trip rate error

t = Coefficient of the standard error of the mean representing user confidence level

σ = Standard deviation of the trip rate

The trip rate errors were computed for each stratification cell, multiplied by the percentage of households estimated to fall within each cell, and summed over all stratification levels for each trip purpose to estimate the weighted error in the total estimated trip rate. The results are shown in Table 58. As may be seen, the use of the total trip rates for estimating trip productions results in estimates with less error than the use of the trip rates for individual trip purposes. The high estimates of percentage errors results from the high variance in the observed trip rates. This is expected since the surveys were small sample surveys and the resulting stratifications yielded some cells with very few observations. It was noted, however, that similar errors were computed when the households were stratified in the same manner as the sampling design specified in the requests for proposals (12).

Several observations are notable in reviewing the estimated trip rate errors in Table 58. First, the lowest errors for all trip purposes and trip types were for the San Antonio and Amarillo surveys. The Brownsville survey had the highest errors, but it should be noted that the number of households surveyed in Brownsville was over 40 percent less than the number surveyed in the other four areas. Even with fewer households, the errors for Brownsville closely relate to those for Tyler and Sherman-Denison. The different retrieval method used in Tyler and Sherman-Denison may be the reason for the higher trip rate errors when compared to the errors in San Antonio and Amarillo. If the sample size in Brownsville had been comparable to San Antonio and Amarillo, it is expected that the trip rates errors would have been comparable as well.

Non-home based trip rates have much higher errors in the trip rates than those for home based work and home based non-work. The implication here may be inaccuracies in the reporting of these trips which led to high variances and, therefore, higher errors in the trip rates.

The final comparisons between the trip rates were to use the trip rates to estimate total trips in each of the other urban areas and compute the percentage difference as compared to the results from the survey. In essence, this comparison was an evaluation of the expected results if trip rates were transferred between the urban areas surveyed. For example, the trip rates (for each trip purpose) from the Amarillo survey were used to estimate the trips in San Antonio. The result was compared to the estimate based on the San Antonio travel survey and the percentage difference computed.

The results for all of the areas are shown in Tables 59 through 63. The results shown in these tables may be used with the data from Table 58 to determine if the final estimate of trips by trip purpose using trip rates transferred from another urban area would produce estimates with an expected level of accuracy comparable with the use of the trip rates from the household survey in

that area. These are discussed in the following paragraphs for each urban area.

Table 58
Estimated Trip Rate Errors by Trip Purpose

Urban Areas	Trip Type	Estimated Error in Total Trip Rate (in %)			
		HBW	HBNW	NHB	Total
San Antonio	Person	12.26	12.28	19.11	9.65
Amarillo	Person	12.41	12.39	15.92	9.41
Brownsville	Person	18.94	15.59	23.97	12.99
Tyler	Person	17.55	15.63	21.07	11.88
Sherman-Denison	Person	15.48	13.66	18.43	11.10
San Antonio	Auto Driver	13.26	15.68	19.86	11.02
Amarillo	Auto Driver	12.70	13.81	16.06	9.68
Brownsville	Auto Driver	20.89	19.61	24.15	14.57
Tyler	Auto Driver	17.47	16.37	21.36	12.15
Sherman-Denison	Auto Driver	15.87	14.91	18.23	11.36

San Antonio

If the Amarillo or Brownsville survey trip rates were used in San Antonio, the resulting estimates of home based work (HBW) and home based non-work (HBNW) person trips would be as accurate as those computed using the San Antonio survey trip rates. The same can be said for HBW auto driver trips. The resulting estimates of non-home based (NHB) person trips and total person trips would not be as accurate. The estimates of HBNW, NHB, and total auto driver trips would not be as accurate as those based on the San Antonio survey. If the Tyler trip rates were used in San Antonio, the resulting estimates would be as accurate for all of the trip purposes except total auto driver trips. The trip rates from Sherman-Denison would produce accurate estimates for only HBNW person trips, total person trips, and HBW auto driver trips.

Amarillo

If the San Antonio trip rates were used to estimate travel in Amarillo, only the estimates for HBW travel would be as accurate as those obtained using the Amarillo survey trip rates. The use of the trip rates from Brownsville would produce estimates just as accurate as the Amarillo survey for all trip purposes except HBW auto driver trips. The use of the Tyler trip rates would produce estimates just as accurate for all trip purposes except HBNW and total person trips. The Sherman-Denison trip rates would be just as accurate for all trip purposes except HBW.

Brownsville

Due to the high errors in the Brownsville trip rates (see Table 58), the trip rates for nearly all of the other urban areas would produce estimates just as accurate as those from the Brownsville survey with only a few exceptions. One of those exceptions is San Antonio. The use of the San Antonio HBNW, NHB, and total auto driver trip rates in Brownsville would produce results much less accurate than the trip rates from the Brownsville survey. The only other exception was the use of the HBNW person trip rate from Tyler.

Tyler

As in Brownsville, the Tyler trip rates had high percentage errors. For this reason, the trip rates from all but San Antonio were found to produce estimates just as accurate as those from the Tyler survey. Only the HBNW and total auto driver trip rates from San Antonio produced estimates that were less accurate than the estimates from the survey.

Sherman-Denison

The trip rates from the Sherman-Denison survey had high error ranges similar to those from the Brownsville and Tyler surveys. Again, the impact is that trip rates from the other urban areas could be used and would produce estimates just as accurate as those from the Sherman-Denison survey with a few exceptions. The most notable exception was, again, San Antonio. The San Antonio HBW person, NHB person, HBNW auto driver, NHB auto driver, and total auto driver trip rates produced less accurate estimates than the trip rates from the Sherman-Denison survey. The only other exception was the HBW trip rates from Amarillo.

Table 59
Transferred Trip Rate Impacts for San Antonio

Trip Type	Trip Purpose	Percentage Difference in Total Trip Estimates Using Trip Rates Transferred From				
		San Antonio	Amarillo	Brownsville	Tyler	Sherman-Denison
Person	HBW	NA	4.55	10.85	9.37	22.54
Person	HBNW	NA	-11.33	-12.08	0.47	- 3.50
Person	NHB	NA	-21.84	-20.65	-13.08	-20.19
Person	All	NA	-11.88	-10.95	- 2.16	- 4.89
Auto Driver	HBW	NA	- 3.14	9.14	- 0.59	11.65
Auto Driver	HBNW	NA	-21.76	-21.30	-14.71	-16.40
Auto Driver	NHB	NA	-23.44	-24.07	-17.95	-23.65
Auto Driver	All	NA	-18.08	-15.95	-12.44	-13.10

Table 60
Transferred Trip Rate Impacts for Amarillo

Trip Type	Trip Purpose	Percentage Difference in Total Trip Estimates Using Trip Rates Transferred From				
		San Antonio	Amarillo	Brownsville	Tyler	Sherman-Denison
Person	HBW	- 4.72	NA	6.22	6.52	18.11
Person	HBNW	12.51	NA	- 1.61	12.95	6.73
Person	NHB	26.13	NA	0.32	12.95	2.63
Person	All	12.78	NA	0.36	11.73	7.21
Auto Driver	HBW	2.71	NA	13.13	4.52	17.00
Auto Driver	HBNW	24.82	NA	- 0.71	7.65	4.86
Auto Driver	NHB	28.31	NA	- 1.10	9.35	1.07
Auto Driver	All	19.99	NA	2.03	7.48	6.04

Table 61
Transferred Trip Rate Impacts for Brownsville

Trip Type	Trip Purpose	Percentage Difference in Total Trip Estimates Using Trip Rates Transferred From				
		San Antonio	Amarillo	Brownsville	Tyler	Sherman-Denison
Person	HBW	- 8.90	- 5.71	NA	- 1.16	10.81
Person	HBNW	12.01	- 1.08	NA	16.38	13.62
Person	NHB	19.93	- 9.26	NA	0.92	- 8.42
Person	All	10.16	- 4.18	NA	8.84	6.17
Auto Driver	HBW	- 5.67	-11.60	NA	-10.05	- 0.54
Auto Driver	HBNW	30.15	- 5.45	NA	11.77	6.59
Auto Driver	NHB	30.37	- 5.17	NA	0.91	- 7.99
Auto Driver	All	21.03	-6.67	NA	3.24	0.12

Table 62
Transferred Trip Rate Impacts for Tyler

Trip Type	Trip Purpose	Percentage Difference in Total Trip Estimates Using Trip Rates Transferred From				
		San Antonio	Amarillo	Brownsville	Tyler	Sherman-Denison
Person	HBW	-10.01	- 5.28	0.90	NA	12.44
Person	HBNW	- 0.39	-11.24	-12.59	NA	- 4.88
Person	NHB	12.80	-10.92	- 9.96	NA	- 7.91
Person	All	1.36	-10.07	- 9.45	NA	- 3.08
Auto Driver	HBW	- 0.88	- 3.28	9.52	NA	13.47
Auto Driver	HBNW	16.61	- 6.83	- 6.70	NA	- 2.10
Auto Driver	NHB	18.79	- 8.02	- 8.11	NA	- 6.58
Auto Driver	All	12.59	- 6.43	- 3.82	NA	- 0.46

Table 63
Transferred Trip Rate Impacts for Sherman-Denison

Trip Type	Trip Purpose	Percentage Difference in Total Trip Estimates Using Trip Rates Transferred From				
		San Antonio	Amarillo	Brownsville	Tyler	Sherman-Denison
Person	HBW	-20.43	-16.77	-11.09	-11.27	NA
Person	HBNW	5.35	- 6.40	- 7.30	6.48	NA
Person	NHB	23.17	- 3.10	- 1.11	9.95	NA
Person	All	5.01	- 7.19	- 5.96	4.24	NA
Auto Driver	HBW	-12.93	-15.91	- 4.25	-12.40	NA
Auto Driver	HBNW	19.06	- 5.33	- 4.38	2.79	NA
Auto Driver	NHB	27.66	- 1.74	- 0.79	8.13	NA
Auto Driver	All	13.23	- 6.53	- 3.10	0.98	NA

Sampling Bias

In nearly any sampling experiment, there is a potential for bias. In the case of household surveys, several areas of bias are known and assumed to have little or no impact on the survey results. For example, the sampled households were selected through a random telephone solicitation procedure. Households with no phones had no opportunity to be selected and the survey is biased in that it does not include households with no phone service. The assumption in this case is that these households have the same travel characteristics of those with phone service. There are other situations where the survey may be biased and the impact on the results are significant. For example, the persons in the sampled households may or may not be representative of the urban area being surveyed. The households are stratified and the expansion factor used to expand the survey data is computed based on the census estimate of the distribution of households. The expansion factor is not biased for that reason. The persons in the expanded households, however, may or may not represent the same distribution as that observed in the census by age or sex. Since the survey collected data on each person in the household, it was possible to compare the resulting distributions of persons by age and sex with the distributions observed in the 1990 census. For example, Figures

1 and 2 present a comparison between the distribution of males and females observed in the surveyed households (expanded) and that reported in the 1990 census for the San Antonio study area. As may be seen, the expanded survey distribution closely tracks the 1990 census distribution. A review of those results did reveal some underreporting and some overreporting in the survey. It was necessary to adjust for these areas of under- and overreporting since the trip rates for each age group and sex did vary. Similar figures for the other four urban areas are presented in Appendix D.

Average person and auto driver trips per person and trip rate variances were computed for each age group by sex. Figures 3 through 10 present plots of the average person and auto driver trips per person for each trip purpose for the San Antonio 1990 household survey. Similar figures are presented in Appendix D for each of the other four urban areas surveyed. Since the observed expanded distributions of persons by age group and sex differed from the census, the computed average trips per person for each age group and sex were multiplied by the number of persons estimated to fall in each group from the census. The results were totaled to develop estimates of the total trips by trip purpose. These totals were then divided by the expanded survey trip totals to compute an adjustment factor. The raw survey trip rates were multiplied by this adjustment factor. Table 59 presented the adjustment factors as computed for each trip purpose in each urban area. All of the adjustment factors were greater than 1. The implication is that the bias in the raw trip rates due to the sample distribution of persons by age and sex would have produced fewer trips than what should have been expected. Tables 64 through 69 present the adjusted trip rates for each urban area.

Figure 1
Distribution of Males by Age Group
Census vs Expanded Survey

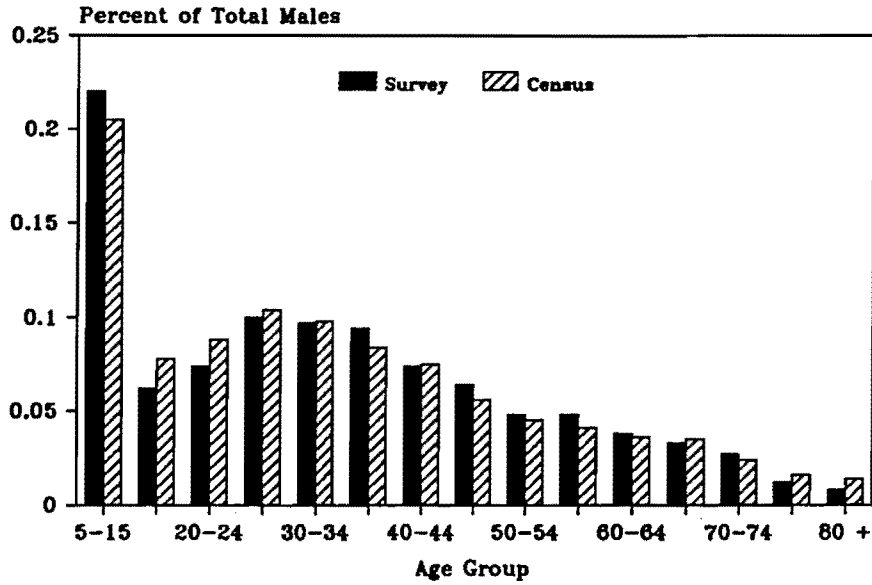


Figure 2
Distribution of Females by Age Group
Census vs Expanded Survey

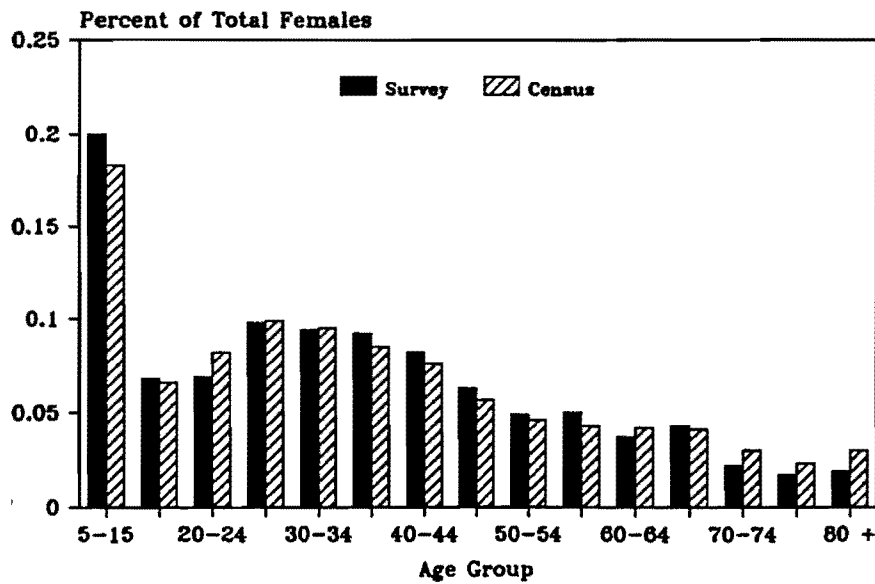


Figure 3
Home Based Work
Person Trips Per Person

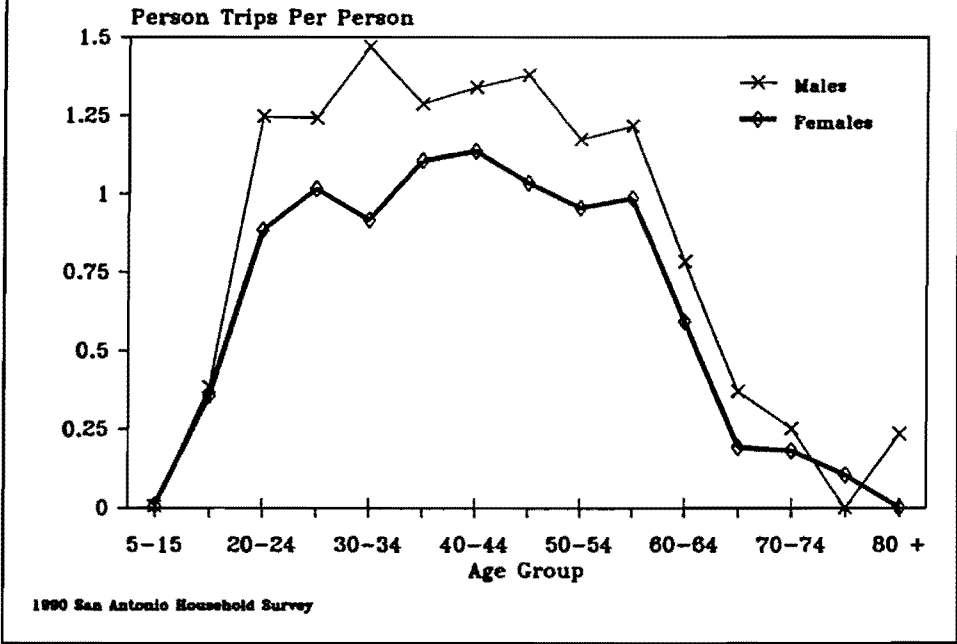


Figure 4
Home Based Non-Work
Person Trips Per Person

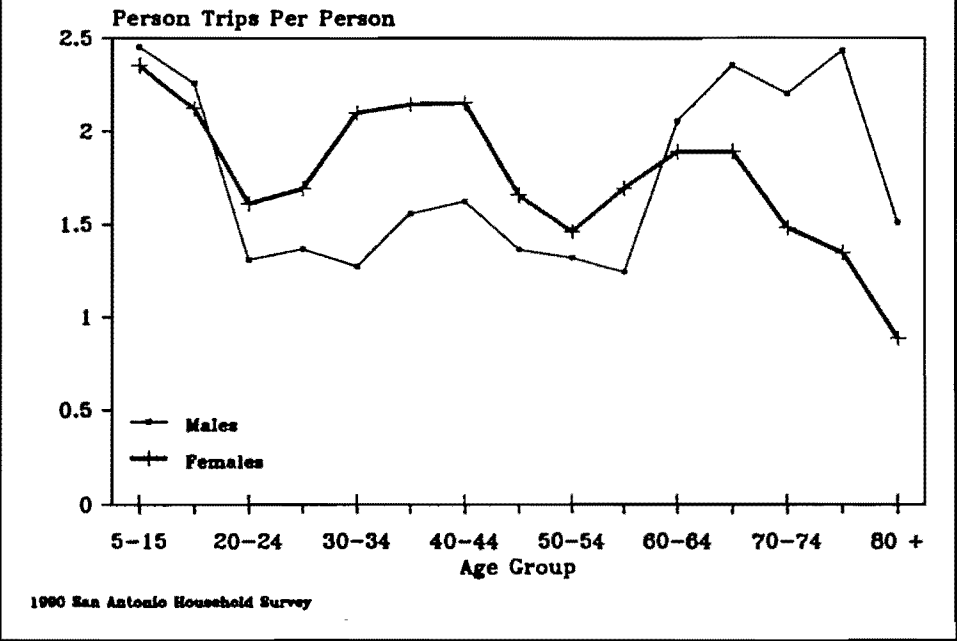


Figure 5
Non-Home Based
Person Trips Per Person

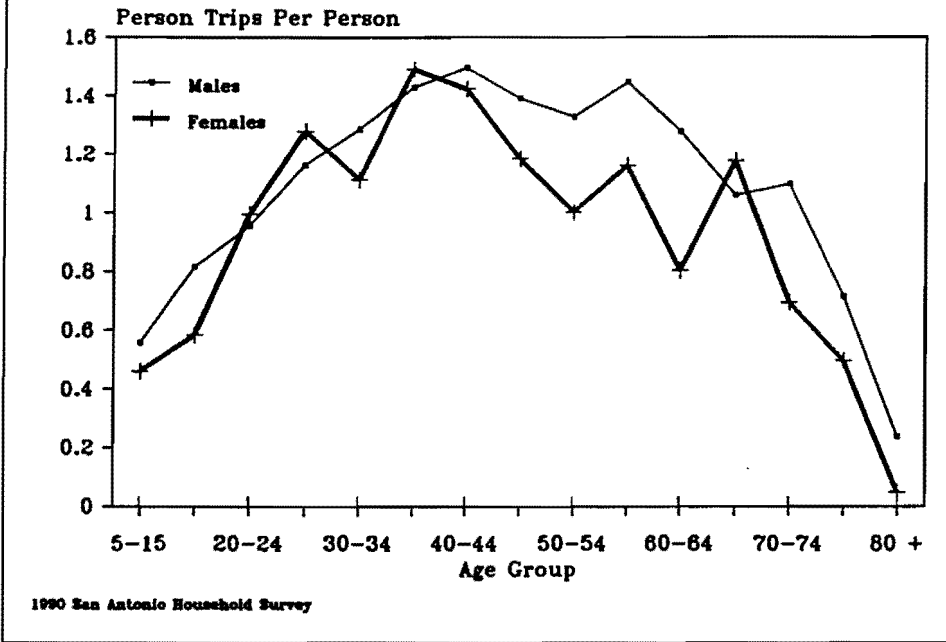


Figure 6
All Purposes Combined
Person Trips Per Person

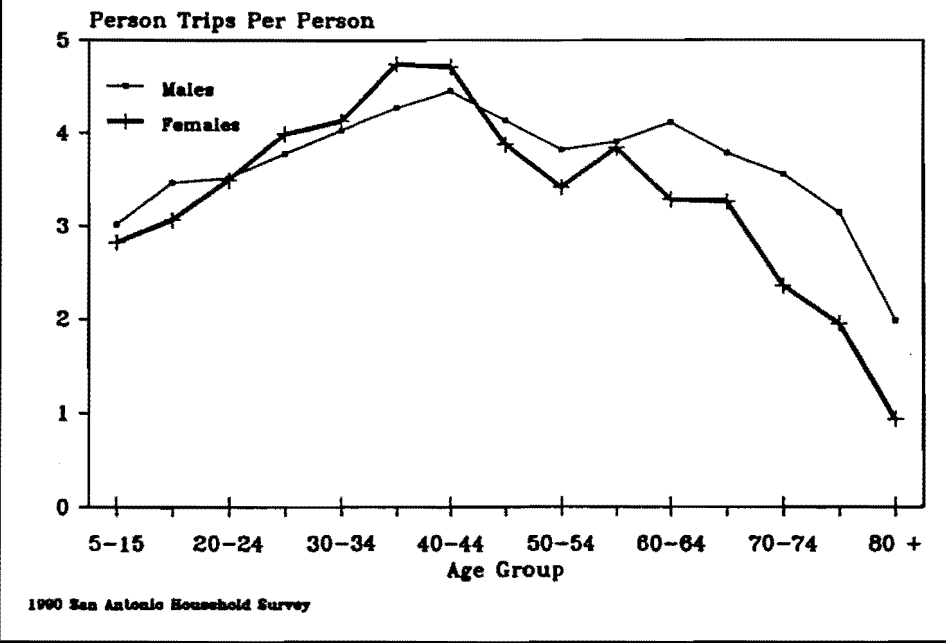


Figure 7
Home Based Work
Auto Driver Trips Per Person

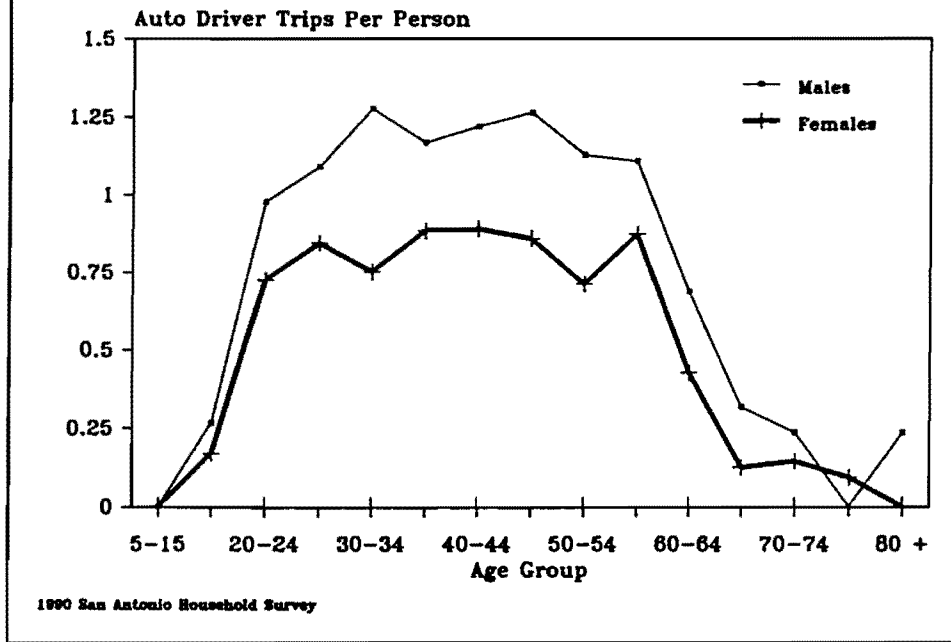


Figure 8
Home Based Non-Work
Auto Driver Trips Per Person

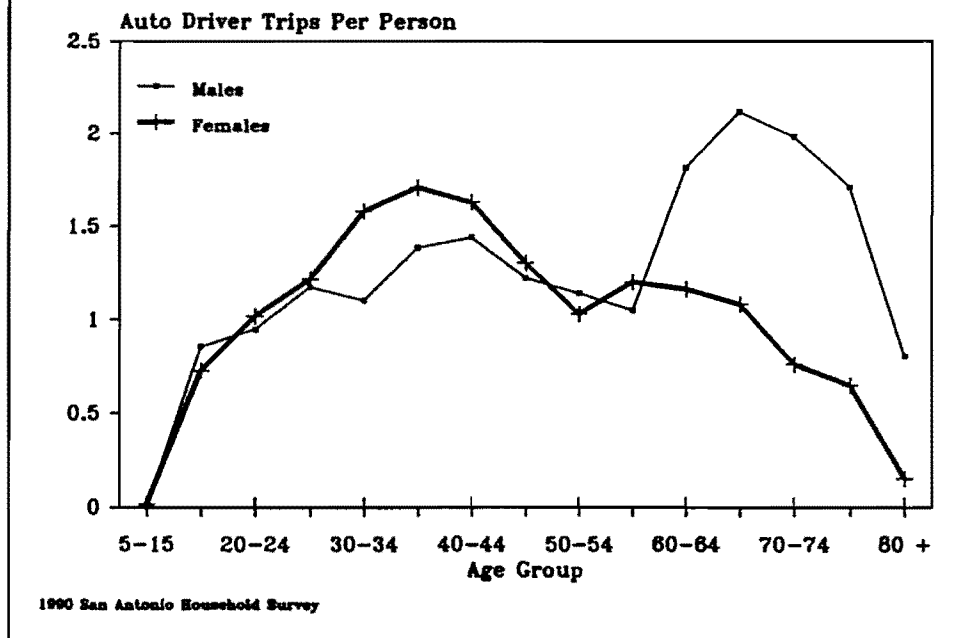


Figure 9
Non-Home Based
Auto Driver Trips Per Person

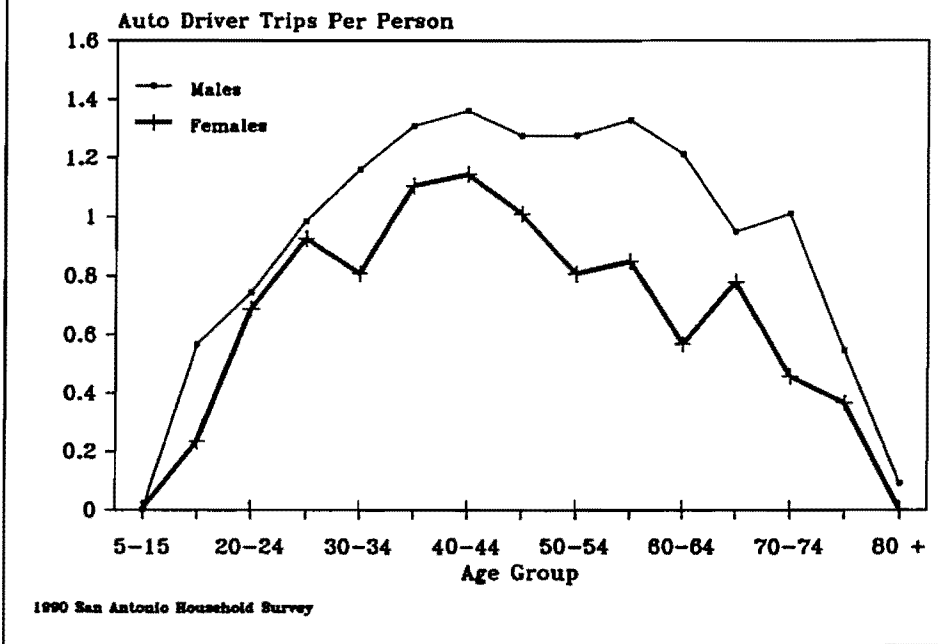
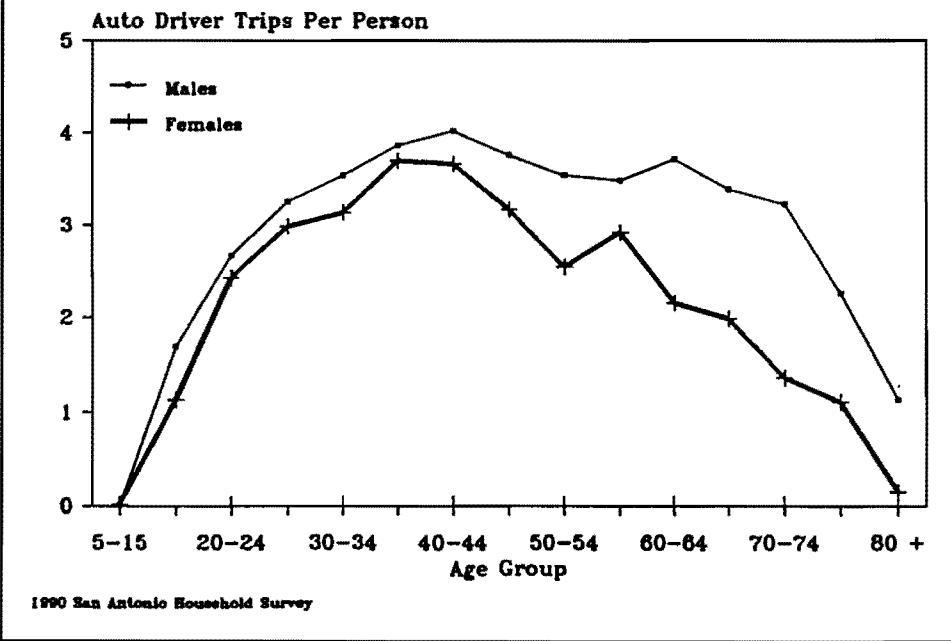


Figure 10
All Purposes Combined
Auto Driver Trips Per Person



**Table 64
Trip Rate Adjustment Factors**

Urban Area	Trip Type	Trip Rate Adjustment Factor		
		HBW	HBNW	NHB
San Antonio	Person	1.0345	1.0277	1.0256
Amarillo	Person	1.0223	1.0133	1.0137
Brownsville	Person	1.0765	1.0825	1.0858
Tyler	Person	1.0666	1.0332	1.0390
Sherman-Denison	Person	1.0562	1.0200	1.0858
San Antonio	Auto Driver	1.0323	1.0402	1.0309
Amarillo	Auto Driver	1.0224	1.0269	1.0190
Brownsville	Auto Driver	1.0742	1.0812	1.0821
Tyler	Auto Driver	1.0671	1.0201	1.0362
Sherman-Denison	Auto Driver	1.0541	1.0246	1.0821

Table 65
Corrected Survey Trip Production Rates by Trip Purpose
1990 San Antonio-Bexar County Household Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.192	0.525	0.802	1.498	1.317	0.056	0.324	0.594	0.569	0.845
\$ 5,000 - \$ 9,999	0.470	1.076	1.439	1.596	1.794	0.295	0.614	0.786	0.619	1.096
\$ 10,000 - \$ 19,999	1.118	1.336	2.081	1.954	2.453	0.927	0.975	1.592	1.351	1.603
\$ 20,000 - \$ 34,999	1.132	1.949	2.561	2.782	2.239	0.979	1.599	2.192	2.472	1.713
\$ 35,000 Plus	1.258	2.439	2.926	3.145	3.547	1.255	2.307	2.737	2.878	3.097

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.362	2.255	5.653	6.238	7.817	0.419	0.901	1.664	1.184	1.828
\$ 5,000 - \$ 9,999	1.695	2.639	4.357	5.549	9.186	0.973	1.490	1.470	2.110	2.654
\$ 10,000 - \$ 19,999	1.725	3.811	5.015	7.587	10.208	1.450	2.528	2.281	3.056	3.319
\$ 20,000 - \$ 34,999	1.880	3.499	4.894	6.797	10.700	1.716	2.658	2.780	3.435	4.553
\$ 35,000 Plus	1.793	2.901	4.494	7.909	11.417	1.693	2.367	3.238	4.306	4.938

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.405	0.643	1.077	1.238	0.932	0.200	0.400	0.387	0.462	0.437
\$ 5,000 - \$ 9,999	1.465	0.998	0.780	1.641	2.156	1.111	0.655	0.336	0.884	0.841
\$ 10,000 - \$ 19,999	1.602	2.194	2.793	3.710	3.497	1.430	1.468	1.515	1.896	2.072
\$ 20,000 - \$ 34,999	1.727	2.419	2.404	3.068	4.247	1.471	1.960	1.893	2.114	2.377
\$ 35,000 Plus	1.810	3.140	3.605	4.225	4.880	1.678	2.779	2.959	3.216	2.900

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.959	3.423	7.532	8.974	10.066	0.675	1.625	2.645	2.215	3.110
\$ 5,000 - \$ 9,999	3.630	4.713	6.576	8.786	13.136	2.379	2.759	2.592	23.613	4.591
\$ 10,000 - \$ 19,999	4.445	7.341	9.889	13.251	16.158	3.807	4.971	5.388	6.303	6.994
\$ 20,000 - \$ 34,999	4.739	7.867	9.859	12.647	17.186	4.166	6.217	6.865	8.021	8.643
\$ 35,000 Plus	4.861	8.480	11.025	15.279	19.844	4.626	7.453	8.934	10.400	10.935

Table 66
Corrected Survey Trip Production Rates by Trip Purpose
1990 Amarillo Household Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.325	0.730	0.804	0.819	1.023	0.186	0.402	0.657	0.408	0.767
\$ 5,000 - \$ 9,999	0.424	1.060	1.314	1.363	1.731	0.377	0.871	1.022	1.294	1.337
\$ 10,000 - \$ 19,999	0.731	1.217	1.879	2.242	1.895	0.703	1.127	1.572	1.927	1.143
\$ 20,000 - \$ 34,999	1.241	1.670	2.339	2.576	3.173	1.163	1.551	2.122	2.315	2.806
\$ 35,000 Plus	1.205	2.318	2.800	2.913	3.299	1.114	2.225	2.739	2.755	3.077

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.919	2.859	5.139	8.917	10.513	1.323	1.577	2.420	6.161	3.595
\$ 5,000 - \$ 9,999	1.671	3.866	4.958	8.580	11.380	1.432	2.453	2.604	4.791	5.134
\$ 10,000 - \$ 19,999	2.015	3.405	4.661	6.626	10.639	1.813	2.389	2.606	3.752	5.225
\$ 20,000 - \$ 34,999	1.671	3.512	4.959	7.926	12.316	1.513	2.741	3.325	3.925	5.569
\$ 35,000 Plus	2.189	3.788	5.418	8.995	12.283	2.072	3.104	3.896	5.055	6.268

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.768	1.484	2.607	0.405	2.409	0.633	1.056	1.383	0.000	1.528
\$ 5,000 - \$ 9,999	1.040	2.065	2.824	4.123	2.182	0.956	1.510	2.075	2.377	0.939
\$ 10,000 - \$ 19,999	1.733	2.517	2.522	3.178	4.889	1.668	1.858	1.503	2.097	2.817
\$ 20,000 - \$ 34,999	1.656	3.259	3.599	3.788	5.614	1.501	2.735	2.777	2.346	3.279
\$ 35,000 Plus	2.299	3.411	4.197	6.105	7.078	2.147	2.967	3.559	4.239	4.599

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	3.012	5.073	8.550	10.141	13.945	2.142	3.035	4.460	6.569	5.890
\$ 5,000 - \$ 9,999	3.135	6.991	9.096	14.066	15.293	2.765	4.834	5.701	8.462	7.410
\$ 10,000 - \$ 19,999	4.479	7.139	9.062	12.046	17.423	4.184	5.374	5.681	7.776	9.185
\$ 20,000 - \$ 34,999	4.568	8.441	10.897	14.290	21.103	4.177	7.027	8.224	8.586	11.654
\$ 35,000 Plus	5.693	9.517	12.415	18.013	22.660	5.333	8.296	10.194	12.049	13.944

Table 67
Corrected Survey Trip Production Rates by Trip Purpose
1991 Brownsville Household Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.157	0.247	0.946	0.917	1.077	0.112	0.194	0.481	0.358	0.659
\$ 5,000 - \$ 9,999	0.571	0.880	1.570	1.305	1.665	0.437	0.555	1.020	1.010	1.075
\$ 10,000 - \$ 19,999	0.589	1.183	1.625	1.968	1.888	0.588	0.938	1.329	1.278	1.367
\$ 20,000 - \$ 34,999	1.168	1.375	2.076	2.723	3.502	1.093	1.149	1.657	2.506	2.678
\$ 35,000 Plus	0.849	2.289	2.692	3.660	3.370	0.848	2.043	2.409	3.287	3.200

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.376	3.496	5.729	7.137	10.616	0.518	1.613	2.721	3.004	3.104
\$ 5,000 - \$ 9,999	1.861	3.392	4.807	8.201	10.682	1.149	2.054	2.437	4.588	4.692
\$ 10,000 - \$ 19,999	2.243	3.949	4.567	9.294	11.964	2.189	2.467	2.654	4.586	4.760
\$ 20,000 - \$ 34,999	2.532	4.736	5.521	7.195	12.101	2.309	3.439	3.986	3.265	5.794
\$ 35,000 Plus	3.303	4.284	6.134	9.137	12.472	3.186	3.381	4.358	5.126	6.018

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.429	0.997	1.741	1.165	1.681	0.248	0.674	0.951	0.520	0.785
\$ 5,000 - \$ 9,999	0.576	1.303	2.467	3.158	1.967	0.338	0.938	1.356	2.130	1.225
\$ 10,000 - \$ 19,999	1.783	2.937	2.231	3.313	2.961	1.777	2.088	1.555	1.772	1.869
\$ 20,000 - \$ 34,999	2.098	2.549	3.366	4.280	5.850	1.963	2.014	2.551	3.119	4.021
\$ 35,000 Plus	2.229	5.613	5.018	5.972	7.247	2.221	4.633	3.853	4.350	4.963

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.962	4.740	8.416	9.219	13.374	0.878	2.481	4.153	3.882	4.548
\$ 5,000 - \$ 9,999	3.008	5.575	8.844	12.664	14.314	1.924	3.547	4.813	7.728	6.992
\$ 10,000 - \$ 19,999	4.615	8.069	8.423	14.575	16.813	4.554	5.493	5.538	7.636	7.996
\$ 20,000 - \$ 34,999	5.798	8.660	10.963	14.198	21.453	5.365	6.602	8.194	8.890	12.493
\$ 35,000 Plus	6.381	12.186	13.844	18.769	23.089	6.255	10.057	10.620	12.763	14.181

Table 68
Corrected Survey Trip Production Rates by Trip Purpose
1991 Tyler Household Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.178	0.682	1.066	2.132	0.799	0.168	0.641	0.710	1.069	0.799
\$ 5,000 - \$ 9,999	0.399	0.471	1.403	1.600	1.540	0.389	0.397	1.179	1.245	0.712
\$ 10,000 - \$ 19,999	0.595	1.060	1.501	2.091	2.133	0.534	1.010	1.501	1.835	1.632
\$ 20,000 - \$ 34,999	1.112	1.490	2.452	2.717	2.590	1.076	1.423	2.379	2.592	2.338
\$ 35,000 Plus	0.898	1.997	3.107	3.277	4.136	0.898	1.922	2.908	3.010	4.029

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.100	2.645	3.874	6.200	7.490	0.680	1.591	2.295	3.061	2.295
\$ 5,000 - \$ 9,999	1.361	1.658	4.513	11.537	7.348	1.144	1.186	2.793	3.570	2.267
\$ 10,000 - \$ 19,999	1.902	3.183	4.391	6.240	9.177	1.611	2.369	2.869	3.468	3.720
\$ 20,000 - \$ 34,999	1.704	3.411	4.109	7.010	9.446	1.578	2.799	2.931	3.692	3.813
\$ 35,000 Plus	2.012	3.605	5.041	8.464	12.229	1.772	3.125	3.820	4.796	6.703

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.520	1.163	1.991	1.557	1.559	0.355	0.787	1.642	0.519	1.037
\$ 5,000 - \$ 9,999	0.942	0.967	2.462	4.330	3.002	0.668	0.868	1.908	3.801	1.496
\$ 10,000 - \$ 19,999	1.295	1.988	2.857	2.702	4.706	1.171	1.488	2.234	2.196	2.682
\$ 20,000 - \$ 34,999	2.016	2.429	3.320	4.502	4.378	1.807	1.893	2.727	3.232	2.270
\$ 35,000 Plus	1.805	2.970	3.898	5.677	7.655	1.717	2.701	3.289	4.234	5.266

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.798	4.490	6.931	9.889	9.848	1.203	4.222	4.647	4.649	4.131
\$ 5,000 - \$ 9,999	2.702	3.096	8.378	17.467	11.890	2.201	2.451	5.880	8.616	4.475
\$ 10,000 - \$ 19,999	3.792	6.231	8.749	11.033	16.016	3.316	4.867	6.604	7.499	8.034
\$ 20,000 - \$ 34,999	4.832	7.330	9.881	14.229	16.414	4.461	6.115	8.037	9.516	8.421
\$ 35,000 Plus	4.715	8.572	12.046	17.418	24.020	4.387	7.748	10.017	12.040	15.998

Table 69
Corrected Survey Trip Production Rates by Trip Purpose
1991 Sherman-Denison Household Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.083	0.365	0.776	0.000	0.355	0.068	0.182	0.633	0.000	0.355
\$ 5,000 - \$ 9,999	0.131	0.346	0.963	2.243	3.169	0.131	0.214	0.826	1.448	3.163
\$ 10,000 - \$ 19,999	0.625	0.746	1.040	2.329	1.606	0.609	0.634	0.774	2.026	1.308
\$ 20,000 - \$ 34,999	1.049	1.129	2.256	2.761	2.743	1.010	1.043	2.043	2.507	2.499
\$ 35,000 Plus	1.217	2.056	2.964	2.886	2.600	1.108	1.968	2.881	2.662	2.513

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.867	2.814	6.460	4.589	3.735	0.263	1.979	3.757	2.563	1.710
\$ 5,000 - \$ 9,999	1.445	2.725	3.679	9.308	4.588	1.080	1.953	2.227	3.715	3.074
\$ 10,000 - \$ 19,999	1.998	3.653	4.972	7.062	10.404	1.784	2.692	3.010	4.178	4.550
\$ 20,000 - \$ 34,999	1.896	4.273	5.005	7.124	10.397	1.790	3.209	3.200	3.990	4.231
\$ 35,000 Plus	2.039	3.000	5.545	8.843	10.771	1.824	2.512	4.186	4.911	5.259

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	0.299	1.689	4.624	1.786	1.360	0.197	1.092	3.336	1.277	1.361
\$ 5,000 - \$ 9,999	0.767	1.594	1.418	5.612	0.000	0.580	1.165	0.887	4.213	0.000
\$ 10,000 - \$ 19,999	1.534	1.960	2.662	4.290	5.796	1.445	1.535	1.531	3.089	3.390
\$ 20,000 - \$ 34,999	1.732	3.158	3.483	4.244	5.809	1.560	2.515	2.672	2.940	3.508
\$ 35,000 Plus	1.884	3.604	4.236	5.763	5.943	1.696	3.074	3.614	4.273	4.096

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4,999	1.249	4.868	11.860	6.375	5.450	0.911	3.326	5.277	6.776	2.065
\$ 5,000 - \$ 9,999	2.343	4.665	6.060	17.163	7.757	2.656	3.702	4.584	8.252	9.627
\$ 10,000 - \$ 19,999	4.157	6.359	8.674	13.681	17.806	3.953	5.841	6.456	9.144	9.366
\$ 20,000 - \$ 34,999	4.677	8.560	10.744	14.129	18.949	4.496	7.326	8.857	10.770	10.826
\$ 35,000 Plus	5.140	8.660	12.745	17.492	19.314	3.129	5.572	10.403	8.850	9.133

One area of concern and interest was that of households and persons reporting no travel during the survey day. Review of some of the hard copy survey forms for households reporting no travel had raised some questions relative to whether the household actually made no trips or was really a late refusal to participate. The impact of zero trips on the resulting average trip rates when expanded from a small sample survey can be significant. Table 33 presented the percentage of households found in each survey that reported no trips. As may be seen, these percentages were significant, and the resulting trip rates may be low as a result.

While those households reporting zero trips were significant, it was also possible that certain individuals within households may have refused to participate. This could lead to some households reporting only partial trip information for the household. These are extremely difficult to identify and their impact is to lower the resulting household trip rates. To view the potential impact, the number and percentage of persons by sex and age group reporting zero trips individually were computed. Figures 11 through 14 present the resulting percentages of persons reporting zero trips (both person trips and auto driver trips) by sex and age group for the San Antonio survey. Similar figures are presented in Appendix D for the other four urban areas surveyed. As will be noted, significant percentages of persons were observed in certain age groups making no trips. A number of explanations may be offered for the variations in the data for specific trip purposes. For purposes of identifying potential areas where late refusals may be a problem, the data in Figure 14 (for San Antonio) reflect the percentage of persons reporting absolutely no travel at all (including walk trips) during their survey day. As would be expected, these percentages show significant increases for persons over 65 years of age. The inconsistency in the data for females may indicate some areas where trips were missed. Unfortunately, no statistically valid means exist at present for correcting for possible errors. It was noted that, in future surveys, more emphasis should be placed on the monitoring and identification of both zero trip households and persons to delineate those that are actually refusals.

Figure 11
 Percentage of Persons in Each Age Group
 Recording Zero Home Based Work Trips

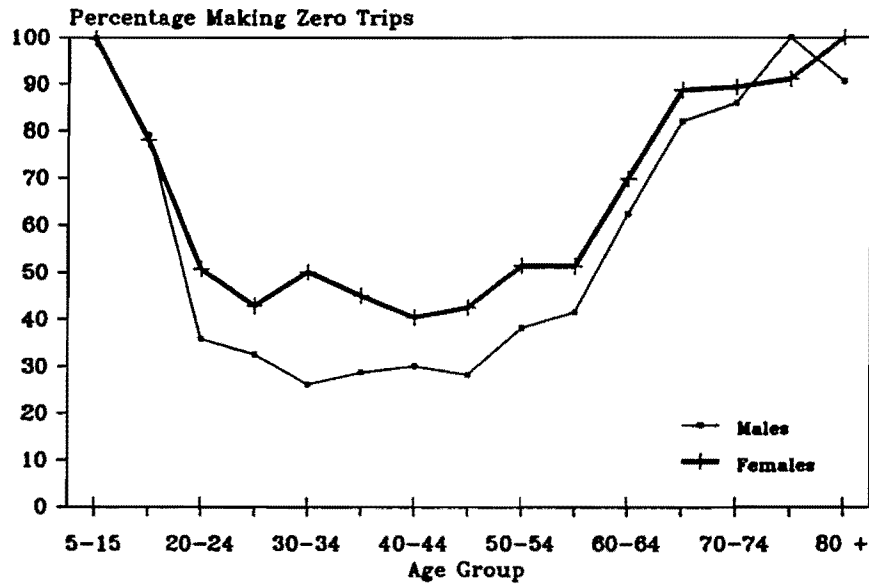


Figure 12
 Percentage of Persons in Each Age Group
 Recording Zero Home Based Non-Work Trips

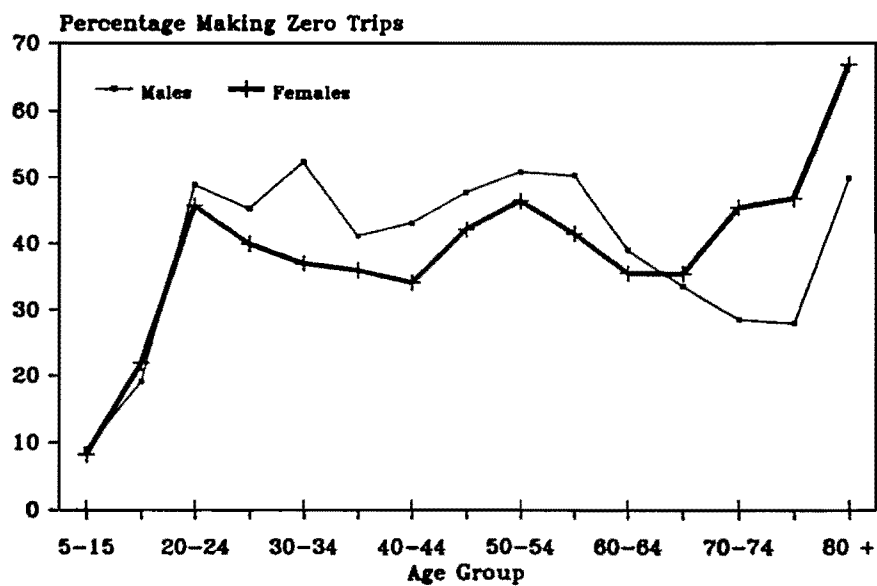
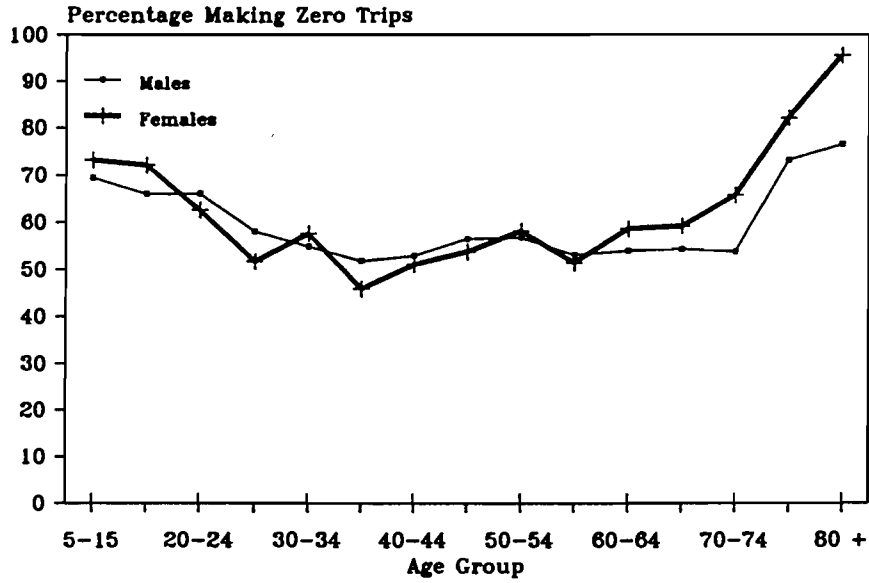
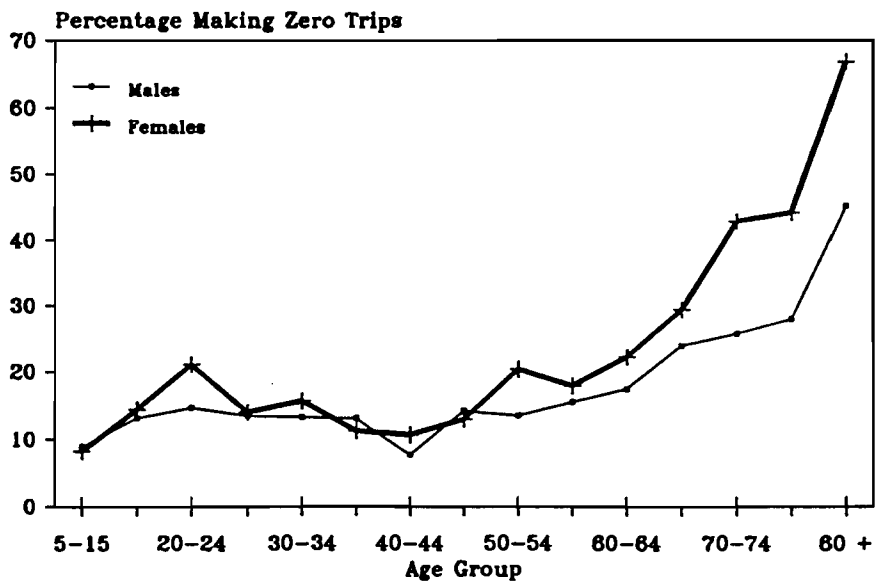


Figure 13
Percentage of Persons in Each Age Group
Recording Zero Non-Home Based Trips



1990 San Antonio Household Survey

Figure 14
Percentage of Persons in Each Age Group
Recording Zero Trips - All Purposes



1990 San Antonio Household Survey

Smoothing Household Trip Rates

As with any sampling procedure where the results are post stratified, a risk occurs that some of the stratification cells will have very limited observations and the results are subject to high variations. This was observed in several of the surveys. Given that there is always some variation in sampling, the decision was made to develop a method for both smoothing the adjusted raw survey trip rates and to fill the voids in the data where few or no observed households or trips were found. This methodology is described in Appendix E. Smoothing the trip rates was constrained to ensure that the final smoothed rates would still yield the same results as the travel survey adjusted raw trip rates.

Modifying Household Trip Rates

As mentioned earlier, the review of the household travel characteristics in terms of individuals stratified by age cohorts had shown fairly high percentages of individuals reporting no trips. This was disturbing since some of these percentages were in ages felt to be high activity and travel age groups. For example, the data in Figure 14 indicate that over 13 percent of males and females in the age group 20 to 24 made zero trips. Review of the data from the five urban areas surveyed in 1990 and 1991 found similar patterns in terms of the percentages of persons reporting zero trips by age cohort. Since those five were done, surveys have been undertaken in Beaumont-Port Arthur, El Paso, and the Houston-Galveston region. Since improved procedures had been implemented in those surveys, it was felt that some of the problem of individuals reporting zero trips may have been addressed and corrected. That review found significant differences in the number of individuals reporting zero trips by age cohort. An analysis of the combined data for zero trip persons by age cohort for the surveys in Beaumont-Port Arthur (1993), El Paso (1994), and Houston-Galveston (1995) resulted in an estimate of the percentage of persons that would be expected to have no outside the home trips or activities by age cohort. The results of that analysis were then used to adjust the expanded survey data from the surveys done in 1990 and 1991 and produce modified smoothed table rates for travel demand modeling in those areas. These trip rates are presented in Tables 70 through 74. Appendix J presents a memorandum which documents the results of that analysis and the methodology used to modify the trip rates.

Table 70
Modified Smoothed Trip Production Rates by Trip Purpose
1990 San Antonio-Bexar County Household Travel Survey

Home Based Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.164	0.574	0.937	1.307	1.364	0.053	0.299	0.591	0.611	0.829
\$ 5000 - \$ 9999	0.530	1.020	1.405	1.640	1.707	0.325	0.574	0.794	0.819	0.864
\$ 10000 - \$ 19999	0.950	1.551	2.005	2.190	2.267	0.748	1.150	1.496	1.534	1.539
\$ 20000 - \$ 34999	1.219	1.901	2.399	2.535	2.622	1.052	1.594	2.045	2.106	2.113
\$ 35000 Plus	1.445	2.370	3.039	3.210	3.380	1.445	2.223	2.853	2.958	2.968

Home Based Non-Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.616	3.150	4.499	6.768	9.653	0.569	1.019	1.264	1.474	1.854
\$ 5000 - \$ 9999	1.747	3.266	4.780	7.261	10.435	0.981	1.543	1.826	2.279	2.754
\$ 10000 - \$ 19999	1.830	3.339	4.957	7.573	10.928	1.548	2.282	2.641	3.347	3.978
\$ 20000 - \$ 34999	1.902	3.403	5.113	7.846	11.359	1.766	2.664	3.097	3.995	4.737
\$ 35000 Plus	1.961	3.456	5.239	8.067	11.709	1.814	2.824	3.307	4.322	5.131

Non-Home Based

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.630	0.686	0.803	1.046	1.080	0.165	0.255	0.412	0.512	0.613
\$ 5000 - \$ 9999	1.123	1.408	1.569	1.952	2.189	0.639	0.962	1.173	1.446	1.694
\$ 10000 - \$ 19999	1.768	2.465	2.793	3.471	4.004	1.145	1.561	1.815	2.251	2.671
\$ 20000 - \$ 34999	1.978	2.515	2.841	3.525	4.108	1.513	1.932	2.142	2.642	3.097
\$ 35000 Plus	2.187	3.209	3.633	4.503	5.282	2.035	2.479	2.675	3.316	3.931

Total-All Purposes

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.410	4.410	6.239	9.121	12.097	0.787	1.573	2.267	2.597	3.296
\$ 5000 - \$ 9999	3.400	5.694	7.754	10.853	14.331	1.945	3.079	3.793	4.544	5.312
\$ 10000 - \$ 19999	4.548	7.355	9.755	13.234	17.199	3.441	4.993	5.952	7.132	8.188
\$ 20000 - \$ 34999	5.099	7.819	10.353	13.906	18.089	4.331	6.190	7.284	8.743	9.947
\$ 35000 Plus	5.593	9.035	11.911	15.780	20.317	5.294	7.526	8.835	10.596	12.030

Table 71
Modified Smoothed Trip Production Rates by Trip Purpose
1990 Amarillo Household Survey

Home Based Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.327	0.672	0.841	0.897	1.050	0.182	0.406	0.602	0.652	0.702
\$ 5000 - \$ 9999	0.490	0.960	1.268	1.370	1.590	0.420	0.799	1.085	1.132	1.264
\$ 10000 - \$ 19999	0.756	1.323	1.729	1.853	2.125	0.735	1.153	1.469	1.512	1.633
\$ 20000 - \$ 34999	1.085	1.838	2.399	2.571	2.939	1.012	1.709	2.208	2.319	2.539
\$ 35000 Plus	1.329	2.173	2.823	3.015	3.431	1.263	2.116	2.720	2.864	3.129

Home Based Non-Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.704	3.625	5.017	8.082	11.853	1.250	2.200	2.815	4.216	4.919
\$ 5000 - \$ 9999	1.879	3.702	5.194	8.409	12.172	1.558	2.498	3.115	4.426	5.374
\$ 10000 - \$ 19999	1.990	3.752	5.304	8.614	12.373	1.702	2.547	3.118	4.443	5.506
\$ 20000 - \$ 34999	2.086	3.792	5.402	8.794	12.549	1.850	2.724	3.312	4.461	5.636
\$ 35000 Plus	2.446	3.829	5.481	8.940	12.692	2.311	3.296	3.968	5.244	6.710

Non-Home Based

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.070	1.397	1.592	1.826	2.079	0.797	1.087	1.205	1.332	1.403
\$ 5000 - \$ 9999	1.309	2.031	2.362	2.848	3.558	1.107	1.510	1.649	1.824	2.017
\$ 10000 - \$ 19999	1.595	2.642	3.098	3.881	4.859	1.449	2.016	2.209	2.453	2.761
\$ 20000 - \$ 34999	1.807	3.118	3.674	4.704	5.894	1.779	2.509	2.756	3.070	3.489
\$ 35000 Plus	2.494	3.870	4.582	5.945	7.459	2.332	3.350	3.700	4.138	4.737

Total-All Purposes

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	3.101	5.694	7.450	10.805	14.982	2.229	3.693	4.622	6.200	7.024
\$ 5000 - \$ 9999	3.678	6.693	8.824	12.627	17.320	3.085	4.807	5.849	7.382	8.655
\$ 10000 - \$ 19999	4.341	7.717	10.131	14.348	19.357	3.886	5.716	6.796	8.408	9.900
\$ 20000 - \$ 34999	4.978	8.748	11.475	16.069	21.382	4.641	6.942	8.276	9.850	11.664
\$ 35000 Plus	6.269	9.872	12.886	17.900	23.582	5.906	8.762	10.388	12.246	14.576

Table 72
Modified Smoothed Trip Production Rates by Trip Purpose
1991 Brownsville Household Survey

Home Based Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.166	0.409	0.804	0.882	1.032	0.154	0.242	0.408	0.496	0.513
\$ 5000 - \$ 9999	0.523	0.892	1.313	1.574	1.699	0.407	0.621	0.855	1.050	1.112
\$ 10000 - \$ 19999	0.633	1.090	1.534	1.891	2.015	0.551	0.836	1.129	1.407	1.472
\$ 20000 - \$ 34999	0.964	1.694	2.332	2.919	3.097	0.901	1.405	1.894	2.382	2.488
\$ 35000 Plus	1.169	2.040	2.766	3.487	3.683	1.168	1.871	2.522	3.189	3.328

Home Based Non-Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.562	3.752	5.462	8.869	12.747	0.589	1.688	2.431	3.491	3.802
\$ 5000 - \$ 9999	1.990	4.196	5.746	9.137	12.935	1.307	2.415	3.244	4.341	5.133
\$ 10000 - \$ 19999	2.997	4.476	5.924	9.306	13.054	2.184	2.868	3.526	4.456	5.344
\$ 20000 - \$ 34999	3.878	4.721	6.080	9.455	13.157	2.850	3.414	4.071	4.996	6.117
\$ 35000 Plus	4.594	4.921	6.207	9.574	13.241	3.460	3.924	4.577	5.495	6.801

Non-Home Based

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.555	1.114	1.532	1.714	1.738	0.183	0.376	0.467	0.549	0.633
\$ 5000 - \$ 9999	0.907	1.790	1.963	2.387	2.664	0.907	1.360	1.414	1.604	1.757
\$ 10000 - \$ 19999	1.590	2.752	2.789	3.387	3.787	1.540	2.175	2.215	2.480	2.683
\$ 20000 - \$ 34999	2.318	3.849	3.941	4.902	5.607	2.164	3.076	3.173	3.553	3.854
\$ 35000 Plus	3.026	5.652	5.696	7.078	8.106	2.954	4.119	4.278	4.762	5.157

Total-All Purposes

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.283	5.275	7.798	11.465	15.517	0.926	2.306	3.306	4.536	4.948
\$ 5000 - \$ 9999	3.420	6.878	9.022	13.098	17.298	2.621	4.396	5.513	6.995	8.002
\$ 10000 - \$ 19999	5.220	8.318	10.247	14.584	18.856	4.275	5.879	6.870	8.343	9.499
\$ 20000 - \$ 34999	7.160	10.264	12.353	17.276	21.861	5.915	7.895	9.138	10.931	12.459
\$ 35000 Plus	8.789	12.613	14.669	20.139	25.030	7.582	9.914	11.377	13.446	15.286

Table 73
Modified Smoothed Trip Production Rates by Trip Purpose
1991 Tyler Household Survey

Home Based Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.247	0.576	0.978	1.228	1.323	0.283	0.436	0.654	0.729	0.799
\$ 5000 - \$ 9999	0.387	0.718	1.162	1.347	1.451	0.351	0.571	0.880	0.944	1.035
\$ 10000 - \$ 19999	0.616	1.062	1.688	1.905	2.106	0.579	0.974	1.516	1.618	1.820
\$ 20000 - \$ 34999	0.951	1.534	2.340	2.658	2.975	0.904	1.493	2.314	2.455	2.785
\$ 35000 Plus	1.165	1.962	3.091	3.421	3.881	1.074	1.891	2.976	3.172	3.641

Home Based Non-Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.296	2.736	3.989	7.026	8.494	0.985	1.563	1.945	2.437	2.656
\$ 5000 - \$ 9999	1.443	3.127	4.455	7.684	9.847	1.168	1.877	2.271	2.834	3.279
\$ 10000 - \$ 19999	1.983	3.379	4.674	7.897	10.348	1.625	2.608	3.116	3.876	4.588
\$ 20000 - \$ 34999	2.090	3.448	4.708	7.944	10.664	1.736	2.807	3.333	4.143	4.981
\$ 35000 Plus	2.198	4.098	5.594	9.374	12.805	2.108	3.597	4.308	5.385	6.570

Non-Home Based

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.791	0.971	1.361	1.719	1.967	0.522	0.707	1.062	1.187	1.245
\$ 5000 - \$ 9999	1.092	1.579	2.204	2.934	3.585	0.877	1.212	1.703	2.034	2.133
\$ 10000 - \$ 19999	1.463	2.114	2.918	3.921	4.852	1.265	1.673	2.281	2.747	2.896
\$ 20000 - \$ 34999	1.875	2.641	3.597	4.850	6.032	1.670	2.124	2.837	3.423	3.613
\$ 35000 Plus	2.155	3.310	4.571	6.231	7.829	2.151	2.902	3.922	4.796	5.125

Total-All Purposes

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.334	4.283	6.328	9.973	11.784	1.750	2.706	3.661	4.353	4.700
\$ 5000 - \$ 9999	2.922	5.424	7.821	11.965	14.883	2.396	3.660	4.854	5.812	6.447
\$ 10000 - \$ 19999	4.062	6.555	9.280	13.723	17.306	3.469	5.255	6.913	8.241	9.304
\$ 20000 - \$ 34999	4.916	7.623	10.645	15.452	19.671	4.310	6.424	8.484	10.021	11.379
\$ 35000 Plus	5.518	9.370	13.256	19.026	24.515	5.333	8.390	11.206	13.353	15.336

Table 74
Modified Smoothed Trip Production Rates by Trip Purpose
1991 Sherman-Denison Household Survey

Home Based Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.076	0.300	0.559	0.727	0.831	0.066	0.189	0.441	0.640	0.802
\$ 5000 - \$ 9999	0.259	0.691	1.128	1.367	1.448	0.185	0.446	0.845	1.026	1.098
\$ 10000 - \$ 19999	0.549	1.002	1.532	1.802	1.852	0.495	0.692	1.190	1.366	1.376
\$ 20000 - \$ 34999	0.870	1.449	2.123	2.465	2.538	0.928	1.215	2.033	2.284	2.300
\$ 35000 Plus	1.527	1.820	2.583	2.963	3.033	1.390	1.661	2.698	2.974	2.995

Home Based Non-Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.284	2.862	3.677	4.716	5.607	0.739	1.618	2.259	2.489	2.509
\$ 5000 - \$ 9999	1.531	3.373	4.969	6.575	8.025	1.152	2.225	2.996	3.507	3.535
\$ 10000 - \$ 19999	1.697	3.810	6.253	8.331	10.262	1.690	2.999	3.936	4.711	4.851
\$ 20000 - \$ 34999	1.809	4.123	6.528	8.822	10.955	1.878	3.115	4.002	4.857	5.057
\$ 35000 Plus	1.898	4.397	6.625	9.072	11.342	1.898	3.288	4.265	5.283	5.603

Non-Home Based

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.736	1.474	2.290	2.495	2.525	0.428	1.109	1.787	2.034	2.086
\$ 5000 - \$ 9999	0.868	1.980	2.731	3.467	3.863	0.692	1.450	1.971	2.412	2.474
\$ 10000 - \$ 19999	1.292	2.628	3.390	4.464	5.086	1.189	1.977	2.422	2.990	3.056
\$ 20000 - \$ 34999	1.801	3.269	3.993	5.364	6.171	1.717	2.592	2.989	3.717	3.803
\$ 35000 Plus	2.466	3.848	4.587	6.265	7.280	2.229	3.337	3.766	4.729	4.875

Total-All Purposes

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.096	4.636	6.526	7.938	8.963	1.233	2.915	4.487	5.163	5.397
\$ 5000 - \$ 9999	2.658	6.045	8.828	11.409	13.336	2.028	4.121	5.813	6.944	7.106
\$ 10000 - \$ 19999	3.538	7.441	11.175	14.597	17.200	3.374	5.668	7.548	9.067	9.283
\$ 20000 - \$ 34999	4.480	8.841	12.643	16.651	19.664	4.523	6.922	9.023	10.857	11.159
\$ 35000 Plus	5.891	10.065	13.796	18.300	21.655	5.517	8.285	10.729	12.986	13.473

Pooling Trip Rates

The evaluation of the trip rates has indicated that the rates are similar in many respects. The only notable exceptions are the trip rates from the San Antonio survey. It appears that travel behavior in large urban areas is different from the smaller urban areas. With the relatively high similarity between the majority of the trip rates in the four small urban areas surveyed, it was reasonable to assume the survey data from those areas could be combined and a set of pooled trip rates developed for travel demand modeling in small urban areas that did not have recent travel surveys. Small urban areas would be defined as those with populations less than or equal to 200,000. There are several ways of combining the survey data to produce a pooled data set. One method would be to simply combine the household survey data for all four areas and compute stratified trip rates. Another would be to combine the expanded trips from each survey, total the estimated households in each stratification cell, and compute trip rates. The difference between these two methods is that one represents an unweighted result and the other represents a weighted result, the amount of weighting dependent on the size of the urban area (and its household distribution). The decision was made to combine the adjusted, expanded trip data from the four urban areas and compute a set of pooled trip rates. The adjusted trips for each urban area represent what was considered the best estimate of travel in those respective areas and, therefore was, considered to be the most reasonable for use in developing an overall set of pooled trip rates for small urban areas. These rates were then smoothed and modified using the same methodology developed for the individual surveys (see Appendices E and J). The final rates recommended for use in urban areas with populations less than or equal to 200,000 are shown in Table 75.

VEHICLE OCCUPANCY

Vehicle occupancy may be defined as the number or average number of persons in a vehicle while the vehicle is being used for travel. It is used as a measure of efficiency in terms of relating the number of persons being carried on transportation facilities to the number of vehicles and in mode split analysis for estimating transit demand. One of the questions asked for each trip in the household surveys was the number of persons in the vehicle being used. These data provide a means for computing the average vehicle occupancy by trip purpose. Several clarifications need to be made at this point. First, there are, in fact, two measures of average vehicle occupancy used in travel demand modeling and analysis. One is the average reported occupancy of the vehicles being used

for travel. Another is what is termed a “conversion factor” which is used for converting estimates of person trips to estimates of vehicle trips. These two measures are not the same and are quite different. The difference lies in the fact that the conversion factor is computed by dividing the total person trips by the total auto driver trips. Since person trips include non-vehicular travel, the conversion factor may be expected to be quite different from the average reported vehicle occupancy which is based only on vehicular travel.

To avoid problems with double counting, average reported vehicle occupancy is computed only for auto driver trips. The purpose of these trips is based on the purpose of the driver. To examine the characteristics of average reported vehicle occupancy and person trip conversion factors, these values were computed for households stratified in the same manner as used for developing trip rates, household size, and income. Tables presenting the stratified reported average vehicle occupancy and person trip conversion factors by trip purpose for each of the urban areas are presented in Appendix F. The weighted averages are shown in Figures 15 and 16. The actual values are shown in Table 76. The average reported vehicle occupancy appears to be fairly consistent for all urban areas with the exception of Brownsville. The average conversion factors indicate more variability. This is most likely due to factors such as the number of vehicles available, average household size, and the number of non-vehicular travel reported in the surveys. Other factors which may influence these data are economic factors (e.g., unemployment) and the availability of other modes of travel such as transit.

In considering the question of transferability, comparisons between the urban areas should be made based on the use of stratified data. The weighted averages (e.g., Table 76) are based on the distributions of households within each area surveyed and do not necessarily reflect differences between categories of households having similar socioeconomic characteristics. The data in Appendix F are the average reported vehicle occupancies and average person trip to vehicle trip conversion factors for households stratified by size and income. Review of that data indicates that these factors do not seem to be transferable between urban areas.

Table 75
Small Urban Area Trip Production Rates by Trip Purpose

Home Based Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.216	0.524	0.824	0.923	1.107	0.180	0.342	0.541	0.609	0.644
\$ 5000 - \$ 9999	0.411	0.827	1.237	1.431	1.595	0.347	0.628	0.945	1.044	1.122
\$ 10000 - \$ 19999	0.674	1.144	1.649	1.867	2.040	0.639	0.962	1.378	1.486	1.572
\$ 20000 - \$ 34999	0.998	1.641	2.320	2.616	2.920	0.954	1.503	2.173	2.356	2.533
\$ 35000 Plus	1.310	2.030	2.862	3.175	3.549	1.230	1.940	2.788	3.011	3.304

Home Based Non-Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.452	3.259	4.694	7.545	11.011	0.945	1.811	2.428	3.309	3.657
\$ 5000 - \$ 9999	1.680	3.577	5.154	8.183	11.601	1.331	2.279	2.957	3.876	4.584
\$ 10000 - \$ 19999	2.010	3.727	5.381	8.576	11.991	1.713	2.698	3.332	4.354	5.155
\$ 20000 - \$ 34999	2.163	3.836	5.482	8.652	12.053	1.886	2.898	3.534	4.525	5.534
\$ 35000 Plus	2.488	4.112	5.803	9.158	12.589	2.294	3.442	4.189	5.318	6.485

Non-Home Based

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.826	1.236	1.622	1.889	1.907	0.531	0.843	1.064	1.157	1.026
\$ 5000 - \$ 9999	1.114	1.878	2.279	2.816	3.171	0.930	1.404	1.647	1.896	1.962
\$ 10000 - \$ 19999	1.507	2.480	3.044	3.857	4.399	1.361	1.915	2.271	2.617	2.790
\$ 20000 - \$ 34999	1.863	3.061	3.741	4.908	5.891	1.760	2.453	2.870	3.363	3.670
\$ 35000 Plus	2.455	3.841	4.663	6.196	7.664	2.327	3.272	3.832	4.512	4.962

Total-All Purposes

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.493	5.018	7.139	10.357	14.025	1.656	2.996	4.033	5.075	5.326
\$ 5000 - \$ 9999	3.206	6.282	8.670	12.430	16.366	2.608	4.311	5.548	6.815	7.668
\$ 10000 - \$ 19999	4.191	7.351	10.074	14.300	18.430	3.712	5.575	6.980	8.458	9.516
\$ 20000 - \$ 34999	5.023	8.538	11.543	16.176	20.864	4.600	6.854	8.577	10.245	11.738
\$ 35000 Plus	6.253	9.983	13.327	18.530	23.802	5.852	8.654	10.808	12.841	14.752

TRIP LENGTH

The data from the household surveys were geocoded to identify the zone where each trip began and the zone where each trip ended. While travel time was also derived from the survey data, analysis of those data indicated individuals had a high propensity to report beginning and ending times in terms of 5-minute intervals. While these data are useful for other analyses, it was not considered usable for the estimation of trip length frequency distributions and input to the travel demand modeling process. The trip records from the surveys were processed and, using the zone-to-zone travel times and distances (computed from the transportation network for each urban area), were added to each trip record. A trip length frequency distribution was computed for each trip purpose, both person and auto driver trips, in each survey.

Initially, two evaluations were done involving trip length frequency distributions (TLFD). The first dealt with a comparative assessment of the ability of the current model for estimating TLFDs to replicate the expanded TLFD observed from the travel surveys. The second dealt with a comparison between the home to work trip length data observed in the household surveys with the 1990 Census Journey to Work data. These evaluations were completed and reported in a Technical Memorandum to TxDOT. A copy of that technical memorandum is included in this report in Appendix G.

Following the evaluation of the TLFD model and the comparison of the trip length frequency distributions with the census data, the average trip lengths were computed for persons by sex and age group for each trip purpose. Tables 78 and 79 present the average trip lengths in terms of travel time by sex and trip purpose for person and auto driver trips in each of the urban areas surveyed.

Figure 15
Average Reported Vehicle Occupancies
By Trip Purpose

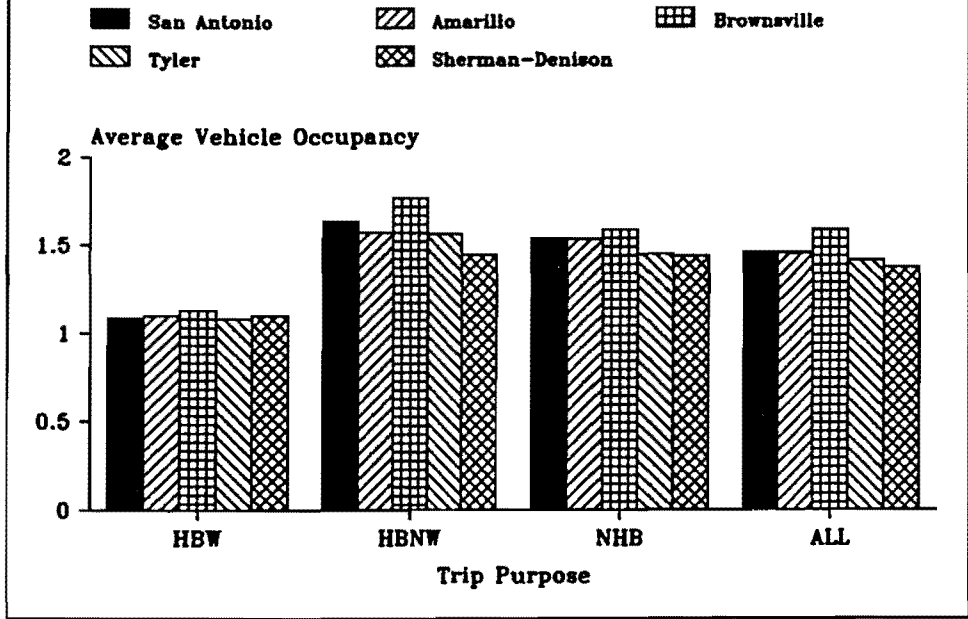


Figure 16
Average Person Trip to Vehicle Trip
Conversion Factors by Trip Purpose

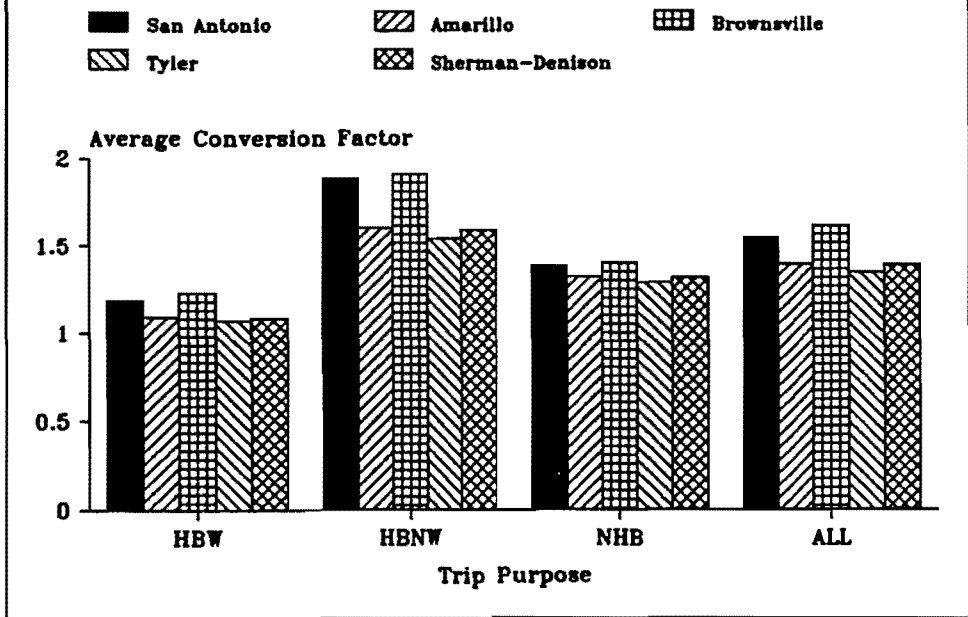


Table 76
Average Reported Vehicle Occupancies

Urban Area	Vehicles* per Household	Vehicles* per Person	Average Reported Vehicle Occupancy			
			HBW	HBNW	NHB	All
San Antonio	1.63	0.56	1.085	1.638	1.538	1.458
Amarillo	1.80	0.69	1.099	1.572	1.533	1.450
Brownsville	1.56	0.42	1.130	1.769	1.588	1.584
Tyler	1.87	0.70	1.083	1.564	1.446	1.411
Sherman-Denison	1.84	0.71	1.100	1.447	1.433	1.371

*Expanded Survey Estimates

Table 77
**Average Person Trip to Vehicle Trip
Conversion Factors**

Urban Area	Vehicles* per Household	Vehicles* per Person	Average Conversion Factor			
			HBW	HBNW	NHB	All
San Antonio	1.63	0.56	1.188	1.889	1.387	1.544
Amarillo	1.80	0.69	1.092	1.603	1.326	1.391
Brownsville	1.56	0.42	1.230	1.912	1.400	1.613
Tyler	1.87	0.70	1.071	1.539	1.291	1.345
Sherman-Denison	1.84	0.71	1.085	1.590	1.317	1.389

*Expanded Survey Estimates

The data in Tables 78 and 79 indicate that males have slightly higher average trip lengths than females. This was consistently the pattern for all trip purposes for both person and auto driver trips. This implies that, overall, males tend to spend more time traveling on a daily basis than females.

Table 78
Average Trip Length in Network Travel Time
Person Trips

Urban Area	Average Person Network Trip Length in Minutes							
	HBW		HBNW		NHB		All	
	Male	Female	Male	Female	Male	Female	Male	Female
San Antonio	16.19	14.45	10.33	9.98	11.51	10.36	12.03	10.91
Amarillo	9.96	8.53	6.07	5.69	6.28	5.75	7.01	6.12
Brownsville	6.42	5.86	5.16	4.99	4.76	4.46	5.28	4.95
Tyler	7.08	6.63	5.17	5.06	5.03	4.61	5.58	5.15
Sherman-Denison	9.29	8.76	6.82	6.65	6.33	5.88	7.14	6.66

Table 79
Average Trip Length in Network Travel Time
Auto Driver Trips

Urban Area	Average Auto Driver Network Trip Length in Minutes							
	HBW		HBNW		NHB		All	
	Male	Female	Male	Female	Male	Female	Male	Female
San Antonio	16.54	14.76	11.10	10.18	11.84	10.48	12.93	11.39
Amarillo	9.77	8.46	6.44	5.59	6.50	5.77	7.38	6.20
Brownsville	6.61	5.93	5.19	4.83	4.86	4.37	5.41	4.86
Tyler	7.09	6.65	5.42	5.09	5.10	4.56	5.80	5.21
Sherman-Denison	9.39	8.89	7.09	6.72	6.46	5.87	7.42	6.78

Average trip length for person and auto driver trips was also examined for households stratified by household size and household income. In addition, trip length was computed for trips by all modes of travel for households stratified by size and income. Tables 80 through 84 present the average trip lengths in network travel time by trip purpose for households stratified by household size and income in each of the urban areas. The average trip lengths shown are for expanded survey data and do not include trips which were not geocoded completely or households that were non-

responsive to the household income question. While some variation is apparent in the average trip lengths, no clear pattern was observed. For the most part, average trip lengths were very similar for households regardless of size or level of income. The categories which showed the most variation were also those with fewer observed households. These average trip lengths do not appear to be transferable. It is not known clearly the impact that urban form and the transportation network have on average trip length. Average trip length does vary between urban areas. This variation is most likely due to the different urban forms and transportation systems.

Tables 85 through 89 present overall average trip lengths in miles and minutes for each mode of travel for which data were collected. All the averages represent expanded survey data. It should be noted that some of these averages are based on a limited number of observed trips. Reference may be made to Tables 44 through 48 for the number of observed and expanded trips for each mode.

Table 80
Average Trip Length in Minutes
1990 San Antonio Household Survey

Home Based Work

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	15.99	10.55	13.07	14.12	15.28	13.94	12.05	11.36	12.88	15.18	15.63	13.99
\$ 5,000 - \$ 9,999	12.11	12.00	13.03	13.43	13.46	12.75	14.75	17.12	14.23	15.07	15.13	15.27
\$ 10,000 - \$ 19,999	11.98	11.62	16.00	16.09	14.85	13.96	12.45	12.35	15.62	16.82	16.33	14.46
\$ 20,000 - \$ 34,999	15.09	15.34	16.04	15.87	17.01	15.85	15.41	15.74	16.16	15.98	17.68	16.14
\$ 35,000 Plus	14.94	16.80	16.29	18.40	15.99	16.82	14.94	16.74	16.44	18.46	16.22	16.90
Wt. Avg.	13.72	15.37	15.97	17.14	15.89	15.82	14.18	15.91	16.13	17.54	16.49	16.25

Home Based Non-Work

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	8.16	8.14	9.37	5.78	7.88	7.89	7.94	8.83	10.22	7.09	8.58	8.70
\$ 5,000 - \$ 9,999	8.81	9.01	9.55	8.59	9.27	9.08	9.45	9.59	9.27	10.20	10.02	9.67
\$ 10,000 - \$ 19,999	10.52	9.54	8.16	9.98	8.99	9.36	10.68	9.64	8.97	10.78	11.22	10.21
\$ 20,000 - \$ 34,999	11.11	11.77	10.45	12.02	9.33	10.75	11.17	11.76	11.19	12.46	9.82	11.22
\$ 35,000 Plus	14.90	12.02	11.18	10.87	10.94	11.26	14.57	11.99	11.31	11.00	11.07	11.46
Wt. Avg.	10.66	11.06	10.12	10.59	9.87	10.38	11.12	11.25	10.76	11.19	10.57	10.97

Non-Home Based

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	8.59	8.61	9.97	8.27	6.94	8.47	11.38	10.25	11.68	8.37	8.22	9.91
\$ 5,000 - \$ 9,999	9.28	9.12	9.32	10.79	11.53	9.90	9.84	9.81	10.37	10.75	10.48	10.05
\$ 10,000 - \$ 19,999	11.40	10.13	10.11	11.00	10.28	10.59	11.88	10.43	9.99	10.93	10.66	10.89
\$ 20,000 - \$ 34,999	11.24	12.01	11.04	11.38	10.99	11.38	11.31	12.00	11.48	12.10	11.58	11.72
\$ 35,000 Plus	11.09	11.88	11.20	12.31	12.24	11.88	11.46	12.05	11.34	12.47	12.34	12.00
Wt. Avg.	10.85	11.48	10.90	11.74	11.43	11.33	11.32	11.73	11.18	12.08	11.72	11.63

Total - All Purposes

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	9.07	8.70	9.82	7.73	8.69	8.80	9.25	9.76	10.92	9.69	10.42	10.09
\$ 5,000 - \$ 9,999	9.47	9.69	10.34	10.10	10.27	9.94	10.37	11.14	11.05	11.25	11.30	10.90
\$ 10,000 - \$ 19,999	11.20	10.10	10.33	11.30	10.29	10.60	11.57	10.41	11.14	12.25	12.28	11.43
\$ 20,000 - \$ 34,999	12.12	12.77	12.20	12.81	10.87	12.09	12.24	12.90	12.98	13.55	11.97	12.74
\$ 35,000 Plus	13.36	13.37	12.60	12.97	12.26	12.81	13.42	13.52	12.96	13.68	12.96	13.32
Wt. Avg.	11.41	12.30	11.83	12.32	11.27	11.86	11.90	12.71	12.59	13.32	12.44	12.66

Table 81
Average Trip Length in Minutes
1990 Amarillo Household Survey

Home Based Work

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	6.52	12.09	7.98	3.41	9.24	8.55	4.91	12.14	7.54	6.58	9.24	8.22
\$ 5,000 - \$ 9,999	7.91	8.94	11.73	8.24	6.97	8.77	8.21	9.12	10.99	7.76	6.95	8.71
\$ 10,000 - \$ 19,999	8.52	9.50	8.01	7.95	8.86	8.64	8.66	9.21	8.22	8.26	8.17	8.64
\$ 20,000 - \$ 34,999	9.30	8.97	8.91	10.88	9.10	9.42	8.63	8.88	8.62	10.83	9.13	9.22
\$ 35,000 Plus	10.72	9.74	10.26	9.81	8.95	9.78	9.93	9.48	10.05	9.58	8.83	9.57
Wt. Avg.	8.86	9.52	9.54	9.79	8.92	9.42	8.64	9.31	9.38	9.71	8.83	9.27

Home Based Non-Work

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	6.63	4.67	5.40	5.35	5.42	5.60	7.15	4.73	5.16	5.06	6.59	5.85
\$ 5,000 - \$ 9,999	5.73	5.92	5.70	5.09	5.93	5.71	5.80	5.89	5.61	5.66	5.31	5.72
\$ 10,000 - \$ 19,999	6.00	6.49	5.80	4.99	5.42	5.82	5.78	6.60	6.23	5.01	5.32	5.91
\$ 20,000 - \$ 34,999	5.84	6.59	5.99	6.07	4.90	5.83	5.91	6.61	6.08	5.86	5.07	5.96
\$ 35,000 Plus	4.77	6.61	6.77	5.96	5.67	6.18	4.74	6.51	6.77	6.13	5.78	6.27
Wt. Avg.	5.88	6.45	6.24	5.81	5.36	5.95	5.84	6.46	6.36	5.86	5.47	6.06

Non-Home Based

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	5.86	4.87	6.26		8.05	6.00	5.83	4.51	6.42		7.58	5.77
\$ 5,000 - \$ 9,999	5.79	5.15	5.46	5.92	4.91	5.50	5.86	5.20	5.69	6.31	5.07	5.66
\$ 10,000 - \$ 19,999	5.86	5.73	5.53	5.85	5.78	5.76	5.86	5.71	5.66	6.36	5.54	5.81
\$ 20,000 - \$ 34,999	6.19	6.29	6.27	6.60	5.57	6.18	6.31	6.45	6.42	6.87	6.03	6.42
\$ 35,000 Plus	5.83	6.27	6.57	5.82	5.71	6.07	5.77	6.28	6.52	5.90	6.03	6.17
Wt. Avg.	5.93	6.08	6.28	5.99	5.70	6.02	5.96	6.15	6.36	6.14	5.98	6.14

Total - All Purposes

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	6.42	5.98	5.91	5.22	6.15	6.01	6.53	5.80	5.90	5.12	7.16	6.10
\$ 5,000 - \$ 9,999	6.06	6.13	6.48	5.64	5.90	6.06	6.17	6.24	6.55	6.17	5.61	6.19
\$ 10,000 - \$ 19,999	6.37	6.74	6.18	5.76	5.94	6.29	6.32	6.85	6.62	6.19	5.80	6.45
\$ 20,000 - \$ 34,999	6.97	6.95	6.73	7.14	5.73	6.66	6.85	7.06	6.87	7.54	6.37	6.95
\$ 35,000 Plus	6.45	7.27	7.49	6.57	6.19	6.87	6.32	7.25	7.57	6.89	6.58	7.08
Wt. Avg.	6.49	6.97	6.95	6.55	5.98	6.63	6.45	7.04	7.15	6.90	6.39	6.85

Table 82
Average Trip Length in Minutes
1991 Brownsville Household Survey

Home Based Work

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	6.35	6.14	5.51	5.91	6.49	6.11	6.79	6.99	4.70	6.47	6.17	6.07
\$ 5,000 - \$ 9,999	5.77	5.07	6.09	4.91	6.71	5.89	6.21	4.95	6.55	5.09	7.47	6.27
\$ 10,000 - \$ 19,999	6.04	5.16	6.78	5.76	6.89	6.46	6.04	6.55	7.24	5.99	7.05	6.73
\$ 20,000 - \$ 34,999	5.29	5.81	5.76	6.40	6.69	6.30	5.40	5.81	6.02	6.43	6.95	6.45
\$ 35,000 Plus	6.77	6.40	5.94	5.93	6.22	6.15	6.77	6.43	6.08	6.05	6.17	6.20
Wt. Avg.	5.84	6.09	6.07	5.94	6.60	6.24	6.00	6.22	6.32	6.09	6.72	6.38

Home Based Non-Work

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	4.77	5.17	5.58	5.46	5.40	5.36	4.19	4.31	5.62	5.80	5.77	5.40
\$ 5,000 - \$ 9,999	3.97	4.40	4.54	5.11	6.06	5.28	3.94	4.18	4.49	5.39	6.03	5.16
\$ 10,000 - \$ 19,999	4.93	5.18	5.81	4.48	5.15	5.06	4.98	5.00	5.55	4.70	5.23	5.10
\$ 20,000 - \$ 34,999	4.88	5.34	5.68	4.79	5.43	5.32	5.03	5.00	5.77	4.69	5.38	5.25
\$ 35,000 Plus	4.81	4.88	5.17	4.71	4.97	4.91	4.83	4.85	5.19	4.65	4.92	4.88
Wt. Avg.	4.67	5.04	5.41	4.77	5.31	5.14	4.71	4.82	5.40	4.85	5.32	5.10

Non-Home Based

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	4.16	4.62	4.69	5.58	4.99	4.82	4.40	4.66	4.63	5.35	5.74	5.00
\$ 5,000 - \$ 9,999	5.91	4.48	4.32	4.45	4.81	4.65	7.09	4.32	4.66	4.60	4.74	4.76
\$ 10,000 - \$ 19,999	3.97	4.91	4.84	4.88	4.54	4.68	3.97	5.01	5.09	4.87	4.62	4.74
\$ 20,000 - \$ 34,999	4.19	4.04	4.66	5.18	4.56	4.57	4.25	4.10	4.74	5.28	4.77	4.69
\$ 35,000 Plus	4.00	4.44	5.08	4.39	4.80	4.62	4.00	4.44	4.89	4.47	4.62	4.54
Wt. Avg.	4.26	4.48	4.82	4.72	4.67	4.63	4.29	4.49	4.85	4.77	4.71	4.65

Total - All Purposes

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	4.75	5.10	5.39	5.53	5.44	5.34	4.64	4.65	5.29	58.80	5.82	5.40
\$ 5,000 - \$ 9,999	4.67	4.53	4.77	4.91	5.96	5.23	4.97	4.34	4.99	5.12	6.04	5.26
\$ 10,000 - \$ 19,999	5.71	5.23	5.76	4.75	5.25	5.17	4.73	5.29	5.86	4.96	5.42	5.30
\$ 20,000 - \$ 34,999	4.71	5.03	5.39	5.22	5.41	5.28	4.81	4.86	5.50	5.39	5.54	5.34
\$ 35,000 Plus	4.75	4.98	5.89	4.85	5.11	5.03	4.75	4.99	5.29	4.96	5.11	5.06
Wt. Avg.	4.72	5.01	5.36	4.95	5.35	5.18	4.78	4.96	5.43	5.11	5.44	5.23

Table 83
Average Trip Length in Minutes
1991 Tyler Household Survey

Home Based Work

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	5.09	6.85	6.20	5.48	9.41	6.47	5.09	7.30	5.67	7.85	9.41	6.98
\$ 5,000 - \$ 9,999	7.78	7.72	7.11	5.98	8.41	7.51	7.75	7.47	5.82	5.18	7.20	6.94
\$ 10,000 - \$ 19,999	6.43	7.82	7.19	8.35	5.70	7.21	6.56	7.78	7.19	8.42	6.00	7.30
\$ 20,000 - \$ 34,999	7.06	7.46	6.87	7.77	7.06	7.28	7.05	7.43	6.94	7.85	6.86	7.27
\$ 35,000 Plus	5.24	6.73	6.59	7.05	6.57	6.73	5.24	6.73	6.63	7.12	6.57	6.75
Wt. Avg.	6.70	7.16	6.74	7.27	6.70	6.97	6.72	7.14	6.75	7.37	6.64	6.98

Home Based Non-Work

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	6.12	3.92	5.13	2.64	3.51	4.31	5.81	3.80	5.63	2.47	4.79	4.67
\$ 5,000 - \$ 9,999	5.85	6.02	5.91	4.40	4.57	5.24	5.77	5.95	5.61	3.67	5.07	5.39
\$ 10,000 - \$ 19,999	5.47	5.53	5.58	6.62	5.24	5.62	5.67	5.47	5.71	6.60	5.78	5.73
\$ 20,000 - \$ 34,999	4.57	5.79	5.92	5.68	4.84	5.50	4.51	5.86	5.91	5.85	4.94	5.60
\$ 35,000 Plus	4.82	5.09	5.29	5.07	4.95	5.08	4.99	5.01	5.39	5.19	5.25	5.19
Wt. Avg.	5.35	5.38	5.52	5.26	4.87	5.25	5.31	5.35	5.59	5.36	5.26	5.38

Non-Home Based

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	4.20	3.97	4.93	3.82	2.79	4.04	4.39	4.57	5.52	2.75	2.62	4.37
\$ 5,000 - \$ 9,999	4.94	5.26	5.33	6.68	6.37	5.65	4.71	5.25	5.53	7.20	7.24	5.82
\$ 10,000 - \$ 19,999	4.54	5.25	5.97	5.16	6.34	5.49	4.46	5.31	5.90	5.26	6.42	5.43
\$ 20,000 - \$ 34,999	4.90	4.64	5.02	4.63	5.37	4.85	4.79	4.75	4.90	4.75	4.89	4.80
\$ 35,000 Plus	5.26	4.71	4.65	4.84	4.53	4.71	5.29	4.68	4.68	4.87	4.56	4.73
Wt. Avg.	4.79	4.79	5.00	4.88	5.03	4.90	4.72	4.83	4.98	4.98	4.95	4.90

Total - All Purposes

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	5.47	4.30	5.24	3.42	3.86	4.51	5.30	4.58	5.60	3.70	5.12	4.97
\$ 5,000 - \$ 9,999	5.83	6.04	5.92	5.16	5.65	5.68	5.82	5.95	5.62	5.47	6.35	5.81
\$ 10,000 - \$ 19,999	5.30	5.83	5.99	6.56	5.63	5.84	5.39	5.90	6.11	6.60	6.34	5.95
\$ 20,000 - \$ 34,999	5.30	5.76	5.86	5.76	5.35	5.66	5.25	5.89	5.87	6.02	5.48	5.78
\$ 35,000 Plus	5.07	5.34	5.43	5.37	5.10	5.31	5.16	5.32	5.52	5.56	5.37	5.44
Wt. Avg.	5.39	5.55	5.64	5.52	5.21	5.48	5.38	5.60	5.71	5.73	5.51	5.61

Table 84
Average Trip Length in Minutes
1991 Sherman-Denison Household Survey

Home Based Work

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	6.12	4.50	8.90		2.63	6.51	4.47	4.79	9.63		2.63	6.65
\$ 5,000 - \$ 9,999	8.11	8.95	6.36	7.67	11.15	8.67	8.11	8.89	6.38	9.31	11.15	9.17
\$ 10,000 - \$ 19,999	7.60	8.49	9.24	7.45	8.68	8.26	7.70	8.58	9.27	7.78	9.13	8.40
\$ 20,000 - \$ 34,999	9.05	9.46	9.31	9.84	8.85	9.37	8.91	9.51	9.51	10.06	8.71	9.44
\$ 35,000 Plus	8.28	9.25	9.76	10.08	8.67	9.51	8.49	9.30	9.82	10.10	8.74	9.56
Wt. Avg.	8.30	9.12	9.48	9.62	8.88	9.24	8.28	9.21	9.61	9.82	8.92	9.34

Home Based Non-Work

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	6.12	5.37	7.19	5.29	2.99	5.94	6.59	5.45	7.97	6.05	2.68	6.38
\$ 5,000 - \$ 9,999	6.08	6.37	5.80	8.07	9.00	6.66	6.17	6.48	6.42	8.18	8.66	6.74
\$ 10,000 - \$ 19,999	6.57	6.69	6.81	7.41	6.99	6.87	6.58	6.80	6.57	7.51	6.71	6.82
\$ 20,000 - \$ 34,999	6.52	7.07	6.52	6.87	6.86	6.85	6.61	7.12	6.79	7.05	7.26	7.02
\$ 35,000 Plus	7.08	7.84	6.85	6.83	6.53	6.95	7.17	7.85	7.04	7.09	6.85	7.22
Wt. Avg.	6.43	7.06	6.74	6.92	6.74	6.84	6.57	7.15	6.93	7.14	6.99	7.02

Non-Home Based

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	5.30	4.98	6.89	8.09	3.40	6.07	4.25	5.29	7.03	9.39	3.40	6.24
\$ 5,000 - \$ 9,999	5.34	5.43	4.23	5.47		5.31	5.30	5.31	4.17	6.29		5.47
\$ 10,000 - \$ 19,999	5.73	6.23	6.33	6.67	6.13	6.21	5.68	6.05	6.05	6.54	6.09	6.06
\$ 20,000 - \$ 34,999	6.59	6.09	5.89	6.34	6.20	6.17	6.56	6.06	5.95	6.48	6.17	6.19
\$ 35,000 Plus	6.84	6.46	6.45	6.52	6.50	6.49	7.05	6.53	6.62	6.598	6.60	6.60
Wt. Avg.	6.04	6.18	6.26	6.46	6.30	6.27	6.02	6.20	6.36	6.60	6.34	6.33

Total - All Purposes

Household Income Range	Average Person Trip Length in Minutes						Average Auto Driver Trip Length in Minutes					
	Household Size						Household Size					
	1	2	3	4	5 +	Wt. Avg.	1	2	3	4	5 +	Wt. Avg.
\$ 0 - \$ 4,999	5.92	5.17	7.19	6.14	3.07	6.01	5.53	5.36	7.71	7.17	2.97	6.35
\$ 5,000 - \$ 9,999	5.95	6.22	5.51	7.03	9.99	6.48	6.03	6.19	5.88	7.51	9.90	6.65
\$ 10,000 - \$ 19,999	6.42	6.78	6.96	7.19	6.87	6.84	6.43	6.83	6.82	7.25	6.84	6.82
\$ 20,000 - \$ 34,999	7.10	7.04	6.93	7.33	6.95	7.07	7.11	7.11	7.23	7.71	7.24	7.28
\$ 35,000 Plus	7.28	7.61	7.39	7.28	6.80	7.29	7.45	7.70	7.65	7.60	7.16	7.57
Wt. Avg.	6.59	7.08	7.13	7.25	6.90	7.06	6.67	7.19	7.40	7.58	7.19	7.27

Table 85
Average Trip Length by Mode of Travel
1990 San Antonio Household Survey

Mode of Travel	Average Trip Length*							
	HBW		HBNW		NHB		All	
	Min	Miles	Min	Miles	Min	Miles	Min	Miles
Person -All Modes	15.82	8.34	10.38	5.10	11.33	5.65	11.86	5.98
Auto driver	16.25	8.62	10.97	5.46	11.63	5.83	12.66	6.47
Auto Passenger	14.76	7.58	10.66	5.22	10.87	5.34	11.08	5.46
Public Transit	12.63	6.20	9.43	4.32	9.95	4.68	10.43	4.92
Walk	4.53	1.66	4.60	1.76	4.83	2.02	4.64	1.80
Bicycle	3.61	1.39	8.73	4.48	8.35	4.50	7.69	3.90
School Bus	7.06	3.19	8.78	4.35	13.44	6.96	9.24	4.61
Other	18.70	10.10	9.57	4.64	14.80	7.96	12.62	6.50

*Based on highway network link distances and travel times

Table 86
Average Trip Length by Mode of Travel
1990 Amarillo Household Survey

Mode of Travel	Average Trip Length*							
	HBW		HBNW		NHB		All	
	Min	Miles	Min	Miles	Min	Miles	Min	Miles
Person -All Modes	9.42	5.47	5.95	3.29	6.02	3.26	6.63	3.69
Auto driver	9.27	5.35	6.06	3.33	6.14	3.32	6.85	3.81
Auto Passenger	11.94	7.41	5.82	3.24	5.64	3.06	6.07	3.39
Public Transit	11.58	6.82	5.93	3.22	4.58	2.26	7.55	4.24
Walk	3.30	1.60	2.68	1.47	3.27	1.56	2.84	1.50
Bicycle	7.07	4.17	2.54	1.26	3.37	1.76	4.48	2.50
School Bus	**	**	6.64	4.01	7.11	4.02	6.73	4.02
Other	4.89	2.91	5.50	2.83	5.18	2.75	5.31	2.82

*Based on highway network link distances and travel times

**No trips were observed by this mode

Table 87
Average Trip Length by Mode of Travel
1991 Brownsville Household Survey

Mode of Travel	Average Trip Length*							
	HBW		HBNW		NHB		All	
	Min	Miles	Min	Miles	Min	Miles	Min	Miles
Person -All Modes	6.24	3.77	5.14	2.98	4.63	2.66	5.18	3.02
Auto driver	6.38	3.90	5.10	2.96	4.65	2.68	5.23	3.06
Auto Passenger	6.17	3.60	5.15	2.97	4.54	2.60	5.08	2.93
Public Transit	5.24	2.90	6.22	3.45	3.93	1.93	5.84	3.21
Walk	2.16	0.99	4.35	2.33	2.13	0.98	3.13	1.58
Bicycle	3.82	2.21	3.35	1.60	**	**	3.65	1.99
School Bus	2.53	0.97	5.13	3.05	6.37	3.79	5.20	3.08
Other	4.02	1.75	4.95	2.84	4.25	2.20	4.70	2.55

* Based on highway network link distances and travel times

**No trips were observed by this mode

Table 88
Average Trip Length by Mode of Travel
1991 Tyler Household Survey

Mode of Travel	Average Trip Length*							
	HBW		HBNW		NHB		All	
	Min	Miles	Min	Miles	Min	Miles	Min	Miles
Person -All Modes	6.97	4.43	5.25	3.26	4.90	2.91	5.48	3.38
Auto driver	6.98	4.45	5.38	3.35	4.90	2.90	5.61	3.47
Auto Passenger	7.12	4.47	5.05	3.12	4.80	2.84	5.08	3.10
Public Transit	**	**	4.64	3.20	4.32	3.12	4.62	3.19
Walk	2.66	1.42	2.27	1.11	2.31	1.23	2.32	1.16
Bicycle	1.65	0.92	2.72	1.62	4.41	2.82	2.82	1.70
School Bus	6.51	3.56	6.21	4.12	6.60	4.13	6.28	4.12
Other	8.94	5.60	4.69	2.81	9.40	6.44	8.17	5.38

*Based on highway network link distances and travel times

**No trips were observed by this mode

Table 89
Average Trip Length by Mode of Travel
1991 Sherman-Denison Household Survey

Mode of Travel	Average Trip Length*							
	HBW		HBNW		NHB		All	
	Min	Miles	Min	Miles	Min	Miles	Min	Miles
Person - All Modes	9.24	5.76	6.84	3.87	6.27	3.57	7.06	4.09
Auto driver	9.34	5.86	7.02	4.00	6.33	3.62	7.27	4.27
Auto Passenger	8.39	4.98	6.73	3.78	6.13	3.45	6.63	3.74
Public Transit	4.86	2.15	6.60	3.67	6.15	3.27	6.42	3.51
Walk	2.38	0.92	3.55	1.60	3.10	1.50	3.42	1.54
Bicycle	6.44	2.87	5.86	3.04	6.81	2.86	5.93	3.02
School Bus	3.02	1.35	6.82	3.74	6.35	3.09	6.73	3.62
Other	9.79	6.32	6.81	3.88	7.34	4.38	7.34	4.35

*Based on highway network link distances and travel times

SUMMARY OF FINDINGS

The household travel surveys conducted in Texas during 1990 and 1991 have provided a great deal of insight into travel characteristics and behavior of households in Texas. The major findings are summarized as follows:

- Travel within urban areas is primarily by private vehicle. Trips by auto driver and auto passenger comprise from a low of 88 percent of travel in San Antonio to a high of 97 percent of all travel in Amarillo.
- When households are stratified by household size and household income, the resulting average trip rates for all trip purposes appear to be very similar for urban areas with 200,000 population and less. It appears that large urban areas (at least those with populations in excess of one million) have significantly different trip rates by trip purpose than small urban areas.
- Trip rates for households stratified by size and income are transferable between small urban areas with 200,000 population or less. A set of pooled trip rates is recommended for use in

small urban areas where travel surveys have not been done recently.

- It appears the resulting trip rates from household travel surveys may be impacted by the location of the study area boundary. Significant numbers of external trips were observed in two of the urban areas surveyed. These may have resulted in lower household trip rates for those areas and accounted for some of the differences noted between the urban area trip rates.
- The use of mail back data retrieval for household surveys appears to result in trip rates with higher errors than the use of telephone data retrieval for surveys of comparable sample size.
- Travel on a per person basis appears to increase until age 40 to 44 and begins to decline slightly until the age of 65 and older. After the age of 65, the average person trips per person begins to decline significantly.
- Relatively high percentages of persons reporting zero trips were noted for all age groups for both males and females. The implication is that the surveys may be failing to obtain complete trip reporting from all individuals in the household. Increased efforts should be implemented in this area in future travel surveys.
- In 1990, the population in the San Antonio study area was estimated to be nearly 1.2 million. Based on the household survey, these residents made over 3.9 million internal person trips daily. On an average, each person 5 years of age and older made 3.6 trips daily. The average number of trips made by each household was 9.5 trips, 8.4 of which were made in a private vehicle as either an auto driver or an auto passenger. Of the total person trips, three percent were made using public transit and five percent were walk trips. The estimated internal daily vehicle miles of travel in the San Antonio study area was 16.5 million. Daily person miles of travel was estimated to be 23.4 million. On an average, each household accounted for 57.1 person miles of travel which required 1.9 hours each day. Each person 5 years of age and over was estimated to spend more than 42 minutes each day in travel time. One of every 5 trips was a home based work trip. More than one out of every four auto driver trips was a home based work trip. Home based trips accounted for more than 70 percent of all person travel and more than 75 percent of all auto driver travel.
- In 1990, the population in the Amarillo study area was estimated to be nearly 188,000. Based on the household survey, those residents 5 years of age and older made over 715,000 internal person trips daily. On an average, each person 5 years of age and older made over

4.1 trips daily. The average number of trips made by each household was 9.9 trips, 9.6 of which were made in a private vehicle as either an auto driver or an auto passenger. Of the total person trips, less than half of one percent were made by public transit and just over one percent were walk trips. The estimated internal daily vehicle miles of travel in the Amarillo study area was 2 million. Daily person miles of travel was estimated to be 2.6 million. On an average, each household accounted for 36.5 person miles of travel which required just over one hour each day. Each person 5 years of age and older was estimated to spend 27.5 minutes each day in travel time. One out of every 5.6 trips was a home based work trip. One out of every 4.3 auto driver trips was a home based work trip. Home based trips accounted for every 2 out of 3 person and auto driver trips.

- In 1990, the population in the Brownsville study area was estimated to be just under 100,000. Based on the household survey, those residents 5 years of age and older made over 317,000 internal person trips daily. On an average, each person 5 years of age and older made 3.5 trips daily. The average number of trips made by each household was nearly 12 trips, 11 of which were made in a private vehicle as either an auto driver or an auto passenger. Of the total person trips, 1.6 percent were made by public transit and just under one percent were walk trips. The estimated internal daily vehicle miles of travel in the Brownsville study area was over 600,000. On an average, each household accounted for over 36 person miles of travel which required just over one hour of time each day. Each person 5 years of age and older was estimated to spend nearly 18 minutes each day in travel time. One out of every 6.7 trips was a home based work trip. One out of every 5 auto driver trips was a home based work trip. Home based trips accounted for over 70 percent of all person trips and nearly 2 out of every 3 auto driver trips.
- In 1990, the population in the Tyler study area was estimated to be just over 150,000. Based on the household travel survey, those residents 5 years of age and older made over 525,000 internal person trips daily. On an average, each person 5 years of age and older made 3.7 trips per day. The average number of trips made by each household was 9.3 trips, 8.9 of which were made in a private vehicle as either an auto driver or an auto passenger. Just one tenth of one percent of the person trips were made by public transit while 1.4 percent of the trips were walk trips. The estimated internal vehicle miles of travel in the Tyler study area

was 1.4 million. Daily person miles of travel was estimated to be 1.8 million. On an average, each household accounted for over 31.3 person miles of travel which required approximately 51 minutes each day. Each person 5 years of age and older was estimated to spend just over 20 minutes each day in travel time. One of every 5.3 person trips was a home based work trip. One of every 4.2 auto driver trips was a home based work trip. Home based trips accounted for every 2 out of 3 trips.

- In 1990, the population in the Sherman-Denison study area was estimated to be 95,000. Based on the household survey, those residents 5 years of age and older made 340,000 internal person trips daily. On an average, each person 5 years of age and older made 3.8 trips daily. The average number of trips made by each household was 9.2, 8.7 of which were made in a private vehicle as either an auto driver or an auto passenger. Of the total person trips, three fourths of one percent were made by public transit and 2.5 percent were walk trips. The estimated internal daily vehicle miles of travel in the Sherman-Denison study area was 1.05 million. Daily person miles of travel was estimated to be 1.4 million. On an average, each household accounted for 37.8 person miles of travel which required just over one hour each day. Each person 5 years of age and older was estimated to spend 27 minutes each day in travel time. One out of every 6.3 trips was a home based work trip. One out of every 5 auto driver trips was a home based work trip. A little less than 2 out of every 3 trips was home based.

III. WORKPLACE SURVEYS

INTRODUCTION

One of the primary outputs from the trip generation phase of the travel demand modeling process is the estimation of attractions. Attractions are estimates of the number of trips that are attracted to specific categories of land use activities. While the household survey produces information used to estimate trip productions based on household characteristics, workplace surveys are intended to provide information for estimating the trips being attracted to different land use activities. In trip generation, each trip represents one production and one attraction. The household survey is the basis for the trip production estimates, and the workplace survey is the basis for the trip attraction estimates.

Workplace surveys are a relatively new type of travel survey. This type of survey was initiated in 1984 in the Dallas-Fort Worth Regional Travel Survey by the North Central Texas Council of Governments. The purpose was to obtain data for developing trip attraction models which would more closely match the results from trip production models developed from household surveys conducted during the same time period. As a result, workplace surveys became a part of the overall travel survey design for the 1990 and 1991 surveys.

Sampling and Survey Methodology

Workplace surveys were conducted in each of the five urban areas surveyed in 1990 and 1991. Workplaces were selected randomly using data from the Texas Employment Commission. Two methods were used in selecting establishments for the survey. One was a weighted systematic sampling procedure; and the other was a random sampling of establishments by size, industry type, and area type. A more detailed description of these methods is presented in References 12, 19, 20, 21, 22, and 23.

Sampling quotas were established for each urban area for workplaces stratified by type of employment and area types. Three types of employment were identified: basic, service, and retail. Table 90 presents the standard industrial classifications which fall within these three types of employment.

Transportation serial zones are classified as being of a certain area type based on the estimated population and employment density within the zone. The reason for such classifications is that trip generating characteristics of different land use activities are believed to vary according to the type of employment (i.e., a surrogate for land use activity) and the location of the activity within the urban area. For example, a retail activity is believed to attract a different number of trips if it is located in the central business district than it would if located in a suburban area. Attraction models are typically developed for land use activities stratified by area type. The attraction model recommended for use by TxDOT (18) in travel demand modeling was consistent with this theory.

Table 90
Standard Industrial Classification (SIC) Groupings
By Employment Type

<u>Employment Type</u>	<u>SIC Range</u>	<u>Industry Group</u>
Basic	1000 - 1499	Mining
	1500 - 1799	Construction
	2000 - 3999	Manufacturing
	4000 - 4999	Transportation
		Communications
		Public Utilities
		Wholesale Trade
5000 - 5199		
Retail	5200 - 5999	Retail Trade
Service	6000 - 6799	Finance
		Insurance
		Real Estate
	7000 - 8199	Services
	8200 - 8299	Education Services
	8300 - 8999	Services
	9000 - 9799	Government

Tables 91 through 95 present the sampling quotas established for each of the workplace surveys. These quotas were established in the respective requests for proposals based on the 1984 Dallas-Fort Worth survey and on professional judgment. The primary difference between the urban areas was the number of establishments and the area types. Additional information on the sampling design may be found in References 19 through 23.

Once selected, the establishment was contacted and asked to participate in the survey. References 19 through 23 contain a detailed discussion of the solicitation process. Workplaces agreeing to participate were then scheduled for the actual survey.

Table 91
Workplace Survey Sample Quotas
1990 San Antonio Travel Survey

Area Type	Industry Type			Total
	Retail	Basic	Service	
Central Business District/Urban	31	20	42	93
Urban Residential	15	5	18	38
Suburban Residential/Rural	67	31	53	151
Total	113	56	113	282

Source: Reference 19

Table 92
Workplace Survey Sample Quotas
1990 Amarillo Travel Survey

Area Type	Industry Type			Total
	Retail	Basic	Service	
Central Business District	3	5	9	17
Urban Fringe	24	7	19	50
Urban Residential	18	7	15	40
Suburban	20	12	21	53
Rural	3	3	4	10
Total	68	34	68	170

Source: Reference 20

Table 93
Workplace Survey Sample Quotas
1990 Brownsville Travel Survey

Area Type	Industry Type			Total
	Retail	Basic	Service	
Central Business District	1	1	0	2
Central Business District Fringe	3	0	0	3
Urban	6	3	2	11
Suburban	14	21	12	47
Suburban Fringe	4	2	3	9
Rural	0	1	1	2
Total	28	28	18	74

Source: Reference 21

Table 94
Workplace Survey Sample Quotas
1991 Tyler Travel Survey

Area Type	Industry Type			Total
	Retail	Basic	Service	
Central Business District	19	10	11	40
Suburban	22	31	13	66
Rural	13	36	24	73
Total	54	77	48	179

Source: Reference 22

Table 95
Workplace Survey Sample Quotas
1991 Sherman-Denison Travel Survey

Area Type	Industry Type			Total
	Retail	Basic	Service	
Central Business District/ Central Business District Fringe	63	17	10	90
Urban/Suburban/Suburban Fringe	18	42	14	74
Rural	24	12	17	53
Total	105	71	41	217

Source: Reference 23

The workplace survey generally consisted of several independent data collection efforts. The first was a survey of the establishment to determine the site layout and collect basic information about the workplace. The site layout was used to determine the number of on-site surveyors that would be needed as well as decide whether to count the vehicles or persons arriving and leaving the site. Other data collected from the establishment included total employment, number of employees at work on the day of the survey, delivery information, etc. Reference 12 presents additional information on the general information collected at each establishment surveyed.

For a selected travel day, two surveys were conducted at each participating establishment. One was a survey of the employees and the other was a survey on the non-employees (i.e., visitors) at the site. The survey of the employees consisted of a self-enumerated travel diary where each employee was asked to keep a diary of the trips he/she made during the survey travel day. The visitor survey was an intercept interview where every nth visitor (at heavy locations) was surveyed by a trained interviewer. The basic data collected in the employee surveys consisted of the same trip information as collected in the household survey. Household information was not collected from the employee. The data collected from the visitors included the location (home or other) from which they came to that site, if they were returning home immediately after leaving the site, their mode of travel (and occupancy if by car, truck, or van), time of arrival at the site, purpose for coming to the site, and fare paid if they came by bus. A more complete description of the survey method and survey instruments is presented in Reference 12.

The last data collection effort done on the selected travel day was the count of persons or vehicles arriving/departing the site. These counts were made during the normal operating hours of the establishment being surveyed. These data elements were critical for the ultimate expansion of the survey data. In addition to the number of persons/vehicles arriving/departing the site, the number of commercial trucks were counted separately to provide data for estimating truck attractions.

DATA EDITING

As with the household survey, a rigorous check was made of the survey data to identify potential errors and, if possible, correct the errors before processing for analysis. The employee survey data were essentially the same travel diary data as collected in the household survey. The same types of problems and errors were found in the employee survey as in the household survey. Since a similar procedure was used to correct the data, it will not be described again. The visitor

survey data were also edited to the extent possible. The major discrepancies found in those data sets were duplication of records and illogical data entries such as the mode of travel being auto driver and the occupancy being coded as zero.

The more critical errors found were missing data elements such as total employment or no vehicle or person counts being made at the site. These were essential to the data expansion and, where no vehicle or person counts were collected, the sites were not included in the subsequent data analysis. Sites where the number of employees at work or the total employment was not collected were also excluded from the analysis. In cases where one of those data elements was collected, e.g., the total employment at the site, the uncollected data element was set equal to that collected. This resulted in some error, but the decision was made to process the data in part because the elimination of all the sites with missing data elements would have seriously compromised any results at all. Sites were also excluded from analysis when no employee surveys were obtained but visitor surveys were. The San Antonio workplace survey had the most problems.

Tables 96 through 100 present the number of usable sites surveyed for each of the urban areas. It should be noted that the number of sites surveyed shown in Table 91 for San Antonio is considerably more than shown in Table 96. The reason for this, as stated previously, was the large number of missing data elements in many of the sites. The consultant had input some of the data elements, and these sites were subsequently not included in the analysis because it was felt the data had been compromised. It will also be noted that these tables do not aggregate the sites as was done in Tables 91 through 95 which presented the sample quotas. Those aggregations were made for purposes of defining and selecting the establishments for surveying. The numbers in Tables 96 through 100 present the disaggregate totals of usable sites which were used for analysis.

DATA EXPANSION

After the survey data were edited, data files were created which contained the workplace general information data, the workplace employee trip data, and the workplace visitor trip data. The first step in processing the data prior to expansion was to link the employee trips. At this point, no distinction was made relative to whether a trip was or was not to/from the workplace site. The trip linking logic used for the employee trips was the same as used in the household survey.

Two methods were used to expand the survey data. The method used depended on the type of counts made at the location. The methods differed only slightly, and these differences are noted

in the following descriptions of the steps taken to expand the survey data.

1. The number of employees surveyed and their work-related trips were summed and the average reported vehicle occupancies computed by trip purpose. The trip purposes identified for analysis were home based work (HBW), home based non-work (HBNW), and non-home based (NHB). These trips were further stratified into person trips and auto driver trips. For each step in the data expansion, the trips were expanded by trip purpose for person and auto driver trips individually.
2. An expansion factor was computed for the employee trips by dividing the number of employees at work on the day of the survey by the number of employees that were surveyed (i.e., returned a completed survey form).
3. The trips summed in step 1 were expanded by multiplying by the expansion factor computed in step 2. The result for each workplace was an estimate of the total trips to the workplace by trip purpose for both person and auto driver trips.
4. The number of visitors surveyed and their trips were summed and the reported average vehicle occupancies computed for each trip purpose for both person and auto driver trips.

Table 96
Number of Usable Workplace Surveys
1990 San Antonio Workplace Survey

Employment Type	Area Type					Totals
	1 CBD	2 Urban	3 Urban Residential	4 Suburban Residential	5 Rural	
Basic	7	9	7	12	1	36
Retail	4	16	14	33	4	71
Service	6	15	18	20	7	66
Totals	17	40	39	65	12	173

Table 97
Number of Usable Workplace Surveys
1990 Amarillo Workplace Survey

Employment Type	Area Type					Totals
	1 CBD	2 Urban Fringe	3 Urban Residential	4 Suburban	5 Rural	
Basic	5	7	6	13	3	34
Retail	5	24	19	20	3	71
Service	9	19	15	22	4	69
Totals	19	50	40	55	10	174

Table 98
Number of Usable Workplace Surveys
1991 Brownsville Workplace Survey

Employment Type	Area Type					Totals
	1 CBD	2 CBD Fringe	3 Urban	4 Suburban	5 Suburban /Rural	
Basic	0	0	3	13	4	20
Retail	0	5	6	13	4	28
Service	1	2	3	21	3	30
Totals	1	7	12	47	11	78

Table 99
Number of Usable Workplace Surveys
1991 Tyler Workplace Survey

Employment Type	Area Type			Totals
	1 CBD	2 Suburban	3 Rural	
Basic	9	15	18	42
Retail	17	18	12	47
Service	15	20	14	49
Totals	41	53	44	138

Table 100
Number of Usable Workplace Surveys
1991 Sherman-Denison Workplace Survey

Employment Type	Area Type						Totals
	1 CBD	2 CBD Fringe	3 Urban	4 Suburban	5 Suburban Fringe	6 Rural	
Basic	5	5	13	12	1	9	45
Retail	13	15	14	5	2	16	65
Service	4	7	6	5	2	13	37
Totals	22	27	33	22	5	38	147

At this point in the data expansion, the subsequent steps depended on whether vehicle or person counts had been made at the location. The steps followed where vehicle counts were made are indicated by the letter “v” and the steps followed where person counts were made are indicated by the letter “p”.

- 5v. The expanded employee auto driver trips and the total counted trucks were subtracted from the total counted vehicles arriving at the location. The result was the estimated total visitor auto driver (i.e., vehicle) trips to the workplace.

- 6v. The total visitor person trips to the workplace were estimated by multiplying the total visitor vehicle trips by the average vehicle occupancy computed from the visitor survey.
- 7v. The number of visitor trips by trip purpose was computed by multiplying the total person and total auto driver visitor trips by the percentage of trips observed by each trip purpose in the visitor survey.
- 5p. The expanded employee person trips were subtracted from the total persons counted arriving/departing the workplace. The result was an estimate of the total visitor person trips to the workplace.
- 6p. The number of visitor auto driver (vehicle) trips to the workplace was computed by dividing the total visitor person trips by the average reported vehicle occupancy computed from the visitor survey.
- 7p. The number of person and auto driver visitor trips by trip purpose was computed by multiplying the total visitor trips by the observed percentage of trips for each trip purpose from the visitor survey.
- 8. The total attractions by trip purpose for person and auto driver trips were computed by summing the attractions computed for the employees and for the visitors. Trips with taxi as the mode of travel were removed and added to the truck counts to estimate the total truck and taxi attractions to the site. It should be noted that those trips for both employees and visitors where the trip began at the workplace and ended at a location other than home were treated as NHB trip productions and not attractions. NHB attractions and productions were computed separately based on the responses in the surveys.
- 9. Attraction rates were computed by dividing the summed attractions by trip purpose by the total employment for the workplace. The total employment was used for this calculation and not the total employees at work on the day of the survey. The reason is this variable will normally be available and used for forecasting purposes.

Once the data were expanded and the attraction rates computed for each workplace, the analysis of the surveys could be done.

ANALYSIS OF THE WORKPLACE SURVEYS

In analyzing the data from the workplace surveys, one of the first observations made was the small number of observations in many of the stratification cells. For example, Table 98 for Brownsville shows that in several cells no observations were found. The attraction rates for these cells must be estimated using data from other urban areas. In the case of Brownsville, some stratification cells did not have any workplaces in them with those employment types. This was not the situation in every case but it does serve to illustrate the point that future surveys should determine the distribution of workplaces by the intended stratifications prior to conducting the survey.

Another observation was that the area types differed slightly in the number between some of the urban areas. For example, only three area types were coded in the Tyler data while six were coded in the Sherman-Denison data. The area types appeared to be consistent for San Antonio, Amarillo, and Brownsville. The fewer the number of area types, the less stratification of the data, and as can be seen for Sherman-Denison, this can have an impact on the results and subsequent interpretation.

While one of the areas of interest is the comparability of the results from the workplace surveys, for clarification purposes each urban area will be discussed separately first and the comparisons done in the section that follows.

San Antonio

The San Antonio workplace survey involved a total of 282 establishments. After data editing and evaluation of the data files, it was determined that 173 of those sites were usable. Table 101 presents some of the aggregate site statistics for the sites surveyed in San Antonio. Of the 176 sites, nearly 5,000 employees and 17,000 visitors were surveyed. The total expanded person trips involving those sites was estimated to be just over 240,000. Of that total, 70 percent were attractions. Of the estimated attractions, 14.4 percent were HBW, 49.4 percent were HBNW, and 36.2 percent were NHB. Tables 102 and 103 present the estimated person and auto driver trip attractions by trip purpose for workplaces stratified by employment type and area type. It should be noted that the data are for attractions only and does not include NHB productions.

Table 101
Aggregate Workplace Survey Data
San Antonio

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	7	9	7	12	1	36
	Employees at Work	2254	801	506	1546	750	5857
	Total Employment	2455	863	583	2106	750	6757
	Surveyed Employees	1009	171	287	453	7	1927
	Surveyed Visitors	744	337	677	955	30	2743
Retail	No. Sites	4	16	14	33	4	71
	Employees at Work	51	578	485	825	404	2343
	Total Employment	262	840	678	1138	423	3341
	Surveyed Employees	25	151	141	224	108	649
	Surveyed Visitors	254	2208	1510	5579	823	10374
Service	No. Sites	6	15	18	20	7	66
	Employees at Work	399	1006	1751	1022	443	4621
	Total Employment	462	1084	1936	1077	457	5016
	Surveyed Employees	109	561	802	553	221	2246
	Surveyed Visitors	382	588	1147	1006	430	3553
Totals	No. Sites	17	40	39	65	12	173
	Employees at Work	2704	2385	2742	3393	1597	12821
	Total Employment	3179	2787	3197	4321	1630	15114
	Surveyed Employees	1143	883	1230	1230	336	4822
	Surveyed Visitors	1380	3133	3334	7540	1283	16670

Table 102
Workplace Person Trip Attractions by Trip Purpose
San Antonio

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	7	9	7	12	1	36
	HBW	3526	1386	915	4355	1074	11256
	HBNW	703	1133	626	5199	3	7663
	NHB	1529	1309	1258	5643	561	10300
	All Purposes	5757	3828	2800	15197	1638	29220
Retail	No. Sites	4	17	14	33	4	72
	HBW	89	1108	958	1425	700	4281
	HBNW	235	9356	5627	15233	2477	32927
	NHB	289	5759	4054	10086	1058	21246
	All Purposes	614	16223	10639	26743	4235	58454
Service	No. Sites	6	15	18	20	7	66
	HBW	726	1858	3204	2409	785	8982
	HBNW	424	7010	11338	8199	4184	31155
	NHB	840	5348	8096	5192	3767	23244
	All Purposes	1991	14215	22639	15800	8736	63380
Totals	No. Sites	17	41	39	65	12	174
	HBW	4341	4352	5077	8189	2560	24519
	HBNW	1362	17498	17592	28630	6664	71745
	NHB	2659	12416	13408	20921	5385	54790
	All Purposes	8361	34266	36077	57740	14609	15105 4

Table 103
Workplace Auto Driver Trip Attractions by Trip Purpose
San Antonio

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	7	9	7	12	1	36
	HBW	2840	1163	813	3779	967	9563
	HBNW	427	845	552	5128	3	6955
	NHB	1112	1130	1080	5313	453	9087
	All Purposes	4379	3138	2445	14220	1423	25604
Retail	No. Sites	4	16	14	33	4	71
	HBW	49	780	814	1152	577	3372
	HBNW	132	7078	4198	12846	2252	26505
	NHB	87	4332	3115	8441	940	16915
	All Purposes	268	12190	8126	22439	3770	46793
Service	No. Sites	6	15	18	20	7	66
	HBW	541	1577	2693	1963	6935	7467
	HBNW	302	4937	8799	6896	4107	25041
	NHB	597	4536	6400	4171	3465	19169
	All Purposes	1440	11050	17891	13030	8265	51677
Totals	No. Sites	17	40	39	65	12	173
	HBW	3430	3521	4319	6895	2238	20402
	HBNW	861	12859	13548	24870	6363	58501
	NHB	1797	9998	10594	17925	4858	45171
	All Purposes	6087	26378	28462	49689	13458	124074

For modeling purposes, the next step is to compute the attraction rates for use in estimating travel demand. This step involves dividing the expanded survey attractions (by trip purpose) by the total employment in each stratification level. Tables 104 and 105 present the resulting model person and auto driver trip attraction rates for San Antonio. The values in Tables 104 and 105 reflect weighted averages. It was possible to compute a model attraction rate for each site surveyed in each stratification cell and the variance between the model rates for the sites surveyed. This reflects a measure of the amount of variation between surveyed workplaces within the cells relative to the model attraction rates. The standard deviation (i.e., the square root of the variance) of these model trip rates divided by the weighted model trip rate results in the coefficient of variation. This is the coefficient of variation for the weighted model attraction rate for the stratified cell. These coefficients of variation are presented in Tables 106 and 107. They are presented here to illustrate the high variation in observed attraction rates between workplaces within the stratification cells. The highest variations were observed for HBNW and NHB trips. Much of the variation between workplaces within the same stratification levels is due to difference in the number of visitor (i.e., non-employee) attractions to the site.

Review of the attraction rates shown in Tables 104 and 105 indicates several areas of concern. The first is the low rates observed for retail establishments in Area Type 1. Review of the data indicated half of the retail establishments surveyed in Area Type 1 had high levels of total employment and low numbers of employees at work on the day of the survey. There is a high probability that errors in the data files or the information collected did not reflect the actual site conditions. For example, the sites surveyed in Area Type 1 may have been corporate headquarters with satellite facilities. The reported total employment may reflect all of the satellite facilities and not just the site that was surveyed in Area Type 1.

The second observation is that overall the attraction rates seem very high. Using employment estimates from the 1990 census for the San Antonio-Bexar County area and multiplying the average attraction rates for each employment type (averaged over all area types), an approximate estimate of the total attractions was computed. The estimate for San Antonio was 6.7 million person trip attractions. This is nearly double the expanded person trip productions of 3.8 million estimated from the household survey in San Antonio. Such an imbalance in these two independent estimates clearly indicates a problem. Subsequent review and evaluation of the workplace survey methodology

identified a potential source of error in double counting of attractions at workplaces located in activity centers where individuals could make multiple stops without leaving the site. It was further reasoned that if every workplace had been surveyed using the same methodology, the resulting trip ends would double count those persons making multiple stops at single activity centers with more than one workplace. This led to a redesign of the workplace survey methodology which is documented in Reference 12.

The third observation made was that the percentage of attractions by trip purpose did not agree with the percentages observed in the household survey. This implies an imbalance between the two surveys and raises questions concerning the reasonableness of the results.

Table 104
Person Trip Attractions per Employee by Trip Purpose
San Antonio

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	7	9	7	12	1	36
	HBW	1.44	1.61	1.57	2.07	1.43	1.67
	HBNW	0.29	1.31	1.07	2.47	0.01	1.13
	NHB	0.62	1.52	2.16	2.68	0.75	1.52
	All Purposes	2.35	4.44	4.80	7.22	2.19	4.32
Retail	No. Sites	4	16	14	33	4	71
	HBW	0.34	1.32	1.41	1.25	1.66	1.28
	HBNW	0.90	11.14	8.30	13.39	5.86	9.86
	NHB	1.11	6.86	5.98	8.86	2.50	6.36
	All Purposes	2.34	19.31	15.69	23.50	10.01	17.50
Service	No. Sites	6	15	18	20	7	66
	HBW	1.57	1.71	1.66	2.24	1.72	1.79
	HBNW	0.92	6.47	5.86	7.61	9.16	6.21
	NHB	1.82	4.93	4.18	4.82	8.24	4.63
	All Purposes	4.31	13.11	11.69	14.67	19.12	12.64
Totals	No. Sites	17	40	39	65	12	173
	HBW	1.37	1.56	1.59	1.90	1.57	1.62
	HBNW	0.43	6.28	5.50	6.63	4.09	4.75
	NHB	0.84	4.46	4.19	4.84	3.30	3.63
	All Purposes	2.63	12.30	11.29	13.36	8.96	9.99

Table 105
Auto Driver Trip Attractions per Employee by Trip Purpose
San Antonio

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	7	9	7	12	1	36
	HBW	1.16	1.35	1.39	1.80	1.29	1.42
	HBNW	0.17	0.98	0.95	2.44	0.01	1.03
	NHB	0.45	1.31	1.85	2.52	0.60	1.35
	All Purposes	1.78	3.64	4.19	6.75	1.90	3.79
Retail	No. Sites	4	16	14	33	4	71
	HBW	0.19	0.93	1.20	1.01	1.37	1.01
	HBNW	0.50	8.43	6.19	11.29	5.33	7.93
	NHB	0.33	5.16	4.59	7.42	2.22	5.06
	All Purposes	1.02	14.51	11.99	19.72	8.91	14.01
Service	No. Sites	6	15	18	20	7	66
	HBW	1.17	1.46	1.39	1.82	1.52	1.49
	HBNW	0.65	4.55	4.55	6.40	8.99	4.99
	NHB	1.29	4.18	3.31	3.87	7.58	3.82
	All Purposes	3.12	10.19	9.24	12.10	18.09	10.30
Totals	No. Sites	17	40	39	65	12	173
	HBW	1.08	1.26	1.35	1.60	1.37	1.35
	HBNW	0.27	4.61	4.24	5.76	3.90	3.87
	NHB	0.57	3.59	3.31	4.15	2.98	2.99
	All Purposes	1.92	9.47	8.90	11.50	8.26	8.21

Table 106
Person Model Attraction Rate
Coefficients of Variation
San Antonio

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	7	9	7	12	1	36
	HBW	0.151	0.248	0.231	0.288	0.000	0.240
	HBNW	19.049	12.540	3.785	1.965	0.000	7.397
	NHB	17.902	3.369	1.392	1.101	0.000	3.651
	All Purposes	7.827	5.008	1.344	1.137	0.000	3.125
Retail	No. Sites	4	16	14	33	4	71
	HBW	1.599	0.511	0.4636	0.817	0.341	0.661
	HBNW	8.140	1.043	2.174	7.127	0.746	6.656
	NHB	2.953	1.313	1.583	8.884	0.692	8.630
	All Purposes	4.752	1.057	1.648	7.470	0.625	6.943
Service	No. Sites	6	15	18	20	7	66
	HBW	0.185	1.619	0.689	1.222	0.227	1.156
	HBNW	3.683	12.543	1.112	6.628	13.567	8.548
	NHB	2.331	7.994	0.995	2.375	10.138	6.909
	All Purposes	1.627	9.208	0.842	2.771	10.996	6.826
Totals	No. Sites	17	40	39	65	12	173
	HBW	0.383	1.122	0.562	0.899	0.252	0.876
	HBNW	11.593	7.752	2.122	10.266	23.914	11.255
	NHB	9.027	5.615	1.526	11.622	19.862	11.065
	All Purposes	4.906	6.030	1.517	9.423	18.556	9.483

Table 107
Auto Driver Model Attraction Rate
Coefficients of Variation
San Antonio

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	7	9	7	12	1	36
	HBW	0.108	0.329	0.226	0.261	0.000	0.278
	HBNW	7.042	12.093	3.880	1.966	0.000	6.235
	NHB	3.633	3.099	1.500	1.134	0.000	2.215
	All Purposes	1.762	4.331	1.299	1.140	0.000	2.392
Retail	No. Sites	4	16	14	33	4	71
	HBW	2.566	0.554	0.440	0.874	0.424	0.707
	HBNW	7.365	1.051	2.175	8.152	0.768	8.161
	NHB	4.458	1.377	1.390	9.903	0.656	10.662
	All Purposes	5.346	1.090	1.564	8.405	0.634	8.260
Service	No. Sites	6	15	18	20	7	66
	HBW	0.304	1.398	0.374	1.235	0.220	1.084
	HBNW	3.479	12.453	1.043	3.961	13.710	9.649
	NHB	3.498	7.216	1.174	2.508	10.756	7.680
	All Purposes	2.066	8.419	0.774	2.946	11.320	7.490
Totals	No. Sites	17	40	39	65	12	173
	HBW	0.415	1.046	0.366	0.898	0.294	.0838
	HBNW	7.219	8.086	2.122	11.536	24.223	13.106
	NHB	4.786	5.477	1.449	12.426	20.936	12.195
	All Purposes	2.360	5.889	1.421	10.247	18.963	10.568

Amarillo

The Amarillo workplace survey involved a total of 174 establishments. This is also the number of sites found with usable data. Table 108 presents some of the aggregate site statistics for the sites surveyed in Amarillo. In the Amarillo workplace survey, a total of 2,774 employees and 13,287 visitors were surveyed. The total expanded person trips involving the 174 sites were estimated to be nearly 150,000. Of that total, over 72 percent were attractions. Of the estimated person trip attractions, 12.3 percent were HBW, 51.4 percent were HBNW, and 36.3 percent were NHB. Tables 109 and 110 present the estimated person and auto driver trip attractions by trip purpose for surveyed workplaces stratified by employment type and area type. These data do not include NHB productions. All computed values have been rounded so the totals may not agree exactly.

The model attraction rates were computed next and are presented in Tables 111 and 112. Tables 113 and 114 present the coefficients of variation for each of the stratification cells and each trip purpose. Review of these attraction rates and the related site characteristics data reveals similar problems as observed in San Antonio. The imbalance between the household productions and aggregate estimates of attractions is less than San Antonio. This probably stems from the data having fewer errors in them and they appeared to be more consistent. There are, however, some obvious problems in the data which probably stem from two sources, small sample sizes and failure to recognize and account for sites located in activity centers with multiple establishments. For example, the retail attraction rate of nearly 50 per employee for HBNW attractions in Area Type 5 is very high when compared to the other area types. In that stratification, however, only three sites were surveyed and those sites had a total employment of 46. Review of the individual records for those sites indicates all three were small employers. Two of the three had person counts of several thousand. Net result was a very high attraction rate. There are several possibilities in a situation such as this. The first is that the data are correct and the problem is simply a very small sample which just happened to include sites with a lot of trips to them. The second is that the person counts are two way instead of one way. This would mean the resulting attraction rate is roughly double what it should have been. A third possibility is the sites were located in activity centers where the number of trips included persons traveling to other sites within the centers and were in effect double counted. The result is an estimated attraction rate which seems very out of line with the other rates in the observed data.

Table 108
Aggregate Workplace Survey Data
Amarillo

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	5	7	6	13	3	34
	Employees at Work	434	69	201	1047	145	1896
	Total Employment	639	143	224	1714	164	2884
	Surveyed Employees	212	38	101	449	61	861
	Surveyed Visitors	167	41	377	244	59	888
Retail	No. Sites	5	24	19	20	3	71
	Employees at Work	311	551	628	490	40	2020
	Total Employment	386	920	1357	1143	46	3852
	Surveyed Employees	92	254	224	184	18	772
	Surveyed Visitors	193	2731	2502	2798	316	8540
Service	No. Sites	9	19	15	22	4	69
	Employees at Work	732	307	372	743	113	2267
	Total Employment	1157	576	731	1427	307	4198
	Surveyed Employees	373	218	211	304	35	1141
	Surveyed Visitors	768	1176	479	1260	176	3859
Totals	No. Sites	19	50	40	55	10	174
	Employees at Work	1477	927	1201	2280	298	6183
	Total Employment	2182	1639	2312	4284	517	10934
	Surveyed Employees	677	510	536	937	114	2774
	Surveyed Visitors	1128	3948	3358	4302	551	13287

Table 109
Workplace Person Trip Attractions by Trip Purpose
Amarillo

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	5	7	6	13	3	34
	HBW	693	112	456	2155	236	3652
	HBNW	33	13	810	176	54	1086
	NHB	410	125	466	1131	168	2300
	All Purposes	1136	250	1732	3462	458	7038
Retail	No. Sites	5	24	19	20	3	71
	HBW	565	1128	1348	1337	111	4489
	HBNW	170	13364	13262	15276	2279	44351
	NHB	575	7186	8279	10237	1361	27638
	All Purposes	1310	21678	22889	26850	3751	76478
Service	No. Sites	9	19	15	22	4	69
	HBW	1209	628	1270	1797	235	5139
	HBNW	1286	3441	1019	2420	2027	10193
	NHB	2005	2866	1078	2490	922	9361
	All Purposes	4500	6935	3367	6707	3184	24693
Totals	No. Sites	19	50	40	55	10	174
	HBW	2467	1868	3075	5290	581	13281
	HBNW	1490	16818	15091	17872	4361	55632
	NHB	2989	10178	9823	13857	2450	39297
	All Purposes	6946	28864	27989	37019	7392	108210

Table 110
Workplace Auto-Driver Trip Attractions by Trip Purpose
Amarillo

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	5	7	6	13	3	34
	HBW	607	103	424	1916	199	3249
	HBNW	28	12	622	148	42	852
	NHB	312	100	381	937	130	1860
	All Purposes	947	215	1427	3001	371	5961
Retail	No. Sites	5	24	19	20	3	71
	HBW	513	936	1110	1106	87	3752
	HBNW	111	7282	9512	10626	1694	29225
	NHB	382	4237	5888	6657	945	18109
	All Purposes	1006	12455	16510	18389	2726	51086
Service	No. Sites	9	19	15	22	4	69
	HBW	1115	569	947	1524	194	4349
	HBNW	1124	2656	725	1859	974	7338
	NHB	1639	2320	818	1920	630	7327
	All Purposes	3878	5545	2490	5303	1798	19014
Totals	No. Sites	19	50	40	55	10	174
	HBW	2234	1608	2481	4546	480	11349
	HBNW	1263	9950	10858	12633	2710	37414
	NHB	2333	6656	7087	9514	1705	27295
	All Purposes	5830	18214	20426	26693	4895	76058

Table 111
Person Trip Attractions per Employee by Trip Purpose
Amarillo

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	5	7	6	13	3	34
	HBW	1.09	0.79	2.04	1.26	1.44	1.27
	HBNW	0.05	0.09	3.62	.010	0.33	0.38
	NHB	0.64	0.88	2.08	0.66	1.02	0.80
	All Purposes	1.78	1.76	7.74	2.02	2.79	2.45
Retail	No. Sites	5	24	19	20	3	71
	HBW	1.46	1.23	0.99	1.17	2.40	1.17
	HBNW	0.44	14.53	9.77	13.37	49.55	11.51
	NHB	1.49	7.81	6.10	8.96	29.58	7.18
	All Purposes	3.39	23.57	16.86	23.50	81.53	19.86
Service	No. Sites	9	19	15	22	4	69
	HBW	1.05	1.09	1.74	1.26	0.76	1.22
	HBNW	1.11	5.97	1.39	1.70	6.60	2.43
	NHB	1.73	4.98	1.48	1.75	3.00	2.23
	All Purposes	3.89	12.04	4.61	4.71	10.36	5.88
Totals	No. Sites	19	50	40	55	10	174
	HBW	1.13	1.14	1.33	1.24	1.13	1.22
	HBNW	0.68	10.26	6.53	4.17	8.43	5.09
	NHB	1.37	6.21	4.25	3.24	4.74	3.59
	All Purposes	3.18	17.61	12.11	8.65	14.30	9.90

Table 112
Auto Driver Trip Attractions per Employee by Trip Purpose
Amarillo

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	5	7	6	13	3	34
	HBW	0.95	0.72	1.89	1.12	1.22	1.13
	HBNW	0.04	0.08	2.78	0.09	0.26	0.30
	NHB	0.49	0.70	1.70	0.55	0.80	0.65
	All Purposes	1.48	1.50	6.37	1.76	2.28	2.07
Retail	No. Sites	5	24	19	20	3	71
	HBW	1.33	1.02	0.82	0.97	1.89	0.97
	HBNW	0.29	7.92	7.01	9.30	36.83	7.59
	NHB	0.99	4.61	4.34	5.82	20.54	4.70
	All Purposes	2.61	13.55	12.17	16.09	59.26	13.26
Service	No. Sites	9	19	15	22	4	69
	HBW	0.96	0.99	1.30	1.07	0.63	1.04
	HBNW	0.97	4.61	0.99	1.30	3.17	1.75
	NHB	1.42	4.03	1.12	1.35	2.05	1.75
	All Purposes	3.35	9.63	3.41	3.72	5.85	4.54
Totals	No. Sites	19	50	40	55	10	174
	HBW	1.02	0.98	1.07	1.06	0.93	1.04
	HBNW	0.58	6.07	4.70	2.95	5.24	3.42
	NHB	1.07	4.06	3.07	2.22	3.30	2.50
	All Purposes	2.67	11.11	8.84	6.23	9.47	6.96

Table 113
Person Model Attraction Rate
Coefficients of Variation
Amarillo

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	5	7	6	13	3	34
	HBW	0.578	0.850	0.292	0.975	0.415	0.718
	HBNW	44.692	3.857	1.278	3.597	3.725	5.320
	NHB	9.537	1.256	0.591	3.650	0.921	3.396
	All Purposes	4.917	0.987	0.799	1.820	0.951	1.881
Retail	No. Sites	5	24	19	20	3	71
	HBW	1.550	0.671	0.734	0.859	0.714	0.903
	HBNW	44.692	3.857	1.278	3.597	3.725	5.320
	NHB	18.914	1.062	2.350	2.779	0.688	2.511
	All Purposes	11.730	0.790	1.691	2.663	0.500	2.033
Service	No. Sites	9	19	15	22	4	69
	HBW	0.667	0.932	3.903	1.000	0.962	2.670
	HBNW	1.244	1.313	6.063	6.350	0.635	3.403
	NHB	0.978	1.065	4.182	3.360	0.480	2.307
	All Purposes	0.760	1.035	3.590	3.577	0.491	2.332
Totals	No. Sites	19	50	40	55	10	174
	HBW	1.118	0.762	3.140	0.924	1.057	1.805
	HBNW	11.387	1.032	1.821	6.519	2.425	3.524
	NHB	9.896	1.151	2.529	5.132	3.805	3.565
	All Purposes	6.004	0.941	1.847	4.874	2.624	2.964

Table 114
Auto Driver Model Attraction Rate
Coefficients of Variation
Amarillo

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	5	7	6	13	3	34
	HBW	0.631	0.876	0.372	1.014	0.375	0.748
	HBNW	45.540	3.723	1.304	3.355	3.725	5.343
	NHB	10.650	0.948	0.551	3.735	0.771	3.514
	All Purposes	5.044	0.895	0.774	1.795	0.889	1.845
Retail	No. Sites	5	24	19	20	3	71
	HBW	1.210	0.757	0.790	0.894	0.678	0.896
	HBNW	40.648	1.039	1.762	3.454	0.558	2.569
	NHB	12.355	1.497	2.609	3.414	0.574	2.860
	All Purposes	8.331	1.062	1.910	3.042	0.465	2.3502
Service	No. Sites	9	19	15	22	4	69
	HBW	0.632	1.009	2.538	1.043	0.943	1.687
	HBNW	1.229	1.514	5.605	7.124	0.669	3.928
	NHB	0.858	1.148	3.598	3.623	0.552	2.359
	All Purposes	0.693	1.161	2.975	3.866	0.417	2.437
Totals	No. Sites	19	50	40	55	10	174
	HBW	0.939	0.847	1.950	0.950	0.958	1.232
	HBNW	9.553	1.235	2.018	7.203	2.907	4.062
	NHB	5.812	1.409	2.704	5.871	3.504	3.798
	All Purposes	4.037	1.146	1.971	5.244	2.780	3.217

Aggregate estimates of the total number of person trip attractions that would be estimated using these rates were computed using total employment data for Amarillo from the 1990 census. The estimate of total person trip attractions was 645,000. This compares quite favorably with the expanded total person trip productions of just over 700,000. Comparing the percentages of trips by trip purpose indicates an imbalance between the two estimates. Based on the household estimates of person trip productions, just over 18 percent of the trip productions were HBW, about 50 percent were HBNW, and 32 percent were NHB. The attraction rates (using averages across all area types) when applied to the total employment estimates resulted in 16 percent estimated as HBW, 47 percent estimated as HBNW and 36 percent estimated as NHB. The imbalance in these estimates is not large and it does not take into account the residential attractions. It is unknown, however, the impact that the stratification by area type would have on the final estimates. A problem is still felt to exist with the methodology applied in the workplace survey.

In the same manner as the San Antonio workplace survey, coefficients of variation were computed for the sampled site model attraction rates within each stratification cell. These are presented in Tables 113 and 114 for the person and auto driver trip attraction rates by trip purpose.

Brownsville

The Brownsville workplace survey involved a total of 78 establishments. This was also found to be the number of sites with usable data. Table 115 presents the aggregate site statistics for the sites surveyed in Brownsville. In the Brownsville workplace survey, a total of 1,264 employees and 5,813 visitors were surveyed. The total expanded person trips involving the 78 sites were estimated to be over 90,000. Of that total, nearly 77 percent were attractions. Of the estimated person trip attractions, 12 percent were HBW, 56 percent were HBNW, and 32 percent were NHB. Tables 116 and 117 present the expanded person and auto driver trip attractions by trip purpose for the surveyed workplaces stratified by employment type and area type. These data do not include NHB productions. All computed values have been rounded so the totals may not agree exactly.

**Table 115
Aggregate Workplace Survey Data
Brownsville**

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	0	0	3	13	4	20
	Employees at Work	0	0	29	1770	825	2624
	Total Employment	0	0	33	2106	846	2985
	Surveyed Employees	0	0	23	400	128	551
	Surveyed Visitors	0	0	20	364	74	458
Retail	No. Sites	0	5	6	13	4	28
	Employees at Work	0	63	81	371	88	603
	Total Employment	0	237	147	478	98	960
	Surveyed Employees	0	39	47	151	27	264
	Surveyed Visitors	0	354	840	2197	532	3923
Service	No. Sites	1	2	3	21	3	30
	Employees at Work	12	18	84	592	72	778
	Total Employment	30	51	145	752	167	1145
	Surveyed Employees	9	10	69	312	49	449
	Surveyed Visitors	12	107	252	820	241	1432
Totals	No. Sites	1	7	12	47	11	78
	Employees at Work	12	81	194	2733	985	4005
	Total Employment	30	288	325	3336	1111	5090
	Surveyed Employees	9	49	139	863	204	1264
	Surveyed Visitors	12	461	1112	3381	847	5813

The model attraction rates were computed next by dividing the expanded attractions by the total employment (from the surveyed workplaces). The results for person and auto driver attractions are presented in Tables 118 and 119. Coefficients of variation are presented in Tables 120 and 121. The attraction rates again appear to be very high for the retail employment. This does not necessarily mean they are wrong. The most significant problem with the Brownsville data is that no observations were found in Area Type 1 for basic and retail and in Area Type 2 for basic. It was indicated in the final report for the Brownsville workplace survey that no basic establishments were found in Area Types 1 and 2. The difficulty in this situation is that future conditions may change and when it does, an attraction rate would be needed for modeling travel demand. Future surveys should avoid this situation by pre-surveying businesses in an urban area to determine estimates of the number (both establishments and employment) that fall within each of the stratification categories to ensure the proposed sampling plan will produce reasonable results.

Using aggregate estimates of employment by type from the 1990 census, the total trip rates for each category of employment were used to generate approximate estimates of the total attractions within the Brownsville area. This method resulted in estimated total person trip attractions exceeding 500,000. The estimated total person trip productions from the household survey was just less than 300,000. This imbalance between the estimates of productions and attractions is significant and indicates a serious problem. Identifying the exact nature of the problem is very difficult. Part of the problem is felt to stem from the methodology used in the workplace survey. Another part of the problem, especially with respect to Brownsville, was the inability to identify and remove external trips. It is suspected that a large number of persons travel across the border in Brownsville to shop and pursue normal activities. These trips are not accounted for in the household survey and could be a significant proportion of the resulting imbalance in the two estimates. The lack of geocoding of the survey data in the workplace surveys prevented the identification and removal of these trips. Relative to the percentages of trips by trip purpose, again the productions and attractions do not match. The household survey had 15 percent of the person trip productions as HBW, 57 percent as HBNW, and 28 percent as NHB. The workplace survey (aggregate estimates) had 10 percent of the person trip attractions as HBW, 57 percent of the attractions as HBNW and 33 percent as NHB.

Table 116
Workplace Person Trip Attractions by Trip Purpose
Brownsville

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	0	0	3	13	4	20
	HBW	0	0	90	2958	1780	4828
	HBNW	0	0	22	3127	25	3174
	NHB	0	0	117	1135	504	1756
	All Purposes	0	0	229	7220	2309	9758
Retail	No. Sites	0	5	6	13	4	28
	HBW	0	220	250	942	158	1570
	HBNW	0	6206	5799	17721	1616	31342
	NHB	0	3583	2576	10411	1293	17863
	All Purposes	0	10009	8625	29074	3067	50775
Service	No. Sites	1	2	3	21	3	30
	HBW	29	31	268	1255	181	1764
	HBNW	25	118	622	3245	833	4843
	NHB	52	166	311	2040	334	2903
	All Purposes	106	316	1200	6540	1348	9510
Totals	No. Sites	1	7	12	47	11	78
	HBW	29	251	607	5155	2119	8161
	HBNW	25	6324	6443	24093	2474	39359
	NHB	52	3749	3004	13587	2131	22523
	All Purposes	106	10324	10054	42835	6724	70043

Table 117
Workplace Auto Driver Trip Attractions by Trip Purpose
Brownsville

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	0	0	3	13	4	20
	HBW	0	0	70	2093	1504	3667
	HBNW	0	0	19	1852	11	1882
	NHB	0	0	98	861	395	1354
	All Purposes	0	0	187	4806	1910	6902
Retail	No. Sites	0	5	6	13	4	28
	HBW	0	151	159	708	136	1154
	HBNW	0	1595	2424	10462	917	15398
	NHB	0	988	1346	6377	805	9516
	All Purposes	0	2734	3929	17547	1858	26068
Service	No. Sites	1	2	3	21	3	30
	HBW	22	15	138	1018	158	1351
	HBNW	18	91	448	1808	547	2912
	NHB	45	122	231	1600	247	2245
	All Purposes	85	228	817	4426	952	6508
Totals	No. Sites	1	7	12	47	11	78
	HBW	22	166	367	3819	1798	6172
	HBNW	18	1685	2891	14121	1475	20190
	NHB	45	1110	1675	8838	1446	13114
	All Purposes	85	2961	4933	26778	4719	39476

**Table 118
Person Trip Attractions per Employee by Trip Purpose
Brownsville**

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	0	0	3	13	4	20
	HBW	0	0	2.72	1.41	2.10	1.62
	HBNW	0	0	0.66	1.49	0.03	1.06
	NHB	0	0	3.54	0.54	0.60	0.59
	All Purposes	0	0	6.92	3.44	2.73	3.27
Retail	No. Sites	0	5	6	13	4	28
	HBW	0	0.93	1.70	1.97	1.61	1.63
	HBNW	0	26.19	39.45	37.07	16.49	32.65
	NHB	0	15.12	17.53	21.78	13.20	18.61
	All Purposes	0	42.24	58.68	60.82	31.30	52.89
Service	No. Sites	1	2	3	21	3	30
	HBW	0.97	0.61	1.85	1.67	1.09	1.54
	HBNW	0.84	2.31	4.29	4.32	4.99	4.23
	NHB	1.73	3.26	2.14	2.71	2.00	2.54
	All Purposes	3.54	6.18	8.28	8.70	8.08	8.31
Totals	No. Sites	1	7	12	47	11	78
	HBW	0.97	0.87	1.87	1.55	1.91	1.60
	HBNW	0.84	21.96	19.83	7.22	2.23	7.73
	NHB	1.73	13.02	9.24	4.07	1.92	4.43
	All Purposes	3.54	35.85	30.94	12.84	6.06	13.76

Table 119
Auto Driver Trip Attractions per Employee by Trip Purpose
Brownsville

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	0	0	3	13	4	20
	HBW	0	0	2.11	0.99	1.78	1.23
	HBNW	0	0	0.57	0.88	0.01	0.63
	NHB	0	0	2.97	0.41	0.47	0.45
	All Purposes	0	0	5.65	2.28	2.26	2.31
Retail	No. Sites	0	5	6	13	4	28
	HBW	0	0.64	1.08	1.48	1.39	1.20
	HBNW	0	6.73	16.49	21.89	9.35	16.04
	NHB	0	4.17	9.16	13.34	8.21	9.91
	All Purposes	0	11.54	26.73	36.71	18.95	27.15
Service	No. Sites	1	2	3	21	3	30
	HBW	0.73	0.29	0.95	1.35	0.95	1.18
	HBNW	0.59	1.78	3.09	2.40	3.28	2.54
	NHB	1.51	2.40	1.59	2.13	1.48	1.96
	All Purposes	2.83	4.47	5.63	5.88	5.71	5.68
Totals	No. Sites	1	7	12	47	11	78
	HBW	0.73	0.58	1.13	1.15	1.62	1.21
	HBNW	0.59	5.85	8.90	4.23	1.33	3.97
	NHB	1.51	3.86	5.15	2.65	1.30	2.58
	All Purposes	2.83	10.29	15.18	8.03	4.25	7.76

Table 120
Person Model Attraction Rate
Coefficients of Variation
Brownsville

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	0	0	3	13	4	20
	HBW	0.000	0.000	0.554	0.702	0.137	0.665
	HBNW	0.000	0.000	0.763	0.870	162.239	1.883
	NHB	0.000	0.000	0.867	2.703	12.356	6.086
	All Purposes	0.000	0.000	0.687	0.593	4.515	1.705
Retail	No. Sites	0	5	6	13	4	28
	HBW	0.000	1.483	1.174	0.523	0.330	0.745
	HBNW	0.000	2.025	2.679	1.157	6.834	2.094
	NHB	0.000	1.564	2.058	0.922	2.355	1.293
	All Purposes	0.000	1.802	2.370	0.955	4.511	1.685
Service	No. Sites	1	2	3	21	3	30
	HBW	0.000	2.097	0.514	1.405	0.993	1.307
	HBNW	0.000	1.401	1.014	22.501	2.666	19.119
	NHB	0.000	1.937	0.921	5.900	1.165	5.271
	All Purposes	0.000	1.753	0.618	12.941	1.941	11.262
Totals	No. Sites	1	7	12	47	11	78
	HBW	0.000	1.428	0.862	1.114	0.323	0.952
	HBNW	0.000	2.081	4.105	9.530	30.285	8.818
	NHB	0.000	1.584	3.092	4.386	11.947	4.693
	All Purposes	0.000	1.838	3.501	6.468	14.559	6.247

Table 121
Auto Driver Model Attraction Rate
Coefficients of Variation
Brownsville

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	0	0	3	13	4	20
	HBW	0.000	0.000	0.537	1.019	0.200	0.812
	HBNW	0.000	0.000	0.762	0.949	162.239	1.533
	NHB	0.000	0.000	0.853	3.267	10.212	5.764
	All Purposes	0.000	0.000	0.666	0.834	3.170	1.641
Retail	No. Sites	0	5	6	13	4	28
	HBW	0.000	1.581	0.656	0.621	0.356	0.699
	HBNW	0.000	1.992	2.322	1.141	5.889	1.855
	NHB	0.000	1.280	2.074	0.879	2.123	1.313
	All Purposes	0.000	11.604	2.089	0.940	3.741	1.509
Service	No. Sites	1	2	3	21	3	30
	HBW	0.000	2.023	0.953	1.115	0.810	1.124
	HBNW	0.000	1.595	0.997	18.132	2.334	14.289
	NHB	0.000	2.246	1.397	5.266	0.764	4.784
	All Purposes	0.000	2.174	0.638	2.686	1.241	2.418
Totals	No. Sites	1	7	12	47	11	78
	HBW	0.000	1.527	1.012	1.069	0.377	0.888
	HBNW	0.000	1.941	3.385	7.633	25.199	7.662
	NHB	0.000	1.259	2.869	4.244	10.111	4.515
	All Purposes	0.000	1.544	2.893	5.255	10.634	5.252

Tyler

The Tyler workplace survey involved 138 establishments and the data from all of them were found to be usable. Table 122 presents the aggregate site statistics for the establishments surveyed in Tyler. A total of 1,455 employees and 12,487 visitors were surveyed. The total expanded person trips involving the 138 sites were estimated to be just over 71,000. Of that total, just over 70 percent were attractions. Of the estimated person attractions at these sites, 7 percent were HBW, 47 percent were HBNW and 46 percent were NHB. Tables 123 and 124 present the expanded person and auto driver attractions for those surveyed sites. These data do not include NHB productions, and all computed values have been rounded so the totals may not agree exactly.

The model attraction rates were computed and are presented in Tables 125 and 126. The coefficients of variation are presented in Tables 127 and 128. The most obvious difference between these data and those presented for San Antonio, Amarillo, and Brownsville is that only three area types were coded. This resulted in more observations within each of the stratification cells, and the resulting attraction rates do not show the large fluctuations observed in the other three urban areas. Using the aggregate estimates of employment by employment type from the 1990 census and applying the average attraction rates (averaged across all area types), approximations of the number of person trip attractions expected to result from the use of these rates were computed. The estimate of total person trip attractions was 660,000. This exceeded the estimated person trip productions of just over 500,000 from the Tyler household survey. The breakdown of the person trip attractions by trip purpose showed 12 percent were HBW, 45 percent were HBNW, and 43 percent were NHB. The same breakdown for trip productions from the household survey was 19 percent HBW, 49 percent HBNW and 32 percent NHB. There is again a large discrepancy between the results from the household survey and the workplace survey. It is still felt that a significant portion of the problem lies with the methodology used in the workplace survey. In addition, the Tyler study area had a very tight study area cordon boundary with a significant number of external trips to the area. The inability to identify and remove these trips from the workplace survey also contributed to the problem.

Table 122
Aggregate Workplace Survey Data
Tyler

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	9	15	18			42
	Employees at Work	107	194	236			537
	Total Employment	279	312	403			994
	Surveyed Employees	102	189	225			516
	Surveyed Visitors	337	373	290			1000
Retail	No. Sites	17	18	12			47
	Employees at Work	153	268	150			571
	Total Employment	465	514	468			1447
	Surveyed Employees	150	230	145			525
	Surveyed Visitors	3291	4279	2461			10031
Service	No. Sites	15	20	14			49
	Employees at Work	185	139	106			430
	Total Employment	309	336	250			895
	Surveyed Employees	181	132	101			414
	Surveyed Visitors	343	530	583			1456
Totals	No. Sites	41	53	44			138
	Employees at Work	445	601	492			1538
	Total Employment	1053	1162	1121			3336
	Surveyed Employees	433	551	471			1455
	Surveyed Visitors	3971	5182	3334			12487

Table 123
Workplace Person Trip Attractions by Trip Purpose
Tyler

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	9	15	18			42
	HBW	245	360	471			1076
	HBNW	922	503	180			1605
	NHB	809	653	535			1997
	All Purposes	1976	1516	1186			4678
Retail	No. Sites	17	18	12			47
	HBW	284	518	327			1129
	HBNW	5131	8662	5474			19267
	NHB	7105	7772	4035			18912
	All Purposes	12520	16952	9836			39308
Service	No. Sites	15	20	14			49
	HBW	515	626	210			1351
	HBNW	184	780	1731			2695
	NHB	641	762	890			2293
	All Purposes	1340	2168	2831			6339
Totals	No. Sites	41	53	44			138
	HBW	1044	1504	1009			3557
	HBNW	6236	9945	7385			23566
	NHB	8554	9187	5460			23201
	All Purposes	15834	20636	13854			50324

Table 124
Workplace Auto Driver Trip Attractions by Trip Purpose
Tyler

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	9	15	18			42
	HBW	222	329	427			978
	HBNW	752	465	149			1366
	NHB	699	602	496			1797
	All Purposes	1673	1396	1072			4141
Retail	No. Sites	17	18	12			47
	HBW	252	455	293			1000
	HBNW	3619	6327	3996			13942
	NHB	5105	5642	2951			13698
	All Purposes	8976	12424	7240			28640
Service	No. Sites	15	20	14			49
	HBW	430	534	192			1156
	HBNW	168	618	1065			1851
	NHB	553	612	636			1801
	All Purposes	1151	1764	1893			4808
Totals	No. Sites	41	53	44			138
	HBW	904	1318	913			3135
	HBNW	4539	7410	5210			17159
	NHB	6358	6855	4083			17296
	All Purposes	11801	15583	10206			37590

Table 125
Person Trip Attractions per Employee by Purpose
Tyler

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	9	15	18			42
	HBW	0.88	1.15	1.17			1.08
	HBNW	3.30	1.61	0.45			1.61
	NHB	2.90	2.09	1.33			2.01
	All Purposes	7.08	4.85	2.95			4.70
Retail	No. Sites	17	18	12			47
	HBW	0.61	1.01	0.70			0.78
	HBNW	11.03	16.85	11.70			13.32
	NHB	15.28	15.12	8.62			13.07
	All Purposes	26.92	32.98	21.02			27.17
Service	No. Sites	15	20	14			49
	HBW	1.67	1.86	0.84			1.51
	HBNW	0.60	2.32	6.93			3.01
	NHB	2.07	2.27	3.56			2.56
	All Purposes	4.34	6.45	11.33			7.08
Totals	No. Sites	41	53	44			138
	HBW	0.99	1.30	0.90			1.07
	HBNW	5.92	8.56	6.59			7.06
	NHB	8.12	7.91	4.87			6.96
	All Purposes	15.03	17.77	12.36			15.09

Table 126
Auto Driver Attractions per Employee by Purpose
Tyler

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	9	15	18			42
	HBW	0.80	1.06	1.06			0.98
	HBNW	2.70	1.49	0.37			1.37
	NHB	2.51	1.93	1.23			1.81
	All Purposes	6.01	4.48	2.66			4.16
Retail	No. Sites	17	18	12			47
	HBW	0.54	0.89	0.63			0.69
	HBNW	7.78	12.31	8.54			9.64
	NHB	10.98	10.98	6.31			9.47
	All Purposes	19.30	24.18	15.48			19.80
Service	No. Sites	15	20	14			49
	HBW	1.39	1.59	0.77			1.29
	HBNW	0.54	1.84	4.26			2.07
	NHB	1.79	1.82	2.54			2.01
	All Purposes	3.72	5.25	7.57			5.37
Totals	No. Sites	41	53	44			138
	HBW	0.86	1.13	0.81			0.94
	HBNW	4.31	6.38	4.65			5.14
	NHB	6.04	5.90	3.64			5.19
	All Purposes	11.21	13.41	9.10			11.27

Table 127
Person Model Attraction Rate
Coefficients of Variation
Tyler

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	9	15	18	0	0	42
	HBW	0.899	0.693	0.600	0.000	0.000	0.694
	HBNW	1.728	5.112	5.032	0.000	0.000	3.517
	NHB	2.395	3.285	1.609	0.000	0.000	2.640
	All Purposes	1.748	3.103	1.372	0.000	0.000	2.299
Retail	No. Sites	17	18	12	0	0	47
	HBW	1.125	0.524	1.638	0.000	0.000	0.952
	HBNW	1.436	0.452	0.555	0.000	0.000	0.815
	NHB	0.680	0.457	0.476	0.000	0.000	0.624
	All Purposes	0.929	0.413	0.464	0.000	0.000	0.660
Service	No. Sites	15	20	14	0	0	49
	HBW	1.017	0.722	0.848	0.000	0.000	0.897
	HBNW	7.431	1.536	3.117	0.000	0.000	3.978
	NHB	3.129	0.871	2.463	0.000	0.000	2.301
	All Purposes	2.604	0.729	2.666	0.000	0.000	2.438
Totals	No. Sites	41	53	44	0	0	138
	HBW	1.390	0.792	0.934	0.000	0.000	1.013
	HBNW	1.980	0.887	1.931	0.000	0.000	1.501
	NHB	1.135	0.840	1.139	0.000	0.000	1.054
	All Purposes	1.327	0.757	1.450	0.000	0.000	1.126

Table 128
Auto Driver Model Attraction Rate
Coefficients of Variation
Tyler

Employment Type	Data Element	Area Type					Totals
		1	2	3	4	5	
Basic	No. Sites	9	15	18	0	0	42
	HBW	0.982	0.699	0.546	0.000	0.000	0.687
	HBNW	1.799	5.146	5.156	0.000	0.000	3.772
	NHB	2.375	3.260	1.599	0.000	0.000	2.629
	All Purposes	1.758	3.103	1.303	0.000	0.000	2.342
Retail	No. Sites	17	18	12	0	0	47
	HBW	1.075	0.560	1.598	0.000	0.000	0.941
	HBNW	1.453	0.430	0.525	0.000	0.000	0.799
	NHB	0.600	0.453	0.470	0.000	0.000	0.575
	All Purposes	0.902	0.409	0.433	0.000	0.000	0.634
Service	No. Sites	15	20	14	0	0	49
	HBW	1.219	0.694	0.800	0.000	0.000	0.953
	HBNW	7.178	1.516	3.999	0.000	0.000	4.567
	NHB	3.281	0.897	2.803	0.000	0.000	2.485
	All Purposes	2.743	0.681	3.170	0.000	0.000	2.589
Totals	No. Sites	41	53	44	0	0	138
	HBW	1.532	0.781	0.880	0.000	0.000	1.040
	HBNW	1.974	0.932	2.136	0.000	0.000	1.574
	NHB	1.090	0.862	1.221	0.000	0.000	1.056
	All Purposes	1.291	0.780	1.545	0.000	0.000	1.146

Sherman-Denison

The Sherman-Denison workplace survey involved a total of 147 sites, all of which were usable. Table 129 presents some of the aggregate site statistics for the sites surveyed in the Sherman-Denison area. A total of 1,277 employees and 7,128 visitors were surveyed. The total expanded person trips involving those 147 establishments was estimated to be over 55,000. Of that total, 73 percent were attractions. Of the estimated 40,000 plus attractions, 15 percent were HBW, 51 percent were HBNW, and 34 percent were NHB. Tables 130 and 131 present the expanded person and auto driver attractions for the 147 surveyed sites stratified by employment type and area type. These data do not include NHB productions, and all values have been rounded.

The model attraction rates were computed and are presented in Tables 132 and 133. The computed coefficients of variations for the weighted model attraction rates are presented in Tables 134 and 135. The first observation made is that six area types were coded in Sherman-Denison. This resulted in very small observations in some of the stratification cells. Using aggregate estimates of employment by employment type from the 1990 census and applying the average attraction rates (averaged across all area types), estimates of the number of person trip attractions expected from the application of these rates were computed. The estimated total person trip attractions was nearly 350,000. This exceeded the estimated total person trip productions from the household survey of 331,000 but only by a little over 5 percent. The breakdown of person trip attractions by trip purpose resulted in 19 percent estimated as HBW, 48 percent estimated as HBNW, and 33 percent estimated as NHB. The same breakdown for person trip productions from the household survey was 16 percent HBW, 50 percent HBNW, and 34 percent NHB. While a small discrepancy exists between the household and workplace survey results, it is not known without actually doing detailed modeling whether the estimates would balance when using these attraction rates. It is felt that the low number of observations in some of the stratifications would warrant further adjustment of the attraction rates which might lead to a further imbalance between the two estimates. It should also be noted that these computations did not include residential attractions which would be a part of the total estimates of household productions. Even though the difference between the total estimates is relatively small, the attractions still exceed the productions; and if the residential attractions were included, the difference would be more.

Table 129
Aggregate Workplace Survey Data
Sherman-Denison

Employment Type	Data Element	Area Type						Totals
		1	2	3	4	5	6	
Basic	No. Sites	5	5	13	12	1	9	45
	Employees at Work	29	78	414	198	3	1113	1835
	Total Employment	30	90	516	229	3	1117	1985
	Surveyed Employees	25	25	169	96	3	230	548
	Surveyed Visitors	40	68	216	231	0	55	610
Retail	No. Sites	13	15	14	5	2	16	65
	Employees at Work	67	94	215	83	51	219	729
	Total Employment	75	112	325	175	66	316	1069
	Surveyed Employees	44	64	103	44	27	120	402
	Surveyed Visitors	574	950	1376	1098	135	1341	5474
Service	No. Sites	4	7	6	5	2	13	37
	Employees at Work	25	71	41	154	12	316	619
	Total Employment	28	79	54	222	12	383	778
	Surveyed Employees	19	49	26	46	8	179	327
	Surveyed Visitors	177	162	44	121	87	205	796
Totals	No. Sites	22	27	33	22	5	38	147
	Employees at Work	121	243	670	435	66	1648	3183
	Total Employment	133	281	895	626	81	1816	3832
	Surveyed Employees	88	138	298	186	38	529	1277
	Surveyed Visitors	791	1180	1636	1450	222	1601	6880

Table 130
Workplace Person Trip Attractions by Trip Purpose
Sherman-Denison

Employment Type	Data Element	Area Type						Totals
		1	2	3	4	5	6	
Basic	No. Sites	5	5	13	12	1	9	45
	HBW	50	159	737	425	6	2053	3430
	HBNW	26	102	183	240	0	53	604
	NHB	76	151	574	361	0	729	1892
	All Purposes	152	412	1494	1026	6	2835	5925
Retail	No. Sites	13	15	14	5	2	16	65
	HBW	135	187	401	163	122	501	1509
	HBNW	928	1481	4025	3710	465	7881	18490
	NHB	877	1345	2177	1723	354	3742	10218
	All Purposes	1940	3013	6603	5596	941	12124	30217
Service	No. Sites	4	7	6	5	2	13	37
	HBW	53	140	70	292	23	599	1177
	HBNW	316	241	122	177	131	517	1504
	NHB	270	283	128	198	47	416	1342
	All Purposes	639	664	320	667	201	1532	4023
Totals	No. Sites	22	27	33	22	5	38	147
	HBW	237	485	1208	880	151	3152	6113
	HBNW	1270	1824	4331	4127	596	8451	20599
	NHB	1222	1779	2879	2283	401	4887	13451
	All Purposes	2729	4088	8418	7290	1148	16490	40163

Table 131
Workplace Auto Driver Trip Attractions by Trip Purpose
Sherman-Denison

Employment Type	Data Element	Area Type						Totals
		1	2	3	4	5	6	
Basic	No. Sites	5	5	13	12	1	9	45
	HBW	46	157	714	391	3	1850	3161
	HBNW	23	82	144	207	0	50	506
	NHB	69	136	521	312	0	653	1691
	All Purposes	138	375	1379	910	3	2553	5358
Retail	No. Sites	13	15	14	5	2	16	65
	HBW	106	166	350	132	110	406	1270
	HBNW	719	1166	3211	3013	282	5525	13916
	NHB	675	1028	1644	1368	236	2671	7622
	All Purposes	1500	2360	5205	4513	628	8602	22808
Service	No. Sites	4	7	6	5	2	13	37
	HBW	48	133	67	232	23	522	1025
	HBNW	271	229	63	151	112	449	1275
	NHB	218	259	83	178	39	351	1128
	All Purposes	537	621	213	561	174	1322	3428
Totals	No. Sites	22	27	33	22	5	38	147
	HBW	199	456	1130	754	137	2778	5454
	HBNW	1013	1477	3419	3370	394	6024	15697
	NHB	962	1423	2249	1858	275	3675	10442
	All Purposes	2174	3356	6798	5982	806	12477	31593

Table 132
Person Trip Attractions per Employee by Trip Purpose
Sherman-Denison

Employment Type	Data Element	Area Type						Totals
		1	2	3	4	5	6	
Basic	No. Sites	5	5	13	12	1	9	45
	HBW	1.65	1.77	1.43	1.86	2.00	1.84	1.73
	HBNW	0.86	1.13	0.35	1.05	0.00	0.05	0.30
	NHB	2.53	1.68	1.11	1.58	0.00	0.66	1.03
	All Purposes	5.04	4.58	2.89	4.49	2.00	2.55	3.06
Retail	No. Sites	13	15	14	5	2	16	65
	HBW	1.80	1.67	1.23	0.93	1.85	1.59	1.41
	HBNW	12.37	13.23	12.39	21.20	7.05	24.94	17.30
	NHB	11.69	12.01	6.70	9.85	5.36	11.84	9.56
	All Purposes	25.86	26.91	20.32	31.98	14.26	38.37	28.27
Service	No. Sites	4	7	6	5	2	13	37
	HBW	1.88	1.77	1.29	1.32	1.94	1.56	1.51
	HBNW	11.27	3.05	2.27	0.80	10.89	1.35	1.93
	NHB	9.63	3.58	2.36	0.89	3.93	1.09	1.72
	All Purposes	22.78	8.40	5.92	3.01	16.76	4.00	5.16
Totals	No. Sites	22	27	33	22	5	38	147
	HBW	1.78	1.73	1.35	1.41	1.87	1.74	1.60
	HBNW	9.55	6.49	4.84	6.59	7.36	4.65	5.38
	NHB	9.19	6.33	3.22	3.65	4.95	2.69	3.51
	All Purposes	20.52	14.55	9.41	11.65	14.18	9.08	10.49

Table 133
Auto Driver Trip Attractions per Employee by Trip Purpose
Sherman-Denison

Employment Type	Data Element	Area Type						Totals
		1	2	3	4	5	6	
Basic	No. Sites	5	5	13	12	1	9	45
	HBW	1.53	1.75	1.38	1.71	1.00	1.66	1.59
	HBNW	0.77	0.91	0.28	0.90	0.00	0.05	0.26
	NHB	2.31	1.51	1.01	1.36	0.00	0.59	0.85
	All Purposes	4.61	4.17	2.67	3.97	1.00	2.30	2.70
Retail	No. Sites	13	15	14	5	2	16	65
	HBW	1.41	1.48	1.08	0.76	1.67	1.28	1.19
	HBNW	9.59	10.41	9.88	17.22	4.28	17.48	13.02
	NHB	9.00	9.18	5.06	7.82	3.58	8.45	7.13
	All Purposes	20.00	21.07	16.02	25.80	9.53	27.22	21.34
Service	No. Sites	4	7	6	5	2	13	37
	HBW	1.71	1.68	1.24	1.04	1.93	1.36	1.32
	HBNW	9.67	2.90	1.17	0.68	9.33	1.17	1.64
	NHB	7.78	3.28	1.54	0.80	3.29	0.92	1.45
	All Purposes	19.16	7.86	3.95	2.52	14.55	3.45	4.40
Totals	No. Sites	22	27	33	22	5	38	147
	HBW	1.50	1.62	1.26	1.21	1.69	1.53	1.42
	HBNW	7.62	5.26	3.82	5.38	4.87	3.32	4.10
	NHB	7.23	5.06	2.51	2.97	3.40	2.02	2.73
	All Purposes	16.35	11.94	7.59	9.56	9.96	6.87	8.25

Table 134
Person Model Attraction Rate
Coefficients of Variation
Sherman-Denison

Employment Type	Data Element	Area Type						Totals
		1	2	3	4	5	6	
Basic	No. Sites	5	5	13	12	1	9	45
	HBW	0.353	0.856	0.536	0.257	0.000	0.227	0.398
	HBNW	1.710	10.243	12.211	15.271	0.000	3.763	30.291
	NHB	0.667	4.492	3.346	6.866	0.000	2.219	6.741
	All Purposes	0.511	4.037	2.752	5.994	0.000	0.660	5.205
Retail	No. Sites	13	15	14	5	2	16	65
	HBW	0.752	0.395	1.215	1.204	0.260	1.446	1.079
	HBNW	1.027	0.900	0.518	0.912	0.159	2.174	1.679
	NHB	0.649	1.033	0.690	0.896	0.847	3.064	2.023
	All Purposes	0.737	0.867	0.437	0.805	0.077	2.362	1.692
Service	No. Sites	4	7	6	5	2	13	37
	HBW	0.531	0.381	1.013	0.506	0.040	0.638	0.598
	HBNW	0.945	2.243	8.898	0.610	0.456	6.884	5.600
	NHB	0.595	1.366	6.276	1.383	0.812	3.840	4.088
	All Purposes	0.686	1.107	5.846	0.550	0.492	3.351	3.413
Totals	No. Sites	22	27	33	22	5	38	147
	HBW	0.635	0.481	0.867	0.513	0.139	0.881	0.771
	HBNW	1.152	1.645	1.973	2.534	0.723	8.167	4.008
	NHB	0.736	1.680	2.230	2.627	0.605	9.312	4.173
	All Purposes	0.823	1.414	1.718	2.206	0.547	6.979	3.432

Table 135
Auto Driver Model Attraction Rate
Coefficients of Variation
Sherman-Denison

Employment Type	Data Element	Area Type						Totals
		1	2	3	4	5	6	
Basic	No. Sites	5	5	13	12	1	9	45
	HBW	0.307	0.792	0.551	0.271	0.000	0.282	0.423
	HBNW	1.710	10.268	13.245	15.163	0.000	4.006	30.620
	NHB	0.675	4.008	3.296	6.849	0.000	2.411	6.494
	All Purposes	0.508	3.542	2.657	5.812	0.000	0.713	4.920
Retail	No. Sites	13	15	14	5	2	16	65
	HBW	1.036	0.483	1.466	1.889	0.450	1.582	1.222
	HBNW	1.004	0.810	0.545	0.946	0.032	2.287	1.712
	NHB	0.628	0.807	0.544	0.775	0.194	3.274	2.019
	All Purposes	0.719	0.711	0.407	0.814	0.166	2.559	1.704
Service	No. Sites	4	7	6	5	2	13	37
	HBW	0.501	0.398	1.074	0.393	0.046	0.842	0.730
	HBNW	0.865	2.363	6.795	0.595	0.426	7.408	4.583
	NHB	0.660	1.420	3.911	1.577	0.867	4.209	3.021
	All Purposes	0.669	1.481	3.456	0.611	0.475	3.508	2.645
Totals	No. Sites	22	27	33	22	5	38	147
	HBW	0.777	0.512	0.956	0.572	0.321	0.922	0.773
	HBNW	1.100	1.526	1.426	2.574	0.965	8.830	4.035
	NHB	0.705	1.366	1.517	2.622	0.659	9.421	4.002
	All Purposes	0.783	1.199	1.148	2.224	0.689	7.070	3.312

Comparison of Attraction Rates

There were a number of ways by which comparison of the attraction rates from the workplace surveys could be done. Evaluation of the survey analyses for each of the urban areas indicated that comparing the results between the urban areas would produce no meaningful results. As discussed in the previous sections, the methodology used in the workplace survey appears to be flawed. The resulting attraction rates do not appear usable without adjusting to account for the potential double counting that may have occurred for all the establishments surveyed that were located in activity centers with other workplaces. A revised survey methodology was proposed and is presented in Reference 12. That methodology was used in subsequent workplace surveys in Beaumont-Port Arthur and El Paso. Results of an evaluation of the pilot workplace survey in Beaumont-Port Arthur indicates that a significant difference is expected between the attraction rates for freestanding versus non-freestanding workplaces (35). It is believed that when the full results are available from those surveys, adjustments may be made to the results from the workplace surveys done in 1990 and 1991 to develop reasonable attraction rates for use in travel demand models. Since the data from those surveys were not available at the writing of this report, that analysis has not been done.

It was noted in the previous section that the workplace surveys in Amarillo and Brownsville did identify whether each workplace was freestanding or non-freestanding. While these sites were identified, the survey methodology used was still the same. An analysis of the attraction rates by freestanding and non-freestanding was done in conjunction with the analysis of the pilot workplace survey in the Beaumont-Port Arthur survey. The results are documented in Reference 35.

Aside from the problem with the survey methodology, comparisons between the urban areas were felt to be difficult due to potential differences in area type definitions and the small number of observations in many of the stratification cells. Variance estimates between establishments within each stratification cell were typically quite high. The use of test such as the paired "t" test may indicate no statistical difference between trip rates even though the numerical difference is quite large. While comparison test was not considered practical, the decision was made to use results from the household surveys and preliminary data from the Beaumont-Port Arthur survey and Houston survey to develop adjusted attraction rates for use in travel demand modeling efforts pending the final receipt and analysis of the full workplace surveys from Beaumont-Port Arthur and El Paso.

Attraction Rate Adjustments

Adjusted attraction rates were developed for the urban areas using the results of the analysis of the pilot survey in Beaumont-Port Arthur and assumptions concerning the distributions of freestanding and non-freestanding workplaces and households within urban areas. Preliminary survey data were available from the Beaumont-Port Arthur and Houston surveys that provided information on the estimated percentages of freestanding and non-freestanding workplaces by employment type and area type. This was combined with the data from Amarillo, and the results from those three surveys are presented in Table 136. Data from the Brownsville workplace survey were not used because of the number of stratification cells with no observations. The data in Table 136 for Amarillo reflect the distribution of the establishments that were surveyed. The data for Beaumont-Port Arthur and Houston reflect the results of a survey designed to provide those estimates.

While no two urban areas are alike in terms of development types and densities, using the data in Table 136, the percentage of freestanding and non-freestanding workplaces by area type and employment type were estimated based on professional judgment and, in certain cases such as San Antonio, knowledge of the area. Tables 137 through 140 present the assumed values for each of the urban areas with the exception of Amarillo, which is presented in Table 136.

Using the estimates of the percentage of freestanding and non-freestanding workplaces by area type and employment type, the assumption was made that the surveyed attractions in each area were representative of the attractions within each stratification cell in the same proportions. For example, if the surveyed attractions for basic employment in Area Type 1 was 2000 in San Antonio and the percentage of freestanding workplaces for that stratification cell was 20 percent, then 20 percent of the 2000 person trip attractions (i.e., 400) were assumed to be for freestanding workplaces.

Table 141 presents the results of the analysis of the Beaumont-Port Arthur pilot survey of workplaces relative to the differences in the attractions of freestanding versus non-freestanding workplaces. It was then possible to adjust the estimated attractions for non-freestanding workplaces using the information in Table 141. Using the previous example, 1600 of the HBNW person trip attractions for basic employment in Area Type 1 would be for non-freestanding workplaces. Since these sites had been surveyed as freestanding sites, the attractions are estimated to be 37 percent higher than they would be if they had been surveyed as non-freestanding sites. The 1600 HBNW

person trip attractions would be multiplied by 0.63 to estimate the number of true HBNW attractions to those non-freestanding sites. The total HBNW person trip attractions for basic employment in Area Type 1 would then be the sum of 400 (for freestanding workplaces) and 1008 (for non-freestanding workplaces). The total of 1408 would then be divided by the total employment in that stratification cell to yield a new adjusted model HBNW person trip attraction rate. It will be noted that Table 141 does not include any differences for the trip purpose HBW. The reason is that these attractions appear to be fairly constant for both freestanding and non-freestanding workplaces and no adjustment was considered necessary.

The second area of adjustments dealt with those stratification cells with few or no observations. In certain situations, the results for certain types of trip purposes were not considered reasonable. An example would be HBNW attractions for basic employment, Area Type 5 in San Antonio. In this stratification cell, only one workplace was surveyed and only 3 HBNW attractions observed. The total employment for this site was 750 and the resulting attraction rate was not considered reasonable. The expected HBNW attractions for this cell were estimated by treating the two-way stratification of attractions (trip purpose and area type) for basic employment as a contingency table. The expected number of attractions for that cell would then be computed by multiplying the row sum by the column sum and dividing by the summed total for all cells. In this example the resulting expected attractions would be 455. This method was used only for developing estimates where the survey results were considered unreasonable. Where no observations were found and/or the results were felt unreasonable, data from the surveys for adjoining cells were combined.

Table 136
Estimated Percentages of
Free- and Non-Freestanding Workplaces

Area Type	Urban Area	Employment Type (percent)					
		Basic		Retail		Service	
		Free	Non Free	Free	Non Free	Free	Non Free
Central Business District	Amarillo	0	100	20	80	67	33
	Beaumont	43	57	50	50	32	68
	Houston	33	67	64	36	55	45
Urban Fringe	Amarillo	29	71	42	58	47	53
	Beaumont	64	36	29	71	59	41
	Houston	71	29	79	21	77	23
Urban Residential	Amarillo	33	67	37	63	53	47
	Beaumont	71	29	43	57	63	37
	Houston	73	27	63	37	80	20
Suburban	Amarillo	77	23	60	40	50	50
	Beaumont	87	13	71	29	50	50
	Houston	69	31	36	64	97	3
Rural	Amarillo	100	0	0	100	75	25
	Beaumont	73	27	50	50	100	0
	Houston	89	11	44	56	89	11

Table 137
Estimated Percentage of
Free- and Non-Freestanding Workplaces
San Antonio Workplace Survey

Area Type	Employment Type (percent)					
	Basic		Retail		Service	
	Free	Non-Free	Free	Non-Free	Free	Non-Free
Central Business District	33	67	20	80	30	70
Urban Fringe	70	30	40	60	47	53
Urban Residential	33	67	37	63	53	47
Suburban	77	23	60	40	50	50
Rural	90	10	45	55	80	20

Table 138
Estimated Percentage of
Free- and Non-Freestanding Workplaces
Brownsville Workplace Survey

Area Type	Employment Type (percent)					
	Basic		Retail		Service	
	Free	Non-Free	Free	Non-Free	Free	Non-Free
Central Business District	0	100	20	80	30	70
Urban Fringe	29	71	42	58	47	53
Urban Residential	50	50	37	63	53	47
Suburban	77	23	60	40	50	50
Rural	90	10	50	50	80	20

Table 139
Estimated Percentage of
Free- and Non-Freestanding Workplaces
Tyler Workplace Survey

Area Type	Employment Type (percent)					
	Basic		Retail		Service	
	Free	Non-Free	Free	Non-Free	Free	Non-Free
Central Business District	0	100	20	80	30	70
Urban Fringe	29	71	42	58	47	53
Urban Residential	33	67	37	63	53	47
Suburban	77	23	60	40	50	50
Rural	90	10	45	55	80	20

Table 140
Estimated Percentage of
Free- and Non-Freestanding Workplaces
Sherman-Denison Workplace Survey

Area Type	Employment Type (percent)					
	Basic		Retail		Service	
	Free	Non-Free	Free	Non-Free	Free	Non-Free
Central Business District	43	57	50	50	32	68
Urban Fringe	70	30	40	60	47	53
Urban Residential	33	67	37	63	53	47
Suburban	77	23	60	40	50	50
Rural	73	27	50	50	80	20

Table 141
Difference In Attraction Rates
Between Free- and Non-Freestanding Workplaces

Employment Type	Percent Difference: Non-Free- versus Freestanding	
	Home Based Non-Work Attractions	Non-Home Based Attractions
Basic	Non-Free = 37% less than Free	Non-Free = 35% less than Free
Retail	Non-Free = 15% less than Free	Non-Free = 19% less than Free
Service	Non-Free = 26% less than Free	Non-Free = 34% less than Free

A third area of adjustments dealt with estimating the attractions for residential land uses. The workplace survey included only establishments with employment. It is known that residential land uses also attract trips for all trip purposes. Unfortunately, the surveys done in 1990 and 1991 did not collect information on these trips. Preliminary results from the household survey in Beaumont-Port Arthur were available and that survey had collected data on the number of trips attracted to residential land uses. The total residential attractions by trip purpose were assumed to have the same relational basis in terms of proportions as those observed in the 1993 Beaumont-Port Arthur household survey. For example, in the Beaumont survey the number of HBW person attractions to residential land uses were found to be 5.8 percent of the total HBW person trip productions. It was then assumed that the total HBW person trip attractions to residential land uses in the urban areas surveyed in 1990 and 1991 would be 5.8 percent of the total HBW person trip productions. Table 142 presents the observed percentages from Beaumont and an example of the resulting estimates of residential land use attractions for San Antonio.

Table 142
Estimates of Residential Attractions
San Antonio Study Area

Trip Purpose	Trip Type	Percent Residential Attractions*	San Antonio Trip Productions	Estimated Household Attractions
HBW	Person	5.8	814,563	47,245
	Auto Driver	5.6	684,185	38,314
HBNW	Person	15.5	2,003,882	310,602
	Auto Driver	19.7	1,073,935	211,565
NHB	Person	15.0	1,092,553	163,883
	Auto Driver	14.5	791,781	114,808

The fourth adjustment (or estimate) that was necessary was an estimate of the number of truck and taxi attractions to residential land uses. Data had not been collected in the 1990 and 1991 surveys to provide this information. Preliminary data from the Houston-Galveston regional commercial vehicle survey indicated that 20 percent of the total truck/taxi trips were to residential land uses. The assumption was then made that this proportion would be the same for all of the urban areas surveyed in 1990 and 1991. The estimate of the total number of truck and taxi attractions to residential land uses was made by applying the truck and taxi attraction rates to the 1990 employment data from the census to estimate the attractions to non-residential land uses. This value was then divided by 0.8 to yield the total truck/taxi attractions with the difference being the attractions to residential land uses.

The last estimate required was to distribute the total residential land use attractions by area type. This was based on the percentage of population estimated in each area type for each of the urban areas. The resulting residential attraction rates were computed by dividing the total attractions by trip purpose within each area type by the estimated total number of households within each area type. Note that the basis for the residential land use attraction rates are households while the basis for non-residential land use attraction rates are respective estimates of total employment by type.

The final recommended attraction rates for each of the five urban areas are presented in Tables 143 through 147. The rates represent the results of the adjustments to the raw survey rates from the workplace surveys as previously discussed. Comparing these rates with those shown in previous tables illustrates the magnitude of the adjustments which varied significantly between the urban areas.

SUMMARY OF FINDINGS

The workplace surveys have resulted in attraction rates which, when adjusted to account for problems in the survey design, should produce reasonable results. The analysis has revealed several areas where future surveys may be improved. Much of these findings have been reported in other research, and the recommended survey changes have been incorporated into the surveys done in Beaumont-Port Arthur, El Paso, and the Houston-Galveston Region travel surveys. It does not appear at this time that attraction rates will be easily transferable between urban areas. Factors influencing this issue are the location of the study area cordon boundary which influences the number and type of external trips and the land use activity mixes within the urban area. Another factor which may influence this is the potential inconsistency in the delineation of area types between urban areas. One area of needed future research is the evaluation of area type designations based on the land use activity mix relative to freestanding and non-freestanding workplaces in lieu of employment density.

**Table 143
Recommended Attraction Rates
Amarillo Urban Area**

Home Based Work

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	1.14	1.65	1.14	0.14	1.11	1.56	1.12	0.12
Urban Fringe	1.74	1.33	1.17	0.09	1.68	1.20	1.15	0.08
Urban Residential	1.74	1.12	1.60	0.10	1.68	0.99	1.49	0.09
Suburban	1.44	1.36	1.31	0.12	1.30	1.26	1.16	0.11
Rural	1.44	1.36	1.31	0.11	1.30	1.26	1.16	0.10

Home Based Non-Work

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	0.02	0.36	0.99	1.02	0.01	0.19	0.64	0.80
Urban Fringe	1.30	9.15	4.94	0.65	0.84	5.60	2.92	0.52
Urban Residential	1.32	9.24	1.12	0.75	0.86	5.59	0.62	0.59
Suburban	0.09	14.06	2.12	0.90	0.06	8.52	1.04	0.71
Rural	0.10	12.71	2.28	0.84	0.06	7.70	1.11	0.67

Non-Home Based

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	0.44	1.42	1.58	0.64	0.32	0.86	1.27	0.47
Urban Fringe	1.18	5.85	4.13	0.41	0.94	4.68	3.38	0.30
Urban Residential	1.20	5.74	1.23	0.48	0.96	4.63	0.93	0.35
Suburban	0.68	9.70	1.72	0.57	0.51	7.14	1.24	0.42
Rural	0.74	8.50	1.90	0.52	0.56	6.26	1.37	0.39

**Table 143 (Continued)
Recommended Attraction Rates
Amarillo Urban Area**

All Purposes Combined

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	1.60	3.43	3.71	1.80	1.44	2.61	3.03	1.39
Urban Fringe	4.22	16.33	10.24	1.15	3.46	11.48	10.48	0.90
Urban Residential	4.26	16.10	3.95	1.33	3.50	11.21	3.04	1.03
Suburban	2.21	25.12	5.15	1.59	1.87	16.92	3.44	1.24
Rural	2.28	22.57	5.49	1.47	1.92	15.22	3.64	1.16

Truck/Taxi

Area Type	Attractions per Employee			Attractions per Household
	Basic	Retail	Service	
CBD	0.31	0.04	0.05	0.10
Urban Fringe	0.28	0.28	0.05	0.06
Urban Residential	0.28	0.20	0.10	0.07
Suburban	0.44	0.33	0.14	0.09
Rural	0.44	0.33	0.14	0.08

Table 144
Recommended Attraction Rates
Brownsville Urban Area

Home Based Work

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	1.15	1.17	1.15	0.11	0.95	0.91	0.94	0.09
Urban Fringe	1.15	1.17	1.15	0.10	0.95	0.91	0.94	0.08
Urban Residential	1.15	1.17	1.15	0.09	0.95	0.91	0.94	0.07
Suburban	1.15	1.17	1.15	0.10	0.95	0.91	0.94	0.08
Rural	1.15	1.15	0.77	0.12	0.95	1.07	0.73	0.09

Home Based Non-Work

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	0.28	12.59	1.39	1.09	0.16	5.96	0.80	0.73
Urban Fringe	0.33	13.06	1.47	0.96	0.19	6.19	0.84	0.64
Urban Residential	0.36	12.95	1.49	0.95	0.21	6.14	0.86	0.63
Suburban	0.40	13.44	1.48	0.98	0.23	6.37	0.85	0.65
Rural	0.42	6.33	1.96	1.16	0.24	3.49	1.25	0.77

Non-Home Based

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	0.17	7.37	0.91	0.51	0.16	4.76	0.86	0.35
Urban Fringe	0.20	7.73	0.97	0.45	0.19	4.99	0.93	0.31
Urban Residential	0.22	7.65	1.00	0.44	0.21	4.94	0.95	0.31
Suburban	0.24	8.03	0.99	0.46	0.23	5.19	0.94	0.32
Rural	0.26	5.40	0.84	0.54	0.24	4.13	0.77	0.37

**Table 144 (Continued)
Recommended Attraction Rates
Brownsville Urban Area**

All Purposes Combined

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	1.60	21.13	3.45	1.71	1.27	11.63	2.60	1.17
Urban Fringe	1.68	21.96	3.59	1.51	1.33	12.09	2.71	1.03
Urban Residential	1.73	21.77	3.64	1.48	1.37	11.99	2.75	1.01
Suburban	1.79	22.64	3.62	1.54	1.41	12.47	2.73	1.05
Rural	1.83	12.88	3.57	1.82	1.43	8.69	2.75	2.28

Truck/Taxi

Area Type	Attractions per Employee			Attractions per Household
	Basic	Retail	Service	
CBD	0.18	0.35	0.49	0.12
Urban Fringe	0.18	0.35	0.49	0.11
Urban Residential	0.18	0.35	0.49	0.10
Suburban	0.18	0.35	0.49	0.11
Rural	0.18	0.28	0.81	0.13

**Table 145
Recommended Attraction Rates
San Antonio - Bexar County**

Home Based Work

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	1.093	0.828	1.192	0.114	0.888	0.574	0.896	0.093
Urban Fringe	1.222	0.828	1.298	0.116	1.034	0.574	1.118	0.094
Urban Residential	1.192	1.071	1.260	0.113	1.064	0.919	1.064	0.092
Suburban	1.572	0.949	1.701	0.113	1.378	0.773	1.393	0.092
Rural	1.086	1.260	1.306	0.120	0.988	1.049	1.164	0.097

Home Based Non-Work

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	0.128	0.471	0.449	0.750	0.047	0.158	0.190	0.511
Urban Fringe	0.696	6.045	3.325	0.761	0.310	2.730	1.398	0.518
Urban Residential	0.482	4.482	3.066	0.742	0.254	1.996	1.420	0.505
Suburban	0.994	7.504	3.950	0.745	0.585	3.778	1.983	0.507
Rural	1.046	3.204	5.176	0.788	0.616	1.739	3.033	0.537

Non-Home Based

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	0.230	0.452	0.669	0.396	0.148	0.120	0.420	0.277
Urban Fringe	0.656	2.934	1.954	0.401	0.499	1.947	1.462	0.281
Urban Residential	0.798	2.543	1.697	0.391	0.604	1.724	1.184	0.274
Suburban	0.965	3.956	1.933	0.393	0.791	2.921	1.370	0.275
Rural	1.013	1.082	3.711	0.416	0.830	0.848	3.012	0.291

Table 145 (Continued)
Recommended Attraction Rates
San Antonio - Bexar County

All Purposes Combined

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	1.451	1.751	2.31	1.260	1.083	0.852	1.506	0.881
Urban Fringe	2.574	9.807	6.577	1.278	1.843	5.251	3.978	0.893
Urban Residential	2.472	8.096	6.023	1.246	1.922	4.639	3.668	0.871
Suburban	3.531	12.409	7.584	1.251	2.754	7.472	4.746	0.874
Rural	3.145	5.546	10.193	1.324	2.434	3.636	7.209	0.925

Truck/Taxi

Area Type	Attractions per Employee			Attractions per Household
	Basic	Retail	Service	
CBD	0.038	0.084	0.113	0.049
Urban Fringe	0.017	0.148	0.016	0.030
Urban Residential	0.007	0.176	0.016	0.029
Suburban	0.039	0.587	0.010	0.029
Rural	0.039	0.587	0.010	0.031

**Table 146
Recommended Attraction Rates
Sherman-Denison**

Home Based Work

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	0.811	0.903	0.924	0.114	0.780	0.730	0.874	0.101
CBD Fringe	0.914	0.840	0.910	0.087	0.933	0.774	0.895	0.077
Urban	0.708	0.625	0.670	0.102	0.707	0.568	0.660	0.091
Suburban	0.930	0.473	0.659	0.083	0.894	0.401	0.439	0.074
Suburban Fringe	0.925	0.755	0.809	0.083	0.854	0.714	0.732	0.074
Rural	0.925	0.755	0.809	0.083	0.854	0.714	0.732	0.074

Home Based Non-Work

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	0.386	7.236	6.397	0.923	0.230	4.295	3.765	0.741
CBD Fringe	0.644	7.608	1.832	0.705	0.383	4.449	1.085	0.566
Urban	0.122	7.265	0.808	0.826	0.073	4.281	0.449	0.663
Suburban	0.644	13.394	0.364	0.675	0.386	7.814	0.217	0.542
Suburban Fringe	0.011	11.577	1.089	0.675	0.007	6.773	0.631	0.542
Rural	0.011	11.577	1.089	0.675	0.007	6.773	0.631	0.542

Non-Home Based

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	2.193	10.471	7.794	0.599	1.651	7.971	5.699	0.440
CBD Fringe	1.609	10.262	3.217	0.458	1.290	7.752	2.434	0.336
Urban	0.779	5.544	1.550	0.536	0.591	4.362	1.196	0.394
Suburban	1.475	9.045	0.735	0.438	1.110	7.166	0.578	0.322
Suburban Fringe	0.482	8.683	1.210	0.438	0.349	6.766	0.876	0.322
Rural	0.495	8.683	1.210	0.438	0.358	6.766	0.876	0.322

Table 146 (Continued)
Recommended Attraction Rates
Sherman-Denison

All Purposes Combined

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD	3.390	18.610	15.115	1.636	2.661	12.996	10.338	1.282
CBD Fringe	3.167	18.710	5.959	1.250	2.606	12.976	4.414	0.979
Urban	1.609	13.434	3.028	1.464	1.371	9.211	2.305	1.148
Suburban	3.049	22.912	1.758	1.196	2.390	15.381	1.234	0.938
Suburban Fringe	1.418	21.015	3.108	1.196	1.210	14.253	2.239	0.938
Rural	1.431	21.015	3.108	1.196	1.210	14.253	2.239	0.938

Truck/Taxi

Area Type	Attractions per Employee			Attractions per Household
	Basic	Retail	Service	
CBD	0.242	0.251	0.168	0.086
CBD Fringe	0.242	0.251	0.168	0.066
Urban	0.384	0.249	0.093	0.077
Suburban	0.437	0.269	0.023	0.063
Suburban Fringe	0.058	0.585	0.041	0.063
Rural	0.058	0.585	0.041	0.063

Table 147
Recommended Attraction Rates
Tyler Urban Area

Home Based Work

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD Urban Fringe	0.52	0.36	0.99	0.07	0.50	0.34	0.87	0.06
Urban Residential Suburban	0.69	0.60	1.11	0.07	0.66	0.55	0.99	0.06
Rural	0.69	0.42	0.50	0.07	0.66	0.39	0.48	0.06

Home Based Non-Work

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD Urban Fringe	0.92	3.99	0.20	0.47	0.62	2.35	0.15	0.39
Urban Residential Suburban	0.53	6.28	0.82	0.46	0.41	3.83	0.54	0.38
Rural	0.17	4.34	2.65	0.49	0.12	2.65	1.36	0.40

Non-Home Based

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD Urban Fringe	0.85	5.53	0.68	0.30	0.75	4.08	0.61	0.22
Urban Residential Suburban	0.72	5.69	0.79	0.29	0.68	4.24	0.65	0.22
Rural	0.53	3.22	1.39	0.31	0.51	2.42	1.02	0.23

**Table 147 (Continued)
Recommended Attraction Rates
Tyler Urban Area**

All Purposes Combined

Area Type	Person Trips				Auto-Driver Trips			
	Attractions per Employee			Attractions per Household	Attractions per Employee			Attractions per Household
	Basic	Retail	Service		Basic	Retail	Service	
CBD Urban Fringe	2.29	9.88	1.87	0.84	1.87	6.77	1.63	0.67
Urban Residential Suburban	1.94	12.57	2.72	0.82	1.75	8.62	2.18	0.66
Rural	1.39	7.98	4.54	0.87	1.29	5.46	2.86	0.69

Truck/Taxi

Area Type	Attractions per Employee			Attractions per Household
	Basic	Retail	Service	
CBD Urban Fringe	0.88	0.50	0.18	0.14
Urban Residential Suburban	1.12	0.40	0.27	0.14
Rural	1.29	0.78	0.46	0.15

IV. SPECIAL GENERATOR SURVEYS

INTRODUCTION

Within nearly every major urban area, certain land use activities are considered unique in terms of the number of trip ends that are attracted to them. These land use activities are called special generators, and the estimation of their trip productions and attractions is typically accomplished outside the normal travel demand modeling chain. Examples of special generators include but are not limited to airports, major schools and universities, hospitals, amusement centers, regional shopping centers, and/or military bases. The identification of those land use activities considered to act as special generators is a joint effort by the local agencies responsible for transportation planning and TxDOT.

During 1990 and 1991, special generator surveys were conducted in three of the five urban areas as part of the travel surveys, San Antonio, Amarillo, and Tyler. It was generally felt that attraction rates for special generators were transferable between urban areas, and these types of surveys did not need to be conducted in all urban areas.

Sampling and Survey Methodology

The sampling and survey methodology employed in special generator surveys are essentially the same as for workplace surveys. Once the generators have been identified, each is surveyed in the same manner as a freestanding workplace. The detailed survey methodology and instruments used are reported in References 12, 24, 25, and 26. In brief, the data collection effort included a general information survey where the data collected depended on the type of generator being surveyed, an employee survey, a visitor (i.e., non-employee) survey, and either 24-hour vehicle counts at all access points or person counts taken during the hours of operation for the generator. The survey data were analyzed and expanded in the same manner as the workplace surveys. There was one major difference between the special generator surveys and the workplace surveys: the surveyed trips were geocoded which allowed the analysis to include trip length information, and external trips could be identified and removed from the computation of internal attraction rates.

DATA EDITING

As with the household and workplace surveys, a significant amount of effort was expended relative to editing the data from the special generator surveys. This effort was similar to that previously described, and similar type problems were encountered with the data. The most significant problem found was geocoding where, in some instances, no surveyed trips were geocoded for some of the special generators. It was also noted that the visitor surveys were geocoded one way, i.e., the trip to the site. This resulted in some bias relative to the overall trip length and the estimation of external trips, but the amount of bias is not known.

San Antonio Special Generator Surveys

The ten generators identified in San Antonio for inclusion in the special generator survey are presented in Table 148 with these generators and some of the data collected in the general information survey. These data were used to expand the survey data to develop estimates of the person and auto driver trip attractions and attraction rates for those sites. For purposes of this report, all attraction rates were computed and reported on the basis of attractions per employee.

Table 148
Special Generators Surveyed
In 1990 San Antonio Travel Survey

Site	SIC Code	Employees at Work	Total Employment	Surveyed Employees	Surveyed Visitors
University of Texas at San Antonio	8221	1628	1700	305	531
Shopping Center	5600	1560	2500	129	275
St. Mary's University	8221	479	650	133	451
Medical Center	8062	2800	3000	59	158
Fort Sam Houston	9700	8600	17039	1716	633
Northeast Baptist Hospital	8062	620	750	108	178
Lackland Air Force Base	9700	10444	25700	1347	546
San Antonio International Airport	4581	850	850	145	649
Kelly Air Force Base	9700	17500	23000	3482	299
Sea World of Texas	7996	850	1694	85	161

Using the same methodology as described in the previous chapter for workplace surveys, the surveyed trips were expanded for each special generator. The difference in expanding the trips was the addition of two trip purposes, person and auto driver external trips. These estimates are removed when computing the final attraction rates to ensure the attraction rates represent internal trips only, since external travel is estimated through other methods. It should be noted that the estimates of external trips were biased due to the visitor trips being geocoded in one direction only; and in the case of the special generators for San Antonio, some sites had no trips geocoded. The resulting estimates of person and auto driver trip attractions are presented in Table 149. The total auto driver trips (i.e., the sum of the total auto driver attractions plus the non-home based auto driver productions) do not equal the total 24-hour vehicle counts at the sites. The difference is the estimated truck and taxi trips to each site.

Using the expanded attractions shown in Table 149 and the total site employment shown in Table 148, the resulting model attraction rates were computed and are presented in Table 150. It should be noted that these rates are the estimated attractions per employee. Table 150 also presents the estimated truck/taxi attractions for each site. The trucks were actually counted at the sites while the taxi trips were estimated from the employee and visitor surveys where the reported mode of travel was taxi. For purposes of computing attraction rates, half of the truck and taxi trips were assumed to be attractions and half assumed to be productions.

**Table 149
Expanded Total Attractions
1990 San Antonio Special Generator Survey**

Site	24-Hr Traffic Count	Person Count	Person Trips					Auto Driver Trips				
			HBW	HBNW	NHB-A	NHB-P	Total*	HBW	HBNW	NHB-A	NHB-P	Total*
University of Texas at San Antonio	9280	NA	2984	5295	816	1767	9095	2501	4427	710	1569	7639
Shopping Center	23228	NA	2709	10181	6418	6960	19308	2171	9101	5616	5924	16888
St. Mary's University	8120	NA	890	6943	1276	3059	9109	691	4334	709	2097	5734
Medical Center	7132	NA	3920	1582	642	2032	6144	3513	1206	506	1722	5224
Fort Sam Houston	59129	NA	16438	22209	12115	17282	50763	14324	19413	10250	14696	43987
Northeast Baptist Hospital	3137	NA	1081	972	806	844	2859	868	841	684	715	2392
Lackland Air Force Base	41234	NA	20083	11349	6667	8677	38099	17965	9828	5774	7388	33566
San Antonio International Airport	12216	NA	1676	3532	2569	3013	7770	1498	2955	1821	2165	6275
Kelly Air Force Base	73902	NA	33587	19414	13434	15915	66435	28687	17849	11944	13779	58480
Sea World of Texas	4166	NA	1275	1125	672	1072	3072	1164	951	561	985	2676

*Totals are for attractions only and do not include the NHB-P (Non-Home Based Productions)

As mentioned previously, the primary difference between the special generator surveys and the workplace surveys (with the exception of the collection of additional data in some cases) was that the surveyed trips were geocoded. The average trip lengths in minutes and miles for the surveyed trips that were geocoded are presented in Table 151 for each of the special generators surveyed in San Antonio. Several key points should be noted concerning the information in Table 151. First, complete information was not collected for all of the special generators. For example, none of the surveyed trips for the North Star Mall shopping center were geocoded, and no trip length information could be computed for that generator. Another example is the data presented for the Medical Center. In that survey, none of the home based work (HBW) surveyed trips were geocoded. Trip length information only is shown in Table 151 for home based non-work (HBNW) and non-home based (NHB) trips. The trip length data presented for the total trips are incomplete and should not be used for analysis purposes. The second point which should be noted is the data presented in Table 151 are weighted survey data. The trip lengths were weighted on the basis of the number of employee and non-employee (visitor) trips and the average trip length for the trips surveyed for each. Unfortunately, in all but two generators, the trips which were geocoded were either all employee or all non-employee. The only two generators which had both employee and non-employee trips geocoded were the University of Texas at San Antonio (UTSA) and St. Mary's University. The average trip lengths in the other generators (shown in Table 151) reflect only employee trips or non-employee trips. Those data, therefore, are biased and their use is not recommended.

The lack of complete geocoding information also biases the estimation of external trips. Of the total person trip ends found at UTSA, 0.6 percent were external trips. For St. Mary's University, 1.4 percent were external. Since no trips were geocoded for the shopping center, the number of external trips could not be estimated. For the Medical Center, about 0.2 percent of the person trip ends were external, but none of the employee trips were geocoded. Since none of the trips to the Northeast Baptist Hospital were geocoded, the estimation of external trips to that site was not possible. For the military bases, none of the visitor trips were geocoded; and, as a result, less than 0.1 percent of the person trip ends were found to be external. At the San Antonio International Airport, 4.2 percent of the person trip ends were found to be external, but none of the employee trips were geocoded. At Sea World of Texas, 11 percent of the person trip ends were found to be external, but none of the employee trips were geocoded. In the subsequent examination of similarities between attraction rates, consideration must be given to the fact that some bias is present in the rates

for all of the special generators except UTSA and St. Mary's University where both employees and visitor trips were geocoded.

Table 152 presents the distribution of the trip attractions by trip purpose for employees and non-employees for each of the special generators. For example, of the total person trips attracted to UTSA, 32.8 percent were home based work (HBW), 58.2 percent were home based non-work (HBNW), and 9.0 percent were non-home based (NHB). With respect to the HBW person trips attracted to UTSA, 96.3 percent were made by employees and 4.7 percent were made by non-employees. The distributions shown in Table 152 reflect the amount of bias that may exist in the average trip lengths shown in Table 151 for those generators where only employee or non-employee trips were geocoded.

As would be expected, employees made the majority of the HBW trips for all of the special generators. Those percentages ranged from a low of 88 percent to a high of 100 percent. The low of 88 percent occurred at the San Antonio International Airport. This appears reasonable if the non-employees that were surveyed were individuals traveling to the airport from home to catch a plane for work-related travel. Work trips were identified by the trip purposes, work and work related.

Employees made no home based non-work trips to any of the special generators. This is expected because the non-employee survey was designed to exclude those individuals that stated they worked at the site, assuming that population would be surveyed as part of the employee survey.

The data in Table 152 do not reveal any apparent bias in the distribution of attractions between employees and non-employees. The results appear reasonable for all special generators.

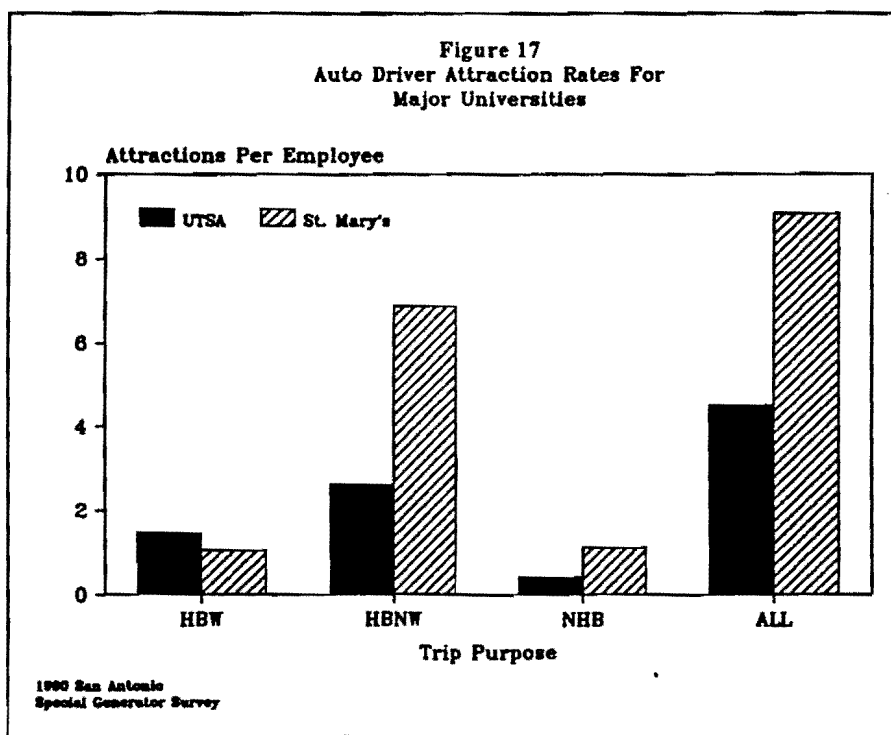
Comparison of Similar Type Generators

The special generator survey in San Antonio was somewhat unique in the number of similar types of generators that were surveyed. There were two major universities, two medical facilities, and three military bases that were surveyed. This afforded an opportunity to examine the results for those facilities to determine if their attraction patterns were approximately the same. The comparisons presented and discussed in the following paragraphs are for auto driver attractions only. The person trip attractions were similar in terms of the comparisons and are not presented simply to reduce the amount of repetitive information.

The two universities surveyed were the University of Texas at San Antonio and St. Mary's University. UTSA is a publicly supported university located in a suburban residential area type. The

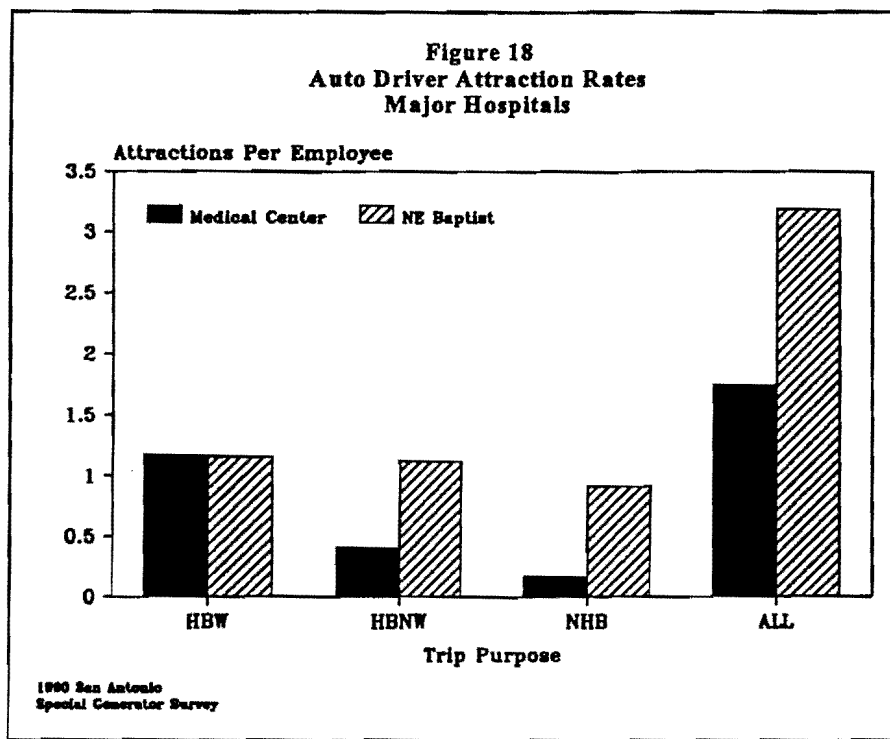
majority of its students were commuters. St. Mary's University is a private university located in an urban area type. The ratio of students to employment for UTSA (i.e., 8.2) is double that of St. Mary's University (i.e., 4.3). Despite the significant difference between the two institutions in terms of total enrollment (13,900 for University of Texas at San Antonio and 2,790 for St. Mary's University), the total person trip ends at the two universities was about the same.

Figure 17 shows a comparison of the auto driver attraction rates by trip purpose between the two universities. As will be noted, the rates for St. Mary's University were much higher than University of Texas at San Antonio with the exception of the HBW trip purpose. These differences may reflect the overall accessibility of the two institutions. UTSA is located outside the suburban developments in the northwest area of the county, while St. Mary's University is located inside Loop 410 in the more densely populated urban area. It would be more convenient for students and faculty to travel to and from the St. Mary's University campus than UTSA. The attraction rates for those two facilities do not appear to be transferable.



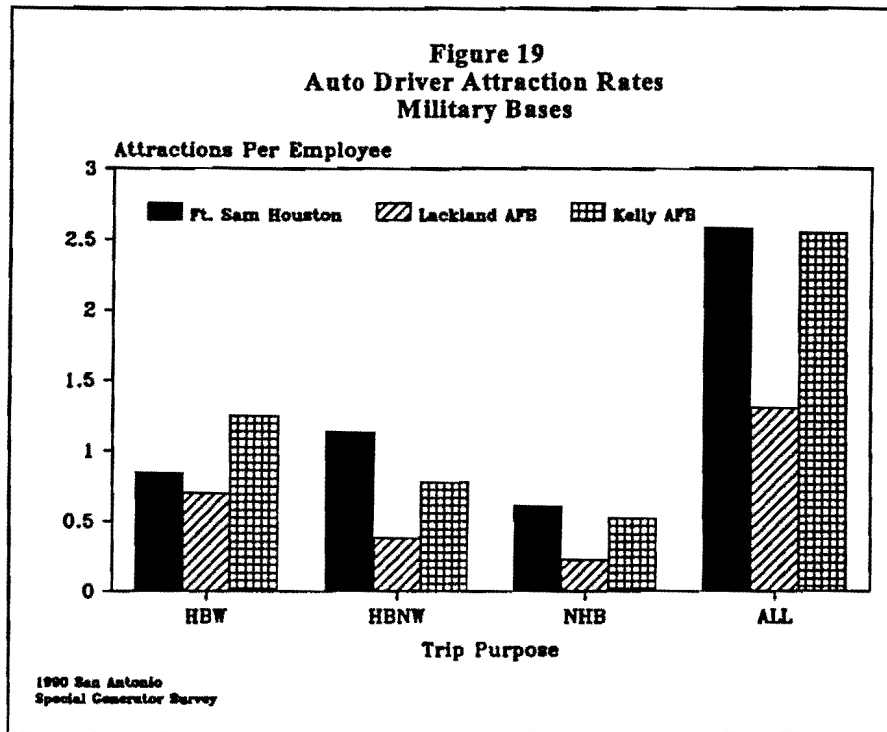
The two medical facilities surveyed were the Medical Center Hospital and the Northeast Baptist Hospital. The Medical Center Hospital had a total employment of 3,000 with 550 hospital beds. Northeast Baptist Hospital had a total employment of 865 with 195 hospital beds. Figure 18 shows

the auto driver attraction rates for these two hospitals by trip purpose. As shown, the HBW attraction rates are almost the same for the two hospitals. The rates for HBNW and NHB for the two are very different. The location of the two facilities may have influenced their relative attractiveness. The Medical Center Hospital is located within the South Texas Medical Center, and its attractiveness may be influenced by the attractiveness of other facilities within the center. The Northeast Baptist Hospital is a freestanding facility. Comparison of the attraction rates for the two facilities indicates only the HBW rates would be transferable between them.



The three military facilities surveyed were Fort Sam Houston (FSH), Lackland Air Force Base (LAFB), and Kelly Air Force Base (KAFB). FSH is an army base; LAFB and KAFB are air force bases. FSH is located in the northeast part of the urban area, and both LAFB and KAFB are located in the southwest part of the urban area adjacent to each other. Figure 19 presents the auto driver attraction rates for these sites by trip purpose. There appears to be considerable variability between the attraction rates for the military bases. The overall rates for FSH and KAFB were approximately the same (and nearly double that for LAFB), but the distributions by trip purpose were different. Based on the general information collected for each of these bases, one possible explanation for the low trip rates for Lackland AFB is that nearly 40 percent of its base personnel

and employees live on base. Many trips could be internal to the base. The trip rates for FSA and KAFB are fairly transferable, but the rates for LAFB do not appear to be transferable.



Comparison with Non-Special Generators

One question which has been posed is whether the sites identified as special generators are truly unique in their trip attractiveness or if reasonable results could be achieved by treating them in the same manner as other workplaces with similar standard industrial classification (SIC) codes. Two types of comparisons may be made. The first is to compare the attraction rates observed for the special generators with those observed for sites which fall within the same industrial classification. The second is to compare the rates with those observed for sites which have been grouped into the three categories of employment typically used in estimating attractions (i.e., basic, retail, and service).

Sites from the full workplace survey in San Antonio were grouped by similar SIC and the average attraction rate and variance computed by trip purpose for person and auto driver attractions for those sites. A 90 percent confidence interval was then computed. The attraction rates for the special generators which had the same general SIC code were then compared to determine if they fell within the 90 percent confidence interval. Attraction rates which fell within that interval implied

that the treatment of that site as a special generator did not achieve a higher degree of accuracy than that which would have been achieved by using the average rate from the workplaces which were within the same SIC category. These comparisons are shown in Tables 153 through 157.

In Table 153, the attraction rates for the special generator North Star Mall are compared with the average rates for those workplaces which had an SIC code between 5200 and 5999. For every trip purpose including truck and taxi, the attraction rates for North Star Mall fell outside the 90 percent confidence interval. The implication is that the use of those rates for that special generator (and others similar to it) will produce better results than would be obtained from the use of the averages from the workplace survey.

In Table 154, the attraction rates for the special generator, San Antonio International Airport, were compared to the average values for workplaces falling within the SIC codes 4000 to 4999. The attraction rates for HBW trips were the only rates which fell outside the 90 percent confidence interval. The implication is that the trip rates for the special generator were similar to those for the workplaces which had the same general SIC code. It should also be recalled that visitors comprised 12 percent of the HBW trips to the airport. If these were excluded, the HBW trip rates may be more comparable to those of the other workplaces in the same SIC category.

In Table 155, the attraction rates for the two hospitals and Sea World of Texas were compared with those average values for workplaces falling in the SIC code range of 7000 to 8199. For nearly all trip purposes for the three special generators, the attraction rates fell outside the 90 percent confidence interval. Only the HBNW rates for Northeast Baptist Hospital fell within the limits of the confidence interval. Since none of the trips for that site were geocoded, the number of external trips could not be estimated and the attraction rates may be too high. The implication is that the attraction rates for those special generators will produce better estimates than would be obtained if using the average rates from the workplace survey for sites falling within the same SIC range.

In Table 156, the attraction rates for the two universities were compared with those average values for workplaces falling in the SIC code range of 8200 to 8299. The results of this comparison were mixed. For example, the HBW and truck/taxi attraction rates for UTSA (person and auto driver) fell within the 90 percent confidence interval. All of the other attraction rates for UTSA did not. The rates for St. Mary's all fell outside the 90 percent confidence interval except the person trip rate for all purposes combined and the auto driver rate for HBNW trips.

In Table 157, the attraction rates for the military bases were compared with the average rates

for those workplaces falling within the SIC code range of 9000 to 9799. Unfortunately, only eight sites were found in the workplace survey which fell within that SIC range; and as may be noted by the size of the confidence intervals in Table 157, the variances were quite high. The results from this comparison are not felt to be conclusive. The implication from comparing the numerical values is that the attraction rates for the military bases are significantly different from the average rates for the workplaces falling within the SIC range 9000 to 9799.

In general, the comparisons between the attraction rates observed for the special generators with workplaces falling within the same general SIC range have indicated the rates for the special generators, overall, are different. This implies that these sites are special and should be treated as special generators.

The second comparisons grouped the special generators into the three general categories of worksites used in travel demand modeling and compared the rates with those from the overall workplace survey. Workplaces from the San Antonio workplace survey were grouped into three categories, basic, retail, and service. For the comparisons to be valid, it was necessary to compare the rates with those workplaces in the same area type. Tables 158 through 161 present the results of these comparisons. It should be noted that no comparison is shown for the San Antonio International Airport because only one workplace was surveyed that had basic employment in Area Type 5.

Table 158 presents a comparison between the attraction rates for North Star Mall with the retail establishments that were surveyed in Area Type 2 (the same area type as the mall). Only the HBW auto driver attraction rate for the mall was within the confidence interval. The implication is that the mall's attractions could not be adequately estimated using the rates for retail establishments as computed from the full workplace survey.

Table 159 presents a comparison of the attraction rates computed for service workplaces in Area Type 2 with the two special generators that would be classified as service in Area Type 2. The large range for the confidence intervals indicates a high degree of variability for workplaces in this employment category and area type. Even though the attraction rates for the special generators were within the confidence interval, a review of the numerical values for the averages indicates the use of the rates from the workplace survey for estimating the attractions for those special generators would produce unreasonable estimates.

Table 160 presents a comparison of the attraction rates computed for service workplaces in Area Type 4 with the three military bases that were also in Area Type 4. With the exception of the

truck/taxi attraction rates, all the attraction rates for the military bases were not within the confidence intervals as computed for the rates from the workplace survey. The implication is that the use of the rates from the workplace survey would not produce reasonable results for the military bases.

Table 161 presents the comparison of the average attraction rates computed for service workplaces in Area Type 5 with the rates from the special generators Northeast Baptist Hospital and Sea World of Texas which were located in the same area type. Again, the large confidence intervals for all of the trip purposes except HBW indicate large variations in the attraction rates for the workplaces with service employment located in Area Type 5. Comparing the average attraction rates for each trip purpose indicates that using the workplace survey rates would yield unreasonable estimates of the attractions for those special generators. The implication is that the rates for those special generators are significantly different from those found in the workplace survey.

General Findings for San Antonio

In general, the attraction rates computed for the special generators surveyed in San Antonio appear reasonable. The sites which were surveyed were found to have significantly different attraction rates than average rates computed for sites surveyed in the workplace survey. Caution should be exercised in these comparisons, since questions have been raised concerning the validity of the survey methodology in the workplace survey. Those questions were serious enough to invalidate any finding concerning the uniqueness of the worksites which were surveyed as special generators. Insufficient data were collected to produce any significant findings concerning the observed trip lengths from the special generator survey. Any subsequent analysis using the trip length information provided in this report for special generators should be done with caution, since many of the values produced did not include complete information. The attraction rates for all but UTSA and St. Mary's University may be slightly biased to the high side because of the inability to identify and remove external trips. This bias is felt to be small due to the nature of the study area in San Antonio and the location of its study area boundary.

Table 150
Attractions per Employee
1990 San Antonio Special Generator Survey

Site	Truck/Taxi Trips**	Truck/Taxi Attraction Rate	Person Trip Attractions per Employee				Auto Driver Trip Attractions per Employee			
			HBW	HBNW	NHB-A	Total	HBW	HBNW	NHB-A	Total
University of Texas at San Antonio	20	0.006	1.755	3.115	0.480	5.350	1.471	2.604	0.418	4.493
Shopping Center	416	0.083	1.084	4.072	2.567	7.723	0.868	3.641	2.247	6.756
St. Mary's University	116	0.089	1.369	10.682	1.963	14.014	1.063	6.667	1.091	8.821
Medical Center	171	0.029	1.307	0.527	0.214	2.048	1.171	0.402	0.169	1.742
Fort Sam Houston	395	0.012	0.965	1.303	0.711	2.979	0.841	1.139	0.602	2.582
Northeast Baptist Hospital	30	0.020	1.441	1.296	1.075	3.812	1.157	1.121	0.912	3.190
Lackland Air Force Base	231	0.005	0.781	0.442	0.259	1.482	0.699	0.382	0.225	1.306
San Antonio International Airport	3346	1.968	1.963	4.156	3.022	9.140	1.762	3.477	2.143	7.382
Kelly Air Force Base	1601	0.035	1.460	0.844	0.584	2.888	1.247	0.776	0.519	2.542
Sea World of Texas	92	0.027	0.753	0.664	0.397	1.814	0.687	0.562	0.331	1.580

**Truck/Taxi trips are totals; half were assumed to be attractions and half assumed to be productions.

**Table 151
Average Trip Length
1990 San Antonio Special Generator Surveys**

Site	Data Element	Person Trip Attractions				Auto Driver Trip Attractions			
		HBW	HBNW	NHB	Total	HBW	HBNW	NHB	Total
University of Texas at San Antonio	Total Surveyed Trips	538	827	146	1511	451	698	129	1278
	Total Geocoded Trips	203	268	51	522	174	213	46	433
	Avg Trip Length in Minutes	15.5	16.3	20.3	16.4	15.5	18.2	19.7	17.5
	Avg Trip Length in Miles	9.3	9.8	12.1	9.9	9.3	11.0	11.8	10.6
Shopping Center	Total Surveyed Trips	208	247	191	646	166	218	165	549
	Total Geocoded Trips	0	0	0	0	0	0	0	0
	Avg Trip Length in Minutes	na	na	na	na	na	na	na	na
	Avg Trip Length in Miles	na	na	na	na	na	na	na	na
St. Mary's University	Total Surveyed Trips	234	570	158	962	189	364	102	655
	Total Geocoded Trips	212	211	92	515	172	200	77	449
	Avg Trip Length in Minutes	15.0	14.5	14.3	14.5	15.6	14.6	14.2	14.7
	Avg Trip Length in Miles	7.5	6.9	6.8	6.9	7.8	6.9	6.8	7.0
Medical Center	Total Surveyed Trips	77	208	59	344	69	163	41	273
	Total Geocoded Trips	0	113	32	145	0	96	23	119
	Avg Trip Length in Minutes	na	17.1	11.4	15.8	na	17.8	10.8	16.5
	Avg Trip Length in Miles	na	8.7	5.6	8.0	na	9.3	5.4	8.5

Table 151 (Continued)
Average Trip Length
1990 San Antonio Special Generator Surveys

Site	Data Element	Person Trip Attractions				Auto Driver Trip Attractions			
		HBW	HBNW	NHB	Total	HBW	HBNW	NHB	Total
Fort Sam Houston	Total Surveyed Trips	3138	628	886	4652	2730	546	750	4026
	Total Geocoded Trips	245	0	165	410	216	0	145	361
	Avg Trip Length in Minutes	17.5	na	3.0	11.6	17.6	na	3.0	11.7
	Avg Trip Length in Miles	8.8	na	1.2	5.7	8.9	na	1.2	5.8
Northeast Baptist Hospital	Total Surveyed Trips	183	151	130	464	147	130	109	386
	Total Geocoded Trips	0	0	0	0	0	0	0	0
	Avg Trip Length in Minutes	na	na	na	na	na	na	na	na
	Avg Trip Length in Miles	na	na	na	na	na	na	na	na
Lackland Air Force Base	Total Surveyed Trips	2525	609	578	3712	2252	524	501	3277
	Total Geocoded Trips	252	0	91	343	228	0	77	305
	Avg Trip Length in Minutes	17.6	na	5.4	14.4	17.7	na	5.0	14.5
	Avg Trip Length in Miles	9.8	na	2.5	7.9	9.9	na	2.3	7.9
San Antonio International Airport	Total Surveyed Trips	267	492	379	1138	239	401	269	909
	Total Geocoded Trips	21	232	245	498	18	171	185	374
	Avg Trip Length in Minutes	10.0	10.3	10.2	10.2	10.9	9.8	10.2	10.1
	Avg Trip Length in Miles	5.1	5.3	5.1	5.2	5.7	4.9	5.1	5.0

Table 151 (Continued)
Average Trip Length
1990 San Antonio Special Generator Surveys

Site	Data Element	Person Trip Attractions				Auto Driver Trip Attractions			
		HBW	HBNW	NHB	Total	HBW	HBNW	NHB	Total
Kelly Air Force Base	Total Surveyed Trips	5941	278	897	7116	5017	253	759	6029
	Total Geocoded Trips	210	0	121	331	176	0	105	281
	Avg Trip Length in Minutes	21.2	na	3.0	14.5	21.4	na	3.0	14.5
	Avg Trip Length in Miles	11.1	na	1.2	7.5	11.2	na	1.2	7.5
Sea World of Texas	Total Surveyed Trips	126	123	79	328	115	105	67	287
	Total Geocoded Trips	0	38	30	68	0	36	26	62
	Avg Trip Length in Minutes	na	25.6	24.2	25.0	na	25.3	23.8	24.7
	Avg Trip Length in Miles	na	15.2	13.8	14.6	na	15.2	13.7	14.6

Table 152
Distribution of Attractions Between Employees and Non-employees
1990 San Antonio Special Generator Surveys

Site	Data Element	Person Trip Attractions				Auto Driver Trip Attractions			
		HBW	HBNW	NHB	Total	HBW	HBNW	NHB	Total
University of Texas at San Antonio	Percentage of Total Attractions	32.8	58.2	9.0	100.0	32.7	58.0	9.3	100.0
	Percentage by Employees	96.3	0.0	51.3	36.2	96.2	0.0	53.7	36.5
	Percentage by Non-employees	4.7	100.0	48.7	63.8	4.8	100.0	46.3	63.5
Shopping Center	Percentage of Total Attractions	14.0	52.7	33.3	100.0	12.9	53.9	33.2	100.0
	Percentage by Employees	90.9	0.0	8.2	15.5	90.4	0.0	7.8	14.2
	Percentage by Non-employees	9.1	100.0	91.8	84.5	9.6	100.0	92.2	85.8
St. Mary's University	Percentage of Total Attractions	9.7	76.4	13.9	100.0	11.9	75.8	12.3	100.0
	Percentage by Employees	94.5	0.0	19.7	11.9	100.0	0.0	27.8	15.3
	Percentage by Non-employees	5.5	100.0	80.3	88.1	0.0	100.0	72.2	84.7
Medical Center	Percentage of Total Attractions	63.7	25.8	10.5	100.0	67.2	23.2	9.6	100.0
	Percentage by Employees	100.0	0.0	39.7	67.9	100.0	0.0	50.4	72.0
	Percentage by Non-employees	0.0	100.0	60.3	32.1	0.0	100.0	49.6	28.0
Fort Sam Houston	Percentage of Total Attractions	32.4	43.8	23.8	100.0	32.6	44.1	23.3	100.0
	Percentage by Employees	97.0	0.0	23.5	37.0	97.0	0.0	23.7	37.1
	Percentage by Non-employees	3.0	100.0	76.5	63.0	3.0	100.0	76.3	62.9

Table 152 (Continued)
Distribution of Attractions Between Employees and Non-employees
1990 San Antonio Special Generator Surveys

Site	Data Element	Person Trip Attractions				Auto Driver Trip Attractions			
		HBW	HBNW	NHB	Total	HBW	HBNW	NHB	Total
Northeast Baptist Hospital	Percentage of Total Attractions	37.8	34.0	28.2	100.0	36.3	35.1	28.6	100.0
	Percentage by Employees	100.0	0.0	15.4	42.1	100.0	0.0	13.0	40.0
	Percentage by Non-employees	0.0	100.0	84.6	57.9	0.0	100.0	87.0	60.0
Lackland Air Force Base	Percentage of Total Attractions	52.7	29.8	17.5	100.0	53.5	29.3	17.2	100.0
	Percentage by Employees	98.9	0.0	39.7	59.1	98.8	0.0	39.7	59.7
	Percentage by Non-employees	1.1	100.0	60.3	40.9	1.2	100.0	60.3	40.3
San Antonio International Airport	Percentage of Total Attractions	21.1	46.5	32.4	100.0	23.3	48.4	28.3	100.0
	Percentage by Employees	87.6	0.0	8.3	21.2	88.2	0.0	10.0	23.4
	Percentage by Non-employees	12.4	100.0	91.7	78.8	11.8	100.0	90.0	76.6
Kelly Air Force Base	Percentage of Total Attractions	50.6	29.2	20.2	100.0	49.1	30.5	20.4	100.0
	Percentage by Employees	90.4	0.0	26.7	51.1	89.4	0.0	25.0	49.0
	Percentage by Non-employees	9.6	100.0	73.3	48.9	10.6	100.0	75.0	51.0
Sea World of Texas	Percentage of Total Attractions	39.8	39.3	20.9	100.0	41.8	38.1	20.1	100.0
	Percentage by Employees	100.0	0.0	30.1	46.1	100.0	0.0	30.7	48.0
	Percentage by Non-employees	0.0	100.0	69.9	53.9	0.0	100.0	69.3	52.0

Table 153
Attraction Rate Comparisons
SIC Codes 5200 - 5999
Special Generator - North Star Mall

Type of Trip	Trip Purpose	Results from Workplace Surveys - Observations 71 Sites			Special Generator North Star Mall
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.436	1.291	1.582	1.084
	HBNW	20.250	7.594	32.906	4.072
	NHB	14.696	4.192	25.199	2.567
	ALL	36.382	13.211	59.553	7.723
Auto Driver Trips	HBW	1.111	0.975	1.248	0.868
	HBNW	16.880	5.032	28.728	3.641
	NHB	12.091	2.696	21.486	2.247
	ALL	30.082	8.803	51.361	6.756
Truck/Taxi	na	0.566	0.244	0.889	0.083

Table 154
Attraction Rate Comparisons
SIC Codes 4000 - 4999
Special Generator - San Antonio International Airport

Type of Trip	Trip Purpose	Results from Workplace Surveys - Observations 14 Sites			Special Generator San Antonio International Airport
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.704	1.495	1.912	1.963
	HBNW	6.735	0.903	12.567	4.156
	NHB	5.914	2.103	9.726	3.022
	ALL	14.353	5.618	23.088	9.140
Auto Driver Trips	HBW	1.453	1.233	1.673	1.762
	HBNW	4.801	0.468	9.134	3.477
	NHB	3.747	1.922	5.572	2.143
	ALL	10.001	3.976	16.027	7.382
Truck/Taxi	na	1.053	0.000	2.779	1.968

Table 155
Attraction Rate Comparisons
SIC Codes 7000 - 8199
Special Generators - Medical Center and Northeast Baptist Hospitals and Sea World of Texas

Type of Trip	Trip Purpose	Results from Workplace Surveys - 18 Sites			Special Generator		
		Average Trips per Employee	90 Percent Confidence Limits		Medical	Northeast Baptist	Sea World of Texas
			Low	High	Average Trips per Employee	Average Trips per Employee	Average Trips per Employee
Person Trips	HBW	2.229	1.565	2.892	1.307	1.441	0.753
	HBNW	5.099	0.860	9.338	0.527	1.296	0.664
	NHB	4.198	2.512	5.884	0.214	1.075	0.397
	ALL	11.525	5.926	17.125	2.048	3.812	1.814
Auto Driver Trips	HBW	1.848	1.185	2.511	1.171	1.157	0.687
	HBNW	4.004	0.794	7.214	0.402	1.121	0.562
	NHB	3.771	2.029	5.512	0.169	0.912	0.331
	ALL	9.623	4.869	14.377	1.742	3.190	1.580
Truck/Taxi	na	0.158	0.049	0.266	0.029	0.020	0.027

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Table 156
Attraction Rate Comparisons
SIC Codes 8200 - 8299
Special Generators - University of Texas at San Antonio and St. Mary's University

Type of Trip	Trip Purpose	Results from Workplace Surveys - 19 Sites			Special Generator	
		Average Trips per Employee	90 Percent Confidence Limits		UTSA	St. Mary's
			Low	High	Average Trips per Employee	Average Trips per Employee
Person Trips	HBW	1.777	1.544	2.010	1.755	1.369
	HBNW	7.968	5.541	10.396	3.115	10.682
	NHB	4.335	2.990	5.679	0.480	1.963
	ALL	14.080	10.827	17.334	5.350	14.014
Auto Driver Trips	HBW	1.571	1.351	1.791	1.471	1.063
	HBNW	6.426	4.615	8.237	2.604	6.667
	NHB	3.569	2.566	4.572	0.418	1.091
	ALL	11.566	8.999	14.132	4.493	8.821
Truck/Taxi	na	0.011	0.001	0.021	0.006	0.089

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Table 157
Attraction Rate Comparisons
SIC Codes 9000 - 9799
Special Generators - Military Bases

Type of Trip	Trip Purpose	Results from Workplace Surveys - 8 Sites			Special Generator		
		Average Trips per Employee	90 Percent Confidence Limits		Ft Sam Houston	Lackland AFB	Kelly AFB
			Low	High	Average Trips per Employee	Average Trips per Employee	Average Trips per Employee
Person Trips	HBW	2.896	1.418	4.375	0.965	0.781	1.460
	HBNW	15.844	0.000	40.632	1.303	0.442	0.844
	NHB	8.133	0.000	17.426	0.711	0.259	0.584
	ALL	26.874	0.000	61.603	2.979	1.482	2.888
Auto Driver Trips	HBW	2.577	1.244	3.909	0.841	0.699	1.247
	HBNW	14.210	0.000	37.029	1.139	0.382	0.776
	NHB	7.199	0.000	15.491	0.602	0.225	0.519
	ALL	23.985	0.000	55.707	2.582	1.306	2.542
Truck/Taxi	na	0.006	0.000	0.016	0.012	0.005	0.035

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Table 158
Attraction Rate Comparisons
Retail Workplaces - Area Type 2
Special Generator - North Star Mall

Type of Trip	Trip Purpose	Results from Workplace Survey - Observations at 16 Sites			Special Generator North Star Mall
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.484	1.240	1.727	1.084
	HBNW	13.582	8.705	18.460	4.072
	NHB	9.369	5.904	12.834	2.567
	ALL	24.435	16.238	32.632	7.723
Auto Driver Trips	HBW	1.044	0.843	1.245	0.868
	HBNW	9.668	6.278	13.057	3.641
	NHB	6.781	4.204	9.358	2.247
	ALL	17.493	11.614	23.371	6.756
Truck/Taxi	na	0.233	0.131	0.335	0.083

Table 159
Attraction Rate Comparisons
Service Workplaces - Area Type 2
Special Generators - St. Mary's University and Medical Center Hospital

Type of Trip	Trip Purpose	Results from Workplace Surveys - 15 Sites			Special Generator	
		Average Trips per Employee	90 Percent Confidence Limits		Medical Center Hospital	St. Mary's University
			Low*	High	Average Trips per Employee	Average Trips per Employee
Person Trips	HBW	2.264	1.153	3.374	1.307	1.369
	HBNW	23.978	0.000	57.359	0.527	10.682
	NHB	15.961	0.000	32.760	0.214	1.963
	ALL	42.203	0.000	91.985	2.048	14.014
Auto Driver Trips	HBW	1.823	0.997	2.650	1.171	1.063
	HBNW	17.161	0.000	40.721	0.402	6.667
	NHB	12.765	0.257	25.274	0.169	1.091
	ALL	31.750	0.000	67.371	1.742	8.821
Truck/Taxi	na	0.000	na	na	0.029	0.089

*Negative low values were set to zero.

Table 160
Attraction Rate Comparisons
Service Workplaces - Area Type 4
Special Generators - Military Bases

Type of Trip	Trip Purpose	Results from Workplace Surveys - 20 Sites			Special Generator		
		Average Trips per Employee	90 Percent Confidence Limits		Ft. Sam Houston	Lackland AFB	Kelly AFB
			Low*	High	Average Trips per Employee	Average Trips per Employee	Average Trips per Employee
Person Trips	HBW	2.621	1.829	3.413	0.965	0.781	1.460
	HBNW	12.135	1.923	22.348	1.303	0.442	0.844
	NHB	6.078	2.153	10.002	0.711	0.259	0.584
	ALL	20.834	6.584	35.084	2.979	1.482	2.888
Auto Driver Trips	HBW	2.328	1.551	3.106	0.841	0.699	1.247
	HBNW	10.394	1.180	19.608	1.139	0.382	0.776
	NHB	5.493	1.964	9.022	0.602	0.225	0.519
	ALL	18.216	5.306	31.125	2.582	1.306	2.542
Truck/Taxi	na	0.024	0.000	0.057	0.012	0.005	0.035

*Negative low values were set to zero.

Table 161
Attraction Rate Comparisons
Service Workplaces - Area Type 5
Special Generators - Northeast Baptist Hospital and Sea World of Texas

Type of Trip	Trip Purpose	Results from Workplace Surveys - 7 Sites			Special Generator	
		Average Trips per Employee	90 Percent Confidence Limits		Northeast Baptist	Sea World of Texas
			Low*	High	Average Trips per Employee	Average Trips per Employee
Person Trips	HBW	1.633	1.459	1.807	1.441	0.753
	HBNW	48.832	0.000	124.308	1.296	0.664
	NHB	35.303	0.000	85.190	1.075	0.397
	ALL	85.768	0.000	211.104	3.812	1.814
Auto Driver Trips	HBW	1.488	1.284	1.691	1.157	0.687
	HBNW	46.875	0.000	119.091	1.121	0.562
	NHB	33.620	0.000	81.713	0.912	0.331
	ALL	81.982	0.000	202.306	3.190	1.580
Truck/Taxi	na	0.008	0.000	0.022	0.020	0.027

*Negative low values were set to zero.

Table 162
Special Generators Surveyed in
1990 Amarillo Special Generator Survey

Site	SIC Code	Employees at Work	Total Employment	Surveyed Employees	Surveyed Visitors
Amarillo College	8222	365	400	192	470
Owens Corning Manufacturing	3229	250	850	107	47
Amarillo International Airport	4581	181	190	68	300
Hospital	8062	712	1000	128	289
Prison	9223	600	900	46	0
Westgate Mall Shopping Center	5600	1139	1822	177	309

Amarillo Special Generator Surveys

Six worksites were identified in Amarillo for inclusion in the special generator survey. Table 162 presents these generators and some of the data collected in the general information survey. The data presented in Table 162 were used in the expansion of the survey data to develop estimates of the person and auto driver trip attractions and attraction rates for those sites.

Using the same methodology as described in the previous chapter for workplace surveys, the surveyed trips were expanded for each special generator and the external trips to each site were removed. The resulting person and auto driver trip attractions are presented in Table 163. It should be noted that the total auto driver trips do not equal the total 24-hour vehicle counts at the sites. The difference is the estimated truck and taxi trips to the site.

The external trips found in the Amarillo special generator survey comprised a significant percentage of the trip ends found in the surveys. For Amarillo College, nearly 6 percent of the person trip ends were external. For Owens Corning Manufacturing, just over 5 percent were external. Of the total person trip ends at Amarillo International Airport, 18.6 percent were external. Nearly 12 percent of the person trip ends at Amarillo High Plains Hospital were external. Over 8 percent of the person trip ends at the prison were external, and nearly 13 percent of the person trip ends at the Westgate Mall were external.

Using the expanded attractions shown in Table 163 and the total site employment shown in Table 162, the resulting model attraction rates were computed and are presented in Table 164. These rates are the estimated attractions per employee. Table 164 also presents the estimated truck and taxi

attractions for each site. The trucks were counted at the sites and the taxi trips were estimated from the employee and visitor surveys where taxi was reported as the mode of travel. For purposes of computing attraction rates, half of the truck and taxi trips were assumed to be attractions and half assumed to be productions.

The average trip lengths in minutes and miles for the surveyed trips that were geocoded are presented in Table 165 for each of the special generators surveyed in Amarillo. The average trip lengths shown in Table 165 represent expanded weighted averages. The surveyed trips for employees and visitors were expanded and multiplied by the average trip length for the geocoded employee and visitor trips to compute an expanded weighted average trip length. The problems encountered in the San Antonio Special Generator Survey with respect to gaps in the geocoding of surveyed trips was not found in the special generators surveyed in Amarillo. The only significant notation is the special generator, the prison. There were no visitors surveyed at the prison. This may have occurred because only certain days are designated for visitors, and the survey may have been done on a non-visitation day. The results for that special generator may be biased but is not considered significant, and the resulting attraction rates and average trip lengths are considered reasonable.

Table 166 presents the distribution of trip attractions by trip purpose for employees and non-employees for each of the special generators surveyed in Amarillo. For example, 11.6 percent of the person trip attractions to Amarillo College were home based work (HBW). Of those HBW person trip attractions, 95.6 percent were made by the employees and 4.4 percent were made by non-employees. In three of the special generators, Amarillo College, Amarillo International Airport, and the Westgate Mall Shopping Center, the percentage of the attractions attributable to employees ranged from about 10 to 15 percent. This type of distribution appears reasonable since these types of generators would be expected to attract significant numbers of non-employee trips. The remaining three generators, Amarillo High Plains Hospital, the Owen Corning Manufacturing Plant, and the prison, had significantly higher percentages of attractions (35 percent to 100 percent) attributable to the employees. These types of special generators would be expected to have fewer attractions due to non-employees. The resulting distributions appear to be reasonable.

Comparison of Similar Type Generators

The limited number of special generators surveyed in Amarillo resulted in no similar type generators; therefore no comparison was possible.

Comparison with Non-Special Generators

To address the question of whether the sites surveyed in Amarillo were uniquely different from workplaces which fell within the same standard industrial classification (SIC), the surveyed workplaces from the Amarillo Workplace Survey were grouped by SIC codes and average attraction rates computed by trip purpose. The attraction rate variances and the 90 percent confidence interval limits were also computed for each trip purpose. Lower confidence limits of less than zero were set to zero. Tables 167 through 172 present the results for those SIC ranges within which the surveyed special generators fell. For example, the results in Table 167 indicate that four workplaces were surveyed in the Amarillo workplace survey which had SIC codes of 8200 to 8299. The SIC code for Amarillo College is 8222. The average HBW person trip attraction rate for those four workplaces was 1.016 attractions per employee. The lower limit of the 90 percent confidence interval was 0.491 and the higher limit was 1.542. The average HBW person trip attraction rate for Amarillo College was 1.668 which is outside the 90 percent confidence limit for the workplaces surveyed within the same SIC range. This implies that the HBW person attraction rate for Amarillo College is significantly different from the average rate for workplaces with a similar SIC code. All but two of the attraction rates for Amarillo College were found to be significantly different from the average for workplaces in the same SIC range. The implication is that Amarillo College is unique and should be treated as a special generator in travel demand modeling. It should be noted that the number of sites in the workplace survey which fell within the same SIC range was very small, i.e., four. Care should be exercised in drawing any conclusions from such a small sample.

Table 168 presents the comparison for the special generator, Owens Corning Manufacturing. There were only six sites in the workplace survey which fell within the same SIC range. Only two of the special generator attraction rates fell within the confidence interval computed for the average attraction rate found in the six workplaces within the same SIC range. The implication is that this is a unique special generator with significantly different attraction rates. Caution must be observed, however, because the sample of six workplaces is very small.

Table 169 presents the comparison for the special generator, Amarillo International Airport.

Only six sites in the workplace survey fell within the same SIC range. Three of the special generator attraction rates fell within the confidence interval for workplaces within the same SIC range. The implication is that this is a unique special generator with significantly different attraction rates. Caution should be observed since the sample of six workplaces is very small.

Table 170 presents the comparison for the special generator, Amarillo High Plains Hospital. There were 32 sites found in the workplace survey which fell within the same SIC range. None of the special generator attraction rates were within the confidence limits for the similar workplaces. It appears the attraction rates for this special generator are significantly different from those workplaces within the same SIC range.

Table 171 presents the comparison for the special generator, the prison. Only two sites in the workplace survey were found that fell within the same SIC range. Only the HBW and truck/taxi attraction rates for the prison were found to fall within the confidence interval. Due to the small number of workplaces found with a similar SIC code and the fact that no visitors were surveyed at the special generator, no conclusive findings may be made from the data presented in Table 171.

Table 172 presents the comparison for the special generator, Amarillo Westgate Mall. There were 71 sites found in the workplace survey with SIC codes falling within the same SIC range as the mall. As shown in Table 172, none of the attraction rates for the mall fell within the confidence intervals for the average rates from those 71 sites. The implication is that the mall is unique with significantly different attraction rates than those for other sites within the same SIC range.

In general, it appears the attraction rates for all of the sites surveyed as special generators are significantly different from the average rates for workplaces falling within the same SIC range.

The second comparisons grouped the special generators into the three general categories of workplaces used in travel demand modeling and compares the attraction rates for the special generators with those from the overall workplace survey. Those three categories were basic, retail, and service. For the comparisons to be valid, it was necessary to compare the rates with those workplaces in the same area type. Tables 173 through 177 present the results of these comparisons.

The comparison of the attraction rates for Amarillo College with those from the survey of service type establishments in Area Type 3 (Table 173) indicates the attraction rates were significantly different for home based non-work (HBNW) and all purposes combined. The rates for HBW, non-home based, and truck/taxi were found not to be significantly different. These results appear mixed, but since the HBNW portion of the overall attractions accounted for the majority of

the total attractions, the use of the rates from the workplace survey would result in an underestimation of the attractions to the generator. The implication is that better estimates would result from using the attraction rates from the special generator survey.

The comparison of the attraction rates for Owens Corning Manufacturing and Amarillo International Airport with those for basic workplaces in Area Type 4 is presented in Table 174. The results are mixed. The HBW (person and auto driver), HBNW person, and all purposes auto driver attraction rates for Owens Corning Manufacturing were outside the confidence intervals for the workplace survey rates. The HBNW (auto driver), NHB (person and auto driver), and truck/taxi rates fell within the confidence intervals. It would appear that using the rates from the workplace survey for that generator would have produced estimates with as good a level of accuracy as those produced in the workplace survey. The attraction rates for the airport were all outside the confidence interval except for HBW and truck/taxi. The use of the workplace rates to estimate the attractions for the airport would have underestimated the total attractions significantly.

Table 175 presents the comparison of the attraction rates for the Amarillo High Plains Hospital with those for service establishments in Area Type 4. Only the attraction rate for truck/taxi trips was found to fall within the confidence interval. The implication is that the hospital should be treated as a special generator and not combined with the data from the workplace survey.

Table 176 presents the comparison between the attraction rates for the prison with those for service establishments in Area Type 5. The attraction rates for HBW and truck/taxi trips were found to fall within the confidence interval for the rates from the workplace survey. The implication is that using the rates from the workplace survey for estimating the attractions for the prison would result in an overestimation of the attractions. The implication is that the prison should be treated as a special generator and not combined with the workplaces from the workplace survey.

Table 177 presents the comparison between the attraction rates for Westgate Mall with those for retail establishments in Area Type 2. Only one of the rates for the mall fell within the confidence interval for the rates from the workplace survey. The implication is that the mall should be treated as a special generator and not combined with other retail establishments.

General Findings for Amarillo

In general, the attraction rates computed for the special generators surveyed in Amarillo appear reasonable. Only one site, Owens Corning Manufacturing, was found where it could be combined with the data from the workplace survey and not produce estimates significantly outside the overall level of accuracy being obtained from the use of the workplace survey. The other special generators were found to have significantly different attraction rates (for most of the trip purposes) than workplaces with similar SIC codes or falling within the same general category and area type as establishments surveyed in the workplace survey. Caution should be exercised, however, since some questions remain concerning the data from the workplace survey. The best estimates of attractions for the sites surveyed as special generators will be obtained from the attraction rates shown in Table 164. The average trip lengths shown in Table 165 appear reasonable.

**Table 163
Expanded Total Attractions
1990 Amarillo Special Generator Survey**

Site	24-Hr Traffic Count	Person Count	Person Trips					Auto Driver Trips				
			HBW	HBNW	NHB-A	NHB-P	Total*	HBW	HBNW	NHB-A	NHB-P	Total*
Amarillo College	7336	na	657	4263	601	2108	5521	568	3880	534	1929	4981
Owens Corning Manufacturing	1558	na	583	402	421	547	1406	406	167	296	373	868
Amarillo International Airport	4213	na	329	1336	730	1513	2395	271	948	490	1129	1709
Amarillo High Plains Hospital	5431	na	1052	1383	836	1274	3270	906	1288	794	1205	2988
Prison	1645	na	924	0	240	300	1164	804	0	228	276	1032
Westgate Mall Shopping Center	na	24810	1884	9406	3890	6464	15181	1582	7245	2998	5298	11825

*Totals are for attractions only and do not include the NHB-P (Non-Home Based Productions)

Table 164
Attractions per Employee
1990 Amarillo Special Generator Survey

Site	Truck/ Taxi Trips**	Truck/Taxi Attraction Rate	Person Trip Attractions per Employee				Auto Driver Trip Attractions per Employee			
			HBW	HBNW	NHB-A	Total	HBW	HBNW	NHB-A	Total
Amarillo College	28	0.035	1.643	10.657	1.503	13.803	1.419	9.699	1.335	12.453
Owens Corning Manufacturing	232	0.137	0.686	0.473	0.495	1.654	0.478	0.196	0.348	1.022
Amarillo International Airport	742	1.953	1.734	7.032	3.840	12.606	1.428	4.989	2.577	8.994
Amarillo High Plains Hospital	672	0.336	1.052	1.383	0.836	3.271	0.906	1.288	0.794	2.988
Prison	24	0.013	1.027	0.000	0.267	1.294	0.893	0.000	0.253	1.146
Westgate Mall Shopping Center	768	0.211	1.034	5.163	2.135	8.332	0.868	3.976	1.646	6.490

**Truck/Taxi trips are totals, half were assumed to be attractions and half assumed to be productions.

Table 165
Average Trip Length
1990 Amarillo Special Generator Surveys

Site	Data Element	Person Trip Attractions				Auto Driver Trip Attractions			
		HBW	HBNW	NHB	Total	HBW	HBNW	NHB	Total
Amarillo College	Total Surveyed Trips	336	591	194	1121	289	542	162	993
	Total Geocoded Trips	296	551	162	1009	253	504	136	893
	Avg Trip Length in Minutes	6.25	7.35	6.28	7.10	6.36	7.49	6.24	7.23
	Avg Trip Length in Miles	3.39	4.13	3.43	3.97	3.46	4.23	3.39	4.06
Owens Corning Manufacturing	Total Surveyed Trips	189	23	41	253	145	10	30	185
	Total Geocoded Trips	165	11	40	216	123	8	30	161
	Avg Trip Length in Minutes	11.31	11.31	11.05	11.25	11.29	11.21	11.10	11.20
	Avg Trip Length in Miles	7.38	7.34	6.79	7.15	7.24	7.05	6.89	7.07
Amarillo International Airport	Total Surveyed Trips	110	169	114	393	91	123	81	295
	Total Geocoded Trips	87	122	106	315	71	94	75	240
	Avg Trip Length in Minutes	19.3	19.71	16.88	18.57	19.14	20.02	16.95	18.81
	Avg Trip Length in Miles	12.4	12.63	10.72	11.87	12.35	12.88	10.73	12.04
Amarillo High Plains Hospital	Total Surveyed Trips	195	234	152	581	168	218	144	530
	Total Geocoded Trips	163	169	135	467	138	158	129	425
	Avg Trip Length in Minutes	9.22	9.76	7.74	9.01	9.26	9.64	7.77	8.97
	Avg Trip Length in Miles	5.01	5.40	4.22	4.94	5.02	5.32	4.25	4.91

Table 165 (Continued)
Average Trip Length
1990 Amarillo Special Generator Surveys

Site	Data Element	Person Trip Attractions				Auto Driver Trip Attractions			
		HBW	HBNW	NHB	Total	HBW	HBNW	NHB	Total
Prison	Total Surveyed Trips	77	0	21	98	67	0	20	87
	Total Geocoded Trips	56	0	11	67	49	0	10	59
	Avg Trip Length in Minutes	16.00	na	14.85	15.81	16.11	na	14.82	15.89
	Avg Trip Length in Miles	10.15	na	9.51	10.04	10.23	na	9.47	10.10
Westgate Mall Shopping Center	Total Surveyed Trips	284	263	179	726	236	207	147	590
	Total Geocoded Trips	222	205	149	576	183	161	123	467
	Avg Trip Length in Minutes	8.81	9.38	8.64	9.11	8.91	9.27	8.68	9.06
	Avg Trip Length in Miles	4.79	5.25	4.74	5.05	4.86	5.19	4.74	5.04

Table 166
Distribution of Attractions Between Employees and Non-employees
1990 Amarillo Special Generator Surveys

Site	Data Element	Person Trip Attractions				Auto Driver Trip Attractions			
		HBW	HBNW	NHB	Total	HBW	HBNW	NHB	Total
Amarillo College	Percentage of Total Attractions	11.6	77.7	10.7	100.0	11.2	78.3	10.5	100.0
	Percentage by Employees	95.6	0.0	42.4	15.6	94.9	0.0	37.3	14.5
	Percentage by Non-employees	4.4	100.0	57.6	84.4	5.1	100.0	62.7	85.5
Owens Corning Manufacturing	Percentage of Total Attractions	41.5	28.6	29.9	100.0	46.8	19.2	34.0	100.0
	Percentage by Employees	72.4	0.0	8.3	32.6	81.3	0.0	8.1	40.8
	Percentage by Non-employees	27.6	100.0	91.7	67.4	18.7	100.0	91.9	59.2
Amarillo International Airport	Percentage of Total Attractions	12.9	58.6	28.5	100.0	14.9	58.1	27.0	100.0
	Percentage by Employees	88.8	0.0	5.3	12.9	89.3	0.0	6.3	15.0
	Percentage by Non-employees	11.2	100.0	94.7	87.1	10.7	100.0	93.7	85.0
Amarillo High Plains Hospital	Percentage of Total Attractions	30.8	44.7	24.5	100.0	28.9	45.7	25.4	100.0
	Percentage by Employees	100.0	0.0	25.8	37.2	100.0	0.0	25.8	35.5
	Percentage by Non-employees	0.0	100.0	74.2	62.8	0.0	100.0	74.2	64.5
Prison	Percentage of Total Attractions	79.4	0.0	20.6	100.0	77.9	0.0	22.1	100.0
	Percentage by Employees	100.0	na	100.0	100.0	100.0	na	100.0	100.0
	Percentage by Non-employees	0.0	na	0.0	0.0	0.0	na	0.0	0.0
Westgate Mall Shopping Center	Percentage of Total Attractions	11.8	64.0	24.2	100.0	12.7	63.3	24.0	100.0
	Percentage by Employees	96.3	0.0	11.6	14.1	95.6	0.0	13.3	15.3
	Percentage by Non-employees	3.7	100.0	88.4	85.9	4.4	100.0	86.7	84.7

Table 167
Attraction Rate Comparisons
SIC Codes 8200 - 8299
Special Generator - Amarillo College

Type of Trip	Trip Purpose	Results from Workplace Surveys-Observations at 4 Sites			Special Generator Amarillo College
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.016	0.491	1.542	1.643
	HBNW	3.540	1.111	5.968	10.657
	NHB	2.551	1.612	3.489	1.503
	ALL	7.107	4.617	9.597	13.803
Auto Driver Trips	HBW	0.914	0.413	1.416	1.419
	HBNW	1.982	0.500	3.464	9.699
	NHB	1.779	0.954	2.603	1.335
	ALL	4.675	3.350	5.999	12.453
Truck/Taxi	na	0.079	0.000	0.206	0.035

Table 168
Attraction Rate Comparisons
SIC Codes 2000 - 3999
Special Generator - Owens Corning Manufacturing

Type of Trip	Trip Purpose	Results from Workplace Surveys-Observations at 6 Sites			Special Generator Owens Corning Manufacturing
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.398	0.750	2.047	0.686
	HBNW	0.448	0.146	0.750	0.473
	NHB	1.464	0.791	2.138	0.495
	ALL	3.310	1.956	4.665	1.654
Auto Driver Trips	HBW	1.067	0.604	1.530	0.478
	HBNW	0.339	0.130	0.548	0.196
	NHB	1.102	0.679	1.526	0.348
	ALL	2.509	1.619	3.399	1.022
Truck/Taxi	na	0.541	0.138	0.945	0.137

Table 169
Attraction Rate Comparisons
SIC Codes 4000 - 4999
Special Generator - Amarillo International Airport

Type of Trip	Trip Purpose	Results from Workplace Surveys - Observations at 6 Sites			Special Generator Amarillo International
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.912	1.307	2.517	1.734
	HBNW	1.542	0.000	3.553	7.032
	NHB	2.156	0.928	3.383	3.840
	ALL	5.610	2.610	8.610	12.606
Auto Driver Trips	HBW	1.745	1.205	2.285	1.428
	HBNW	1.538	0.000	3.537	4.989
	NHB	1.948	0.853	3.042	2.577
	ALL	5.231	2.391	8.072	8.997
Truck/Taxi	na	0.185	0.007	0.362	1.953

Table 170
Attraction Rate Comparisons
SIC Codes 7000 - 8199
Special Generator - Amarillo High Plains Hospital

Type of Trip	Trip Purpose	Results from Workplace Surveys - Observations at 32 Sites			Special Generator Amarillo High Plains Hospital
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.852	1.371	2.333	1.052
	HBNW	5.535	2.899	8.171	1.383
	NHB	4.119	2.685	5.553	0.836
	ALL	11.506	7.541	15.470	3.271
Auto Driver Trips	HBW	1.596	1.137	2.055	0.906
	HBNW	4.838	2.494	7.182	1.288
	NHB	3.566	2.344	4.788	0.794
	ALL	10.000	6.515	13.484	2.988
Truck/Taxi	na	0.205	0.097	0.313	0.336

Table 171
Attraction Rate Comparisons
SIC Codes 9000 - 9799
Special Generator - Prison

Type of Trip	Trip Purpose	Results from Workplace Surveys - Observations at 2 Sites			Special Generator Prison
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.341	1.018	1.665	1.027
	HBNW	0.029	0.000	0.075	0.000
	NHB	1.060	0.465	1.655	0.267
	ALL	2.430	1.558	3.302	1.294
Auto Driver Trips	HBW	1.277	0.848	1.706	0.893
	HBNW	0.028	0.000	0.073	0.000
	NHB	0.926	0.364	1.489	0.253
	ALL	2.231	1.285	3.177	1.146
Truck/Taxi	na	0.019	0.000	0.050	0.013

Table 172
Attraction Rate Comparisons
SIC Codes 5200 - 5999
Special Generator - Amarillo Westgate Mall

Type of Trip	Trip Purpose	Results from Workplace Surveys - Observations at 71 Sites			Special Generator Amarillo Westgate Mall
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.592	1.392	1.792	1.034
	HBNW	14.349	9.709	18.990	5.163
	NHB	11.762	8.572	14.951	2.135
	ALL	27.703	20.339	35.068	8.332
Auto Driver Trips	HBW	1.315	1.144	1.486	0.868
	HBNW	13.045	8.838	17.253	3.976
	NHB	10.054	7.382	12.726	1.646
	ALL	24.414	17.917	30.911	6.490
Truck/Taxi	na	0.774	0.434	1.114	0.211

Table 173
Attraction Rate Comparisons
Service Workplaces - Area Type 3
Special Generator - Amarillo College

Type of Trip	Trip Purpose	Results from Workplace Survey - Observations at 15 Sites			Special Generator Amarillo College
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	2.491	1.148	3.833	1.643
	HBNW	3.340	0.822	5.858	10.657
	NHB	3.181	1.365	4.996	1.503
	ALL	9.011	4.645	13.377	13.803
Auto Driver Trips	HBW	2.280	0.968	3.591	1.419
	HBNW	2.924	0.779	5.069	9.699
	NHB	2.740	1.191	4.289	1.335
	ALL	7.944	4.184	11.703	12.453
Truck/Taxi	na	0.053	0.006	0.100	0.035

Table 174
Attraction Rate Comparisons
Basic Workplaces - Area Type 4
Special Generators - Owens Corning Manufacturing and Amarillo International Airport

Type of Trip	Trip Purpose	Results from Workplace Surveys - Observations at 13 Sites			Special Generator	
		Average Trips per Employee	90 Percent Confidence Limits		Owens Corning Manufacturing	Amarillo International Airport
			Low*	High	Average Trips Per Employee	Average Trips per Employee
Person Trips	HBW	1.486	0.935	2.037	0.686	1.734
	HBNW	0.166	0.030	0.303	0.473	7.032
	NHB	1.439	0.473	2.405	0.495	3.840
	ALL	3.091	1.574	4.608	1.654	12.606
Auto Driver Trips	HBW	1.214	0.686	1.742	0.478	1.428
	HBNW	0.156	0.031	0.280	0.196	4.989
	NHB	1.241	0.288	2.194	0.348	2.577
	ALL	2.610	1.121	4.099	1.022	8.994
Truck/Taxi	na	1.053	0.000	2.314	0.137	1.953

*Negative low values were set to zero.

Table 175
Attraction Rate Comparisons
Service Workplaces - Area Type 4
Special Generator - Amarillo High Plains Hospital

Type of Trip	Trip Purpose	Results from Workplace Survey - Observations at 22 Sites			Special Generator Amarillo High Plains Hospital
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.737	1.344	2.131	1.052
	HBNW	5.271	1.888	8.654	1.383
	NHB	4.019	2.222	5.816	0.836
	ALL	11.028	5.850	16.205	3.271
Auto Driver Trips	HBW	1.491	1.141	1.842	0.906
	HBNW	4.562	1.533	7.591	1.288
	NHB	3.457	1.930	4.983	0.794
	ALL	9.510	4.946	14.074	2.988
Truck/Taxi	na	0.309	0.130	0.488	0.336

Table 176
Attraction Rate Comparisons
Service Workplaces - Area Type 5
Special Generator - Prison

Type of Trip	Trip Purpose	Results from Workplace Survey - Observations at 4 Sites			Special Generator Prison
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.050	0.466	1.635	1.027
	HBNW	3.780	1.457	6.103	0.000
	NHB	2.220	1.004	3.436	0.267
	ALL	7.051	4.006	10.095	1.294
Auto Driver Trips	HBW	0.828	0.376	1.281	0.893
	HBNW	2.202	0.720	3.685	0.000
	NHB	1.627	0.690	2.564	0.253
	ALL	4.658	2.859	6.457	1.146
Truck/Taxi	na	0.186	0.005	0.367	0.013

Table 177
Attraction Rate Comparisons
Retail Workplaces - Area Type 2
Special Generator - Westgate Mall

Type of Trip	Trip Purpose	Results from Workplace Survey - Observations at 24 Sites			Special Generator Westgate Mall
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.569	1.302	1.837	1.034
	HBNW	9.191	5.933	12.450	5.163
	NHB	8.579	5.869	11.290	2.135
	ALL	19.340	13.588	25.092	8.332
Auto Driver Trips	HBW	1.290	1.042	1.538	0.868
	HBNW	8.443	5.300	11.585	3.976
	NHB	7.745	5.121	10.370	1.646
	ALL	17.478	11.857	23.100	6.490
Truck/Taxi	na	0.734	0.217	1.251	0.211

Tyler Special Generator Surveys

Five establishments were identified in Tyler for inclusion in the special generator survey. Table 178 presents these generators and some of the data collected in the general information survey. The data presented in Table 178 are those which were used to expand the survey data to develop person and auto driver trip attraction estimates and attraction rates (attractions per employee) for those sites.

Table 178
Special Generators Surveyed
In 1991 Tyler Travel Survey

Site	SIC Code	Employees at Work	Total Employment	Surveyed Employees	Surveyed Visitors
Tyler Pounds Field Airport	4000	148	183	40	284
Kelly Springfield Tire Manufacturing	3011	1072	1445	71	79
Broadway Square Mall	5800	450	500	102	1130
Tyler Medical Center	8062	1248	1248	344	397
University of Texas at Tyler	8221	300	350	92	1026

Using the same methodology described in the previous chapter for workplace surveys, the surveyed trips were expanded for each special generator, and the external trips were removed. The resulting person and auto driver trip attractions are presented in Table 179. The total auto driver trips (i.e., sum of the total auto driver attractions plus the non-home based auto driver productions) does not equal the total 24-hour vehicle counts at the sites. The difference is the estimated truck and taxi trips to each site.

The external trips to the special generators surveyed in Tyler represent a significant proportion of the overall trip ends at those sites. The resulting trip attraction rates are much lower, since they are for internal trips only. The significantly high numbers of external trips indicate a potential problem with study area boundary location. For Tyler Pounds Field Airport, over 27 percent of the person trip ends were external. For Kelly Springfield Tire Manufacturing, over 45 percent of the person trip ends were external. Of the total person trip ends at the Broadway Square Mall, over 20 percent were external. Nearly 30 percent of the person trip ends at the Tyler Medical Center were

external, and over 37 percent of the person trip ends at the University of Texas at Tyler were external.

Using the expanded attractions shown in Table 179 and the total employment for each site shown in Table 178, the resulting model attraction rates were computed and are shown in Table 180. The unit for these attraction rates is attractions per employee. Table 180 also presents the estimated truck and taxi trips to each site. The trucks were counted at each site, and the taxi trips were estimated from the employee and visitor surveys where taxi was reported as the mode of travel to the site. Half of the truck and taxi trips were assumed to be attractions and half productions.

In addition to computing attraction rates for each site, the average trip lengths by trip purpose were computed and are presented in Table 181. These averages represent expanded weighted averages. Since most of the surveyed trips were geocoded, the averages presented in Table 181 are felt to be representative of those special generators. It is of interest to note that the average trip length by trip purpose for these sites does not have the same pattern as that observed in the household survey. Typically, in most urban areas, the average trip length for HBW trips is much higher than that for HBNW and NHB. In all but one of the special generators, the average HBW trip length was less than that for HBNW and NHB.

Table 182 presents the distribution of attractions by trip purpose and the split between employees and non-employees for each of the sites surveyed. For example, about one third (i.e., 33 percent) of the total person attractions to the Tyler Pounds Field Airport were HBW. Of those HBW attractions, nearly 58 percent were made by employees and about 42 percent by non-employees. For all the attractions to the airport, 30 percent were made by employees and 70 percent by non-employees. The distributions shown in Table 182 are felt to be reasonable in that they reflect what would be expected. For example, the majority of trips to Kelly Springfield Tire Manufacturing (96 percent) were employees. This is to be expected since a manufacturing plant would not typically attract a lot of trips from non-employees. The other extreme is Broadway Square Mall. Due to the nature of its activity (i.e., retail center), it would be expected to attract a lot of trips from other persons besides the employees at the site. The survey of that generator found that 92 percent of the attractions to the site were due to non-employees. Overall, the distributions appear reasonable for the types of activities at those sites.

Comparison of Similar Type Generators

The limited number of special generators surveyed in Tyler resulted in no similar type generators. No comparison of attraction rates between the surveyed special generators was made since it was not considered to be a valid comparison.

Comparison with Non-Special Generators

As with San Antonio and Amarillo, a comparison was made between the attraction rates observed for the special generators and the rates observed for workplaces surveyed. The intent was to address the question of whether or not these sites were unique and should be treated as special generators. The first comparison was between each special generator and those workplaces in the workplace survey whose SIC code was within the same range. The concept was that workplaces having the same SIC code were similar in their principal activity and would possibly have similar trip attraction rates.

The comparison was done by identifying those workplaces in the survey whose SIC code fell within the same range as a special generator, computing the average attraction rates for those workplaces, and then computing the confidence interval for those rates at a 90 percent confidence level. The attraction rates for the special generator were then examined to determine if they fell within the confidence interval. Those rates falling within the confidence interval were considered to be similar to the rate from the workplace survey relative to the level of accuracy being obtained in the use of those attraction rates. Judgment was necessary relative to the number of observations from the workplace survey and the validity of the computed confidence intervals.

The first special generator examined was Tyler Pounds Field Airport. The data are presented in Table 183. Only three workplaces were found in the workplace survey which had an SIC code within the range 4000 to 4999. The resulting confidence intervals for the attraction rates were subsequently very large for all of the trip purposes except HBW and truck/taxi. The HBW and truck/taxi attraction rates for the airport did fall within the confidence intervals. Due to the small number of observations, the comparison is not considered conclusive.

The second special generator examined was Kelly Springfield Tire Manufacturing. The data are presented in Table 184. Ten workplaces were found in the workplace survey which had SIC codes falling within the range 2000 to 3999. The resulting confidence intervals are large for all trip purposes except HBW. The HBNW and truck/taxi attraction rates for the special generator were the

only rates which fell within the confidence interval while the attraction rates for the other trip purposes did not. These results appear mixed, but examination of the rates for Kelly Manufacturing and the average rates for the workplaces from the workplace survey reveal significant differences in the numerical values. Since HBW attraction rates are the most stable and those did not fall within the confidence intervals, the attraction rates for Kelly Springfield Tire Manufacturing are felt to be significantly different from those for workplaces within the same SIC code range. Caution is recommended in drawing definitive conclusions due to the limited number of observations from the workplace survey.

The third special generator examined was Broadway Square Mall. The data are presented in Table 185. There were 46 workplaces found in the workplace survey with SIC codes falling in the range 5200 to 5999. The resulting confidence intervals were considered reasonable indicators of the level of accuracy that would be obtained in the use of those average attraction rates. The attraction rates for the mall were found to be significantly different for HBW, NHB, and truck/taxi trips. It appears the trip rates from the workplace survey would yield reasonable estimates of HBNW and total attractions for the mall but less accurate estimates for HBW and NHB. The implication is that the mall is not necessarily unique.

The fourth special generator examined was the Tyler Medical Center. The data are presented in Table 186. There were 27 workplaces found in the workplace survey with SIC codes falling in the range 7000 to 8199. The resulting confidence intervals were considered reasonable indicators of the level of accuracy that would be obtained in the use of those average attraction rates. Only HBNW attraction rates for the Medical Center were found to fall within the confidence intervals. The numerical difference between the attraction rates for the medical center and the average rates for the workplaces was significant. Tyler Medical Center should be treated as a unique special generator.

The final special generator was the University of Texas at Tyler. The SIC range for that activity was 8200 to 8299. Only one workplace was found in the workplace survey with an SIC code in that range. No valid comparison was felt to be possible.

In the second type of comparison the attraction rates for the special generators were compared with the average rates for workplaces grouped into the three employment categories used in travel demand modeling; basic, retail, and service. To ensure validity, only workplaces with the same area type designation were compared. For example, employment at the Tyler Pounds Field Airport and Kelly Springfield Tire Manufacturing was defined as basic. Both generators were located in Area

Type 3. The attraction rates for workplaces with basic employment located in Area Type 3 were averaged, 90 percent confidence intervals computed, and then compared with the rates for those two special generators. The results are shown in Table 187. There were 19 workplaces found in the workplace survey with basic employment located in Area Type 3. None of the attraction rates for Kelly Springfield Tire Manufacturing fell within the confidence intervals. All but the NHB attraction rates for the airport fell within the confidence intervals. The implication is that Kelly Springfield Tire Manufacturing should be treated as a special generator and that the Tyler Pounds Field Airport could be treated as a typical basic workplace located in Area Type 3 with no significant loss in accuracy.

The second comparison was between the attraction rates for Broadway Square Mall and the average rates for 18 retail workplaces located in Area Type 2. Those results are shown in Table 188. Only the attraction rate for HBNW person trips fell within the limits of the confidence interval. The implication is that retail workplaces located in the same area type would yield unreasonable estimates of the attractions for the mall. For that reason, the mall was considered unique and should be treated as a special generator.

The third comparison was between the attraction rates for the Tyler Medical Center and the average rates for 21 service workplaces located in Area Type 2. Those results are shown in Table 189. None of the attraction rates for the Medical Center fell within the confidence interval limits. The implication is that the Medical Center is significantly different from the other service employment workplaces in Area Type 2 in terms of trip attraction rates.

The final comparison was between the attraction rates for the University of Texas at Tyler and the average rates for 14 service employment workplaces located in Area Type 3. The results are shown in Table 190. The low number of observations from the workplace survey resulted in large confidence intervals for all of the trip purposes except HBW. The truck/taxi attraction rate for the university was the only attraction rate that fell within the confidence interval limits for the average attraction rates from the workplace survey. Due to the large confidence intervals, the comparisons for those trip purposes are felt to be inconclusive, and the university should continue to be treated as a special generator.

General Findings for Tyler

In general, the attraction rates for the special generators surveyed in Tyler appear reasonable. In comparing the attraction rates for workplace surveys and special generators, no conclusive

findings were found to warrant not treating those sites as special generators. Since some questions still remain concerning the validity of the results from the workplace survey, any findings from these comparisons should be used with caution. The best estimates of attractions for those special generators will be obtained from the attraction rates shown in Table 180. The average trip lengths shown in Table 181 are considered reasonable.

COMPARISONS BETWEEN URBAN AREAS

The purpose of this section is to examine the issue of transferability of special generator attraction rates between urban areas. Conducting these types of surveys requires considerable resources in terms of funding and manpower. If the data are transferable, the need to conduct these types of surveys within each urban area would be reduced.

The immediate question is whether the attraction rates are transferable. The key in addressing this is the comparability of the special generators themselves. Review of the data shown in Table 148, 162, and 178 indicates special generators were surveyed in all three urban areas in the general categories of higher education (i.e., universities), medical facilities, shopping centers, and airports. The attraction rates for each of these categories are examined in the following paragraphs.

Higher Education

Two universities were surveyed in San Antonio and one was surveyed in Amarillo and Tyler. Figures 20 and 21 present comparisons of the person and auto driver attraction rates for those surveys by trip purpose. The first observation which may be made is that the attraction rates for HBW person and auto driver trips are very similar. The HBNW person attraction rates for St. Mary's in San Antonio and Amarillo College are very similar. The NHB attraction rates are similar for both person and auto driver trips for all of the universities except the University of Texas at San Antonio. One possible explanation for the University of Texas at Tyler being different is the impact of external trips on the internal attraction rates. It was noted previously that the study area boundary for Tyler was within close proximity to the developed areas of Tyler; and as a result, the number of external trips recorded in the survey were much higher than those observed for the other urban areas. Since travel to universities is dominated by non-employees, this could be expected to have an impact on the internal attraction rate for that site. A similar explanation is not feasible for the University of Texas at San Antonio. It apparently is unique and, being set in a rural location away from the major

developed areas, simply attracted fewer trips.

Medical Facilities

Figures 22 and 23 present a comparison of the person and auto driver attraction rates for the medical facilities surveyed in San Antonio, Amarillo, and Tyler. Two facilities were surveyed in San Antonio. With the exception of the Medical Center in San Antonio, the attraction rates for the Northeast Baptist Hospital in San Antonio, the Amarillo High Plains Hospital, and the Tyler Medical Center appear to be very similar. The Medical Center in San Antonio is located in an area where its attractiveness may be diluted by other medical facilities. It was noted that nearly 67 percent of the attractions to the Medical Center were by employees. This was significantly different from the other three facilities which had 35 to 50 percent of the attractions attributable to their employees. The rates do appear to be transferable with no significant loss in overall accuracy.

Airports

Figures 24 and 25 present comparisons of the person and auto driver attraction rates by trip purpose for the three airports which were surveyed. With the exception of HBW trips, significant differences are apparent between the attraction rates for the urban areas. It should be noted, however, that 38 percent of the trips to the Tyler Pounds Field Airport were external. This, compared to 27 percent for Amarillo and 6 percent for San Antonio, may explain the relatively low attraction rates for Tyler. If the study area boundaries were similar for Tyler and Amarillo, the attraction rates would probably be similar. San Antonio, however, is a much larger area and would be expected to have different rates; but the rates shown in Figures 24 and 25 are fairly comparable between the airport in San Antonio and the one in Amarillo.

Shopping Centers

Figures 26 and 27 present comparisons of the person and auto driver attraction rates for the retail shopping centers surveyed in the three urban areas. The HBW attraction rates are similar for all three sites. The HBNW and NHB attraction rates are similar for the shopping centers surveyed in San Antonio and Amarillo. The rates for the shopping center in Tyler are significantly higher than those in the other two shopping centers. There is no obvious reason for the high rates in Tyler. The employment at the shopping center in Tyler was only 500 as compared to 2,500 for the one in San

Antonio and 1800 for the one in Amarillo. The shopping centers may not have been comparable in terms of the number and mix of stores within the centers. The rates for the centers in San Antonio and Amarillo appear similar enough to be transferred and used in other urban areas where special generator surveys have not been done.

SUMMARY

In general, the attraction rates from the special generator surveys appear reasonable and are recommended for use in the travel demand models in those urban areas. It should be noted that the location of the study area boundary has a significant impact on the attraction rates for special generators, and this impact also influences the attraction rates for other workplaces as well. Table 191 presents recommended attraction rates to be used for selected special generators in urban areas where special generator surveys are not available. These rates are felt to provide reasonable estimates for use in travel demand models but, where possible, should be replaced with local data.

Table 179
Expanded Total Attractions
1991 Tyler Special Generator Survey

Site	24-Hr Traffic Count	Person Count	Person Trips					Auto Driver Trips				
			HBW	HBNW	NHB-A	NHB-P	Total*	HBW	HBNW	NHB-A	NHB-P	Total*
Tyler Pounds Field Airport	1624	na	249	272	191	440	712	239	261	175	412	675
Kelly Springfield Tire Manufacturing	2446	na	1032	6	108	163	1146	954	6	107	163	1067
Broadway Square Mall	15590	na	820	4533	3486	4491	8838	708	4234	3235	4117	8177
Tyler Medical Center	na	8282	1519	1593	1037	1654	4149	1292	1371	922	1428	3585
University of Texas at Tyler	5842	na	465	1853	573	1074	2890	425	1566	546	996	2538

*Totals are for attractions only and do not include the NHB-P (Non-Home Based Productions)

Table 180
Attractions per Employee
1990 Tyler Special Generator Survey

Site	Truck/Taxi Trips**	Truck/Taxi Attraction Rate	Person Trip Attractions per Employee				Auto Driver Trip Attractions per Employee			
			HBW	HBNW	NHB-A	Total	HBW	HBNW	NHB-A	Total
Tyler Pounds Field Airport	138	0.366	1.362	1.485	1.041	3.888	1.303	1.427	0.957	3.687
Kelly Springfield Tire Manufacturing	168	0.058	0.714	0.004	0.075	0.793	0.660	0.004	0.074	0.738
Broadway Square Mall	266	0.266	1.639	9.066	6.971	17.676	1.417	8.467	6.470	16.354
Tyler Medical Center	250	0.099	1.217	1.277	0.831	3.325	1.035	1.098	0.739	2.872
University of Texas at Tyler	80	0.114	1.329	5.294	1.636	8.258	1.215	4.476	1.560	7.251

**Truck/Taxi trips are totals; half were assumed to be attractions and half assumed to be productions.

Table 181
Average Trip Length
1991 Tyler Special Generator Survey

Site	Data Element	Person Trip Attractions				Auto Driver Trip Attractions			
		HBW	HBNW	NHB	Total	HBW	HBNW	NHB	Total
Tyler Pounds Field Airport	Total Surveyed Trips	90	130	85	305	86	124	77	287
	Total Geocoded Trips	81	125	85	291	80	119	77	276
	Avg Trip Length in Minutes	8.50	11.23	9.50	9.83	8.49	11.41	9.45	9.89
	Avg Trip Length in Miles	5.85	7.96	6.76	6.91	5.84	8.08	6.70	6.95
Kelly Springfield Tire Manufacturing	Total Surveyed Trips	127	8	36	171	119	8	36	163
	Total Geocoded Trips	121	7	36	164	113	7	36	156
	Avg Trip Length in Minutes	5.24	7.34	6.43	5.39	5.39	7.34	6.44	5.54
	Avg Trip Length in Miles	3.58	5.44	4.69	3.71	3.70	5.44	4.66	3.82
Broadway Square Mall	Total Surveyed Trips	184	615	524	1323	159	575	483	1217
	Total Geocoded Trips	176	427	524	1127	152	401	483	1036
	Avg Trip Length in Minutes	4.77	5.64	4.64	5.05	5.03	5.60	4.70	5.08
	Avg Trip Length in Miles	2.84	3.57	2.82	3.12	3.01	3.57	2.86	3.16

Table 181 (Continued)
Average Trip Length
1991 Tyler Special Generator Survey

Site	Data Element	Person Trip Attractions				Auto Driver Trip Attractions			
		HBW	HBNW	NHB	Total	HBW	HBNW	NHB	Total
Tyler Medical Center	Total Surveyed Trips	477	222	200	899	407	185	175	767
	Total Geocoded Trips	476	183	200	859	407	150	175	732
	Avg Trip Length in Minutes	3.99	6.63	4.44	5.12	4.08	6.64	4.58	5.20
	Avg Trip Length in Miles	2.22	3.85	2.42	2.90	2.27	3.84	2.50	2.93
University of Texas at Tyler	Total Surveyed Trips	162	627	213	1002	148	525	204	877
	Total Geocoded Trips	159	541	213	913	145	442	204	791
	Avg Trip Length in Minutes	3.58	5.27	6.38	5.37	3.82	5.97	6.42	5.88
	Avg Trip Length in Miles	2.10	3.27	3.94	3.31	2.26	3.73	3.97	3.64

Table 182
Distribution of Attractions Between Employees and Non-employees
1991 Tyler Special Generator Survey

Site	Data Element	Person Trip Attractions				Auto Driver Trip Attractions			
		HBW	HBNW	NHB	Total	HBW	HBNW	NHB	Total
Tyler Pounds Field Airport	Percentage of Total Attractions	35.0	38.2	26.8	100.0	35.4	38.7	25.9	100.0
	Percentage by Employees	64.7	0.0	46.1	35.0	65.7	0.0	50.3	36.4
	Percentage by Non-employees	35.3	100.0	53.9	65.0	34.3	100.0	49.7	63.6
Kelly Springfield Tire Manufacturing	Percentage of Total Attractions	90.1	0.5	9.4	100.0	89.4	0.6	10.0	100.0
	Percentage by Employees	98.3	0.0	81.5	96.1	98.1	0.0	82.2	95.9
	Percentage by Non-employees	1.7	100.0	18.5	3.9	1.9	100.0	17.8	4.1
Broadway Square Mall	Percentage of Total Attractions	9.3	51.3	39.4	100.0	8.7	51.8	39.5	100.0
	Percentage by Employees	66.8	0.0	4.3	7.9	66.7	0.0	3.5	7.1
	Percentage by Non-employees	33.2	100.0	95.7	92.1	33.3	100.0	96.5	92.9
Tyler Medical Center	Percentage of Total Attractions	36.6	38.4	25.0	100.0	36.0	38.2	25.8	100.0
	Percentage by Employees	92.4	0.0	21.8	39.3	94.2	0.0	21.3	39.4
	Percentage by Non-employees	7.6	100.0	78.2	60.7	5.8	100.0	78.7	60.6
University of Texas at Tyler	Percentage of Total Attractions	16.1	64.1	19.8	100.0	16.7	61.7	21.6	100.0
	Percentage by Employees	94.8	0.0	25.7	20.3	96.5	0.0	24.4	21.4
	Percentage by Non-employees	5.2	100.0	74.3	79.7	3.5	100.0	75.6	78.6

Table 183
Attraction Rate Comparisons
SIC Codes 4000 - 4999
Special Generator - Tyler Pounds Field Airport

Type of Trip	Trip Purpose	Results from Workplace Surveys - Observations at 3 Sites			Special Generator Tyler Pounds Field Airport
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.337	1.091	1.583	1.362
	HBNW	5.697	0.000	13.390	1.485
	NHB	7.078	0.000	16.763	1.041
	ALL	14.112	0.000	31.399	3.888
Auto Driver Trips	HBW	1.235	0.905	1.566	1.303
	HBNW	5.697	0.000	13.390	1.427
	NHB	7.078	0.000	16.763	0.957
	ALL	14.010	0.000	31.223	3.687
Truck/Taxi	na	0.400	0.305	1.495	0.366

Table 184
Attraction Rate Comparisons
SIC Codes 2000 - 3999
Special Generator - Kelly Springfield Tire Manufacturing

Type of Trip	Trip Purpose	Results from Workplace Surveys - Observations at 10 Sites			Special Generator Kelly Springfield Tire Manufacturing
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.723	1.477	1.969	0.714
	HBNW	3.647	0.000	8.067	0.004
	NHB	4.399	0.470	8.329	0.075
	ALL	9.769	1.382	18.157	0.793
Auto Driver Trips	HBW	1.619	1.372	1.866	0.660
	HBNW	3.531	0.000	7.972	0.004
	NHB	4.275	0.333	8.217	0.074
	ALL	9.425	1.031	17.819	0.738
Truck/Taxi	na	2.069	0.000	4.703	0.058

Table 185
Attraction Rate Comparisons
SIC Codes 5200 - 5999
Special Generator - Tyler Broadway Square Mall

Type of Trip	Trip Purpose	Results from Workplace Surveys - Observations at 46 Sites			Special Generator Broadway Square Mall
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.106	0.953	1.259	1.639
	HBNW	9.507	7.391	11.624	9.066
	NHB	9.654	8.187	11.121	6.971
	ALL	20.268	16.885	23.651	17.676
Auto Driver Trips	HBW	0.974	0.833	1.116	1.417
	HBNW	8.986	7.076	10.897	8.467
	NHB	8.944	7.613	10.275	6.470
	ALL	18.905	15.830	21.979	16.354
Truck/Taxi	na	0.998	0.628	1.369	0.266

Table 186
Attraction Rate Comparisons
SIC Codes 7000 - 8199
Special Generator - Tyler Medical Center

Type of Trip	Trip Purpose	Results from Workplace Surveys - Observations at 27 Sites			Special Generator Tyler Medical Center
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.952	1.493	2.412	1.217
	HBNW	5.162	1.020	9.304	1.277
	NHB	4.590	2.497	6.684	0.831
	ALL	11.705	5.726	17.683	3.325
Auto Driver Trips	HBW	1.821	1.376	2.266	1.035
	HBNW	4.773	0.879	8.666	1.098
	NHB	4.132	2.170	6.094	0.739
	ALL	10.725	5.109	16.342	2.872
Truck/Taxi	na	0.673	0.293	1.053	0.099

Table 187
Attraction Rate Comparisons
Basic Workplaces - Area Type 3
Special Generators - Kelly Springfield Tire Manufacturing and Tyler Pounds Field Airport

Type of Trip	Trip Purpose	Results from Workplace Surveys - Observations at 19 Sites			Special Generator	
		Average Trips per Employee	90 Percent Confidence Limits		Kelly Springfield Manufacturing	Tyler Airport
			Low*	High	Average Trips per Employee	Average Trips per Employee
Person Trips	HBW	1.508	1.291	1.725	0.714	1.362
	HBNW	1.072	0.307	1.837	0.004	1.485
	NHB	1.636	1.186	2.086	0.075	1.041
	ALL	4.215	3.028	5.403	0.793	3.888
Auto Driver Trips	HBW	1.278	1.088	1.468	0.660	1.303
	HBNW	0.955	0.199	1.710	0.004	1.427
	NHB	1.509	1.077	1.941	0.074	0.957
	ALL	3.742	2.612	4.872	0.738	3.687
Truck/Taxi	na	1.480	0.097	2.863	0.058	0.366

*Negative low values were set to zero.

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Table 188
Attraction Rate Comparisons
Retail Workplaces - Area Type 2
Special Generator - Tyler Broadway Square Mall

Type of Trip	Trip Purpose	Results from Workplace Survey - Observations at 18 Sites			Special Generator Broadway Square Mall
		Average Trips per Employee	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.052	0.855	1.249	1.639
	HBNW	11.123	8.881	13.365	9.066
	NHB	10.417	8.510	12.324	6.971
	ALL	22.592	18.782	26.402	17.676
Auto Driver Trips	HBW	0.902	0.712	1.093	1.417
	HBNW	10.704	8.529	12.879	8.467
	NHB	9.598	7.879	11.316	6.470
	ALL	21.204	17.598	24.811	16.354
Truck/Taxi	na	1.008	0.436	1.581	0.266

Table 189
Attraction Rate Comparisons
Service Workplaces - Area Type 2
Special Generator - Tyler Medical Center

Type of Trip	Trip Purpose	Results from Workplace Survey - Observations at 21 Sites			Special Generator Tyler Medical Center
		Average Trips per Employee*	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.837	1.450	2.225	1.217
	HBNW	2.557	1.512	3.601	1.277
	NHB	2.656	2.117	3.195	0.831
	ALL	7.050	5.770	8.330	3.325
Auto Driver Trips	HBW	1.699	1.311	2.086	1.035
	HBNW	2.342	1.417	3.267	1.098
	NHB	2.399	1.917	2.880	0.739
	ALL	6.439	5.354	7.524	2.872
Truck/Taxi	na	0.387	0.135	0.638	0.099

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Table 190
Attraction Rate Comparisons
Service Workplaces - Area Type 3
Special Generator - University of Texas at Tyler

Type of Trip	Trip Purpose	Results from Workplace Survey - Observations at 14 Sites			Special Generator University of Texas at Tyler
		Average Trips per Employee*	90 Percent Confidence Limits		Average Trips per Employee
			Low	High	
Person Trips	HBW	1.210	0.970	1.451	1.329
	HBNW	6.204	0.000	14.066	5.294
	NHB	3.961	0.783	7.139	1.636
	ALL	11.376	0.398	22.353	8.258
Auto Driver Trips	HBW	1.143	0.929	1.356	1.215
	HBNW	5.881	0.000	13.314	4.476
	NHB	3.686	0.619	6.753	1.560
	ALL	10.710	0.284	21.135	7.251
Truck/Taxi	na	0.795	0.302	1.288	0.114

Figure 20
Comparison of Higher Education
Person Trip Attraction Rates

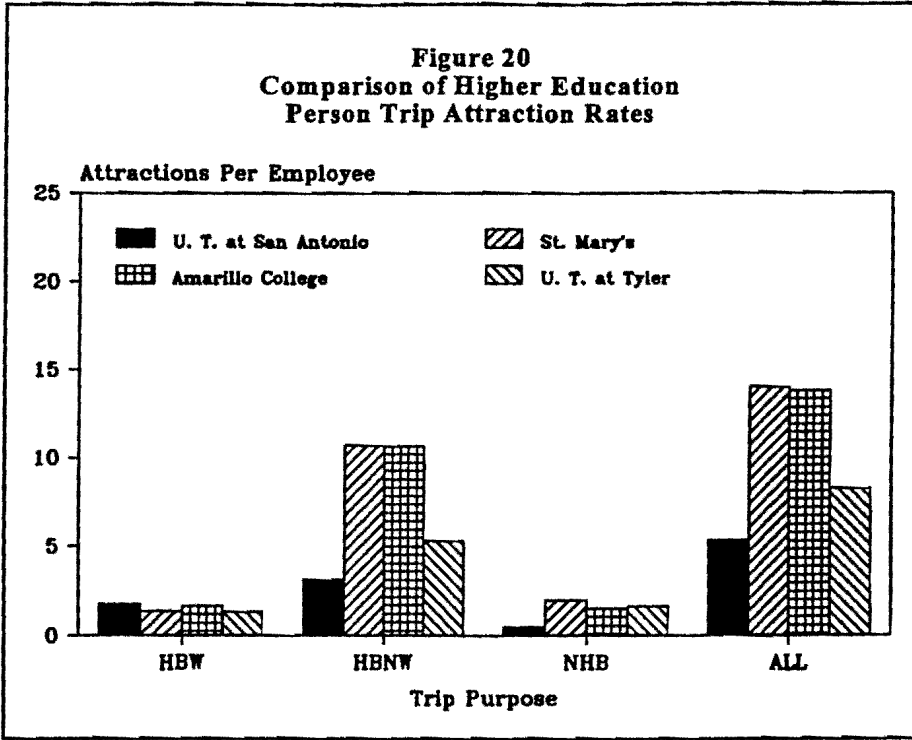


Figure 21
Comparison of Higher Education
Auto Driver Trip Attraction Rates

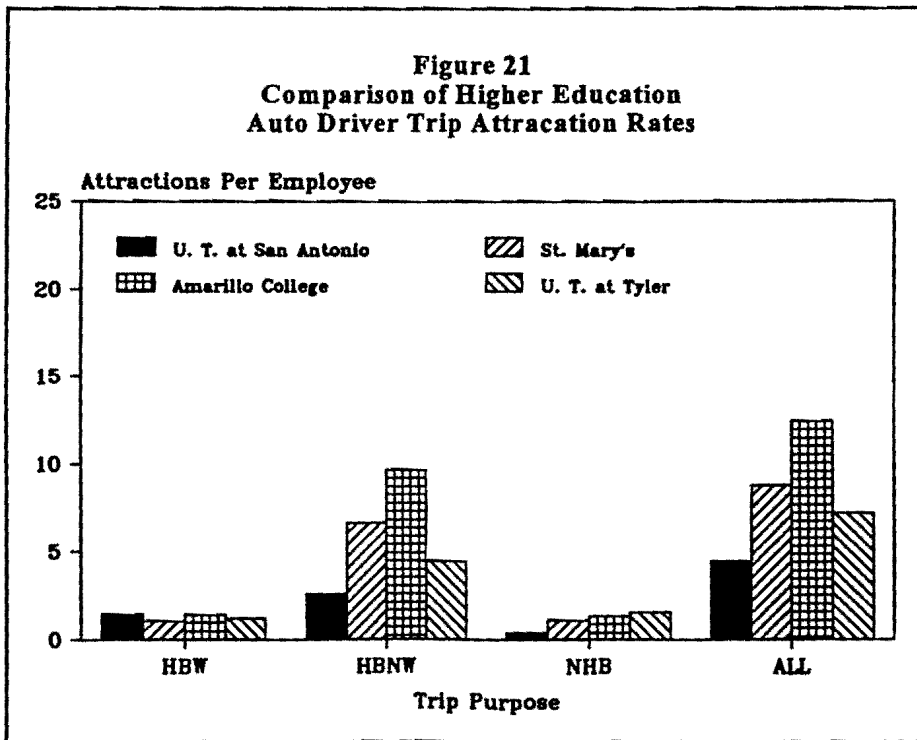


Figure 22
Comparison of Medical Facilities
Person Trip Attraction Rates

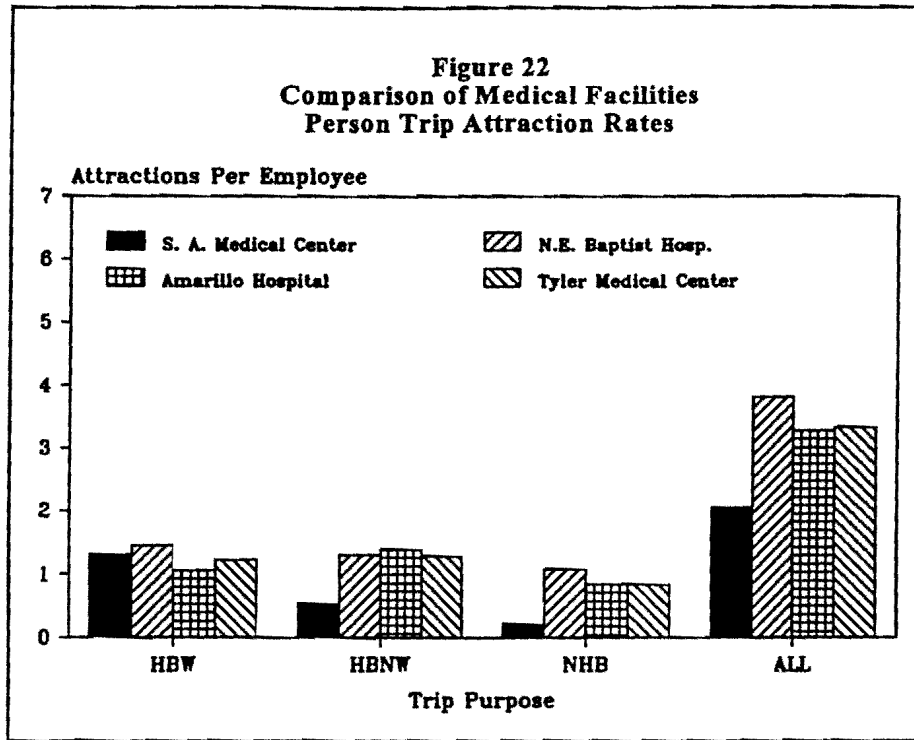


Figure 23
Comparison of Medical Facilities
Auto Driver Trip Attraction Rates

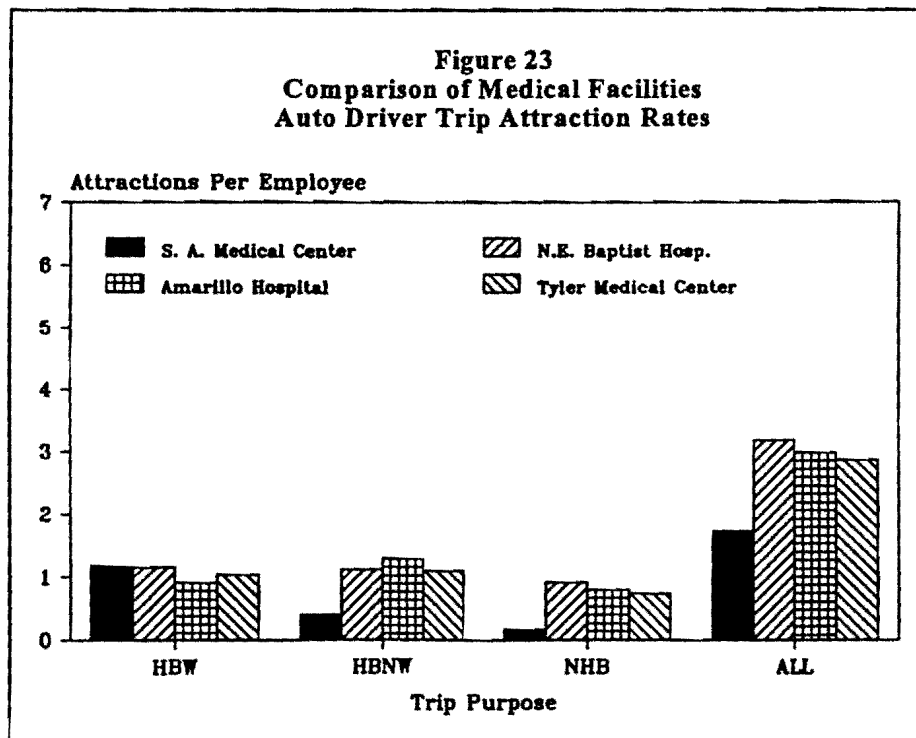


Figure 24
Comparison of Airport Facilities
Person Trip Attraction Rates

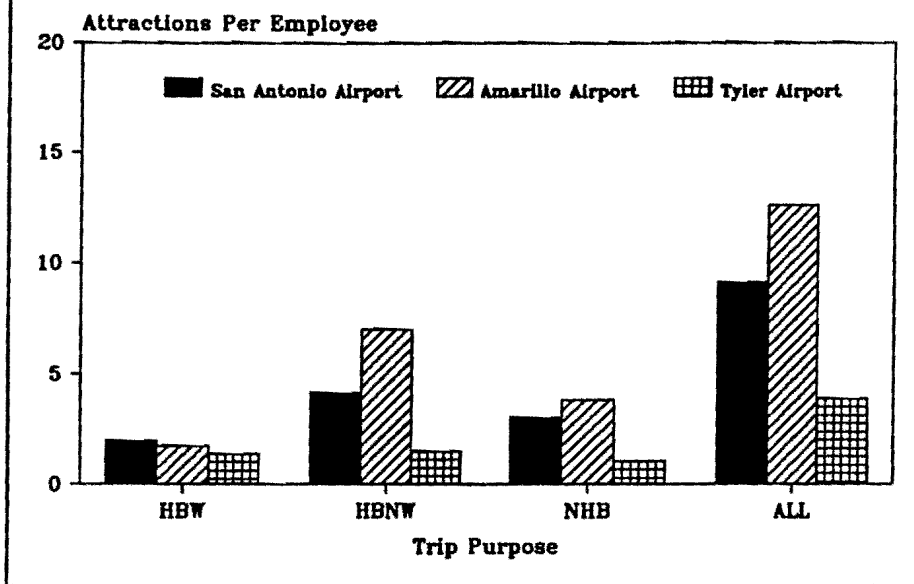


Figure 25
Comparison of Airport Facilities
Auto Driver Trip Attraction Rates

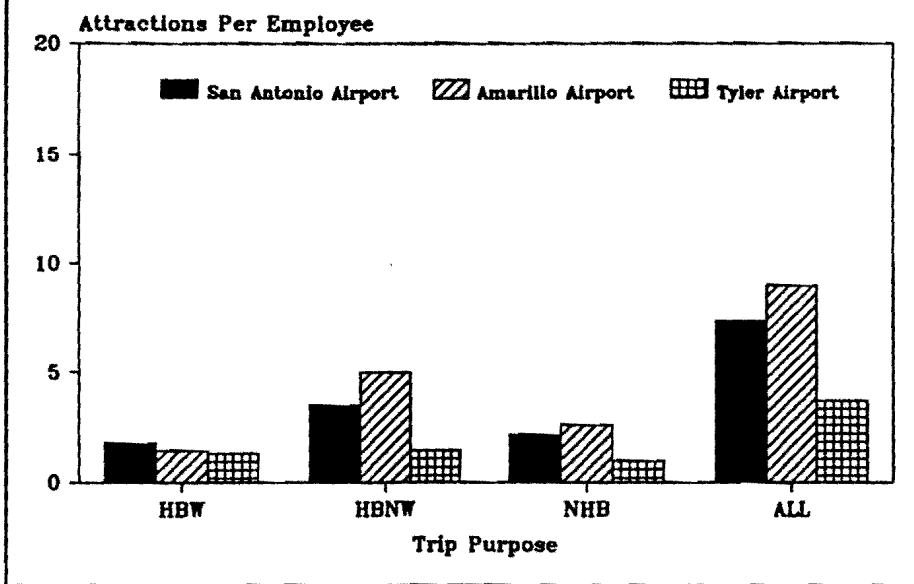


Figure 26
Comparison of Shopping Center
Person Trip Attraction Rates

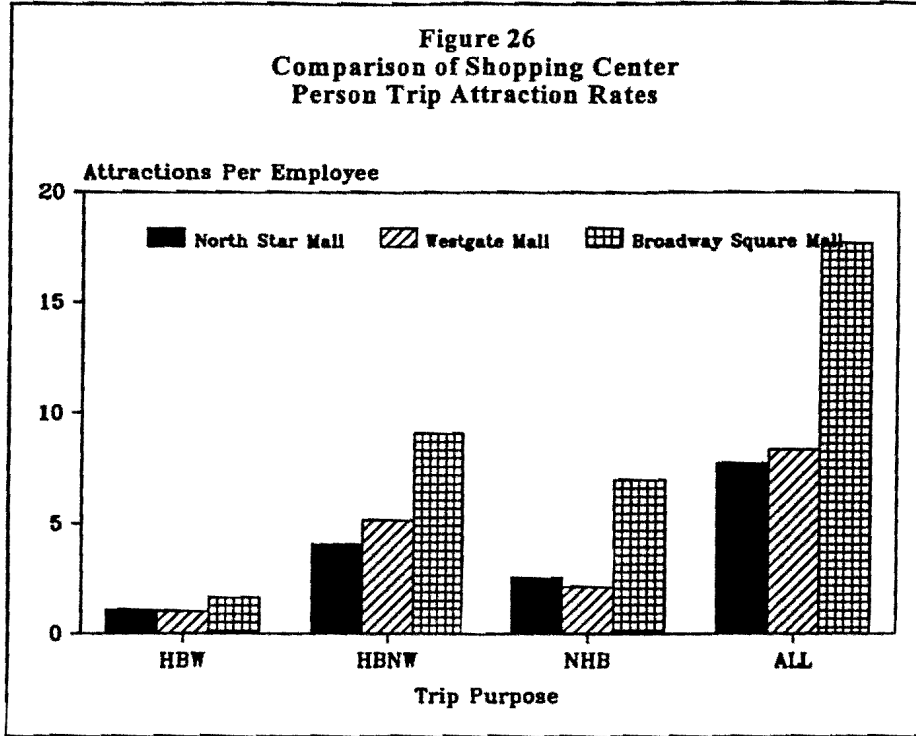


Figure 27
Comparison of Shopping Center
Auto Driver Trip Attraction Rates

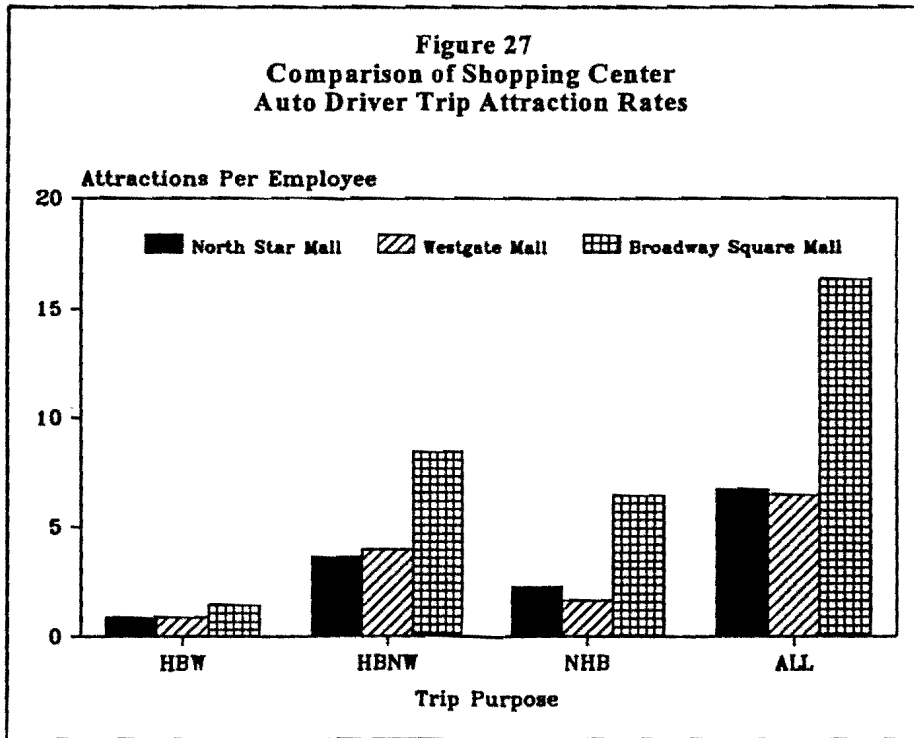


Table 191
Recommended Attractions per Employee
For Special Generators

Special Generator	Truck/Taxi Attraction Rate	Person Trip Attractions per Employee				Auto Driver Trip Attractions per Employee			
		HBW	HBNW	NHB-A	Total	HBW	HBNW	NHB-A	Total
Universities/Colleges	0.079	1.524	10.670	1.733	13.927	1.292	8.183	1.213	10.688
Hospitals	0.152	1.237	1.319	0.914	3.470	1.033	1.169	0.815	3.017
Airports - Medium/Small Urban Areas	1.160	1.548	4.259	2.441	8.248	1.366	3.208	1.767	6.341
Airports/ Large Urban Areas	1.968	1.963	4.156	3.022	9.140	1.762	3.477	2.143	7.382
Regional Shopping Centers	0.147	1.059	4.618	2.351	8.028	0.868	3.809	1.947	6.624
Military Bases	0.024	1.213	1.074	0.648	2.935	1.044	0.958	0.561	2.563

V. COMMERCIAL VEHICLE SURVEYS

Commercial vehicle surveys were conducted in all five urban areas surveyed in 1990 and 1991. The objective of these surveys was to obtain information for modeling commercial vehicular travel and estimating the trip length frequency distribution for commercial vehicles. The surveys were designed to produce data by which an average trip rate for commercial vehicles could be estimated.

Commercial vehicles are often referred to as commercial trucks and/or simply trucks. This is somewhat misleading, since all types of vehicles are used for commercial purposes. The surveys were referred to as commercial truck surveys.

The purpose of this chapter is to summarize the results of the commercial truck surveys that were conducted in San Antonio, Amarillo, Brownsville, Tyler, and Sherman-Denison. Brief descriptions are given of the basic survey design and sampling methodologies that were used in the survey. More detailed discussions may be found in References 19, 32, 33, and 34 concerning the surveys done in San Antonio, Amarillo, Brownsville, and Sherman-Denison. A description and evaluation of the commercial truck survey methodologies are also presented in Reference 12. The survey in Tyler was assumed to use the same procedure as that performed in Sherman-Denison since it was done by the same consultant. The reader is referred to those reports for specific detail on survey methodology, sampling procedures, quality control, etc. The analysis of the survey data presented in this report does not necessarily agree with that reported by the consultants. Reasons for this difference are related to the extensive data editing and correcting done on the survey data after receipt from the consultants.

SURVEY DESIGN

The basic design of the commercial truck surveys was to randomly select a number of commercial trucks operating within each study area and request their participation in the survey. Those agreeing to participate were asked to record all of the commercial truck trips made over a 24-hour period in a travel diary; or if trip logs were maintained, the trips could be taken directly from those logs. The information requested was the beginning and ending locations and arrival and departure times for each trip. In some cases, information on the type of vehicle was also collected.

SAMPLING METHODOLOGY

Since two consultants were involved in the commercial truck surveys, slightly different procedures were used to sample commercial trucks for solicitation in the travel survey. The procedure used in San Antonio, Amarillo, and Brownsville was to identify those business establishments in the telephone book which most likely operated trucks for commercial purposes within the study area. Every nth establishment was contacted and asked to participate in the survey. In Sherman-Denison and Tyler, the sample of vehicles was randomly selected from a listing of commercial trucks (with capacity of over a ton) registered in the study area. Only vehicles which were registered to a business name in the study area were included in the sample. The business which registered each selected vehicle was contacted and asked to participate in the survey.

DATA EDITING AND PROCESSING

The commercial truck survey data received from the consultants were reviewed and edited. The typical types of errors found were data entry errors where sample numbers had been entered incorrectly. The survey instruments provided space for recording up to 18 trips. A space was then provided for the respondent (or surveyor) to record the additional trips made during the survey day. In some records, this field was coded when fewer than 18 trips had been recorded. In those situations, the assumption was made that the correct entry was zero. In other situations, it appeared the entry was intended to signify "unknown" and again these were changed to zero.

After editing, each data file was processed to create trip files, with each record representing a complete trip by a commercial truck. Each record contained the sample number (a unique number assigned to each vehicle surveyed), the date the travel occurred, the trip number (trips were numbered sequentially for each vehicle), the time the trip began, the time the trip ended, a description of the trip origin and destination, the serial zone where the trip originated and the serial zone where the trip ended, and the number of additional trips over those recorded in the survey instrument. Using network travel times and distances for each of the study areas, the network travel distance and time were added to each record where a valid origin and destination zone was coded. Locations that could not be geocoded were coded with a zone number of 8888. Trips whose origin or destination were outside the study area had zone numbers coded 9999. Travel times and distances for trips with either the origin or destination coded as an unknown or external location were coded as zero.

The data files were then processed to sum the number of internal and external trips by each vehicle surveyed. Additional trips that were coded were split proportionately, internal and external, on the basis of the overall survey proportions of internal and external trips. For example, if 70 percent of all the surveyed trips were internal and 30 percent were external and a vehicle was recorded as making 30 additional trips, 70 percent of those 30 additional trips were assumed to be internal and 30 percent were assumed to be external. All of the recorded survey trips and additional reported trips were included in the computation of the average trips per truck and related statistics. Only those trips which were geocoded and had a valid zone of origin and destination were included in the development of the trip length frequency distributions and average trip lengths. The results are presented and discussed in the next section.

SURVEY RESULTS

Table 192 presents the summary data for each of the commercial truck surveys. The number of vehicles surveyed in each of the urban areas varied from 83 in Tyler to 444 in Amarillo. Figure 28 presents a visual comparison of the average internal trips per truck for each of the urban areas. Three of the urban areas, San Antonio, Brownsville, and Tyler, have very similar trip rates. The rates for Amarillo and Sherman-Denison are much lower. In examining the data in Table 192, the number of external truck trips has a significant impact on the results. For example, the average internal trips per truck in Sherman-Denison was just over three, but 46 percent of the truck trips surveyed were external. Over 20 percent of the trips in Tyler were external. It should also be noted that the sample sizes for Sherman-Denison and Tyler were much lower than those for the other three urban areas. Based on the computed standard deviations, the required sample size for an error of ± 10 percent in the average trips per truck with a confidence level of 95 percent would be 289 for San Antonio, 467 for Amarillo, 290 for Brownsville, 2,458 for Sherman-Denison, and 492 for Tyler. The sample sizes in Sherman-Denison and Tyler do not appear adequate to produce a reliable estimate of average trips per truck.

Figures 29 through 33 present frequency distributions of the observed number of trucks by the number of internal trips surveyed. For example, Figure 29 indicates that over 11 percent of the trucks surveyed in San Antonio made zero internal trips. These figures illustrate the dispersion in the survey data for each of the urban areas. For example, Figure 30 shows that in the Amarillo

survey nearly 60 percent of the trucks surveyed made three or fewer internal trips. In San Antonio, just over 26 percent of the trucks made three or fewer internal trips and in Brownsville, just over 21 percent made three or fewer trips. In Tyler nearly 45 percent made three or fewer trips and in Sherman-Denison, nearly 70 percent made fewer than three internal trips. The large percentages of trucks making such few internal trips may indicate some bias in the survey, since commercial vehicles by their nature would be expected to maximize their potential for profit by increasing their use. This reasoning ignores the impact of external travel, and simply examining the internal travel may present a biased view toward the commercial usage of these vehicles.

Table 193 presents the trip length information from the commercial truck surveys for each of the urban areas. The majority of the surveyed internal trips were geocoded for all of the urban areas. The resulting average trip lengths are felt to accurately represent the average trip lengths for commercial truck trips in those areas. The average trip lengths tend to reflect the size of the urban area in all cases except one, Amarillo. The average trip length for Amarillo was 9.0 minutes which is identical to that for San Antonio, even though San Antonio is much larger. Amarillo was the second largest urban area surveyed, and the similarity between it and San Antonio may imply a maximum trip length for commercial vehicles which is reached when an urban area approaches the size of Amarillo. This is speculation and a great deal more data and analysis would be necessary to prove or disprove this theory, especially in light of the fact that this trend was not followed by Sherman-Denison, the smallest area surveyed (in terms of population). The physical size and shape of the urban area are felt to be contributing factors in determining average trip lengths, especially for commercial vehicles.

Figures 34 through 38 present the commercial truck trip length frequency distributions for each of the urban areas. These distributions are not very smooth but appear to generally follow the shape of observed trip length frequency distributions for noncommercial travel. Care should be observed in interpreting these data and figures, because they represent raw survey data and not expanded data.

SUMMARY

In reviewing the commercial truck survey data, the observed trip rates and average trip lengths appear reasonable. It was not possible to expand the survey data because no information was

known about the population of commercial trucks from which the samples were drawn. For example, it was not known and no way was found by which the total number of commercial trucks operating within any of the urban areas surveys could be determined. That information would be necessary to expand the survey data and develop estimates of overall commercial truck travel in the study area as well as estimates of total commercial vehicles miles (or hours) of travel. This flaw in the overall survey was evaluated and recommendations made to revise the survey methodology to allow for the expansion of the data. Those recommendations were presented in Reference 12, and the reader is referred to that report for additional information.

Table 192
Commercial Truck Surveys
Trip Summary Data

Element	Type	San Antonio	Amarillo	Brownsville	Sherman-Denison	Tyler
Trucks	Number Surveyed	397	444	403	141	83
Internal Trips	Number Surveyed	3,271	2,331	3,498	429	704
	Average per Truck	8.24	5.25	8.68	3.04	8.48
	Standard Deviation	7.15	5.79	7.55	4.24	9.60
External Trips	Number Surveyed	283	336	412	363	184
	Average per Truck	0.71	0.76	1.02	2.58	2.22
	Standard Deviation	1.78	2.01	2.69	3.13	3.28
Total Trips	Number Surveyed	3,554	2,667	3,910	792	888
	Average per Truck	8.95	6.01	9.70	5.62	10.70
	Standard Deviation	7.07	6.28	8.28	4.47	10.03

Table 193
Commercial Truck Surveys
Internal Trip Length Summary

Element	San Antonio	Amarillo	Brownsville	Sherman-Denison	Tyler
Surveyed Internal Trips	3,271	2,331	3,498	429	704
Geocoded Internal Trips	2,180	2,092	2,975	423	516
Percent Geocoded	66.6	89.7	85.0	98.6	73.3
Average Trip Length - Miles	4.6	5.6	2.7	4.6	3.4
Average Trip Length - Minutes	9.1	9.0	4.7	7.6	5.6

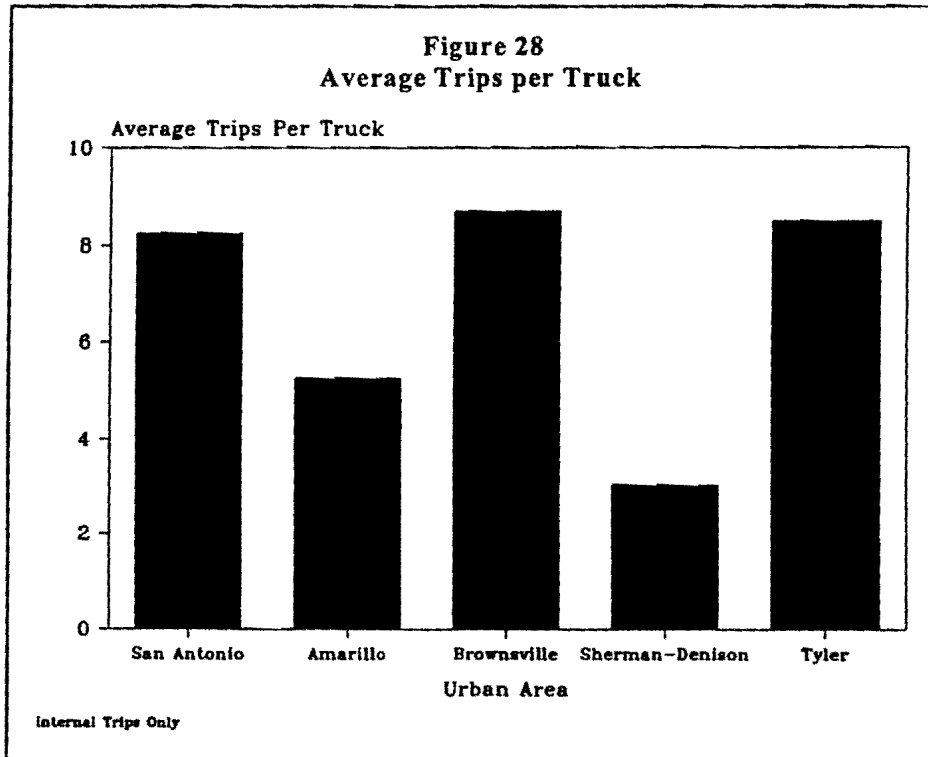


Figure 29
Trip Frequency Distribution
San Antonio Commercial Vehicles

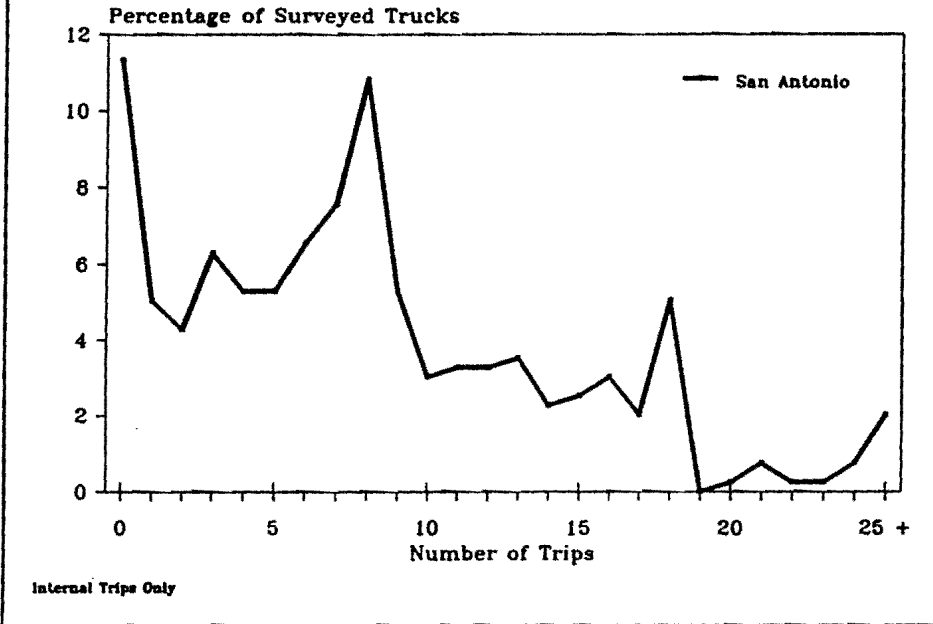


Figure 30
Trip Frequency Distribution
Amarillo Commercial Vehicles

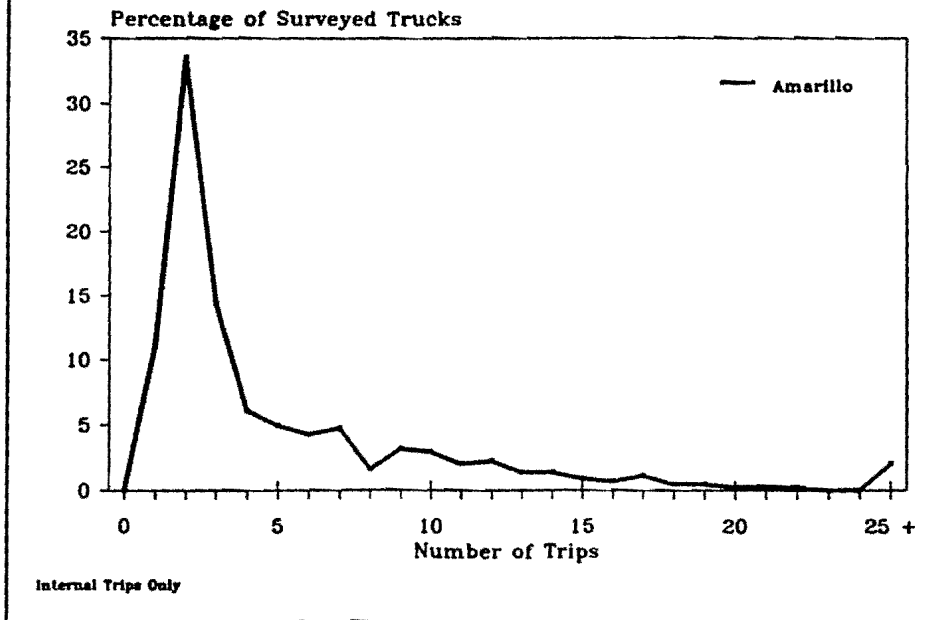


Figure 31
Trip Frequency Distribution
Brownsville Commercial Vehicles

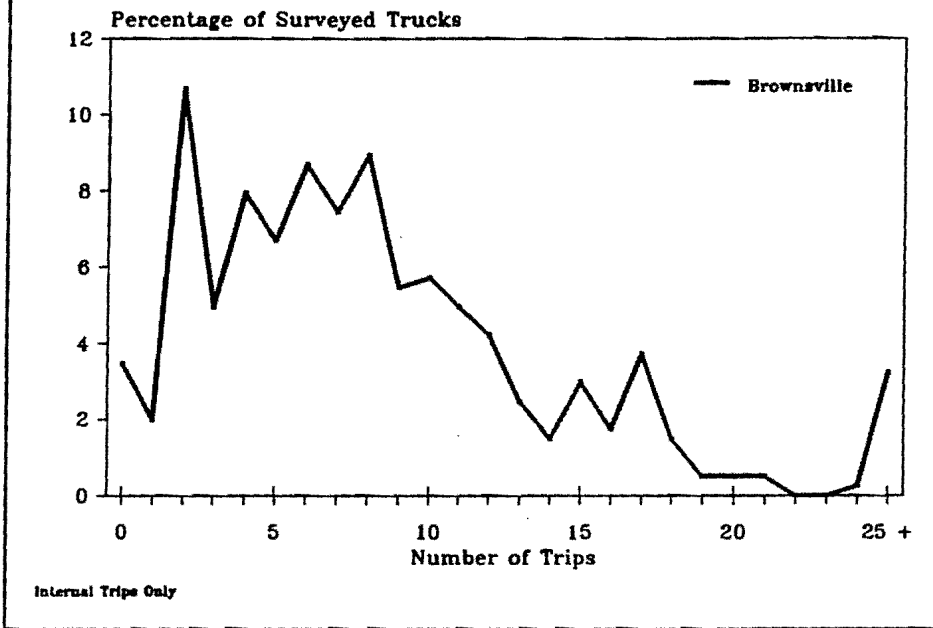


Figure 32
Trip Frequency Distribution
Sherman-Denison Commercial Vehicles

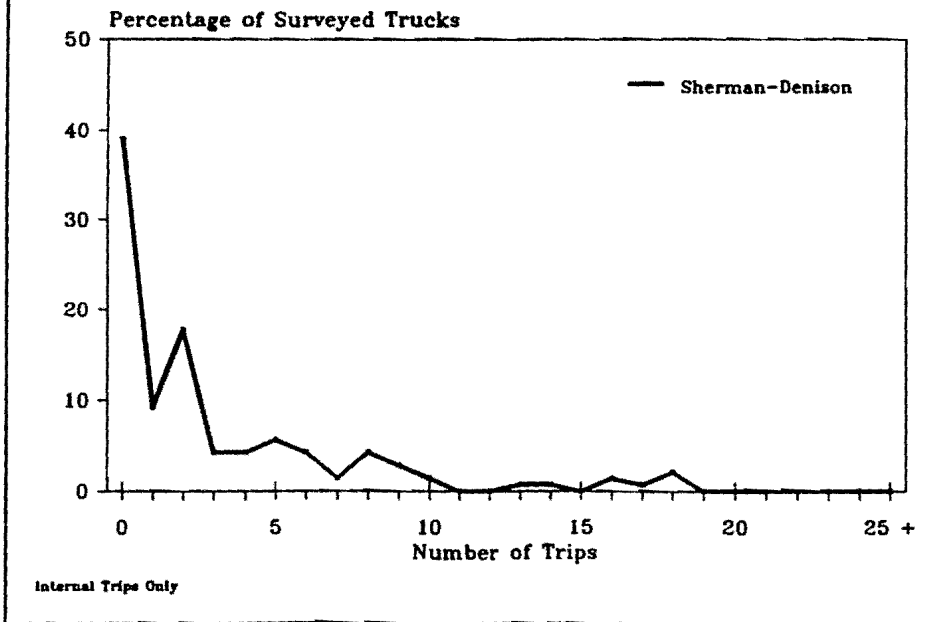


Figure 33
Trip Frequency Distribution
Tyler Commercial Vehicles

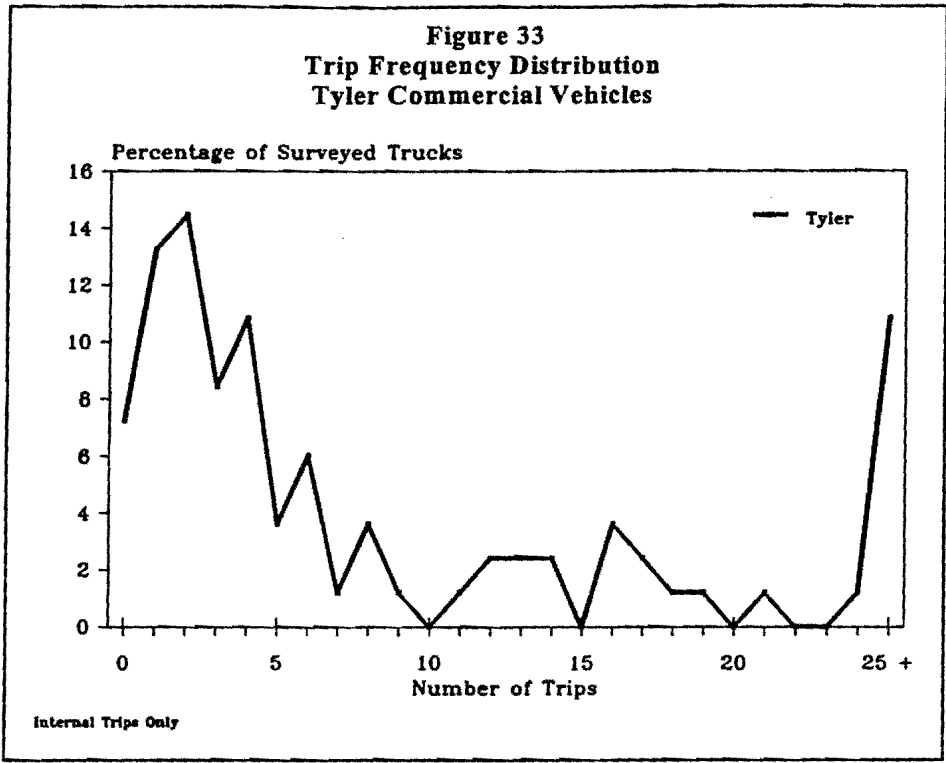


Figure 34
Trip Length Frequency Distribution
San Antonio Commercial Vehicles

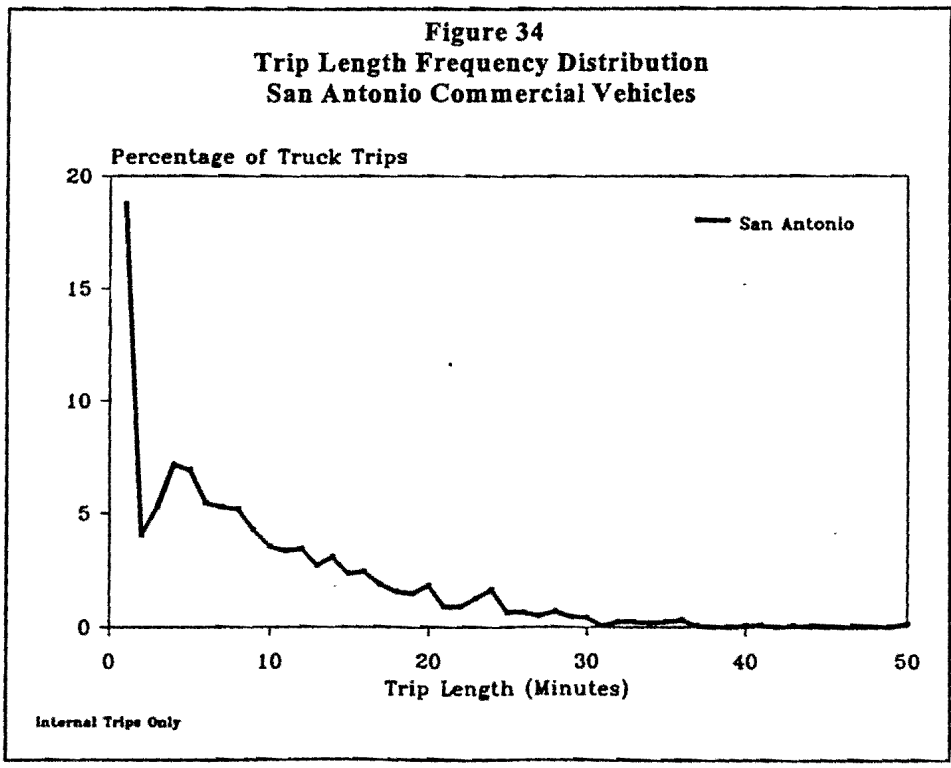


Figure 35
Trip Length Frequency Distribution
Amarillo Commercial Vehicles

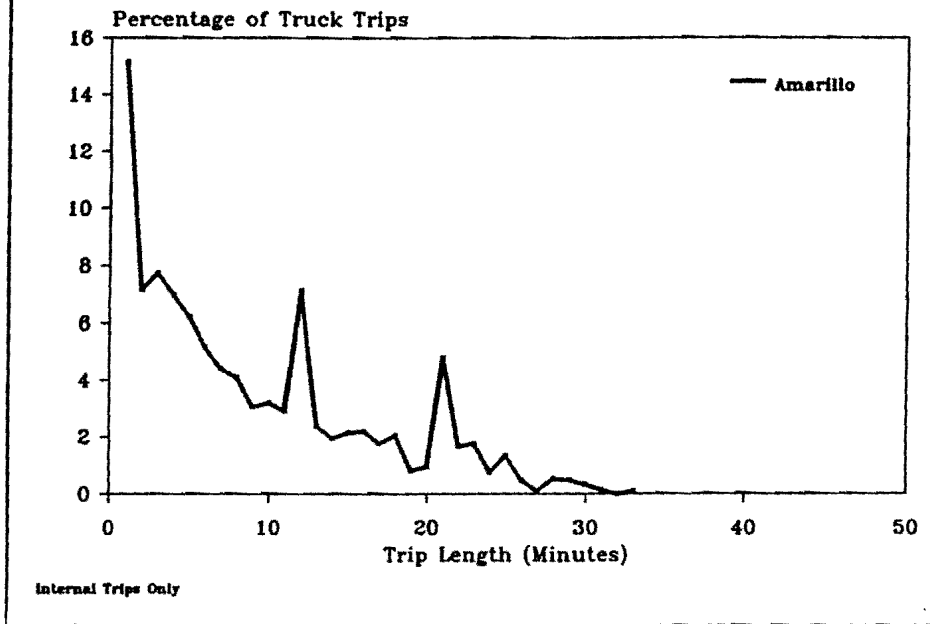


Figure 36
Trip Length Frequency Distribution
Brownsville Commercial Vehicles

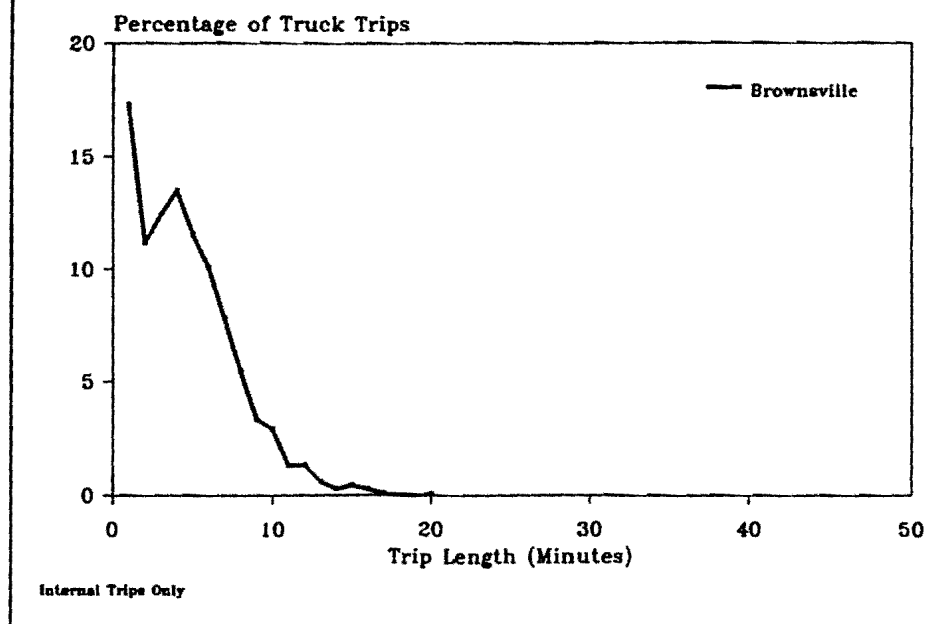


Figure 37
Trip Length Frequency Distribution
Sherman-Denison Commercial Vehicles

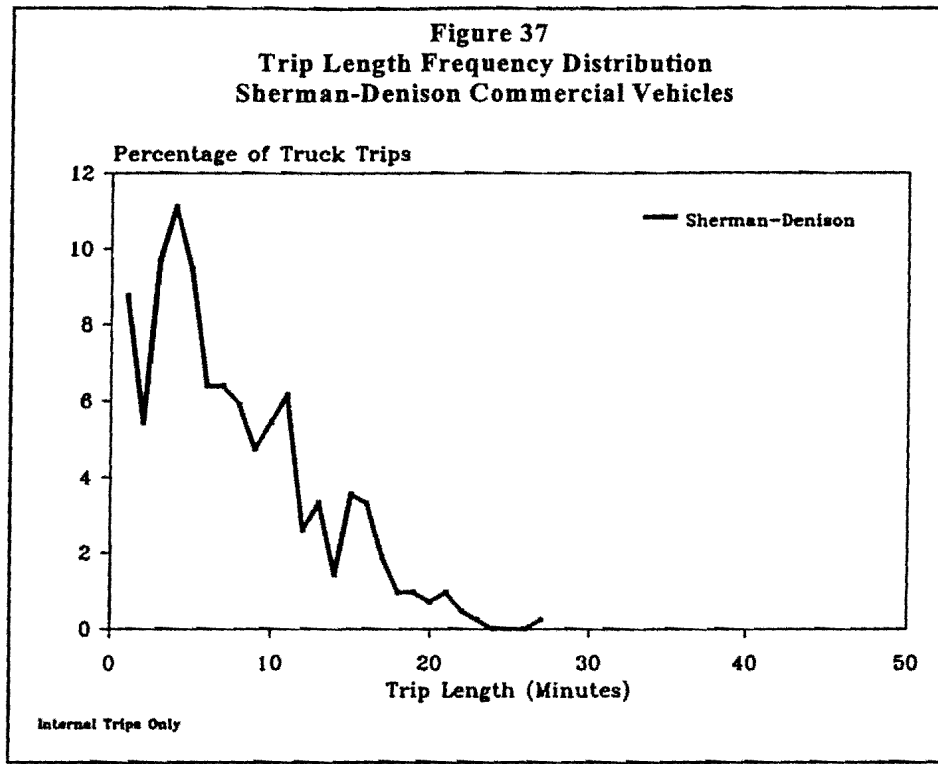
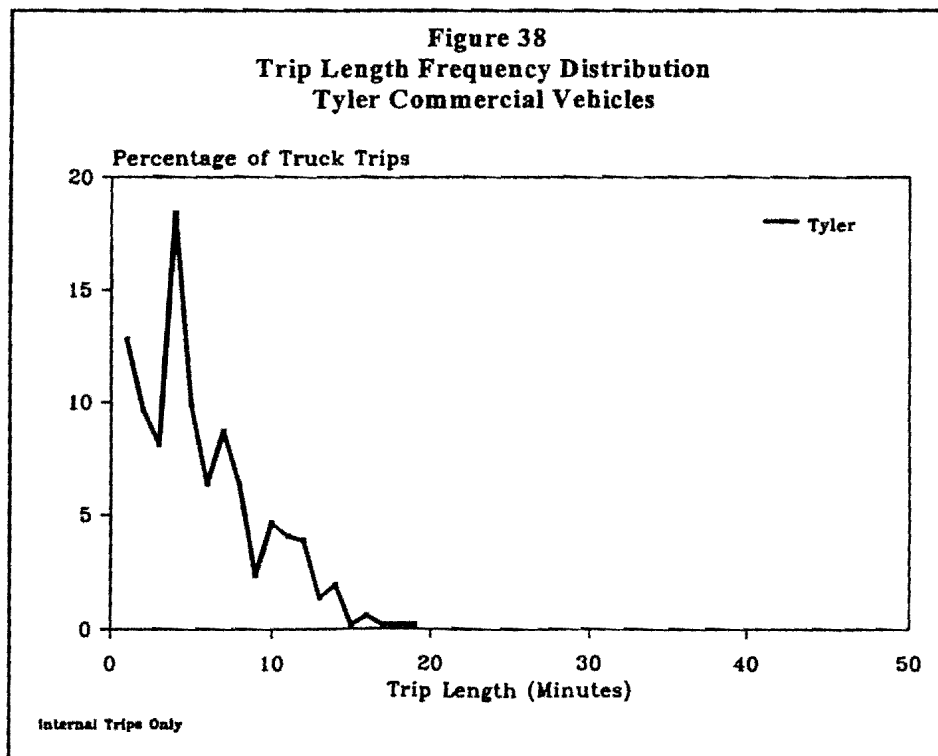


Figure 38
Trip Length Frequency Distribution
Tyler Commercial Vehicles



VI. EXTERNAL STATION SURVEYS

External station travel surveys were conducted in each of the five urban areas surveyed in 1990 and 1991. Each urban area has a study area boundary which defines the area for transportation planning purposes. The points at which transportation facilities cross this boundary are referred to as external stations. For modeling purposes (and surveys as well), these stations are limited to highways and streets. External station surveys are conducted to obtain information on the amount, type, and characteristics of travel in and out of the study area.

The purpose of this chapter is to present the findings of the analysis of the data collected in the external station surveys done in San Antonio, Amarillo, Brownsville, Sherman-Denison, and Tyler. Only general descriptions and discussions are presented relative to the survey methods, instruments, training, etc. Detailed information on these surveys are presented in References 27, 28, 29, 30, and 31. The reader is referred to those reports for additional details and discussions on the external station surveys.

SURVEY METHODOLOGIES

Due to staff and budget limits, the external station surveys were not full two-way 24-hour surveys of all vehicles passing through each external station. For safety reasons, the surveys were done only during daylight hours. To reduce the cost and amount of delay to the traveling public, only outbound vehicles were surveyed with the assumption that the characteristics of the outbound movements would be a mirror image of the inbound movements. In all but two of the urban areas surveyed, all external stations were surveyed. In San Antonio and Sherman-Denison, just over half of the external stations were surveyed.

The consultants employed two methods in the external station surveys. The predominant method used was the technique where a vehicle was stopped and a trained interviewer asked survey questions and recorded the responses on a survey form. The second method used (in limited fashion) was the mailback postcard survey. Postage paid postcards with the survey questions were handed to the occupants of each vehicle passing through the station, with a request they fill out the information and return it by mail. Later evaluations of the results of both methods resulted in recommendations that only the interview method be used in future external station surveys.

To ensure that the data were expanded correctly, 24-hour vehicle counts were taken in each direction at each external station. These became the control totals for all data expansion. Manual vehicle classification counts were also taken in Tyler, Sherman-Denison, and Brownsville at each station surveyed during the hours the survey was done. These counts were the basis for estimating the number and percentage of vehicles by type entering and leaving the study area in those areas. The vehicle type indications in the raw surveys were the basis for vehicle type splits in the other two external station surveys. Specific information on the forms, methods, training, quality control, etc., are discussed in References 27, 28, 29, 30, and 31.

DATA COLLECTED

The same basic information was collected in all of the external station surveys. It was intended that the survey data from each of the individual urban areas be comparable. The data collected included the time of the survey, the number of people in the vehicle, the type of vehicle (six vehicle types were precoded on the survey form), and whether the vehicle was a through trip (i.e., passing through the study area without stopping) or if the trip originated within the study area. If the vehicle was passing through (i.e., an external-external trip), the drivers were asked what highway they were on when they entered the study area and from what city they were traveling. If the trip had originated in the study area, they were asked the address of the last place they got into the vehicle (i.e., the origin of the trip) and the approximate time they left that location.

DATA EDITING AND PROCESSING

The survey data received from the consultants were reviewed and processed for each urban area individually. Some problems were encountered in reviewing the data, and some of the data were found to be unusable. The principal checks done were to ensure that all of the data were coded in the record. In some records, some of the information had either not been coded or not collected. Those records with missing data that were considered important were removed from the data files.

AMARILLO EXTERNAL STATION SURVEYS

The external station survey for Amarillo was conducted in October and November of 1990. Nineteen external stations were identified in the study area, and each was included in the survey. The

survey method used at all of the external stations was the direct interview method. The time periods that the surveys were done varied from three to 11 hours. Only vehicles in the outbound direction were surveyed. Table 194 presents the stations that were surveyed and summary information on the number of surveys and traffic counts at each station. A total of 44,800 vehicles were counted in the outbound direction. Of those vehicles, nearly 12 percent were surveyed. The sampling rate at individual stations varied from a low of just under 4 percent to a high of 84 percent. The lower sampling rates occurred at the higher volume stations where the survey duration was typically around 3 hours.

Six vehicle types were precoded on the survey forms for use by the interviewer in recording the type of vehicle being surveyed. These types were passenger car/truck/van/motorcycle, bus, taxi, school bus, commercial vehicle (over one ton), and other. These were grouped into three categories for analysis purposes, passenger vehicles, commercial vehicles, and other vehicles. The percentage of vehicles surveyed in each of these three categories at each of the external stations is shown in Table 195. The external stations were grouped into three categories, freeway, arterial, and other, based on their functional classifications.

Figures 39 through 41 present plots of the percentage of vehicles by vehicle category for each of the three functional groupings of facilities. For all of the external stations except one, the majority of vehicles surveyed were passenger vehicles. The one station different was Station 389 where two thirds of the vehicles were commercial; this facility provided access to the county land fill, and the majority of the vehicles surveyed were dump trucks. Expanding the survey data at each station and summing the number of estimated vehicles by type resulted in 87.2 percent of the vehicles estimated as passenger vehicles, 11.6 percent as commercial vehicles, and 1.2 percent as other vehicles.

Table 196 presents the breakdown of the survey data in terms of the percentage of external-local and external-external trips for each vehicle type by station. External-local trips are those trips whose point of origin (for outbound trips) was within the study area, and external-external trips are those trips passing through the study area. IH 40 had the highest percentages of through (external-external) passenger trips, 43 percent and 32 percent. It is interesting to note that the station with the highest volume of total traffic (i.e., Station 384, IH 27 South) had one of the lowest percentages (5.1 percent) of through passenger trips. In terms of commercial vehicles, two of the largest percentages of through trips occurred on IH 40 (40 percent and 47 percent). Expanding the survey data by station

and vehicle type, estimating the number of local and through trips at each station, and summing over all stations resulted in 83 percent of all passenger vehicles entering and leaving the study area estimated to be external-local trips, 67 percent of all commercial vehicles estimated to be external local trips, and 62 percent of other vehicles estimated to be external local trips. For all vehicles combined, 81 percent were estimated to be local trips and 19 percent through trips.

Expanding the survey data up to the 24-hour traffic counts at each station results in estimates of the total numbers of passenger, commercial, and other vehicles entering and leaving the study area as well as the number of local and through trips at each station. Table 197 presents the estimates of total local and through passenger, commercial, and other vehicle trips at each station.

Table 198 presents the average vehicle occupancies that were observed for each vehicle type for local and through trips. Passenger vehicles were observed to have an average of 1.6 persons per vehicle for external-local trips and 1.7 for through trips. This difference is not considered to be significant. Commercial vehicles had significantly lower average vehicle occupancies as would be expected, since these type of trips are less likely to involve multiple family members. The average vehicle occupancies for commercial vehicles were 1.2 for local trips and 1.3 for through trips. The average vehicle occupancies for other vehicles were much higher, since these were trips involving vehicles which would be expected to carry more occupants (e.g., bus, school bus, taxi, etc.). These averages were 3.0 for local trips and 3.4 for through trips. For all vehicle types, the average occupancy for local trips was 1.5 and for through trips 1.7. These averages are for expanded vehicle trips for all stations. Table 198 presents the data for individual stations.

Since the location of each trip's origin and/or entry point into the study area was collected as a part of the survey, the trips were geocoded. Using the transportation network and the zone-to-zone travel times and distances, the trip lengths were determined for all of the trips which could be geocoded. Tables 199 and 200 present the average trip lengths in miles and minutes by vehicle type for local and through trips at each external station and the expanded averages for all stations. Figures 42 through 47 present plots of the frequency of trips by network travel time and distance. The shape of these distributions appears similar to a normal distribution.

The average passenger vehicle trip length expanded for all stations was 12 miles and 18 minutes for local trips and 23 miles and 31 minutes for through trips. The average commercial trip lengths were 12 miles (19.32 kilometers) and 20 minutes for local trips and 24 miles and 33 minutes

for through trips. Other vehicle trip lengths averaged 12 miles and 17 minutes for local trips and 23 miles and 33 minutes for through trips. The average trip lengths for external-local trips are nearly three times greater than the average trip length for internal vehicle trips as measured in the household travel survey. Multiplying the average trip length in miles at each station by the total vehicle trips at each station results in an estimate of the total VMT in the urban area due to external trips. These estimates are shown in Table 201. From the household survey in Amarillo, the total estimated internal auto driver VMT was 1.9 million. The estimated VMT due to external-local and external through trips is 1.2 million. The implication is that external travel is a significant portion of the total travel in the study area. This may indicate a need to expand the study area boundary to reduce the impact that external travel has on the overall estimates of travel within the study area.

Summary

The external station survey done in Amarillo has produced estimates of the total external-local and external-external trips. It has also provided data for estimating the total VMT due to these trips. Comparing the results of the external survey with the household survey for Amarillo indicates that external travel is a major portion of the overall travel within the current Amarillo study area. Just over 71,000 external vehicle trips are estimated to be local. The total estimate of internal vehicle trips for Amarillo was just over 500,000. As a percentage of the total vehicle trips (not including internal commercial vehicle trips), the external vehicle trips represent nearly one in every eight trips (i.e., 12.5 percent). In terms of VMT, these trips (i.e., external-local) represent nearly 40 percent. Since external-local trips may also be generating a significant number of unaccounted trips (i.e., trips made inside the study area by persons who drove into the study area from an external location), the overall estimates of travel may be significantly underestimated with such a large percentage of total trips being external-local.

BROWNSVILLE EXTERNAL STATION SURVEYS

The external station survey for Brownsville was conducted between February and May of 1991. There were nine external stations identified in the study area, and each was included in the survey. The survey method used at all of the external stations was the direct interview method. The time periods the surveys were conducted varied from seven hours to 12 hours. All but one of the

stations were surveyed between 10 and 12 hours. Only vehicles in the outbound direction were surveyed. The Brownsville external station survey was unique in that two of the stations identified as external stations were Mexico border crossings. These stations, while surveyed as external stations, were in fact not true external stations. Their location is in the middle of the total urbanized area when development on the Mexican side of the border is taken into consideration. Care should be exercised in using and interpreting the data for those stations; and in some of the discussions and data summaries in this report, the data for those stations are excluded and/or reported separately.

Table 202 presents the stations that were surveyed and summary information on the number of surveys and traffic counts at each station. A total of 34,497 vehicles were counted in the outbound direction. Of those vehicles, 8.6 percent (2,973) were surveyed. The sampling rate at individual stations varied from a low of zero percent to a high of nearly 36 percent. Station 147 was surveyed, but the data were later found to be unusable. Only the number of usable surveys is listed in Table 202. The lowest sampling rates (with the exception of Station 147) occurred at those stations with the highest volumes of traffic.

Six vehicle types were precoded on the survey instruments to allow the interviewer to record the type of vehicle being driven. These types were the same in all five of the urban areas surveyed. These were grouped into three categories for analysis purposes, passenger vehicles, commercial vehicles, and other vehicles. The percentage of vehicles surveyed in each of these three categories at each station is shown in Table 203. The number of commercial vehicles surveyed at the border crossings (Stations 141 and 142) were very small. This occurred because commercial vehicle drivers refused to participate in the survey (27). Since vehicle classification counts were taken at all of the external stations, they provide a better estimate of the distribution of vehicles by vehicle type at each station. These percentages are shown in Table 204. The survey data were expanded at each station to equal the total 24-hour vehicle count at that station, the estimated number by vehicle type summed over all stations, and the percentage within each vehicle type computed to estimate the expanded average percentage splits by vehicle type for all stations combined. The result was that 91.6 percent of the vehicles entering and leaving the study area were passenger vehicles, 7.3 percent were commercial vehicles, and 1.1 percent were other vehicles.

Since all of the external stations fell within the same basic functional classification, no comparison was made between the observed percentage splits by vehicle type between facilities

within the same functional classification.

Table 205 presents a breakdown of the survey data in terms of the percentage of external-local and external-external (through) trips for each vehicle type by station. The percentages for Station 147 are assumed to be the same as the averages over all stations. The percentages for commercial vehicles may be biased for Stations 141 and 142, since essentially no commercial vehicles were surveyed at those stations. To compensate for this bias, the assumption was made that the commercial vehicles at these stations would have approximately the same average percentage of external-local and external-external trips as the average percentages observed for all of the other stations (except Station 147). The majority of vehicles entering and leaving the Brownsville study area were external-local trips. Overall, approximately 95 percent of the vehicles were external-local and 5 percent were external-through.

Expanding the survey data up to the 24-hour vehicle counts made at each station and multiplying by the appropriate percentages, estimates of the external-local and external-external trips by vehicle type were computed. These estimates are shown in Table 206. For the Brownsville study area, just over 69,000 vehicles are estimated to enter and leave on an average weekday. Nearly 34 percent of those vehicles pass through the border crossings with Mexico.

Table 207 presents the computed average vehicle occupancies by vehicle type and trip type for each of the stations. For those stations where no vehicles were surveyed, the average occupancies for all of the stations were entered. Average vehicle occupancies at the external stations range from a low of 1.11 for through commercial vehicles to a high of over 12 for other vehicles. It appears the other type vehicles surveyed included some buses. It should be noted that some of the number of observations for those categories were very small and caution should be observed in the use of these numbers.

Using the transportation network for the Brownsville study area and the geocoded external-local and external-external survey trips, the network travel distance and time were determined and added to the surveyed trip records. Tables 208 and 209 present the average trip lengths in miles and minutes by vehicle type for local and through trips at each external station and the expanded average for all stations. Figures 48 through 53 present plots of the frequency of trips by network travel time and distance. The average trip lengths in miles ranged from a low of 2.8 miles for local passenger vehicles to a high of 13.6 miles for through passenger vehicles. The highest averages were observed

for Stations 148 and 149 which were located on the eastern boundary of the study area. Multiplying the average trip length in miles for each vehicle type and trip type by the estimated number of vehicles results in an estimate of the total VMT by vehicle type for both local and through trips at each station. These estimates are shown in Table 210. The total estimated VMT due to external travel in the Brownsville study area is approximately 365,000. Data from the Brownsville household survey estimated that the total internal VMT in the study area was 556,000 (not including internal truck trips). External travel comprises a large percentage (nearly 40 percent) of the total travel within the Brownsville study area. This may indicate the study area boundaries are too close in the area. It should be noted however, that 20 percent of the VMT due to external travel was related to the two border crossings. Expanding the study area boundary would have no impact on that travel. Total vehicle trips at the external stations were just over 69,000. In terms of the total internal vehicle travel, this represents nearly 28 percent of all vehicle trips within the study area. Since little is known concerning the number of additional trips made by those vehicles which originate outside the study area, there is a potential for underestimating total travel within the study area.

SAN ANTONIO EXTERNAL STATION SURVEY

The external station surveys for San Antonio were conducted between March and May of 1990. Of 34 external stations in the study area, only 18 (53 percent) were surveyed, due to the costs involved and the nature of the external stations. Those not surveyed were minor roadways, two of which no count data were available. The sites with no count data were assumed to be negligible and have not been included in the analysis in this report. The sites that were surveyed accounted for 92.6 percent of the vehicles counted as entering and leaving the study area. The survey method used at all but one of the sites was the direct interview method. Pilot surveys tested and compared two survey methods, postcard mailback and direct interview. Results of those comparisons led to a recommendation that the survey methodology be direct interview. This was the method used at all but one of the stations. It is unclear as to the reasons for using the postcard method at that one station. It appears that station may have been surveyed just prior to the results of the pilot surveys being available and the decision to proceed with the direct interview method. Additional documentation on the comparisons between the two methods may be found in Reference 27. The time periods the surveys were conducted varied from 3 hours to 12 hours. Only vehicles in the

outbound direction were surveyed. Table 211 presents the stations that were surveyed and summary information on the number of surveys and traffic counts at each station. Table 211-A presents the stations that were not surveyed, their functional classification, and 24-hour vehicle count. A total of 98,332 vehicles were counted in the outbound direction at those stations surveyed. Of those vehicles, 7.7 percent were surveyed. The sampling rate at individual stations varied from a low of 2.5 percent to a high of 28.2 percent. The lower sampling rates occurred at the higher volume stations where the sampling duration was typically about 3 hours. A total of 14,990 vehicles (both directions) were counted at the stations that were not surveyed.

Six vehicle types — passenger car/truck/van/motorcycle, bus, taxi, school bus, commercial vehicle (over one ton), and other — were precoded on the survey forms for use by the interviewers in recording the type of vehicle being surveyed. These were grouped into three categories for analysis purposes, passenger vehicles, commercial vehicles, and other vehicles (which included everything but those two categories). The percentage of vehicles surveyed in each of these three categories at each of the external stations is shown in Table 212. The majority of vehicles at all of the stations were passenger vehicles. The highest percentages of commercial vehicles were observed on the interstate stations, with the highest (12.2 percent) on IH 10 West. Weighted averages for all of the stations surveyed were 93 percent passenger vehicles, 6 percent commercial vehicles, and 1 percent other vehicles. These percentages reflect the percentage of vehicles surveyed. They may be biased to some extent depending on the refusal rate of certain types of vehicles (e.g., commercial vehicles). Since vehicle classification surveys were done at the stations, these percentages represent the best basis for estimating the numbers of vehicles by type at each station. For those stations that were not surveyed, the percentage of vehicles by vehicle type were estimated to be the same as the averages observed for the low volume stations; 96.1 percent were assumed to be passenger vehicles, 2.5 percent commercial vehicles, and 1.4 percent other vehicles.

Table 213 presents a breakdown of the survey data in terms of the percentage of external-local and external-external (through) trips for each vehicle type at each station. The major facilities crossing the study area had the highest percentages of external-external (through) trips. These percentages ran from a low of just over 10 percent to a high of 35 percent for passenger vehicles, lows of around 25 percent to highs of 60 percent for commercial vehicles, and lows of 33 percent to highs of 67 percent for other vehicles. Due to the high volumes of traffic at those stations, the

weighted averages over all the surveyed stations were dominated by those. For example, the percentage of external-local trips by passenger vehicles for all non-interstate facilities ranged from 90 to 100 percent. The percentage for interstate facilities ranged from 65 to 89 percent. The resulting weighted average for passenger vehicles was 88.5 percent estimated as external-local. In estimating the percentage split of local and through trips by vehicle type for those stations that were not surveyed, the average percentages for the low volume stations were used. For passenger vehicles at those nonsurveyed stations, 96.2 percent were assumed to be local and 3.8 percent through trips. For commercial vehicles at those stations, 79.2 percent were assumed to be local and 20.8 percent to be through trips. For other vehicles, 68.3 percent were assumed to be local and 31.7 percent through trips. Nearly 87 percent of all trips into and out of the San Antonio study area are estimated to be local trips. Approximately 13 percent are estimated to be through trips.

Expanding the survey data up to the 24-hour vehicle counts at each station resulted in estimates of the total passenger, commercial, and other vehicles entering and leaving the study area as well as the number of local and through trips at each station. Table 214 presents the estimates of total local and through passenger, commercial, and other vehicle trips at each surveyed station. Table 214-A presents the estimates for those external stations that were not surveyed.

Table 215 presents the average vehicle occupancies that were observed for each vehicle type for local and through trips. Passenger vehicles were observed to have an average of 1.6 persons per vehicle for external-local trips and 2.1 persons per vehicle for through trips. This difference is most likely due to family members traveling together through the study area. Commercial vehicles had lower average vehicle occupancies. The average vehicle occupancy for commercial vehicles was 1.4 for local trips and 1.3 for through trips. Other vehicles had occupancies of 1.1 for local trips and 3.4 for through trips. Overall average vehicle occupancies recorded were 1.6 for local trips and 2 for through trips. These values appear reasonable.

Since the origin and/or entry point of each trip were collected as part of the survey, the trips were geocoded with each origin and/or entry point being equated to a zone in the transportation study area. Using the transportation network and the zone-to-zone travel times and distances, the trip lengths were determined for all of the trips which were geocoded. Tables 216 and 217 present the average trip lengths in miles and minutes by vehicle type for local and through trips at each external station surveyed. The average values assumed for those external stations that were not surveyed were

16.51 miles for passenger vehicle local trips, 37.57 miles for passenger vehicle through trips, 16.64 miles for commercial vehicle local trips, 41.91 miles for commercial vehicle through trips, 16.15 miles (26 kilometers) for other vehicle local trips, and 42.62 miles for other vehicle through trips. These were based on the observed averages for low volume stations that were surveyed. Figures 54 through 59 present plots of the frequency of trips by network travel time and distance.

The average passenger vehicle trip length (expanded) for all of the stations surveyed was over 20 miles and nearly 31 minutes for local trips and nearly 43 miles and over 60 minutes for through trips. These values illustrate the physical size of the urban area, which was much larger than the other four areas surveyed. The average commercial vehicle trip lengths were 22 miles and 33 minutes for local trips and 43 miles and 60 minutes for through trips. The average other vehicle trip lengths were 21 miles and 32 minutes for local trips and 44 miles and 61 minutes for through trips. As would be expected, the average trip lengths for all types of vehicles were very similar for through trips. The average trip length for external local trips for passenger vehicles was roughly three times the average trip length for auto driver trips as estimated from the San Antonio household survey (6.5 miles per trip). Multiplying the average trip length in miles at each station by the total vehicle trips at each station results in an estimate of the total VMT in the urban area due to external trips (both local and through). These estimates are shown in Table 218 for the surveyed stations and in Table 218-A for the non-surveyed stations. From the household survey in San Antonio, the total estimated internal auto driver VMT was nearly 16 million. The estimate of VMT due to all external travel is approximately 4.6 million. As a percentage of internal VMT (not including internal truck VMT), external related travel represents about 22 percent of the total VMT. In terms of vehicle trips, the San Antonio household survey estimated nearly 2.5 million auto driver trips internally, while the external-local and external-external trips totaled 202,000. As a percentage, the external related travel was only about 7.6 percent of the internal travel. These percentages are significantly less than those observed in the other four urban areas. This may be a result of the size of the urban area in San Antonio and the total amount of travel within that area. It is obvious that the external related travel in San Antonio has less impact on overall travel estimates than the same travel in the other urban areas. The potential for additional unrecorded trips would be less in terms of total travel in San Antonio since external trips represent a smaller percentage of total travel.

Summary

The external station surveys done in San Antonio have produced estimates of the total external-local and external-external (through) trips for that study area. They have also provided data for estimating the total VMT due to external related travel. Comparison of the results of the external station survey and the household survey indicates that external related travel comprises only about 7 percent of the total internal trips and about 24 percent of the total VMT. Since many trips associated with external travel may not be a part of overall travel demand estimates, the impact of such travel in San Antonio appears to be significantly less than the impact in the smaller urban areas. This lesser impact may be due to the physical location of the study area boundary in San Antonio as well as the physical size of the area and the total travel within that area.

SHERMAN-DENISON EXTERNAL STATION SURVEYS

The external station surveys in Sherman-Denison were conducted in March of 1991. There were 24 external stations identified in the study area but only 14 (58 percent) were surveyed due to the costs involved and the nature of the external stations. Those not surveyed were typically minor roadways with low volumes of traffic. The sites that were surveyed accounted for 94 percent of the vehicles counted entering and leaving the study area. The survey method used at all but two of the sites surveyed was the direct interview method. Due to the high volumes of traffic at the two US 75 external stations, both were surveyed using the mailback postcard method. Additional documentation on the survey methods used in Sherman-Denison may be found in Reference 31. All of the surveys were conducted during an 11.5-hour period during daylight hours. Only vehicles in the outbound direction were surveyed. Table 219 presents the stations that were surveyed and summary information on the number of surveys and traffic counts at each station. Table 219-A presents the stations that were not surveyed and their 24-hour vehicle counts. A total of 38,008 vehicles were counted in the outbound direction at those stations surveyed. Of those vehicles, 48.9 percent were surveyed. The sampling rates at individual stations varied from a low of 24.5 percent to a high of 81.7 percent. The lower sampling rates occurred at the high volume stations for US 75 where the postcard method was used. A total of 4,730 vehicles (both directions) were counted at the stations that were not surveyed.

Six vehicle types were precoded on the survey forms for use by the interviewers in recording the type of vehicle being surveyed. These types were passenger car/truck/van/motorcycle, bus, taxi, school bus, commercial vehicle (over one ton), and other. These were grouped into three categories for analysis purposes, passenger vehicles, commercial vehicles, and other vehicles (which included everything but those two categories). The percentage of vehicles surveyed in each of these three categories at each of the external stations surveyed is shown in Table 220. The majority of vehicles surveyed at all of the stations were passenger vehicles. These ranged from a low of 58 percent to a high of just over 96 percent of the vehicles surveyed. The lowest percentages of passenger vehicles were observed at the high volume stations for US 75 and US 82. US 75 appears to be a major commercial route since 40 percent of the vehicles surveyed at those stations were commercial vehicles. The weighted average for all of the stations surveyed was 78 percent passenger vehicles, 21 percent commercial vehicles, and 1 percent other vehicles. The high volumes at the US 75 external stations dominate the weighting and indicate that in transferring data from the surveyed stations to the non-surveyed stations, the overall weighted averages for all surveyed stations would result in biased estimates. For that reason, the averages used to develop estimates for the nonsurveyed external stations were from the low volume stations in the Sherman-Denison external survey. The assumed percentage distribution of trips by vehicle type for the non-surveyed stations was 94.2 percent passenger vehicles, 4.5 percent commercial vehicles, and 1.3 percent other vehicles. There may be some bias in the distributions of vehicles by vehicle type at the surveyed stations. This bias would be present if a significant number of vehicles in any category refused to participate in the survey. The high sampling rates shown in Table 219 indicate that this bias is not significant for the Sherman-Denison external station survey and for purposes of this analysis was assumed to be negligible.

Table 221 presents a breakdown of the survey data in terms of the percentage of external-local (local) and external-external (through) trips for each vehicle type at each station surveyed. The percentage of trips that were through trips ranged from a low of 5.1 percent to a high of just over 48 percent (all vehicles). Since some of the highest percentage through trips were observed at the high volume stations, the weighted average for all stations was nearly 25 percent through trips. For passenger vehicles, the percentage of trips that were through trips ranged from a low of 4.8 percent to a high of 26.9 percent. For commercial vehicles, this percentage ran from a low of 4.4 percent to

a high of over 81 percent. For other vehicles, this percentage ranged from a low of 0 percent to a high of 65.4 percent. Over 80 percent of the outbound commercial vehicles at the US 75 north station were through trips. Due to the influence of traffic volumes on the weighted averages for all stations, the assumed percentages of local and through trips for the non-surveyed stations were taken from the low volume stations. The assumed values for the non-surveyed stations were 91.8 percent local and 8.2 percent through for passenger vehicles, 81.9 percent local and 18.1 percent through for commercial vehicles, and 77.3 percent local and 22.7 percent through for other vehicles. Data from the surveyed stations indicates that nearly one out of every four vehicles counted at the external stations was a vehicle traveling through the study area.

Expanding the survey data up to the 24-hour vehicle counts at each station results in estimates of the total passenger, commercial, and other vehicles entering and leaving the study area as well as the number of local and through trips at each station. Table 222 presents these estimates for the stations that were surveyed and Table 222-A presents the estimates for the stations that were not surveyed.

Table 223 presents the average vehicle occupancies that were observed for each vehicle type for local and through trips. Passenger vehicles were observed to have an average of 1.45 persons per vehicle for local trips and 1.74 persons per vehicle for through trips. Similar differences were noted for most of the other urban areas surveyed. Commercial vehicles had significantly lower occupancies. Commercial vehicle local trips were observed to have an average occupancy of 1.14 persons, while through trips were observed to have an average of 1.07 persons. Other vehicles had occupancies of 6.63 for local trip and 4.18 for through trips. Overall average occupancies for all vehicles were 1.48 for local trips and 1.39 for through trips. The overall low average for through trips is a result of the high number of surveyed through trip commercial vehicles with low vehicle occupancies. This may also indicate a potential bias due to the unknown number of refusals to participate in the survey. The relative vehicle occupancy for local versus through trips in Sherman-Denison does not appear similar to those observed in the other urban areas surveyed.

Since the origin and/or entry point of each trip was collected as part of the survey, the trips were geocoded with each origin and/or entry point equated to a zone in the transportation study area. Using the transportation network and the zone-to-zone travel times and distances, the trip lengths were determined for all of the trips which were geocoded. Tables 224 and 225 present the average

trip lengths in miles and minutes by vehicle type for local and through trips at each external station surveyed. The average values assumed for the stations that were not surveyed were 7.3 miles for passenger vehicle local trips, 15.26 miles for passenger vehicle through trips, 7.68 miles for commercial vehicle local trips, 13.54 miles for commercial vehicle through trips, 6.91 miles for other vehicle local trips, and 19.11 miles for other vehicle through trips. These averages were taken from the low volume stations surveyed in Sherman-Denison. Figures 60 through 65 present plots of the frequency of surveyed trips by network travel time and distance.

The average passenger vehicle trip length (expanded) for all of the stations surveyed was 8.5 miles and 11.1 minutes for local trips and nearly 19 miles and 22 minutes for through trips. These estimates may be a reflection of the overall shape of the study area which included two urban areas; also, the study area was not symmetrical. An external trip traveling through the study area north to south (or vice versa) would travel much farther to get through the area than a trip traveling from east to west (or vice versa). The average commercial vehicle trip lengths were 10.8 miles and 13.7 minutes for local trips and 24.7 miles and 28.6 minutes for through trips. The average other vehicle trip lengths were 8.1 miles and 10.7 minutes for local trips and 21.2 miles and 24.7 minutes for through trips. These averages indicate relatively much higher network speeds than those observed in the other urban areas surveyed. The average trip lengths for external-local passenger vehicle trips was roughly double the average auto driver internal trip length observed from the Sherman-Denison household survey (4.3 miles and 7.3 minutes). The external-local trips (all vehicles) from the external station surveys had much higher average speeds (46 miles per hour) than the internal auto driver trips from the household survey (35 miles per hour). A similar disparity was not found in the other urban areas surveyed and may indicate an imbalance in network speeds for certain facilities which are tied to external stations. More investigation would be necessary to adequately explain this difference.

Multiplying the average trip length in miles at each station by the total vehicle trips results in an estimate of the total VMT in the urban area due to external trips (both local and through). These estimates are shown in Table 226 for the stations that were surveyed and in Table 226-A for the stations that were not surveyed. From the Sherman-Denison household survey, the total estimated auto driver internal VMT was 1.06 million (not including internal commercial vehicle trips). The estimated VMT due to external travel is 960,000. The implication is that external travel

forms a major portion of the overall travel in the Sherman-Denison study area. Not including the internal commercial vehicle travel, external travel accounts for nearly 48 percent of the total VMT in the study area. The total internal auto driver trips from the household survey was 245,000. The total external trips (based on counted volumes) was nearly 82,000. In terms of total trips (not including the internal commercial vehicle trips), external trips represent approximately 25 percent of all vehicle trips. Additional travel in the study area due to trips which originate outside the area may be significant.

Summary

The external station surveys in the Sherman-Denison study area have produced estimates of the total external-local and external-external through trips for that area. They have also provided data for estimating the total VMT due to external related travel. Comparison of the results of the external station surveys and the household surveys indicates that external related travel comprises nearly 25 percent of the total vehicle trips in the study area and nearly 48 percent of the total VMT. Since many trips associated with external travel may not be a part of the overall travel demand estimates, the impact of such travel in Sherman-Denison appears to be significant. This may be an indication that the study area boundary needs to be reviewed. The average speeds associated with the network travel times and distances for external travel were found to be significantly higher than those observed for auto driver trips in the household survey. This may be a result of high percentages of through trips on high speed facilities or an imbalance in the speeds on some of the facilities in the network. Given the information available at this time, it is not known whether or not this is an indication of potential problems, but further investigation may be warranted.

TYLER EXTERNAL STATION SURVEYS

The external station surveys in Tyler were done in April and May of 1991. There were 32 external stations identified in the study area, and each was included in the survey. Both the postcard mailback and direct interview survey methods were used. The postcard mailback method was used at the 10 stations with the highest traffic volumes. The direct interview method was used at the other 22 stations. The surveys were all done during the daylight hours and involved time periods of 12 hours. Only vehicles in the outbound direction were surveyed. Table 227 presents the stations that

were surveyed and summary information on the number of surveys and traffic counts at each station. A total of 75,807 vehicles were counted in the outbound direction. Of those vehicles, over 27 percent were surveyed. The sampling rate at individual stations varied from a low of 4.4 percent to a high of 77.8 percent. The lowest sampling rate occurred at the IH 20 external station which had the highest traffic count.

Six vehicle types were precoded on the survey forms for use by persons completing the survey and by interviewers in recording the type of vehicle being surveyed. These types were passenger car/truck/van/motorcycle, bus, taxi, school bus, commercial vehicle (over one ton), and other. These were grouped into three categories for analysis purposes, passenger vehicles, commercial vehicles, and other vehicles. The percentage of vehicles surveyed in these three categories at each of the external stations is shown in Table 228. The majority of the vehicles surveyed at all of the stations were passenger vehicles. One exception was Station 234, SH 64 East, where the passenger vehicles surveyed were the lowest of the three categories. At that station, only 7.7 percent of the vehicles were passenger vehicles while 75 percent were commercial vehicles and 17.3 percent were other vehicles. With the exception of that station, the percentage of passenger vehicles surveyed ranged from a low of 80.7 percent to a high of 98.2 percent. The percentage of vehicles surveyed that were commercial vehicles ranged from a low of 1.2 percent to a high of 14.6 percent (with the exception of Station 234). For all stations combined expanded to the 24-hour vehicle counts, 93 percent of the vehicles were estimated to be passenger vehicles, 5.9 percent commercial vehicles, and 1.1 percent other vehicles.

Table 229 presents the survey data breakdown in terms of the percentage of external-local (local) and external-external (through) trips for each vehicle type by station. The percentage of passenger vehicle trips observed to be through trips ranged from 4.5 percent to 81.4 percent. For commercial vehicles, the percentage through trips ranged from 0 percent to 89.4 percent. At the IH 20 East station, over 82 percent of all vehicles were observed to be through trips. For all stations combined, over 30 percent of passenger vehicles were through trips, 49.2 percent of commercial vehicles were through trips, and 41.4 percent of other vehicles were through trips. For all vehicle types, 77 percent of the external trips are estimated to be local in nature and 23 percent are estimated to be through.

Expanding the survey data at each station up to the 24-hour vehicle count results in estimates of the total numbers of passenger, commercial, and other vehicles entering and leaving the study area as well as the number of local and through trips at each station. Table 230 presents the estimates of total local and through passenger, commercial, and other vehicle trips at each station. An estimated 153,647 vehicles entered and left the study area. Of those, 118,291 were estimated to be external local vehicle trips and 35,356 were estimated to be through trips. The total internal auto driver trips estimated from the Tyler household survey was 376,338 (not including internal commercial vehicle trips). The implication is that external related travel in the Tyler study area accounts for approximately 29 percent of the total vehicular travel (not including internal commercial vehicle trips).

Table 231 presents the average vehicle occupancies that were observed for each vehicle type for local and through trips. Passenger vehicles were observed to have an average of 1.43 persons per vehicle for local trips and 1.63 persons per vehicle for through trips. This difference is comparable to that observed in the other urban areas surveyed. Commercial vehicles had significantly fewer average occupancies of 1.25 persons per vehicle for local trips and 1.18 persons per vehicle for through trips. The average occupancies for other vehicles were 11.88 for local trips and 7.7 for through trips. For all vehicles, the averages were 1.51 for local trips and 1.7 for through trips.

Since the location of each trip's origin and/or entry point into the study area was collected as a part of the survey, the trips were geocoded. Using the transportation network and the zone-to-zone travel times and distances, the trip lengths were determined for all of the trips which could be geocoded. Tables 232 and 233 present the average trip lengths in miles and minutes by vehicle type for local and through trips at each external station and the expanded averages for all stations. Figures 66 through 71 present plots of the frequency of trips by network travel time and distance.

The average passenger vehicle trip length expanded for all stations was 9.5 miles and 12.1 minutes for local trips and 13.7 miles and 16.1 minutes for through trips. The average commercial trip lengths were 9.3 miles and 11.9 minutes for local trips and 15.7 miles and 18 minutes for through trips. Other vehicle trip lengths averaged 9.3 miles and 11.9 minutes for local trips and 14.4 miles and 16.6 minutes for through trips. The average trip lengths for auto driver trips estimated from the household survey were 3.4 miles and 5.6 minutes. The local external trips typically averaged nearly three times the distance and over twice the time as the internal trips.

Multiplying the average trip lengths by the total vehicles at each station results in estimates of VMT. These are presented in Table 234 for both local and through trips by vehicle type. The total VMT due to external travel in the Tyler study area is estimated to be 1.6 million with 1.1 million being local trips and 0.5 million being through trips. The total internal auto driver VMT estimated from the Tyler household survey was just over 1.3 million (not including internal commercial vehicle trips). These estimates imply that the majority of travel in the Tyler study area (at least in terms of VMT) is due to external trips. This may indicate a need to expand the study area boundary to reduce the significance of external related travel.

Summary

The external station survey done in Tyler has produced estimates of total external-local and external-external trips. It has also provided data for the estimation of total vehicle miles of travel due to external related trips in the study area. Comparing the results of the external station survey with those from the household survey has resulted in a finding that external travel comprises a major portion of the overall travel in the Tyler study area. In terms of the total vehicular travel (not including internal commercial vehicle trips), external trips account for approximately 29 percent of the vehicular trips. The major impact in the study area is the amount of vehicle miles of travel due to external trips. These trips produce more VMT in the study area than the internal auto driver trips as estimated from the household survey. The implications are that a significant potential for error exists in the estimation of internal travel demand due to the lack of data on additional internal trips that may be produced by persons originating from outside the study area. A need may exist to expand the study area boundary to reduce the impact of external travel on the travel demand estimates.

COMPARISON OF EXTERNAL STATION SURVEYS

The external station surveys done in 1990 and 1991 represented a significant data collection effort. The data collected for the areas surveyed are the best basis for the estimation and forecast of external travel in those respective urban areas. One area of interest is the question of comparability between urban areas relative to external travel. It is obvious that the urban areas surveyed were significantly different in many respects, and some of the data would not be expected to be

comparable. The importance of comparability lies in the ability to transfer some of the data to urban areas that have not had recent external station surveys. The purpose of this section is to present a relative comparison of some of the data and attempt to identify those elements which appear to be very similar between the areas surveyed. The data that are compared represent overall averages for all of the stations in each urban area. No attempt was made to stratify the data for comparison, but this area may warrant future investigation.

Surveyed Vehicles by Vehicle Type

As mentioned previously, one area of interest was the distribution of vehicles entering and leaving urban areas by vehicle type. The trip length characteristics of different vehicle types were found to be significantly different, and estimates of overall travel due to external trips would be improved by stratifying the vehicle estimates by vehicle type. Table 235 presents the percentages of surveyed vehicles by vehicle type for each of the urban areas. For comparison purposes, other vehicles have been grouped with commercial vehicles, since they appeared to have very similar characteristics and represented a relatively low percentage of overall travel into the urban areas. It will be noted in Table 235 that two sets of data are shown for Brownsville. One represents the results of the surveyed vehicles, and the other represents the results of the vehicle classification counts done at the external stations. The two are slightly different. Since the data shown in Table 235 may be influenced by the number of refusals to participate in the survey, one recommendation for future external station surveys is that vehicle classification counts be done. This would ensure more consistency between urban areas. Overall, the distribution of vehicles by type appears fairly consistent with the exception of Sherman-Denison where a significantly different distribution with nearly one in every four vehicles being a commercial or other vehicle type was found. For urban areas that do not have recent external station surveys, the recommended distribution of vehicles by type is 92 percent passenger vehicles and 8 percent commercial/other vehicles. These represent overall averages for all stations. Careful review should be made of the distributions reported for individual urban areas relative to the functional classification of the facility at the external station. It was observed that the distribution of vehicles by type varied significantly between different facilities and appears to be related to both the functional classification and traffic volume.

Distribution of Local and Through Trips

Another area of concern with regard to estimating external trip characteristics is the distribution of those trips by local and through movements. The commercial and other vehicle categories were combined for comparison purposes. Table 236 presents the breakdown by vehicle type for each urban area surveyed. The distribution of passenger vehicle trips by local and through movements appears somewhat comparable. The distribution of commercial/other vehicle trips by local and through movements does not appear comparable. Much of the differences between the urban areas may be due to the location of the study area boundary in the respective urban areas. Since these data do not appear to be comparable, no specific percentages are recommended for use in those urban areas without a recent external station survey. It is suggested that the analyst use the percentages for the urban area that most closely match the area under analysis in terms of size and study area boundary location.

External Vehicle Miles of Travel

External travel in some urban areas represents a significant proportion of overall travel. Table 237 presents some comparisons for the urban areas in terms of total estimates of vehicle trips and VMT. The data presented represent the estimates developed from the household surveys in each urban area and those from the external station surveys. The data in Table 237 indicate that external travel represents a significant portion of overall travel in terms of VMT. This is due to the comparatively high average trip lengths that were observed for these trips which were typically two to three times higher than that for internal travel. The implication is that more research is needed in estimating, predicting, and understanding this portion of travel. Since little is known about the number of additional trips that may be made by persons who travel into a study area (i.e., an external-local trip), with the numbers of these trips being made, a significant potential exists for underestimating internal travel demand. The extension of the study area boundaries could mitigate these impacts; and, in some cases, it appears the study area boundaries should be relocated.

**Table 194
 Surveyed External Stations
 Amarillo External Station Survey**

Station No.	Facility	Functional Classification	Duration (Hrs)	24-Hr Volume	24-Hr Outbound Volume	Usable Surveys	Percent Surveyed
372	US 87 / 287 North	Freeway	3	6,810	2,963	345	11.6
373	Webb Road	Collector	11	377	190	51	26.8
374	SH 136	Principal Arterial	10.5	4,511	2,255	748	33.2
375	St. Francis Road	Principal Arterial	11	300	164	59	36.0
376	US 60 East	Principal Arterial	11	6,605	3,090	738	23.9
377	Spur 552	Principal Arterial	10	513	312	94	30.1
378	IH 40 East	Freeway	3	10,685	5,501	313	5.7
379	US 287 East	Principal Arterial	3	8,283	4,969	380	7.6
380	FM 1151	Principal Arterial	10.5	630	301	86	28.6
381	FM 1258	Principal Arterial	10.75	259	129	71	56.3
382	Osage Road	Principal Arterial	10	620	349	167	47.9
383	FM 1541	Principal Arterial	10.67	2,560	1,043	376	36.0
384	IH 27 South	Freeway	3.5	29,080	14,749	542	3.7
385	FM 2590	Minor Arterial	10.67	1,272	636	270	42.5
386	FM 2219	Principal Arterial	10.5	1,241	622	194	31.2
387	FM 2186	Principal Arterial	10.5	508	234	109	46.6
388	IH 40 West	Freeway	3	11,295	6,070	320	5.3
389	Indian Hill Road	Collector	10.5	313	175	147	84.0
390	FM 1061	Principal Arterial	10.5	1,924	1,048	302	28.8

Table 195
Percentage of Vehicles Surveyed
By Vehicle Type
Amarillo External Station Survey

Station No.	Facility	Passenger Vehicles (%)	Commercial Vehicles (%)	Other Vehicles (%)
372	US 87 / 287 North	83.8	11.3	4.9
373	Webb Road	92.2	7.8	0.0
374	SH 136	92.5	7.0	0.5
375	St. Francis Road	64.4	33.9	1.7
376	US 60 East	90.7	8.8	0.5
377	Spur 552	86.2	13.8	0.0
378	IH 40 East	72.2	25.6	2.2
379	US 287 East	85.8	13.9	0.3
380	FM 1151	94.2	5.8	0.0
381	FM 1258	85.9	14.1	0.0
382	Osage Road	95.2	3.6	1.2
383	FM 1541	93.9	5.1	1.1
384	IH 27 South	91.0	8.3	0.7
385	FM 2590	96.3	3.7	0.0
386	FM 2219	95.4	4.6	0.0
387	FM 2186	93.6	6.4	0.0
388	IH 40 West	87.2	11.9	0.9
389	Indian Hill Road	33.3	66.0	0.7
390	FM 1061	93.4	6.6	0.0
All Stations*		87.2	11.6	1.2

*Based on expanded data at each station.

Table 196
Estimated Percentage of External-Local
And External-External Trips by Station
Amarillo External Station Survey

Station #	Description	Passenger Vehicles (%)		Commercial Vehicles (%)		All Other Vehicles (%)		All Vehicles (%)	
		Local	Through	Local	Through	Local	Through	Local	Through
372	US 87 / 287 North	79.2	20.8	56.4	43.6	88.4	11.6	77.1	22.9
373	Webb Road	93.6	6.4	100.0	0.0	-	-	94.1	5.9
374	SH 136	91.6	8.4	76.9	23.1	50.0	50.0	90.4	9.6
375	St. Francis Road	89.5	10.5	90.0	10.0	100.0	0.0	89.8	10.2
376	US 60 East	93.4	6.6	78.5	21.5	50.0	50.0	91.9	8.1
377	Spur 552	75.3	24.7	92.3	7.7	-	-	77.7	22.3
378	IH 40 East	57.1	42.9	60.0	40.0	14.3	85.7	56.9	43.1
379	US 287 East	76.7	23.3	73.6	26.4	0.0	100.0	76.1	23.9
380	FM 1151	75.3	24.7	80.0	20.0	-	-	75.6	24.4
381	FM 1258	88.5	11.5	90.0	10.0	-	-	88.7	11.3
382	Osage Road	94.3	5.7	100.0	0.0	100.0	0.0	94.6	5.4
383	FM 1541	79.6	20.4	89.5	10.5	100.0	0.0	80.3	19.7
384	IH 27 South	94.9	5.1	68.9	31.1	75.0	25.0	92.6	7.4
385	FM 2590	94.2	5.8	90.0	10.0	-	-	94.1	5.9
386	FM 2219	83.2	16.8	66.7	33.3	-	-	82.5	17.5
387	FM 2186	79.4	20.6	71.4	28.6	-	-	78.9	21.1
388	IH 40 West	67.7	32.3	52.6	47.4	66.7	33.3	65.9	34.1
389	Indian Hill Road	95.9	4.1	99.0	1.0	100.0	0.0	98.0	2.0
390	FM 1061	93.6	6.4	95.0	5.0	-	-	93.7	6.3
Total*		83.4	16.6	66.7	33.3	62.2	37.8	81.2	18.8

*Expanded data

Table 197
Estimates of Local and Through Vehicle Trips
By Vehicle Type
Amarillo External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
372	US 87 / 287 North	4,520	1,184	5,704	434	336	770	297	39	336	5,251	1,559	6,810
373	Webb Road	325	22	347	30	-	30	-	-	-	355	22	377
374	SH 136	3,823	350	4,173	242	72	314	12	12	24	4,077	434	4,511
375	St. Francis Road	173	120	193	92	102	102	5	-	5	269	31	300
376	US 60 East	5,593	394	5,987	457	125	582	18	18	36	6,068	537	6,605
377	Spur 552	333	109	442	65	6	71	-	-	-	398	115	513
378	IH 40 East	4,404	3,311	7,715	1,639	1,092	2,731	33	206	239	6,076	4,609	10,685
379	US 287 East	5,449	1,657	7,106	850	305	1,155	0	22	22	6,299	1,984	8,283
380	FM 1151	446	147	593	30	7	37	-	-	-	476	154	630
381	FM 1258	197	26	223	33	3	36	-	-	-	230	29	259
382	Osage Road	557	33	590	22	-	22	8	-	8	587	33	620
383	FM 1541	1,913	490	2,403	115	14	129	28	-	28	2,056	504	2,560
384	IH 27 South	25,110	1,341	26,451	1,663	751	2,414	161	54	215	26,934	2,146	29,080
385	FM 2590	1,155	70	1,225	42	5	47	-	-	-	1,197	75	1,272
386	FM 2219	985	198	1,183	39	19	58	-	-	-	1,024	217	1,241
387	FM 2186	378	97	475	23	10	33	-	-	-	401	107	508
388	IH 40 West	6,672	3,178	9,850	706	636	1,342	72	34	106	7,450	3,848	11,298
389	Indian Hill Road	100	4	104	205	2	207	2	-	2	307	6	313
390	FM 1061	1,682	115	1,797	121	6	127	-	-	-	1,803	121	1,924
Total		63,817	12,748	76,565	6,805	3,399	10,206	633	385	1,018	71,257	16,532	87,789

Table 198
Estimates of Local and Through Vehicle Miles Traveled
By Vehicle Type
Amarillo External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
372	US 87/ 287 North	58,202	27,429	85,631	6,515	7,818	14,333	3,934	922	4,856	68,651	36,169	104,820
373	Webb Road	2,815	419	3,234	197	0	197	0	0	0	3,012	419	3,431
374	SH 136	49,205	7,799	57,004	2,541	1,690	4,231	110	247	357	51,856	9,736	61,592
375	St. Francis Road	2,416	150	2,566	1,347	186	1,533	21	0	21	3,784	336	4,120
376	US 60 East	85,251	10,520	95,771	5,546	3,417	8,963	274	325	599	91,071	14,262	105,333
377	Spur 552	4,180	2,138	6,318	592	157	749	0	0	0	4,772	2,295	7,067
378	IH 40 East	56,910	78,528	135,438	14,562	25,674	40,236	282	4,829	5,111	71,754	109,031	180,785
379	US 287 East	69,280	38,024	107,304	6,983	6,324	13,307	0	505	505	76,263	44,853	121,116
380	FM 1151	5,900	2,620	8,520	333	67	400	0	0	0	6,233	2,687	8,920
381	FM 1258	2,613	328	2,941	269	63	332	0	0	0	2,882	391	3,273
382	Osage Road	5,706	479	6,185	222	0	222	78	0	78	6,006	479	6,485
383	FM 1541	19,523	5,364	24,887	1,631	259	1,890	360	0	360	21,514	5,623	27,137
384	IH 27 South	283,624	33,814	317,438	25,061	20,100	45,161	1,499	1,265	2,764	310,184	55,179	365,363
385	FM 2590	11,710	707	12,417	248	6	254	0	0	0	11,958	713	12,671
386	FM 2219	12,668	1,119	13,787	663	430	1,093	0	0	0	13,331	1,549	14,880
387	FM 2186	4,468	1,411	5,879	272	119	391	0	0	0	4,740	1,530	6,270
388	IH 40 West	75,475	74,076	149,551	11,398	14,842	26,240	883	841	1,724	87,756	89,759	177,515
389	Indian Hill Road	1,095	72	1,167	2,418	36	2,454	27	0	27	3,540	108	3,648
390	FM 1061	18,191	2,374	20,565	1,550	118	1,668	0	0	0	19,741	2,492	22,233
	Total	769,232	287,371	1,056,603	82,348	81,306	163,654	7,468	8,934	16,402	859,048	377,611	1,236,659

Table 199
Estimates of Local and Through Mean Trip Length in Miles
By Vehicle Type
Amarillo External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
372	US 87 / 287 North	12.88	23.16	15.01	15.00	23.30	18.62	13.28	23.38	14.47	13.07	23.19	15.39
373	Webb Road	8.66	18.89	9.31	6.65	0.00	6.65	0.00	0.00	0.00	8.49	18.89	9.10
374	SH 136	12.87	22.30	13.66	10.54	23.35	13.49	9.09	20.52	14.80	12.72	22.42	13.65
375	St. Francis Road	13.97	7.41	13.28	14.72	18.26	15.08	4.11	0.00	4.11	14.04	11.03	13.73
376	US 60 East	15.24	26.71	16.00	12.15	27.27	15.41	15.25	18.19	16.72	15.01	26.56	15.95
377	Spur 552	12.56	19.59	14.30	9.03	28.75	10.55	0.00	0.00	0.00	11.98	20.03	13.78
378	IH 40 East	12.92	23.71	17.56	8.89	23.50	14.73	8.25	23.58	21.39	11.81	23.66	16.92
379	US 287 East	12.71	22.95	15.10	8.21	20.72	11.52	0.00	23.17	23.17	12.11	22.61	14.62
380	FM 1151	13.20	17.88	14.36	11.37	9.14	10.92	0.00	0.00	0.00	13.09	17.46	14.16
381	FM 1258	13.26	12.86	13.22	8.19	17.26	9.10	0.00	0.00	0.00	12.54	13.41	12.64
382	Osage Road	10.25	14.33	10.48	9.98	0.00	9.98	10.43	0.00	10.43	10.24	14.33	10.46
383	FM 1541	10.20	10.94	10.35	14.09	19.02	14.61	13.21	0.00	13.21	10.46	11.16	10.61
384	IH 27 South	11.30	25.21	12.00	15.07	26.76	18.71	9.31	23.58	12.87	11.52	25.71	12.56
385	FM 2590	10.15	10.00	10.14	5.84	1.39	5.40	0.00	0.00	0.00	9.99	9.46	9.96
386	FM 2219	12.86	5.64	11.65	17.28	22.41	18.99	0.00	0.00	0.00	13.02	7.12	11.99
387	FM 2186	11.84	14.42	12.37	11.68	12.75	11.98	0.00	0.00	0.00	11.83	14.27	12.34
388	IH 40 West	11.31	23.31	15.18	16.14	23.35	19.56	12.50	23.83	16.27	11.78	23.32	15.71
389	Indian Hill Road	10.94	16.96	11.18	11.83	16.96	11.88	12.86	0.00	12.86	11.55	16.96	11.66
390	FM 1061	10.82	20.70	11.45	12.80	18.53	13.09	0.00	0.00	0.00	10.95	20.59	11.56
Total		12.05	22.54	13.80	12.10	23.92	16.08	11.78	23.20	16.10	12.06	22.84	14.09

Table 200
Estimates of Local and Through Mean Trip Length in Minutes
By Vehicle Type
Amarillo External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
372	US 87 / 287 North	18.45	31.27	21.11	20.91	31.94	25.72	18.60	32.00	20.18	18.66	31.43	21.58
373	Webb Road	12.45	27.00	13.38	9.75	0.00	9.75	0.00	0.00	0.00	12.23	27.00	13.10
374	SH 136	18.97	31.17	19.99	15.08	32.58	19.12	13.00	28.50	20.75	18.72	31.33	19.93
375	St. Francis Road	21.09	11.00	20.03	21.83	25.00	22.15	7.00	0.00	7.00	21.08	15.67	20.53
376	US 60 East	22.99	36.30	23.87	17.94	37.00	22.05	23.00	24.50	23.75	22.61	36.07	23.71
377	Spur 552	17.97	26.25	20.01	12.58	38.00	14.54	0.00	0.00	0.00	17.08	26.81	19.26
378	IH 40 East	18.47	33.24	24.81	12.10	33.19	20.54	11.00	33.33	30.14	16.71	33.23	23.83
379	US 287 East	18.39	31.33	21.40	11.41	28.21	15.85	0.00	31.00	31.00	17.45	30.85	20.66
380	FM 1151	19.23	23.85	20.37	16.25	12.00	15.40	0.00	0.00	0.00	19.05	23.29	20.08
381	FM 1258	19.22	17.43	19.02	11.78	23.00	12.90	0.00	0.00	0.00	18.16	18.13	18.15
382	Osage Road	14.79	19.56	15.06	14.50	0.00	14.50	15.50	0.00	15.50	14.79	19.56	15.05
383	FM 1541	15.17	14.61	15.06	20.53	26.00	21.11	20.25	0.00	20.25	15.54	14.92	15.42
384	IH 27 South	16.29	33.80	17.18	21.26	36.00	25.84	13.33	33.00	18.25	16.58	34.55	17.91
385	FM 2590	14.98	14.00	14.92	8.56	2.00	7.90	0.00	0.00	0.00	14.75	13.25	14.66
386	FM 2219	18.31	7.74	16.54	24.00	31.00	26.33	0.00	0.00	0.00	18.52	9.79	16.99
387	FM 2186	17.09	19.52	17.59	16.80	17.00	16.86	0.00	0.00	0.00	17.07	19.30	17.54
388	IH 40 West	16.54	33.17	21.90	23.95	33.28	28.37	18.00	34.00	23.33	17.26	33.19	22.68
389	Indian Hill Road	17.72	24.00	17.98	18.82	24.00	18.88	20.00	0.00	20.00	18.47	24.00	18.59
390	FM 1061	16.65	28.61	17.41	19.37	27.00	19.75	0.00	0.00	0.00	16.83	28.53	17.57
Total		17.56	31.23	19.83	17.23	33.16	22.54	16.75	32.52	22.71	17.52	31.66	20.18

Table 201
Estimates of Local and Through Average Vehicle Occupancy
By Vehicle Type
Amarillo External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
372	US 87 / 287 North	1.79	2.00	1.83	1.14	1.24	1.18	1.07	1.50	1.12	1.69	1.82	1.72
373	Webb Road	1.34	1.00	1.32	1.25	0.00	1.25	0.00	0.00	0.00	1.33	1.00	1.31
374	SH 136	1.60	1.60	1.60	1.02	1.08	1.04	2.00	12.50	7.25	1.56	1.82	1.59
375	St. Francis Road	1.38	1.25	1.37	1.00	1.00	1.00	12.00	0.00	12.00	1.45	1.17	1.42
376	US 60 East	1.46	1.50	1.46	1.04	1.29	1.09	1.00	3.00	2.00	1.42	1.50	1.43
377	Spur 552	1.46	1.75	1.53	1.17	2.00	1.23	0.00	0.00	0.00	1.41	1.76	1.49
378	IH 40 East	1.77	2.04	1.88	1.31	1.38	1.34	2.00	1.50	1.57	1.65	1.86	1.74
379	US 287 East	1.68	2.00	1.76	1.41	1.36	1.40	0.00	4.00	4.00	1.65	1.92	1.71
380	FM 1151	1.67	1.55	1.64	1.25	2.00	1.40	0.00	0.00	0.00	1.65	1.57	1.63
381	FM 1258	1.70	1.29	1.66	1.00	1.00	1.00	0.00	0.00	0.00	1.60	1.25	1.56
382	Osage Road	1.35	1.67	1.37	1.50	0.00	1.50	15.00	0.00	15.00	1.53	1.67	1.54
383	FM 1541	1.45	1.26	1.41	1.06	1.00	1.05	1.25	0.00	1.25	1.42	1.26	1.39
384	IH 27 South	1.60	1.92	1.62	1.13	1.57	1.27	8.33	2.00	6.75	1.62	1.80	1.63
385	FM 2590	1.38	1.40	1.38	1.00	1.00	1.00	0.00	0.00	0.00	1.37	1.37	1.37
386	FM 2219	1.42	1.35	1.41	1.17	1.00	1.11	0.00	0.00	0.00	1.41	1.32	1.39
387	FM 2186	1.28	1.57	1.34	1.20	1.00	1.14	0.00	0.00	0.00	1.28	1.52	1.33
388	IH 40 West	1.87	1.92	1.89	1.35	1.44	1.39	1.00	2.00	1.33	1.82	1.84	1.82
389	Indian Hill Road	1.72	1.00	1.69	1.21	2.00	1.22	1.00	0.00	1.00	1.37	1.33	1.37
390	FM 1061	1.70	1.56	1.69	1.11	1.00	1.10	0.00	0.00	0.00	1.66	1.53	1.65
Total		1.64	1.89	1.68	1.22	1.40	1.28	3.23	2.17	2.83	1.61	1.80	1.65

Table 202
Surveyed External Stations
Brownsville External Station Survey

Station No.	Facility	Functional Classification	Duration (Hrs)	24-Hr Volume	24-Hr Outbound Volume	Usable Surveys	Percent Surveyed
141	Gateway Bridge	Principal Arterial	12.0	15,230	7,615	227	3.0
142	B & M Bridge	Principal Arterial	12.0	8,230	4,140	353	8.5
143	US 281	Principal Arterial	10.5	4,399	2,214	459	20.7
144	US 77 / 83	Principal Arterial	7.0	27,171	13,481	460	3.4
145	FM 1847	Minor Arterial	12.0	4,793	2,371	441	18.6
146	FM 511	Principal Arterial	11.5	3,400	1,757	468	26.6
147	Old Port Isabel Road	Minor Arterial	11.0	94	47	0	0.0
148	SH 48 / FM 1792	Principal Arterial	11.0	5,457	2,698	503	18.6
149	SH 4	Principal Arterial	11.0	364	174	62	35.6

Table 203
Percentage of Vehicles Surveyed By Vehicle Type
Brownsville External Station Survey

Station No.	Facility	Passenger Vehicles (%)	Commercial Vehicles (%)	Other Vehicles (%)
141	Gateway Bridge	98.7	0.4	0.9
142	B & M Bridge	100.0	0.0	0.0
143	US 281	94.8	3.9	1.3
144	US 77 / 83	91.1	7.4	1.5
145	FM 1847	97.7	1.6	0.7
146	FM 511	78.6	20.5	0.9
147	Old Port Isabel Road	-	-	-
148	SH 48/FM 1792	95.6	3.4	1.0
149	SH 4	100.0	0.0	0.0
Totals*		94.3	4.6	1.1

*Based on expanded data at each station.

Table 204
Percentage of Vehicles Counted By Vehicle Type
Brownsville External Station Survey

Station No.	Facility	Passenger Vehicles (%)	Commercial Vehicles (%)	Other Vehicles (%)
141	Gateway Bridge	94.7	5.2	0.1
142	B & M Bridge	94.4	4.2	1.4
143	US 281	88.0	9.1	2.9
144	US 77 / 83	90.1	8.7	1.2
145	FM 1847	96.9	2.3	0.8
146	FM 511	75.6	22.6	1.8
147	Old Port Isabel Road	92.3	0.0	7.7
148	SH 48/FM 1792	94.7	4.6	0.7
149	SH 4	96.0	3.0	1.0
Totals*		91.6	7.3	1.1

*Based on expanded data at each station.

Table 205
Estimated Percentage of External-Local
And External-External Trips by Station
Brownsville External Station Survey

Station #	Description	Passenger Vehicles (%)		Commercial Vehicles (%)		All Other Vehicles (%)		All Vehicles (%)	
		Local	Through	Local	Through	Local	Through	Local	Through
141***	Gateway Bridge	94.6	5.4	94.9	5.1	100.0	0.0	94.7	5.3
142 ***	B & M Bridge	94.9	5.1	94.9	5.1	-	-	94.9	5.1
143	US 281	92.0	8.0	94.4	5.6	83.3	16.7	91.9	8.1
144	US 77 / 83	95.7	4.3	94.1	5.9	100.0	0.0	95.7	4.3
145	FM 1847	97.9	2.1	100.0	0.0	100.0	0.0	98.0	2.0
146	FM 511	95.9	4.1	97.9	2.1	100.0	0.0	96.4	3.6
147**	Old Port Isabel Rd.	95.2	4.8	94.9	5.1	98.7	1.3	95.2	4.8
148	SH 48 / FM 1792	95.4	4.6	88.2	11.8	100.0	0.0	95.2	4.8
149	SH 4	85.5	14.5	-	-	-	-	85.5	14.5
	Total*	95.2	4.8	94.9	5.1	98.7	1.3	95.2	4.8

* Based on expanded survey data for all stations.

** Percentages assumed equal to averages for all other stations.

*** Percentages for commercial vehicles assumed equal to averages for all other stations.

Table 206
Estimates of Local and Through Vehicle Trips
By Vehicle Type
Brownsville External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
141	Gateway Bridge	13,644	779	14,423	752	40	792	15	0	15	14,411	819	15,230
142	B & M Bridge	7,373	396	7,769	328	18	346	114	1	115	7,815	415	8,230
143	US 281	3,561	310	3,871	378	22	400	107	21	128	4,045	354	4,399
144	US 77 / 83	23,428	1,053	24,481	2,224	140	2,364	326	0	326	25,978	1,193	27,171
145	FM 1847	4,547	98	4,645	110	0	110	38	0	38	4,695	98	4,793
146	FM 511	2,465	106	2,571	752	16	768	61	0	61	3,278	122	3,400
147	Old Port Isabel Rd.	83	4	87	0	0	0	7	0	7	90	4	94
148	SH 48 / FM 1792	4,930	238	5,168	221	30	251	38	0	38	5,189	268	5,457
149	SH 4	299	50	349	10	1	11	4	0	4	312	52	364
Total		60,330	3,034	63,364	4,776	266	5,042	710	22	732	65,816	3,322	69,138

Table 207
Estimates of Local and Through Average Vehicle Occupancy
By Vehicle Type
Brownsville External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
141	Gateway Bridge	1.89	2.08	1.90	1.57	1.11	1.55	12.27	na	12.16	1.83	1.94	1.83
142	B & M Bridge	1.81	1.67	1.81	1.57	1.11	1.55	12.27	4.00	12.16	1.83	1.94	1.83
143	US 281	1.63	1.94	1.66	1.24	1.00	1.22	1.80	4.00	2.17	1.62	1.97	1.64
144	US 77 / 83	1.64	2.06	1.66	1.84	1.00	1.79	19.29	na	19.29	1.94	1.95	1.94
145	FM 1847	1.55	1.89	1.55	1.29	na	1.29	1.67	na	1.67	1.54	1.89	1.55
146	FM 511	1.58	1.33	1.57	1.13	1.50	1.14	1.25	na	1.25	1.48	1.35	1.48
147	Old Port Isabel Rd.	1.72	1.98	1.73	na	na	na	12.27	na	12.27	1.83	1.94	1.83
148	SH 48 / FM 1792	1.70	2.00	1.71	1.00	1.50	1.06	7.00	na	7.00	1.73	1.96	1.74
149	SH 4	2.30	2.78	2.37	1.57	1.11	1.55	12.27	na	12.27	2.30	2.78	2.37
	Total	1.72	1.98	1.73	1.57	1.11	1.55	12.27	4.00	12.16	1.83	1.94	1.83

Table 208
Estimates of Local and Through Mean Trip Length in Miles
By Vehicle Type
Brownsville External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
141	Gateway Bridge	2.76	8.15	3.05	5.83	7.16	5.90	3.78	na	3.79	2.78	8.15	3.07
142	B & M Bridge	2.60	7.98	2.87	5.83	7.16	5.90	5.72	4.74	5.71	2.60	7.98	2.87
143	US 281	5.40	8.02	5.61	5.82	4.74	5.76	6.56	4.74	6.26	5.43	7.84	5.63
144	US 77 / 83	5.90	6.91	5.94	6.31	7.26	6.36	6.06	na	6.06	5.93	6.95	5.97
145	FM 1847	5.36	6.91	5.39	5.59	na	5.59	4.55	na	4.55	5.36	6.91	5.39
146	FM 511	5.07	9.05	5.23	5.07	8.54	5.15	5.41	na	5.41	5.08	8.99	5.22
147	Old Port Isabel Rd.	5.06	8.22	5.21	na	na	na	6.00	na	6.00	5.09	8.18	5.23
148	SH 48 / FM 1792	10.35	13.64	10.50	3.74	7.16	4.22	7.98	na	7.98	10.20	13.46	10.36
149	SH 4	9.85	14.71	10.55	5.83	7.16	5.90	6.00	na	6.00	9.85	14.71	10.55
	Total	5.06	8.22	5.21	5.83	7.16	5.93	6.00	4.74	5.96	5.09	8.18	5.23

Table 209
Estimates of Local and Through Mean Trip Length in Minutes
By Vehicle Type
Brownsville External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
141	Gateway Bridge	4.62	9.33	4.87	7.27	8.01	7.31	6.50	5.00	6.48	4.65	9.33	4.89
142	B & M Bridge	4.92	11.39	5.25	7.27	8.01	7.31	7.48	5.00	7.45	4.92	11.39	5.25
143	US 281	7.66	9.86	7.84	8.00	5.00	7.83	8.60	5.00	8.00	7.69	9.59	7.84
144	US 77 / 83	7.13	8.22	7.18	7.63	8.00	7.65	7.43	na	7.43	7.18	8.20	7.22
145	FM 1847	7.88	9.22	7.90	7.71	na	7.71	6.67	na	6.67	7.87	9.22	7.89
146	FM 511	6.72	10.53	6.88	6.61	11.00	6.70	7.00	na	7.00	6.70	10.59	6.84
147	Old Port Isabel Rd.	6.42	9.97	6.59	na	na	na	7.66	na	7.66	6.52	9.97	6.66
148	SH 48 / FM 1792	13.06	16.27	13.21	4.50	8.01	4.92	10.00	na	10.00	12.86	15.96	13.01
149	SH 4	12.42	16.67	13.03	7.27	8.01	7.31	7.66	na	7.66	12.42	16.67	13.03
Total		6.42	9.97	6.59	7.27	8.01	7.31	7.66	5.00	7.44	6.88	9.90	7.03

Table 210
Estimates of Local and Through Vehicle Miles Traveled
By Vehicle Type
Brownsville External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
141	Gateway Bridge	37,657	6,348	44,005	4,382	289	4,671	57	1	58	42,096	6,638	48,734
142	B & M Bridge	19,169	3,162	22,331	1,912	126	2,038	651	7	658	21,732	3,295	25,027
143	US 281	19,232	2,483	21,715	2,199	106	2,305	697	101	798	22,128	2,690	24,818
144	US 77 / 83	138,228	7,274	145,502	14,036	1,013	15,049	1,976	0	1,976	154,240	8,287	162,527
145	FM 1847	24,371	674	25,045	616	0	616	174	0	174	25,161	674	25,835
146	FM 511	12,497	954	13,451	3,814	138	3,952	331	0	331	16,642	1,092	17,734
147	Old Port Isabel Rd.	418	34	452	0	0	0	43	0	43	461	34	495
148	SH 48 / FM 1792	51,026	3,243	54,269	828	230	1,058	305	0	305	52,159	3,473	55,632
149	SH 4	2,943	745	3,688	60	4	64	22	0	22	3,025	749	3,774
Total		305,541	24,917	330,458	27,847	1,906	29,753	4,256	109	4,365	337,644	26,932	364,576

Table 211
Surveyed External Stations
San Antonio External Station Survey

Station No.	Facility	Functional Classification	Duration (Hrs)	24-Hr Volume	24-Hr Outbound Volume	Usable Surveys	Percent Surveyed
622	FM 1957	Minor Arterial	8.5	746	454	112	24.7
604	FM 1346	Collector	8.5	824	345	94	27.2
633	FM 482	Collector	7.5	1,050	359	68	18.9
613	Somerset Road	Minor Arterial	9.5	1,644	790	223	28.2
610	US 281(S)	Principal Arterial	5.0	2,193	1,139	234	20.5
623	FM 471	Principal Arterial	6.0	2,914	1,517	390	24.7
624	SH 16 (N)	Principal Arterial	6.0	3,157	1,581	247	15.6
601	FM 78	Minor Arterial	7.5	5,230	3,222	395	12.3
605	US 87 (E)	Principal Arterial	5.0	6,965	3,721	410	11.0
607	US 181 (S)	Principal Arterial	3.5	9,687	5,061	329	6.5
612	SH 16 (S)	Principal Arterial	4.0	9,749	5,955	377	6.3
628	US 281 (N)	Principal Arterial	12.0	13,356	6,645	1,699	25.6
621	US 90 (W)	Freeway	3.0	13,509	8,812	345	3.9
609	IH 37 (S)	Interstate Freeway	3.0	15,257	8,522	450	5.3
602	IH 10 (E)	Interstate Freeway	3.5	19,310	10,065	253	2.5
626	IH 10 (W)	Interstate Freeway	12.0	20,063	10,970	1,052	9.6
616	IH 35 (S)	Interstate Freeway	3.0	20,254	7,299	304	4.2
600	IH 35 (N)	Interstate Freeway	4.0	41,194	21,875	597	2.7
				187,102	98,332	7,579	7.7

Table 211 - A
Non-Surveyed External Stations
San Antonio External Station Survey

Station No.	Facility	Functional Classification	24-Hr Volume
603	FM 2538	Minor Arterial	500
606	FM 3432	Minor Arterial	1,300
608	FM 1303	Minor Arterial	860
611	Pleasanton Road	Principal Arterial	840
614	FM 476	Collector	1,150
615	FM 2790	Collector	710
617	US 81	Principal Arterial	3,700
618	Pearsall Road	Minor Arterial	800
619	Wisdom Road	Collector	830
620	La Costa Road	Collector	1,750
625	Boerne Stage Road	Minor Arterial	400
627	FM 3351	Collector	1,550
629	Smithson Valley Road	Minor Arterial	160
630	FM 3009	Collector	440
TOTAL			15,014

Table 212
Percentage of Vehicles Surveyed
By Vehicle Type
San Antonio External Station Survey

Station No.	Facility	Passenger Vehicles (%)	Commercial Vehicles (%)	All Other Vehicles (%)
622	FM 1957	99.1	0.9	0.0
604	FM 1346	95.7	3.2	1.1
633	FM 482	95.6	2.9	1.5
613	Somerset Road	97.8	1.8	0.4
610	US 281(S)	94.4	3.4	2.1
623	FM 471	94.9	3.3	1.8
624	SH 16 (N)	97.2	1.6	1.2
601	FM 78	95.7	3.0	1.3
605	US 87 (E)	94.9	5.1	0.0
607	US 181 (S)	98.2	1.8	0.0
612	SH 16 (S)	96.3	2.7	1.1
628	US 281 (N)	94.9	4.4	0.7
621	US 90 (W)	97.4	2.0	0.6
609	IH 37 (S)	93.1	5.6	1.3
602	IH 10 (E)	94.5	4.3	1.2
626	IH 10 (W)	87.3	12.2	0.6
616	IH 35 (S)	94.4	5.6	0.0
600	IH 35 (N)	88.8	9.5	1.7
Weighted Average		93.0	6.0	1.0

Table 213
Estimated Percentage of External-Local
And External-External Trips by Station
San Antonio External Station Survey

Station #	Description	Passenger Vehicles (%)		Commercial Vehicles (%)		All Other Vehicles (%)		All Vehicles (%)	
		Local	Through	Local	Through	Local	Through	Local	Through
622	FM 1957	95.5	4.5	0.0	100.0	-	-	94.6	5.4
604	FM 1346	96.7	3.3	66.7	33.3	100.0	0.0	95.7	4.3
633	FM 482	100.0	0.0	100.0	0.0	100.0	0.0	100.0	0.0
613	Somerset Rd.	98.2	1.8	100.0	0.0	100.0	0.0	98.2	1.8
610	US 281 (S)	89.6	10.4	50.0	50.0	40.0	60.0	87.2	12.8
623	FM 471	97.3	2.7	100.0	0.0	100.0	0.0	97.4	2.6
624	SH 16 (N)	97.5	2.5	75.0	25.0	33.3	66.7	96.4	3.6
601	FM 78	97.1	2.9	33.3	66.7	100.0	0.0	95.2	4.8
605	US 87 (E)	96.7	3.3	76.2	23.8	-	-	95.6	4.4
607	US 181 (S)	97.2	2.8	100.0	0.0	-	-	97.3	2.7
612	SH 16 (S)	92.8	7.2	100.0	0.0	75.0	25.0	92.8	7.2
628	US 281 (N)	96.5	3.5	75.7	24.3	91.7	8.3	95.5	4.5
621	US 90 (W)	94.3	5.7	71.4	28.6	50.0	50.0	93.6	6.4
609	IH 37 (S)	64.9	35.1	64.0	36.0	66.7	33.3	64.9	35.1
602	IH 10 (E)	88.7	11.3	90.9	9.1	33.3	66.7	88.1	11.9
626	IH 10 (W)	86.4	13.6	39.8	60.2	66.7	33.3	80.6	19.4
616	IH 35 (S)	84.7	15.3	52.9	47.1	-	-	82.9	17.1
600	IH 35 (N)	87.2	12.8	66.7	33.3	40.0	60.0	84.4	15.6
All Stations		88.5	11.5	63.2	36.8	54.3	45.7	86.7	13.3

Table 214
Estimates of Local and Through Vehicle Trips
By Vehicle Type
San Antonio External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
622	FM 1957	706	33	739	0	7	7	0	0	0	706	40	746
604	FM 1346	763	26	789	17	9	26	9	0	9	789	35	824
633	FM 482	1,004	0	1,004	30	0	30	16	0	16	1,050	0	1,050
613	Somerset Rd.	1,578	29	1,607	30	0	30	7	0	7	1,615	29	1,644
610	US 281 (S)	1,857	216	2,073	38	37	75	18	28	46	1,913	281	2,194
623	FM 471	2,691	75	2,766	96	0	96	52	0	52	2,839	75	2,914
624	SH 16 (N)	2,992	77	3,069	38	13	51	13	25	38	3,043	115	3,158
601	FM 78	4,860	145	5,005	52	105	157	68	0	68	4,980	250	5,230
605	US 87 (E)	6,392	218	6,610	271	85	356	0	0	0	6,663	303	6,966
607	US 181 (S)	9,246	266	9,512	174	0	174	0	0	0	9,420	266	9,686
612	SH 16 (S)	8,703	675	9,378	263	0	263	80	27	107	9,046	702	9,748
628	US 281 (N)	12,231	444	12,675	445	143	588	86	8	94	12,762	595	13,357
621	US 90 (W)	12,408	750	13,158	193	77	270	41	40	81	12,642	867	13,509
609	IH 37 (S)	9,219	4,986	14,205	547	307	854	132	66	198	9,898	5,359	15,257
602	IH 10 (E)	16,186	2,062	18,248	755	75	830	77	155	232	17,018	2,292	19,310
626	IH 10 (W)	15,116	2,379	17,495	974	1,474	2,448	80	40	120	16,170	3,893	20,063
616	IH 35 (S)	16,194	2,925	19,119	600	534	1,134	0	0	0	16,794	3,459	20,253
600	IH 35 (N)	31,898	4,682	36,580	2,610	1,303	3,913	280	420	700	34,788	6,405	41,193
Total		154,044	19,988	174,032	7,133	4,169	11,302	959	809	1,768	162,136	24,966	187,102

Table 214 - A
Estimates of Local and Through Vehicle Trips
By Vehicle Type
For Unsurveyed Stations
San Antonio External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
603	FM 2538	463	18	481	10	2	12	5	2	7	478	22	500
606	FM 3432	1,202	47	1,249	25	6	31	14	6	20	1,241	59	1,300
608	FM 1303	795	31	826	17	4	21	9	4	13	821	39	860
611	Pleasanton Rd	776	31	807	16	4	20	9	4	13	801	39	840
614	FM 476	1,063	42	1,105	22	6	28	12	5	17	1,097	53	1,150
615	FM 2790	656	26	682	13	4	17	8	3	11	677	33	710
617	US 81	3,421	135	3,556	70	19	89	38	17	55	3,529	171	3,700
618	Pearsall Rd	740	29	769	15	4	19	8	4	12	763	37	800
619	Wisdom Rd	768	30	798	16	4	20	8	4	12	792	38	830
620	La Costa Rd	1,618	64	1,682	33	9	42	18	8	26	1,669	81	1,750
625	Boerne Stage Rd	369	15	384	8	2	10	4	2	6	381	19	400
627	FM 3352	1,433	57	1,490	29	8	37	16	7	23	1,478	72	1,550
629	Smithson Valley Rd	148	6	154	3	1	4	1	1	2	152	8	160
630	FM 3009	407	16	423	9	2	11	4	2	6	420	20	440
Totals		13,859	547	14,406	286	75	361	154	69	223	14,299	691	14,990

Table 215
Estimates of Local and Through Average Vehicle Occupancy
By Vehicle Type
San Antonio External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
622	FM 1957	1.43	1.80	1.45		1.00	1.00				1.43	1.67	1.45
604	FM 1346	1.47	2.67	1.51	1.50	1.00	1.33	46.00		46.00	1.97	2.25	1.98
633	FM 482	1.37		1.37	1.00		1.00	1.00		1.00	1.35		1.35
613	Somerset Rd.	1.62	2.00	1.62	2.25		2.25	1.00		1.00	1.63	2.00	1.63
610	US 281 (S)	1.73	1.96	1.75	1.50	1.00	1.25	1.50	2.00	1.80	1.72	1.83	1.74
623	FM 471	1.51	1.60	1.51	1.31		1.31	2.57		2.57	1.52	1.60	1.52
624	SH 16 (N)	1.50	2.00	1.51	1.33	1.00	1.25	2.00	2.00	2.00	1.50	1.89	1.51
601	FM 78	1.37	2.18	1.40	1.00	1.12	1.08	1.20		1.20	1.37	1.74	1.38
605	US 87 (E)	1.45	1.62	1.46	1.00	1.20	1.05				1.43	1.50	1.44
607	US 181 (S)	1.65	2.44	1.67	1.00		1.00				1.64	2.44	1.66
612	SH 16 (S)	1.80	2.15	1.82	1.10		1.10	41.67	2.00	31.75	2.12	2.15	2.12
628	US 281 (N)	1.49	1.63	1.50	1.32	1.67	1.41	7.45	2.00	7.00	1.53	1.64	1.53
621	US 90 (W)	1.52	2.47	1.57	1.80	1.50	1.71	1.00	1.00	1.00	1.52	2.32	1.57
609	IH 37 (S)	1.94	2.37	2.10	1.13	1.22	1.16	19.00	3.50	13.83	2.13	2.32	2.20
602	IH 10 (E)	1.48	1.67	1.50	1.10	1.00	1.09	20.00	1.50	7.67	1.54	1.63	1.55
626	IH 10 (W)	1.47	2.07	1.56	1.18	1.22	1.20	1.25	2.00	1.50	1.46	1.75	1.51
616	IH 35 (S)	1.88	2.20	1.93	3.56	1.13	2.41				1.94	2.04	1.95
600	IH 35 (N)	1.46	2.13	1.55	1.11	1.42	1.21	5.75	4.67	5.10	1.47	2.15	1.58
	Total	1.58	2.14	1.64	1.36	1.28	1.33	10.95	3.36	7.48	1.62	2.04	1.68

Table 216
Estimates of Local and Through Mean Trip Length in Miles
By Vehicle Type
San Antonio External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
622	FM 1957	15.65	24.12	16.03	0.00	29.97	29.97	0.00	0.00	0.00	15.65	25.10	16.15
604	FM 1346	17.78	25.49	18.04	15.91	44.29	25.37	20.32	0.00	20.32	17.77	30.19	18.30
633	FM 482	16.68	0.00	16.68	18.26	0.00	18.26	25.39	0.00	25.39	16.86	0.00	16.86
613	Somerset Rd.	10.15	24.33	10.41	3.40	0.00	3.40	3.47	0.00	3.47	9.99	24.34	10.25
610	US 281 (S)	19.65	43.08	22.09	23.32	43.99	33.65	17.13	41.53	31.77	19.70	43.04	22.69
623	FM 471	14.74	39.62	15.41	17.68	0.00	17.68	14.74	0.00	14.74	14.84	39.62	15.48
624	SH 16 (N)	19.33	35.14	19.73	16.67	40.41	22.60	14.50	42.71	33.30	19.28	37.41	19.94
601	FM 78	15.55	26.95	15.88	16.48	32.16	26.93	18.22	0.00	18.22	15.60	29.14	16.25
605	US 87 (E)	18.75	34.03	19.26	15.55	31.95	19.46	0.00	0.00	0.00	18.62	33.45	19.27
607	US 181 (S)	18.67	30.74	19.01	15.81	0.00	15.81	0.00	0.00	0.00	18.62	30.74	18.95
612	SH 16 (S)	19.27	43.33	21.00	27.14	0.00	27.14	13.53	45.58	21.54	19.45	43.42	21.16
628	US 281 (N)	15.62	42.18	16.56	15.71	41.46	21.97	20.01	46.09	22.18	15.65	42.06	16.83
621	US 90 (W)	18.63	39.48	19.81	23.45	43.27	29.11	18.15	44.43	31.29	18.70	40.05	20.06
609	IH 37 (S)	26.56	45.04	33.04	25.30	45.80	32.68	31.88	44.27	36.01	26.56	45.07	33.06
602	IH 10 (E)	22.94	38.55	24.71	18.36	44.40	20.73	21.32	40.92	34.39	22.73	38.90	24.65
626	IH 10 (W)	17.65	42.70	21.06	23.92	41.30	34.38	26.54	40.92	31.33	18.07	42.16	22.74
616	IH 35 (S)	23.72	45.84	27.11	22.66	46.36	33.82	0.00	0.00	0.00	23.69	45.92	27.49
600	IH 35 (N)	22.10	42.83	24.76	23.86	44.96	30.90	20.93	44.51	35.08	22.22	43.37	25.52
Total		20.26	42.75	22.85	22.07	43.11	29.83	21.41	43.51	31.52	20.35	42.83	23.35

Table 217
Estimates of Local and Through Mean Trip Length in Minutes
By Vehicle Type
San Antonio External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
622	FM 1957	25.69	35.80	26.14	0.00	43.00	43.00	0.00	0.00	0.00	25.69	37.00	26.29
604	FM 1346	28.74	39.67	29.10	25.00	62.00	37.33	36.00	0.00	36.00	28.73	45.25	29.44
633	FM 482	25.57	0.00	25.57	28.00	0.00	28.00	42.00	0.00	42.00	25.88	0.00	25.88
613	Somerset Rd.	17.26	37.75	17.63	5.75	0.00	5.75	6.00	0.00	6.00	17.00	37.75	17.37
610	US 281 (S)	34.81	65.65	38.02	39.50	64.75	52.13	30.50	62.33	49.60	34.86	65.20	38.75
623	FM 471	24.68	57.90	25.58	29.31	0.00	29.31	24.00	0.00	24.00	24.82	57.90	25.67
624	SH 16 (N)	34.22	54.33	34.72	28.33	60.00	36.25	26.00	65.00	52.00	34.11	57.33	34.96
601	FM 78	26.91	42.64	27.37	27.75	48.00	41.25	30.80	0.00	30.80	26.97	44.89	27.83
605	US 87 (E)	30.17	48.23	30.77	24.94	45.40	29.81	0.00	0.00	0.00	29.95	47.44	30.72
607	US 181 (S)	30.65	44.11	31.03	25.67	0.00	25.67	0.00	0.00	0.00	30.56	44.11	30.93
612	SH 16 (S)	31.57	64.81	33.95	42.70	0.00	42.70	22.33	68.00	33.75	31.81	64.93	34.18
628	US 281 (N)	26.28	64.95	27.64	26.09	63.83	35.27	31.91	68.00	34.92	26.31	64.72	28.03
621	US 90 (W)	27.81	55.95	29.40	34.80	60.00	42.00	26.00	61.00	43.50	27.91	56.55	29.74
609	IH 37 (S)	38.91	62.82	47.30	36.63	64.00	46.48	45.75	61.00	50.83	38.88	62.87	47.30
602	IH 10 (E)	33.70	53.30	35.92	25.90	61.00	29.09	31.00	56.00	47.67	33.34	53.73	35.76
626	IH 10 (W)	25.73	59.31	30.30	35.33	56.97	48.35	40.75	56.00	45.83	26.38	58.40	32.59
616	IH 35 (S)	34.47	64.14	39.02	33.67	64.50	48.18	0.00	0.00	0.00	34.44	64.19	39.53
600	IH 35 (N)	32.06	60.96	35.77	34.66	63.11	44.14	30.50	62.00	49.40	32.25	61.46	36.80
Total		30.83	60.35	34.22	32.75	60.34	42.92	32.47	60.79	45.42	30.92	60.36	34.85

Table 218
Estimates of Local and Through Vehicle Miles Traveled
By Vehicle Type
San Antonio External Station Survey

Station	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Thru	Total	Local	Thru	Total	Local	Thru	Total	Local	Thru	Total
622	FM 1957	11,049	802	11,851	0	201	201	0	0	0	11,049	1,003	12,052
604	FM 1346	13,558	663	14,221	280	389	669	211	0	211	14,049	1,052	15,101
633	FM 482	16,743	0	16,743	556	0	556	400	0	400	17,699	0	17,699
613	Somerset Rd.	16,026	704	16,730	101	0	101	23	0	23	16,150	704	16,854
610	US 281 (S)	36,487	9,285	45,772	869	1,640	2,509	316	1,148	1,464	37,672	12,073	49,745
623	FM 471	39,661	2,958	42,619	1,700	0	1,700	773	0	773	42,134	2,958	45,092
624	SH 16 (N)	57,833	2,696	60,529	632	510	1,142	183	1,079	1,262	58,648	4,285	62,933
601	FM 78	75,572	3,912	79,484	861	3,366	4,227	1,239	0	1,239	77,672	7,278	84,950
605	US 87 (E)	119,844	7,423	127,267	4,209	2,701	6,910	0	0	0	124,053	10,124	134,177
607	US 181 (S)	172,628	8,188	180,816	2,757	0	2,757	0	0	0	175,385	8,188	183,573
612	SH 16 (S)	167,712	29,259	196,971	7,144	0	7,144	1,088	1,222	2,310	175,944	30,481	206,425
628	US 281 (N)	191,052	18,712	209,764	6,989	5,920	12,909	1,716	358	2,074	199,757	24,990	224,747
621	US 90 (W)	231,157	29,610	260,767	4,524	3,344	7,868	736	1,801	2,537	236,417	34,755	271,172
609	IH 37 (S)	244,845	224,556	469,401	13,834	14,087	27,921	4,218	2,924	7,142	262,897	241,567	504,464
602	IH 10 (E)	371,305	79,491	450,796	13,858	3,355	17,213	1,645	6,324	7,969	386,808	89,170	475,978
626	IH 10 (W)	266,791	101,597	368,388	23,302	60,856	84,158	2,131	1,640	3,771	292,224	164,093	456,317
616	IH 35 (S)	384,132	134,097	518,229	13,596	24,766	38,362	0	0	0	397,728	158,863	556,591
600	IH 35 (N)	704,946	200,542	905,488	62,281	58,591	120,872	5,863	18,702	24,565	773,090	277,835	1,050,925
Total		3,121,341	854,495	3,975,836	157,493	179,726	337,219	20,542	35,198	55,740	3,299,376	1,069,419	4,368,795

Table 218 - A
Estimates of Local and Through Vehicle Miles Traveled
By Vehicle Type
For Unsurveyed Stations
San Antonio External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
603	FM 2538	7,644	676	8,320	166	84	250	81	85	166	7,891	845	8,736
606	FM 3432	19,845	1,766	21,611	416	251	667	226	256	482	20,487	2,273	22,760
608	FM 1303	13,125	1,165	14,290	283	168	451	145	170	315	13,553	1,503	15,056
611	Pleasanton Rd	12,812	1,165	13,977	266	168	434	145	170	315	13,223	1,503	14,726
614	FM 476	17,550	1,578	19,128	366	251	617	194	213	407	18,110	2,042	20,152
615	FM 2790	10,831	977	11,808	216	168	384	129	128	257	11,176	1,273	12,449
617	US 81	56,481	5,072	61,553	1,165	796	1,961	614	725	1,339	58,260	6,593	64,853
618	Pearsall Rd	12,217	1,090	13,307	250	168	418	129	170	299	12,596	1,428	14,024
619	Wisdom Rd	12,680	1,127	13,807	266	168	434	129	170	299	13,075	1,465	14,540
620	La Costa Rd	26,713	2,404	29,117	549	377	926	291	341	632	27,553	3,122	30,675
625	Boerne Stage Rd	6,092	564	6,656	133	84	217	65	85	150	6,290	733	7,023
627	FM 3352	23,659	2,141	25,800	483	335	818	258	298	556	24,400	2,774	27,174
629	Smithson Valley Rd	2,443	225	2,668	50	42	92	16	43	59	2,509	310	2,819
630	FM 3009	6,720	601	7,321	150	84	234	65	85	150	6,935	770	7,705
Totals		228,812	20,551	249,363	4,759	3,144	7,903	2,487	2,939	5,426	236,058	26,634	262,692

Table 219
Surveyed External Stations
Sherman-Denison External Station Survey

Station #	Description	Duration (Hrs)	24-Hr. Volume	24-Hr. Outbound Volume	Usable Surveys	Percent Surveyed
291	SH 5	11.5	12	12	342	62.40
290	FM 902	11.5	12	12	470	69.50
275	FM 996	11.5	12	12	574	64.00
280	SH 75-A	11.5	12	12	755	67.20
283	FM 1753	11.5	12	12	800	69.30
282	FM 120 (E)	11.5	12	12	835	65.10
289	SH 11	11.5	12	12	1,389	81.70
284	US 69	11.5	12	12	1,281	64.10
277	FM 120 (N)	11.5	12	12	1,709	68.40
296	SH 56	11.5	12	12	1,792	65.30
286	US 82 (E)	11.5	12	12	2,035	67.40
297	US 82 (W)	11.5	12	12	2,616	63.90
292	US 75 (S)	11.5	12	12	1,969	24.70
281	US 75 (N)	11.5	12	12	2,031	24.50
All Stations			161	161	18,598	48.90

Table 219 - A
Non-Surveyed External Stations
Sherman-Denison External Station Survey

Station No.	Facility	24-Hr Volume
274	Hagerman Rd.	230
276	Georgetown Rd.	1,010
278	FM 84	900
279	PR 20	200
285	Dripping Springs Rd.	170
287	Bethany Rd.	120
288	FM 697	570
293	Farmington Rd.	190
294	Hall Cemetery Rd.	190
295	FM 902	1,150
		4,730

Table 220
Percentage of Vehicles Surveyed by Vehicle Type
Sherman-Denison External Station Survey

Station #	Description	Passenger Vehicles	Commercial Vehicles	All Other Vehicles
291	SH 5	94.7	4.4	0.9
290	FM 902	94.3	4.5	1.3
275	FM 996	95.6	4.2	0.2
280	SH 75-A	95.8	2.1	2.1
283	FM 1753	96.1	3.4	0.5
282	FM 120 (E)	96.0	2.9	1.1
289	SH 11	95.3	3.7	0.9
284	US 69	92.0	7.1	0.9
277	FM 120 (N)	92.2	5.3	2.6
296	SH 56	94.2	4.9	0.8
286	US 82 (E)	89.4	9.3	1.3
297	US 82 (W)	87.7	11.1	1.2
292	US 75 (S)	59.2	40.1	0.7
281	US 75 (N)	58.0	40.8	1.3
Total		77.6	21.2	1.1

Table 221
Estimated Percentage of External-Local
And External-External Trips by Station
Sherman-Denison External Station Survey

Station #	Description	Passenger Vehicles		Commercial Vehicles		All Other Vehicles		All Vehicles	
		Local	Through	Local	Through	Local	Through	Local	Through
291	SH 5	91.4	8.6	86.7	13.3	66.7	33.3	90.9	9.1
290	FM 902	73.1	26.9	76.2	23.8	83.3	16.7	73.4	26.6
275	FM 996	94.7	5.3	83.3	16.7	100.0	0.0	94.3	5.7
280	SH 75-A	90.9	9.1	68.8	31.3	62.5	37.5	89.8	10.2
283	FM 1753	95.2	4.8	85.2	14.8	100.0	0.0	94.9	5.1
282	FM 120 (E)	94.1	5.9	75.0	25.0	77.8	22.2	93.4	6.6
289	SH 11	95.1	4.9	84.6	15.4	100.0	0.0	94.7	5.3
284	US 69	90.8	9.2	71.4	28.6	66.7	33.3	89.2	10.8
277	FM 120 (N)	91.8	8.2	95.6	4.4	77.3	22.7	91.6	8.4
296	SH 56	93.8	6.2	95.6	4.4	93.3	6.7	93.3	6.7
286	US 82 (E)	86.8	13.2	55.6	44.4	53.8	46.2	83.4	16.6
297	US 82 (W)	81.9	18.1	49.1	50.9	75.0	25.0	78.1	21.9
292	US 75 (S)	91.0	9.0	35.3	64.7	84.6	15.4	68.6	31.4
281	US 75 (N)	75.3	24.7	18.7	81.3	34.6	65.4	51.7	48.3
	Total	87.3	12.7	33.0	67.0	65.4	34.6	75.5	24.5

Table 222
Estimates of Local and Through Vehicle Trips
By Vehicle Type
Sherman-Denison External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
291	SH 5	917	87	1,004	40	6	46	7	3	10	964	96	1,060
290	FM 902	935	343	1,278	46	14	61	14	4	17	995	361	1,356
275	FM 996	1,622	90	1,712	62	12	75	3	1	3	1,687	103	1,790
280	SH 75-A	1,907	192	2,098	32	15	46	29	16	47	1,968	223	2,191
283	FM 1753	2,098	106	2,204	66	11	77	11	1	12	2,175	118	2,293
282	FM 120 (E)	2,238	139	2,377	53	18	71	21	6	27	2,312	163	2,475
289	SH 11	3,151	163	3,313	110	20	130	32	0	33	3,293	183	3,476
284	US 69	3,419	345	3,764	208	83	291	25	13	38	3,652	441	4,093
277	FM 120 (N)	4,138	369	4,508	246	11	258	98	29	125	4,482	409	4,891
296	SH 56	4,827	321	5,149	153	36	189	43	3	45	5,023	360	5,383
286	US 82 (E)	4,759	726	5,485	316	253	570	42	37	78	5,117	1,016	6,133
297	US 82 (W)	5,792	1,284	7,075	441	457	898	74	24	99	6,307	1,765	8,072
292	US 75 (S)	8,592	850	9,442	2,259	4,138	6,397	89	17	106	10,940	5,005	15,945
281	US 75 (N)	7,731	2,539	10,271	1,353	5,873	7,225	79	148	227	9,163	8,560	17,723
Total		52,125	7,555	59,681	5,387	10,948	16,335	566	300	865	58,078	18,803	76,881

Table 222 - A
Estimates of Local and Through Vehicle Trips
By Vehicle Type
For Non-Surveyed External Stations
Sherman-Denison External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
274	Hagerman Rd.	199	18	217	8	2	10	2	1	3	209	21	230
276	Georgetown Rd.	873	78	951	35	8	43	12	4	16	920	90	1010
278	FM 84	778	70	848	31	7	38	11	3	14	820	80	900
279	PR 20	173	15	188	7	1	8	3	1	4	183	17	200
285	Dripping Springs Rd	147	13	160	6	1	7	2	1	3	155	15	170
287	Bethany Rd.	104	9	113	4	1	5	2	0	2	110	10	120
288	FM 697	493	44	537	20	4	24	7	2	9	520	50	570
293	Farmington Rd.	164	15	179	7	1	8	2	1	3	173	17	190
294	Hall Cemetery Rd.	164	15	179	7	1	8	2	1	3	173	17	190
295	FM 902	994	89	1083	40	9	49	14	4	18	1048	102	1150
Totals		4089	366	4455	165	35	200	57	18	75	4311	419	4730

Table 223
Estimates of Local and Through Average Vehicle Occupancy
By Vehicle Type
Sherman-Denison External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
291	SH 5	1.36	1.43	1.37	1.23	1.50	1.27	1.50	1.00	1.33	1.36	1.42	1.36
290	FM 902	1.38	1.39	1.39	1.13	1.40	1.19	1.60	10.00	3.00	1.37	1.46	1.40
275	FM 996	1.47	1.66	1.48	1.25	1.25	1.25	55.00	0.00	55.00	1.56	1.61	1.57
280	SH 75-A	1.58	1.97	1.62	1.27	1.00	1.19	2.30	2.33	2.31	1.59	1.94	1.62
283	FM 1753	1.42	1.78	1.44	1.61	1.50	1.59	1.25	0.00	1.25	1.42	1.76	1.44
282	FM 120 (E)	1.36	1.32	1.36	1.17	1.33	1.21	8.86	2.50	7.44	1.42	1.36	1.42
289	SH 11	1.40	1.72	1.42	1.23	1.13	1.21	6.38	0.00	6.38	1.45	1.66	1.46
284	US 69	1.39	1.54	1.40	1.29	1.04	1.22	2.63	1.75	2.33	1.39	1.45	1.40
277	FM 120 (N)	1.46	1.67	1.48	1.21	1.00	1.20	6.06	2.30	5.20	1.54	1.70	1.56
296	SH 56	1.41	1.56	1.42	1.22	1.33	1.24	6.07	12.00	6.47	1.45	1.63	1.46
286	US 82 (E)	1.47	1.81	1.51	1.16	1.15	1.16	3.21	8.00	5.42	1.46	1.87	1.53
297	US 82 (W)	1.45	1.73	1.50	1.09	1.04	1.07	12.96	1.50	10.09	1.56	1.55	1.56
292	US 75 (S)	1.44	1.54	1.45	1.15	1.08	1.10	2.64	1.50	2.46	1.39	1.16	1.32
281	US 75 (N)	1.55	1.92	1.64	1.06	1.05	1.05	10.67	4.65	6.73	1.56	1.37	1.47
Total		1.45	1.74	1.49	1.14	1.07	1.09	6.63	4.18	5.79	1.48	1.39	1.45

Table 224
Estimates of Local and Through Mean Trip Length in Miles
By Vehicle Type
Sherman-Denison External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
291	SH 5	7.02	12.92	7.53	5.61	18.27	7.30	11.78	7.79	10.45	6.99	13.10	7.55
290	FM 902	8.07	7.19	7.83	5.55	6.88	5.87	6.00	8.94	6.49	7.92	7.19	7.73
275	FM 996	5.86	16.56	6.43	6.40	16.85	8.14	1.04	0.00	1.04	5.87	16.59	6.49
280	SH 75-A	8.29	23.32	9.66	10.85	13.61	11.71	7.40	24.10	13.66	8.32	22.75	9.79
283	FM 1753	5.63	16.08	6.13	6.54	10.32	7.10	4.17	0.00	4.17	5.65	15.52	6.15
282	FM 120 (E)	5.18	14.00	5.70	6.12	10.83	7.30	3.00	14.72	5.61	5.18	13.68	5.74
289	SH 11	9.71	14.65	9.95	11.09	17.32	12.05	9.55	0.00	9.55	9.75	14.95	10.03
284	US 69	5.23	12.62	5.91	5.63	12.42	7.57	3.77	13.04	6.86	5.24	12.59	6.03
277	FM 120 (N)	9.18	21.78	10.21	9.18	24.61	9.87	7.93	22.14	11.16	9.15	21.89	10.22
296	SH 56	5.54	13.79	6.06	9.18	24.61	9.87	5.23	16.49	5.98	5.55	13.87	6.11
286	US 82 (E)	7.76	11.90	8.31	8.11	11.55	9.63	8.18	10.81	9.40	7.79	11.77	8.45
297	US 82 (W)	6.62	14.64	8.07	7.96	14.54	11.61	6.72	16.39	9.14	6.72	14.64	8.45
292	US 75 (S)	13.89	25.31	14.92	13.78	27.06	22.37	14.91	21.76	15.96	13.88	26.75	17.92
281	US 75 (N)	9.30	23.47	12.81	9.90	24.77	21.98	6.50	25.58	18.98	9.37	24.40	16.63
Total		8.49	18.66	9.78	10.79	24.67	20.09	8.07	21.23	12.62	8.70	22.20	12.00

Table 225
Estimates of Local and Through Mean Trip Length in Minutes
By Vehicle Type
Sherman-Denison External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
291	SH 5	9.16	14.86	9.65	7.62	21.00	9.40	15.50	9.00	13.33	9.14	15.06	9.68
290	FM 902	10.51	8.09	9.86	7.13	7.80	7.29	7.60	11.00	8.17	10.31	8.10	9.73
275	FM 996	7.90	19.55	8.51	8.45	20.25	10.42	2.00	0.00	2.00	7.91	19.64	8.58
280	SH 75-A	10.87	27.12	12.35	14.00	15.40	14.44	10.20	28.33	17.00	10.91	26.45	12.49
283	FM 1753	8.35	18.86	8.86	9.39	12.25	9.81	6.00	0.00	6.00	8.37	18.22	8.88
282	FM 120 (E)	7.62	16.57	8.14	8.50	14.00	9.87	5.14	18.00	8.00	7.62	16.35	8.19
289	SH 11	12.50	16.65	12.70	13.93	19.62	14.81	12.15	0.00	12.15	12.54	16.97	12.77
284	US 69	7.49	14.99	8.18	7.71	14.58	9.67	5.75	15.25	8.92	7.49	14.92	8.29
277	FM 120 (N)	11.88	25.22	12.97	11.99	27.75	12.69	10.06	25.20	13.50	11.84	25.29	12.97
296	SH 56	7.84	15.91	8.34	11.99	27.75	12.69	7.79	19.00	8.53	7.85	15.99	8.40
286	US 82 (E)	10.74	14.17	11.20	11.14	13.64	12.25	11.43	12.83	12.08	10.78	13.99	11.31
297	US 82 (W)	8.58	16.96	10.10	10.29	16.88	13.64	8.71	19.00	11.28	8.70	16.97	10.51
292	US 75 (S)	17.17	29.11	18.24	16.94	31.37	26.27	18.91	25.00	19.85	17.14	30.97	21.48
281	US 75 (N)	12.14	27.24	15.87	12.96	28.72	25.77	8.78	29.71	22.46	12.23	28.30	19.99
Total		11.14	21.66	12.47	13.72	28.62	23.70	10.65	24.66	15.50	11.37	25.76	14.89

Table 226
Estimates of Local and Through Vehicle Miles Traveled
By Vehicle Type
Sherman-Denison External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
291	SH 5	6,441	1,121	7,562	226	113	339	73	24	98	6,740	1,258	7,999
290	FM 902	7,540	2,469	10,009	256	99	355	87	26	113	7,883	2,594	10,477
275	FM 996	9,504	1,497	11,001	399	210	609	3	1	4	9,906	1,708	11,614
280	SH 75-A	15,810	4,466	20,277	346	197	544	215	421	634	16,371	5,084	21,455
283	FM 1753	11,807	1,705	13,512	431	118	550	48	1	48	12,286	1,824	14,110
282	FM 120 (E)	11,592	1,951	13,543	327	193	519	62	86	150	11,981	2,230	14,212
289	SH 11	30,585	2,383	32,968	1,221	347	1,568	311	0	311	32,117	2,730	34,847
284	US 69	17,877	4,354	22,231	1,169	1,032	2,201	96	167	263	19,142	5,553	24,695
277	FM 120 (N)	37,985	8,042	46,026	2,259	282	2,541	771	633	1405	41,015	8,957	49,972
296	SH 56	26,766	4,433	31,199	891	518	1409	221	49	270	27,878	5,000	32,878
286	US 82 (E)	36,945	8,640	45,858	2,565	2,923	5,488	345	391	464	39,855	11,954	51,810
297	US 82 (W)	38,343	18,787	57,130	3,514	6,640	10,154	498	405	902	42,355	25,832	68,186
292	US 75 (S)	119,381	21,521	140,902	31,139	111,985	143,124	1328	353	1680	151,848	133,859	285,706
281	US 75 (N)	71,936	59,591	131,527	13,396	145,449	158,845	510	3795	4305	85,842	208,835	294,677
Total		442,512	140,962	583,474	58,141	270,106	328,247	4567	6350	10917	505,220	417,418	922,638

Table 226 - A
Estimates of Local and Through Vehicle Miles Traveled
By Vehicle Type
For Non-Surveyed External Stations
Sherman-Denison External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
274	Hagerman Rd.	1,453	275	1,728	61	27	88	14	19	33	1,528	321	1,849
276	Georgetown Rd.	6,373	1,190	7,563	269	108	377	83	76	159	6,725	1,374	8,099
278	FM 84	5,679	1,068	6,747	238	95	333	76	57	133	5,993	1,220	7,213
279	PR 20	1,263	229	1,492	54	14	68	21	19	40	1,338	262	1,600
285	Dripping Springs Rd	1,073	198	1,271	46	14	60	14	19	33	1,133	231	1,364
287	Bethany Rd.	759	137	896	31	14	45	14	0	14	804	151	955
288	FM 697	3,599	671	4,270	154	54	208	48	38	86	3,801	763	4,564
293	Farmington Rd.	1,197	229	1,426	54	14	68	14	19	33	1,265	262	1,527
294	Hall Cemetery Rd.	1,197	229	1,426	54	14	68	14	19	33	1,265	262	1,527
295	FM 902	7,256	1,358	8,614	307	122	429	97	76	173	7,660	1,556	9,216
Totals		29,849	5,584	35,433	1,268	476	1,744	395	342	737	31,512	6,402	37,914

Table 227
Surveyed External Stations
Tyler External Station Survey

Station #	Description	Functional Class**	Duration (Hrs)	Total 24-Hr. Volume	24-Hr. Outbound Volume	Usable Surveys	Percent Surveyed
257	FM 14	Collector	12	3,459	1,689	1,035	61.3
258	FM 2015	Collector	12	1,598	807	390	48.3
259	SH 155 (N)	Minor Arterial	12	4,976	2,598	389	15.0
229	US 271	Primary Arterial	12	7,549	3,476	507	14.6
230	CR 384	Collector	12	302	164	74	45.1
231	FM 2767	Collector	12	1,556	763	387	50.7
232	SH 31 (E)	Minor Arterial	12	5,707	2,884	1,665	57.7
233	FM 850	Collector	12	788	388	277	71.4
234	SH 64 (E)	Collector	12	7,907	3,877	1,160	29.9
235	CR 285	Collector	12	1,281	634	171	27.0
236	FM 848	Collector	12	1,173	636	222	34.9
237	SH 110 (S)	Collector	12	15,801	7,977	1,685	21.1
238	FM 346	Collector	12	4,429	2,142	1,169	54.6
239	FM 756	Collector	12	1,262	632	348	55.1
240	US 69 (S)	Primary Arterial	12	9,563	4,219	940	22.3
241	FM 2493	Collector	12	4,141	2,049	1,407	68.7
Subtotals				71,492	34,935	11,826	

**Table 227 (Continued)
 Surveyed External Stations
 Tyler External Station Survey**

Station #	Description	Functional Class**	Duration (Hrs)	Total 24-Hr. Volume	24-Hr. Outbound Volume	Usable Surveys	Percent Surveyed
242	CR 178	Collector	12	398	182	118	64.8
243	SH 155 (S)	Minor Arterial	12	8,013	4,156	794	19.1
244	CR 1113	Collector	12	250	125	78	62.4
245	FM 2661	Collector	12	1,096	618	350	56.6
246	CR 1134	Collector	12	221	97	48	49.5
247	SH 31 (W)	Primary Arterial	12	13,348	6,545	1,192	18.2
248	FM 279	Collector	12	1,366	731	383	52.4
249	SH 64 (W)	Minor Arterial	12	3,978	2,044	1,331	65.1
250	FM 724	Collector	12	473	241	153	63.5
251	SH 110 (N)	Collector	12	2,118	975	718	73.6
253	FM 849	Collector	12	2,064	1,041	810	77.8
254	US 69 (N)	Primary Arterial	12	13,538	6,706	1,320	19.7
255	CR 431	Collector	12	1,370	713	465	65.2
256	CR 35	Collector	12	228	117	69	59.0
260	IH 20 (E)	Interstate Highway	12	14,560	7,419	324	4.4
252	IH 20 (W)	Interstate Highway	12	19,134	9,162	785	8.6
Subtotals				82,155	40,872	8,938	
Totals				153,647	75,807	20,764	27.4%

Table 228
Percentage of Vehicles Surveyed by Vehicle Type
Tyler External Station Survey

Station #	Description	Passenger Vehicles	Commercial Vehicles	All Other Vehicles
257	FM 14	95.0	3.5	1.5
258	FM 2015	95.4	3.8	0.8
259	SH 155 (N)	93.6	5.1	1.3
229	US 271	94.9	3.9	1.2
230	CR 384	91.9	5.4	2.7
231	FM 2767	91.5	5.4	3.1
232	SH 31 (E)	90.7	8.5	0.8
233	FM 850	91.0	8.3	0.7
234	SH 64 (E)	7.7	75.0	17.3
235	CR 285	80.7	14.6	4.7
236	FM 848	88.3	10.8	0.9
237	SH 110 (S)	98.2	1.2	0.6
238	FM 346	89.6	9.0	1.4
239	FM 756	94.0	4.9	1.1
240	US 69 (S)	96.0	3.1	0.9
241	FM 2493	86.1	13.6	0.3
242	CR 178	90.7	5.1	4.2
243	SH 155 (S)	96.5	2.6	0.9
244	CR 1113	92.3	5.1	2.6
245	FM 2661	90.0	9.4	0.6
246	CR 1134	93.8	6.2	0.0
247	SH 31 (W)	97.7	1.6	0.7
248	FM 279	95.3	4.7	0.0
249	SH 64 (W)	90.7	8.9	0.4
250	FM 724	86.3	9.2	4.5
251	SH 110 (N)	92.3	7.2	0.5
253	FM 849	92.8	6.0	1.2
254	US 69 (N)	96.4	2.9	0.7
255	CR 431	92.5	7.1	0.4
256	CR 35	88.4	11.6	0.0
260	IH 20 (E)	83.0	14.5	2.5
252	IH 20 (W)	89.9	8.8	1.3
Totals		93.0	5.9	1.1

Table 229
Estimated Percentage of External-Local
And External-External Trips by Station
Tyler External Station Survey

Station #	Description	Passenger Vehicles		Commercial Vehicles		All Other Vehicles		All Vehicles	
		Local	Through	Local	Through	Local	Through	Local	Through
257	FM 14	82.2	17.8	75.0	25.0	44.4	55.6	81.4	18.6
258	FM 2015	89.2	10.8	60.0	40.0	30.8	69.2	87.7	12.3
259	SH 155 (N)	82.7	17.3	80.0	20.0	100.0	0.0	82.8	17.2
229	US 271	93.3	6.7	80.0	20.0	67.4	32.6	92.5	7.5
230	CR 384	86.8	13.2	100.0	0.0	100.0	0.0	87.8	12.2
231	FM 2767	93.5	6.5	90.5	9.5	81.6	18.4	93.0	7.0
232	SH 31 (E)	87.0	13.0	68.3	31.7	50.0	50.0	85.0	15.0
233	FM 850	81.7	18.3	78.3	21.7	100.0	0.0	81.6	18.4
234	SH 64 (E)	50.0	50.0	84.6	15.4	100.0	0.0	92.7	7.3
235	CR 285	78.3	21.7	72.0	28.0	50.0	50.0	76.0	24.0
236	FM 848	56.6	43.4	70.8	29.2	60.0	40.0	58.1	41.9
237	SH 110 (S)	50.0	50.0	81.0	19.0	90.4	9.6	94.4	5.6
238	FM 346	66.4	33.6	57.1	42.9	65.6	34.4	65.5	34.5
239	FM 756	79.2	20.8	64.7	35.3	0.0	100.0	77.6	22.4
240	US 69 (S)	93.2	6.8	82.8	17.2	77.2	22.8	92.8	7.2
241	FM 2493	95.5	4.5	93.7	6.3	100.0	0.0	95.3	4.7
242	CR 178	86.9	13.1	83.3	16.7	58.8	41.2	85.6	14.4
243	SH 155 (S)	94.5	5.5	76.2	23.8	100.0	0.0	94.1	5.9
244	CR 1113	75.0	25.0	100.0	0.0	100.0	0.0	76.9	23.1
245	FM 2661	52.1	47.9	48.5	51.5	42.9	57.1	51.7	48.3
246	CR 1134	84.4	15.6	66.7	33.3	0.0	0.0	83.3	16.7
247	SH 31 (W)	90.9	9.1	84.2	15.8	78.2	21.8	90.7	9.3
248	FM 279	94.2	5.8	88.9	11.1	0.0	0.0	94.0	6.0
249	SH 64 (W)	85.7	14.3	78.8	21.2	66.7	33.3	85.0	15.0
250	FM 724	90.9	9.1	85.7	14.3	54.5	45.5	88.9	11.1
251	SH 110 (N)	72.7	27.3	59.6	40.4	0.0	100.0	71.4	28.6
253	FM 849	34.4	65.6	26.5	73.5	34.8	65.2	34.0	66.0
254	US 69 (N)	89.3	10.7	84.2	15.8	89.1	10.9	89.2	10.8
255	CR 431	80.0	20.0	69.7	30.3	0.0	100.0	78.9	21.1
256	CR 35	85.2	14.8	87.5	12.5	0.0	0.0	85.5	14.5
260	IH 20 (E)	18.6	81.4	10.6	89.4	37.2	62.8	17.9	82.1
252	IH 20 (W)	61.5	38.5	21.7	78.3	19.7	80.3	57.5	42.5
Totals		78.9	21.1	50.8	49.2	58.6	41.4	77.0	23.0

Table 230
Estimates of Local and Through Vehicle Trips
By Vehicle Type
Tyler External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
257	FM 14	2,700	585	3,285	90	30	120	24	30	54	2,814	645	3,459
258	FM 2015	1,360	164	1,524	37	25	61	4	8	13	1,401	197	1,598
259	SH 155 (N)	3,850	806	4,656	205	51	256	64	0	64	4,119	857	4,976
229	US 271	6,685	476	7,162	238	60	298	60	30	89	6,983	566	7,549
230	CR 384	241	37	278	16	0	16	8	0	8	265	37	302
231	FM 2767	1,331	92	1,423	76	8	84	40	9	49	1,447	109	1,556
232	SH 31 (E)	4,500	675	5,176	332	154	487	22	24	44	4,854	853	5,707
233	FM 850	586	131	717	51	14	65	6	0	6	643	145	788
234	SH 64 (E)	7,041	538	7,579	225	41	266	62	0	62	7,328	579	7,907
235	CR 285	809	225	1,034	135	52	187	30	30	60	974	307	1,281
236	FM 848	586	449	1,036	90	37	127	6	5	10	682	491	1,173
237	SH 110 (S)	14,666	844	15,510	159	38	197	85	9	94	14,910	891	15,801
238	FM 346	2,633	1,334	3,967	227	170	398	42	23	64	2,902	1,527	4,429
239	FM 756	939	247	1,186	40	22	62	0	14	14	979	283	1,262
240	US 69 (S)	8,556	621	9,176	244	51	295	71	20	92	8,871	692	9,563
241	FM 2493	3,405	159	3,564	527	35	562	15	0	15	3,947	194	4,141
Subtotals		59,888	7,383	67,273	2,692	788	3,481	539	202	738	63,119	8,373	71,492

Table 230 (Continued)
Estimates of Local and Through Vehicle Trips
By Vehicle Type
Tyler External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
242	CR 178	314	47	361	17	3	20	10	7	17	341	57	398
243	SH 155 (S)	7,307	424	7,730	161	50	212	71	0	71	7,539	474	8,013
244	CR 1113	173	58	231	13	0	13	6	0	6	192	58	250
245	FM 2661	514	473	986	50	53	103	3	3	7	567	529	1,096
246	CR 1134	175	32	207	9	5	14	0	0	0	184	37	221
247	SH 31 (W)	11,847	1,187	13,034	179	34	213	79	22	101	12,105	1,243	13,348
248	FM 279	1,227	75	1,302	57	7	64	0	0	0	1,284	82	1,366
249	SH 64 (W)	3,090	517	3,607	278	75	353	12	6	18	3,380	598	3,978
250	FM 724	371	37	408	37	6	43	12	10	22	420	53	473
251	SH 110 (N)	1,422	534	1,956	91	62	153	0	9	9	1,513	605	2,118
253	FM 849	660	1,256	1,916	33	92	125	8	15	23	701	1,363	2,064
254	US 69 (N)	11,661	1,395	13,056	328	62	390	82	10	92	12,071	1,467	13,538
255	CR 431	1,013	253	1,266	68	29	97	0	7	7	1,081	289	1,370
256	CR 35	172	30	202	23	3	26	0	0	0	195	33	228
260	IH 20 (E)	2,247	9,841	12,088	225	1,887	2,112	134	226	360	2,606	11,954	14,560
252	IH 20 (W)	10,579	6,630	17,208	366	1,316	1,682	48	195	244	10,993	8,141	19,134
Subtotals		52,772	22,789	75,558	1,935	3,684	5,620	465	510	977	55,172	26,983	82,155
Totals		112,660	30,172	142,832	4,627	4,472	9,101	1,004	712	1,714	118,291	35,356	153,647

Table 231
Estimates of Local and Through Average Vehicle Occupancy
By Vehicle Type
Tyler External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
257	FM 14	1.45	1.70	1.50	1.11	1.00	1.08	1.29	2.00	1.69	1.44	1.68	1.49
258	FM 2015	1.36	1.52	1.38	1.56	1.50	1.53	1.00	15.50	10.67	1.37	2.10	1.46
259	SH 155 (N)	1.44	1.44	1.44	1.25	1.00	1.20	29.00	0.00	29.00	1.86	1.42	1.78
229	US 271	1.35	1.69	1.37	1.38	1.00	1.30	3.00	1.50	2.50	1.36	1.61	1.38
230	CR 384	1.41	1.44	1.41	1.25	0.00	1.25	4.00	0.00	4.00	1.48	1.44	1.47
231	FM 2767	1.38	1.71	1.45	1.42	1.50	1.43	32.30	5.50	27.83	2.46	1.56	2.40
232	SH 31 (E)	1.38	1.48	1.39	1.20	1.11	1.17	18.33	15.29	16.69	1.44	1.80	1.49
233	FM 850	1.39	1.48	1.41	1.17	1.20	1.17	18.00	0.00	18.00	1.52	1.45	1.51
234	SH 64 (E)	1.43	1.44	1.43	1.12	1.33	1.15	20.67	0.00	20.67	1.58	1.44	1.57
235	CR 285	1.30	1.40	1.32	1.72	1.29	1.60	1.00	1.25	1.13	1.35	1.37	1.35
236	FM 848	1.24	1.41	1.32	1.47	1.14	1.37	1.00	20.00	10.50	1.27	1.59	1.41
237	SH 110 (S)	1.42	1.58	1.43	1.06	1.00	1.05	2.78	52.00	7.70	1.42	2.08	1.46
238	FM 346	1.57	1.62	1.59	1.18	1.11	1.15	27.82	12.00	22.24	1.92	1.72	1.85
239	FM 756	1.36	1.46	1.38	1.18	1.17	1.18	0.00	31.00	31.00	1.35	2.95	1.71
240	US 69 (S)	1.43	1.89	1.46	1.21	1.20	1.21	1.43	1.50	1.44	1.42	1.82	1.45
241	FM 2493	1.43	1.50	1.44	1.20	1.08	1.19	21.80	0.00	21.80	1.48	1.42	1.48

Table 231 (Continued)
Estimates of Local and Through Average Vehicle Occupancy
By Vehicle Type
Tyler External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
242	CR 178	1.60	1.79	1.63	1.20	1.00	1.17	7.00	21.00	12.60	1.74	4.00	2.07
243	SH 155 (S)	1.44	1.55	1.45	1.13	1.40	1.19	7.71	0.00	7.71	1.49	1.53	1.49
244	CR 1113	1.48	1.33	1.44	1.25	0.00	1.25	2.50	0.00	2.50	1.50	1.33	1.46
245	FM 2661	1.51	1.54	1.53	1.19	1.35	1.27	1.00	1.00	1.00	1.48	1.52	1.50
246	CR 1134	1.37	1.14	1.33	1.00	2.00	1.33	0.00	0.00	0.00	1.35	1.25	1.33
247	SH 31 (W)	1.38	1.53	1.39	1.00	1.00	1.00	3.00	1.00	2.56	1.38	1.50	1.39
248	FM 279	1.39	1.43	1.39	1.19	1.00	1.17	0.00	0.00	0.00	1.38	1.39	1.38
249	SH 64 (W)	1.45	1.56	1.47	1.35	1.24	1.33	18.00	24.00	20.00	1.50	1.75	1.54
250	FM 724	1.47	1.67	1.48	1.25	1.00	1.21	9.50	2.33	6.43	1.68	1.71	1.69
251	SH 110 (N)	1.45	1.52	1.47	1.32	1.33	1.33	0.00	12.33	12.33	1.45	1.66	1.51
253	FM 849	1.58	1.53	1.54	1.08	1.36	1.29	25.33	10.17	15.22	1.81	1.61	1.68
254	US 69 (N)	1.47	1.35	1.45	1.28	1.17	1.26	1.50	1.00	1.44	1.46	1.34	1.45
255	CR 431	1.38	1.71	1.45	1.30	1.60	1.39	0.00	7.50	7.50	1.38	1.82	1.47
256	CR 35	1.46	1.33	1.44	1.57	1.00	1.50	0.00	0.00	0.00	1.47	1.30	1.45
260	IH 20 (E)	1.44	1.74	1.69	1.00	1.19	1.17	2.00	6.40	4.75	1.43	1.74	1.69
252	IH 20 (W)	1.51	1.68	1.58	1.47	1.15	1.22	63.50	7.00	18.30	1.78	1.72	1.76
	Total	1.43	1.63	1.48	1.25	1.18	1.21	11.88	7.72	10.15	1.51	1.70	1.56

Table 232
Estimates of Local and Through Mean Trip Length in Miles
By Vehicle Type
Tyler External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
257	FM 14	8.40	11.97	9.04	8.22	12.29	9.24	9.73	11.78	10.88	8.41	11.97	9.07
258	FM 2015	9.14	8.35	9.06	8.84	12.54	10.32	8.39	9.82	9.35	9.13	8.93	9.11
259	SH 155 (N)	10.17	12.47	10.57	7.87	14.81	9.26	11.27	0.00	11.27	10.07	12.61	10.51
229	US 271	10.97	18.20	11.45	10.35	19.66	12.21	9.27	21.31	13.29	10.94	18.52	11.51
230	CR 384	10.17	15.35	10.85	6.63	0.00	6.63	6.06	0.00	6.06	9.82	15.35	10.49
231	FM 2767	8.42	10.31	8.54	8.73	9.27	8.78	8.62	13.48	9.43	8.44	10.47	8.58
232	SH 31 (E)	8.79	16.36	9.78	8.70	17.80	11.58	10.11	16.72	13.67	8.79	16.63	9.96
233	FM 850	8.72	11.58	9.24	7.58	12.76	8.70	9.11	0.00	9.11	8.63	11.70	9.20
234	SH 64 (E)	7.53	17.50	8.24	8.41	15.04	9.43	9.37	0.00	9.37	7.57	17.32	8.29
235	CR 285	8.55	8.45	8.52	8.51	12.56	9.64	9.32	12.16	10.74	8.56	9.51	8.79
236	FM 848	8.78	9.73	9.19	8.51	11.04	9.25	9.71	9.39	9.55	8.75	9.82	9.20
237	SH 110 (S)	7.44	14.76	7.84	9.12	10.33	9.35	7.74	2.40	7.21	7.46	14.44	7.85
238	FM 346	7.16	10.64	8.33	7.11	11.28	8.90	4.35	10.09	6.38	7.11	10.70	8.35
239	FM 756	8.28	9.97	8.63	8.75	11.15	9.60	0.00	8.53	8.53	8.30	9.99	8.68
240	US 69 (S)	9.44	16.77	9.84	12.33	20.83	13.79	8.91	16.66	10.63	8.69	16.09	9.23
241	FM 2493	6.33	13.35	6.64	6.32	12.35	6.70	7.33	0.00	7.33	6.33	13.17	6.65

Table 232 (Continued)
Estimates of Local and Through Mean Trip Length in Miles
By Vehicle Type
Tyler External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
242	CR 178	7.72	3.98	7.23	7.04	12.20	7.90	3.81	2.90	3.44	7.57	4.33	7.11
243	SH 155 (S)	9.44	16.77	9.84	11.55	20.14	13.60	7.67	0.00	7.67	9.47	17.13	9.92
244	CR 1113	9.02	11.78	9.71	9.89	0.00	9.89	9.39	0.00	9.39	9.09	11.78	9.71
245	FM 2661	8.46	10.71	9.54	7.77	10.63	9.25	8.79	2.47	5.63	8.40	10.65	9.49
246	CR 1134	3.73	5.16	3.95	8.76	16.22	11.25	0.00	0.00	0.00	3.98	6.54	4.40
247	SH 31 (W)	8.82	14.41	9.33	8.83	19.17	10.46	9.54	15.21	10.80	8.83	14.55	9.36
248	FM 279	9.09	15.51	9.46	8.95	10.25	9.09	0.00	0.00	0.00	9.08	15.05	9.44
249	SH 64 (W)	10.40	14.44	10.98	10.64	14.96	11.56	10.15	10.33	10.21	10.42	14.47	11.03
250	FM 724	8.18	12.50	8.57	8.60	14.30	9.41	8.35	9.68	8.92	8.22	12.21	8.67
251	SH 110 (N)	13.20	6.72	11.43	13.11	7.99	11.04	0.00	1.46	1.46	13.19	6.77	11.36
253	FM 849	3.34	1.29	1.99	2.21	2.24	2.24	1.23	1.85	1.64	3.27	1.36	2.01
254	US 69 (N)	10.60	13.14	10.87	9.91	13.70	10.51	11.11	21.59	12.27	10.58	13.22	10.87
255	CR 431	7.85	7.42	7.76	8.55	5.70	7.68	0.00	1.16	1.16	7.89	7.11	7.73
256	CR 35	9.29	6.34	8.86	7.53	18.54	8.91	0.00	0.00	0.00	9.08	7.56	8.86
260	IH 20 (E)	11.18	15.83	14.97	7.45	16.88	15.87	10.87	16.18	14.19	10.84	16.00	15.08
252	IH 20 (W)	14.72	14.33	14.57	14.96	16.37	16.06	11.49	16.00	15.10	14.71	14.70	14.71
Total		9.46	13.71	10.36	9.32	15.68	12.44	9.26	14.44	11.41	9.45	13.97	10.49

Table 233
Estimates of Local and Through Mean Trip Length in Minutes
By Vehicle Type
Tyler External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
257	FM 14	11.17	13.90	11.66	10.78	14.44	11.69	12.71	13.67	13.25	11.17	13.92	11.68
258	FM 2015	12.30	9.45	11.99	11.33	14.83	12.73	11.00	12.00	11.67	12.27	10.23	12.02
259	SH 155 (N)	12.81	14.70	13.14	9.88	17.00	11.30	14.60	0.00	14.60	12.69	14.84	13.06
229	US 271	13.91	21.97	14.45	12.75	24.00	15.00	12.00	26.00	16.67	13.86	22.39	14.50
230	CR 384	13.25	18.67	13.97	9.75	0.00	9.75	9.00	0.00	9.00	12.91	18.67	13.61
231	FM 2767	11.19	12.48	11.27	11.58	12.00	11.62	10.80	16.00	11.67	11.20	12.70	11.30
232	SH 31 (E)	11.67	20.62	12.84	11.59	22.29	14.98	13.00	20.00	16.77	11.67	20.90	13.05
233	FM 850	11.86	14.59	12.36	10.06	14.20	10.96	11.50	0.00	11.50	11.72	14.55	12.24
234	SH 64 (E)	9.79	20.90	10.58	10.97	18.17	12.08	13.22	0.00	13.22	9.85	20.71	10.65
235	CR 285	11.56	10.43	11.32	11.56	15.43	12.64	13.00	15.25	14.13	11.61	11.76	11.64
236	FM 848	11.34	13.02	12.07	11.06	14.71	12.13	12.00	14.00	13.00	11.31	13.16	12.09
237	SH 110 (S)	9.76	18.13	10.22	11.88	13.25	12.14	10.56	3.00	9.80	9.79	17.77	10.24
238	FM 346	9.79	13.23	10.94	9.67	14.07	11.55	5.82	12.83	8.29	9.72	13.32	10.96
239	FM 756	11.07	12.71	11.41	11.82	13.83	12.53	0.00	11.00	11.00	11.10	12.71	11.46
240	US 69 (S)	10.91	18.72	11.44	15.58	22.20	16.72	11.57	20.50	13.56	11.05	19.03	11.62
241	FM 2493	8.14	15.87	8.49	8.07	15.92	8.56	9.60	0.00	9.60	8.14	15.88	8.50

Table 233 (Continued)
Estimates of Local and Through Mean Trip Length in Minutes
By Vehicle Type
Tyler External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
242	CR 178	10.05	5.21	9.42	10.00	16.00	11.00	4.67	3.00	4.00	9.89	5.59	9.27
243	SH 155 (S)	11.89	20.00	12.33	14.88	24.40	17.14	9.86	0.00	9.86	11.93	20.47	12.44
244	CR 1113	12.39	16.89	13.51	13.50	0.00	13.50	13.00	0.00	13.00	12.48	16.89	13.50
245	FM 2661	10.68	13.59	12.07	9.69	13.59	11.70	10.00	3.00	6.50	10.59	13.53	12.01
246	CR 1134	4.74	6.71	5.04	11.00	19.00	13.67	0.00	0.00	0.00	5.05	8.25	5.58
247	SH 31 (W)	11.20	17.90	11.81	11.44	23.33	13.32	12.43	19.50	14.00	11.22	18.07	11.85
248	FM 279	11.64	19.38	12.08	11.31	12.00	11.39	0.00	0.00	0.00	11.63	18.74	12.05
249	SH 64 (W)	13.12	18.00	13.82	13.31	19.12	14.54	12.75	13.00	12.83	13.14	18.09	13.88
250	FM 724	10.59	15.42	11.03	11.17	17.00	12.00	10.50	11.67	11.00	10.64	14.94	11.12
251	SH 110 (N)	17.50	8.93	15.16	17.35	10.86	14.73	0.00	2.00	2.00	17.49	9.03	15.07
253	FM 849	4.58	2.55	3.25	3.15	3.97	3.76	2.00	2.83	2.56	4.48	2.65	3.27
254	US 69 (N)	13.69	16.37	13.98	12.63	16.00	13.16	13.75	26.00	15.11	13.66	16.42	13.96
255	CR 431	10.17	8.65	9.87	10.83	6.40	9.48	0.00	1.00	1.00	10.22	8.27	9.80
256	CR 35	12.56	8.44	11.95	9.71	23.00	11.38	0.00	0.00	0.00	12.22	9.90	11.88
260	IH 20 (E)	13.44	17.66	16.88	9.00	18.88	17.83	13.00	18.00	16.13	13.03	17.86	17.00
252	IH 20 (W)	18.35	16.72	17.73	18.53	18.31	18.36	14.00	17.75	17.00	18.34	17.01	17.77
Total		12.13	16.11	12.97	11.93	17.96	14.89	11.88	16.64	13.86	12.12	16.36	13.09

Table 234
Estimates of Local and Through Vehicle Miles Traveled
By Vehicle Type
Tyler External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
257	FM 14	22,692	6,999	29,691	742	370	1,111	227	354	583	23,661	7,723	31,385
258	FM 2015	12,438	1,368	13,806	326	308	635	34	81	114	12,798	1,757	14,555
259	SH 155 (N)	39,154	10,048	49,203	1,612	758	2,369	721	0	721	41,487	10,806	52,293
229	US 271	73,385	8,672	82,030	2,465	1,171	3,636	525	635	1,187	76,375	10,478	86,853
230	CR 384	2,448	564	3,012	108	0	108	49	0	49	2,605	564	3,169
231	FM 2767	11,207	954	12,161	667	75	741	346	108	455	12,220	1,137	13,357
232	SH 31 (E)	39,570	11,045	50,616	2,892	2,745	5,637	208	402	609	42,670	14,192	56,862
233	FM 850	5,110	1,515	6,625	388	181	569	52	1	53	5,550	1,697	7,247
234	SH 64 (E)	53,007	9,421	62,429	1,892	615	2,507	576	0	575	55,475	10,036	65,511
235	CR 285	6,914	1,898	8,812	1,147	658	1,806	279	365	644	8,340	2,921	11,262
236	FM 848	5,150	4,368	9,518	764	408	1,173	52	50	101	5,966	4,826	10,792
237	SH 110 (S)	109,101	12,456	121,558	1,454	388	1,841	653	23	676	111,208	12,867	124,075
238	FM 346	18,849	14,192	33,041	1,617	1,923	3,540	181	229	411	20,647	16,344	36,992
239	FM 756	7,779	2,459	10,238	349	246	592	0	120	123	8,128	2,825	10,953
240	US 69 (S)	68,974	7,108	76,082	3,010	1,060	4,070	5,116	2,963	8,079	77,100	11,131	88,231
241	FM 2493	21,559	2,122	23,680	3,330	436	3,766	107	0	108	24,996	2,558	27,554
Subtotal		497,337	95,189	592,502	22,763	11,342	34,101	9,126	5,331	14,488	529,226	111,862	641,091

Table 234 (Continued)
Estimates of Local and Through Vehicle Miles Traveled
By Vehicle Type
Tyler External Station Survey

Station #	Description	Passenger Vehicles			Commercial Vehicles			All Other Vehicles			All Vehicles		
		Local	Through	Total	Local	Through	Total	Local	Through	Total	Local	Through	Total
242	CR 178	2,423	188	2,611	119	41	160	38	20	58	2,580	249	2,829
243	SH 155 (S)	68,974	7,108	76,082	1,866	1,016	2,882	541	0	542	71,381	8,124	79,506
244	CR 1113	1,560	680	2,240	127	0	127	60	0	60	1,747	680	2,427
245	FM 2661	4,344	5,062	9,407	389	566	955	28	8	35	4,761	5,636	10,397
246	CR 1134	652	166	818	81	75	155	-1	0	0	732	241	973
247	SH 31 (W)	104,499	17,099	121,598	1,581	644	2,225	747	341	1,088	106,827	18,084	124,911
248	FM 279	11,150	1,162	12,312	511	73	584	0	0	0	11,661	1,235	12,896
249	SH 64 (W)	32,139	7,467	39,606	2,958	1,118	4,076	122	61	183	35,219	8,646	43,865
250	FM 724	3,035	464	3,498	319	88	407	103	90	194	3,457	642	4,099
251	SH 110 (N)	18,766	3,586	22,353	1,199	495	1,694	0	14	12	19,965	4,095	24,059
253	FM 849	2,207	1,615	3,822	73	206	279	10	28	38	2,290	1,849	4,139
254	US 69 (N)	123,574	18,331	141,905	3,252	843	4,095	911	222	1,133	127,737	19,396	147,133
255	CR 431	7,954	1,879	9,833	579	168	747	0	7	7	8,533	2,054	10,587
256	CR 35	1,597	188	1,785	174	61	235	0	0	0	1,771	250	2,020
260	IH 20 (E)	25,124	155,809	180,933	1,673	31,853	33,526	1,465	3,636	5,101	28,262	191,298	219,560
252	IH 20 (W)	155,707	94,990	250,698	5,469	21,542	27,011	561	3,120	3,680	161,737	119,652	281,389
Subtotals		563,705	315,794	879,501	20,370	58,789	79,158	4,585	7,547	12,131	588,660	382,131	970,790
Totals		1,061,042	410,983	1,472,025	43,133	70,131	113,264	13,711	12,878	26,589	1,117,886	493,992	1,611,878

**Table 235
Distribution of Surveyed Vehicles**

Urban Area	Passenger Vehicles	Commercial/Other Vehicles
Amarillo	87.2 %	12.8 %
Brownsville - Surveyed	94.3 %	5.7 %
Brownsville - Counted	91.6 %	8.4 %
San Antonio	93.0 %	7.0 %
Sherman-Denison	77.6 %	22.4 %
Tyler	93.0 %	7.0 %

**Table 236
Distribution of Surveyed External Trips
By Local and Through Movements**

Urban Area	Passenger Vehicles		Commercial/Other Vehicles	
	Local	Through	Local	Through
Amarillo	83.4 %	16.6 %	66.3 %	33.7 %
Brownsville	95.2 %	4.8 %	95.0%	5.0 %
San Antonio	89.1 %	10.9 %	61.9 %	38.1 %
Sherman-Denison	87.6 %	12.4 %	35.3 %	64.7 %
Tyler	78.9 %	21.1 %	52.1 %	47.9 %

Table 237
Vehicle Travel Comparisons
Household Survey and External Station Survey

Urban Area	Total Vehicle Trips		Vehicle Miles Traveled	
	Internal Auto Driver	External	Internal Auto Driver	External
Amarillo	518,179	87,789	1,974,832	1,236,659
Brownsville	196,176	69,138	601,162	364,576
San Antonio	2,549,900	202,092	16,489,693	4,631,487
Sherman-Denison	245,486	81,611	1,046,900	960,552
Tyler	389,109	153,647	1,350,208	1,611,878

Figure 39
Percentage of Vehicles by Vehicle Type
On Freeways at External Stations

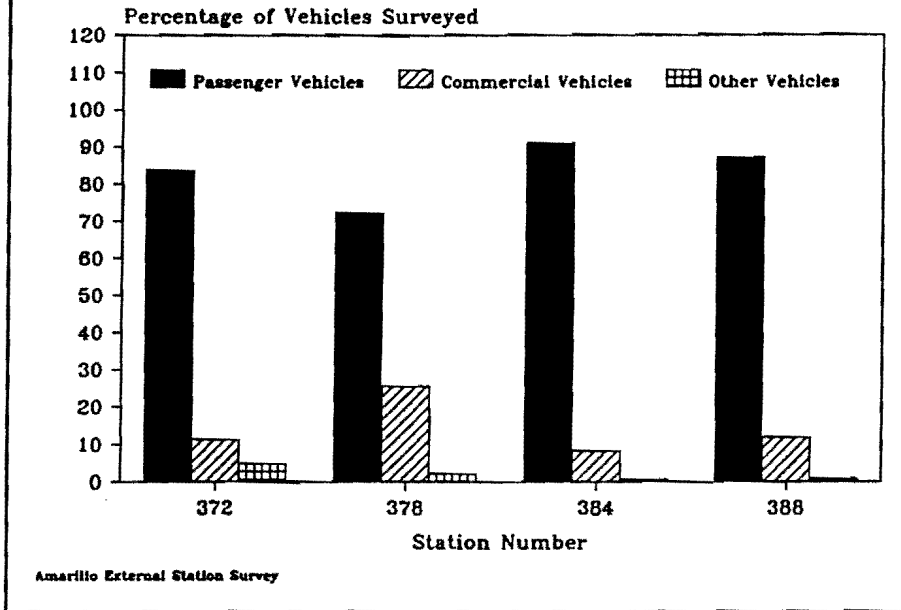


Figure 40
Percentage of Vehicles by Vehicle Type
On Arterials at External Stations

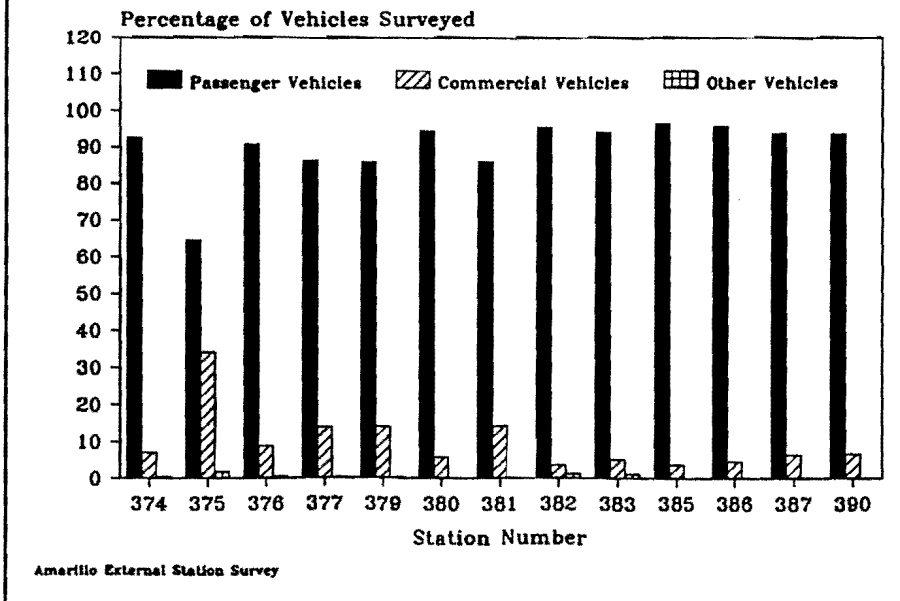


Figure 41
Percentage of Vehicles by Vehicle Type
On Other Facilities at External Stations

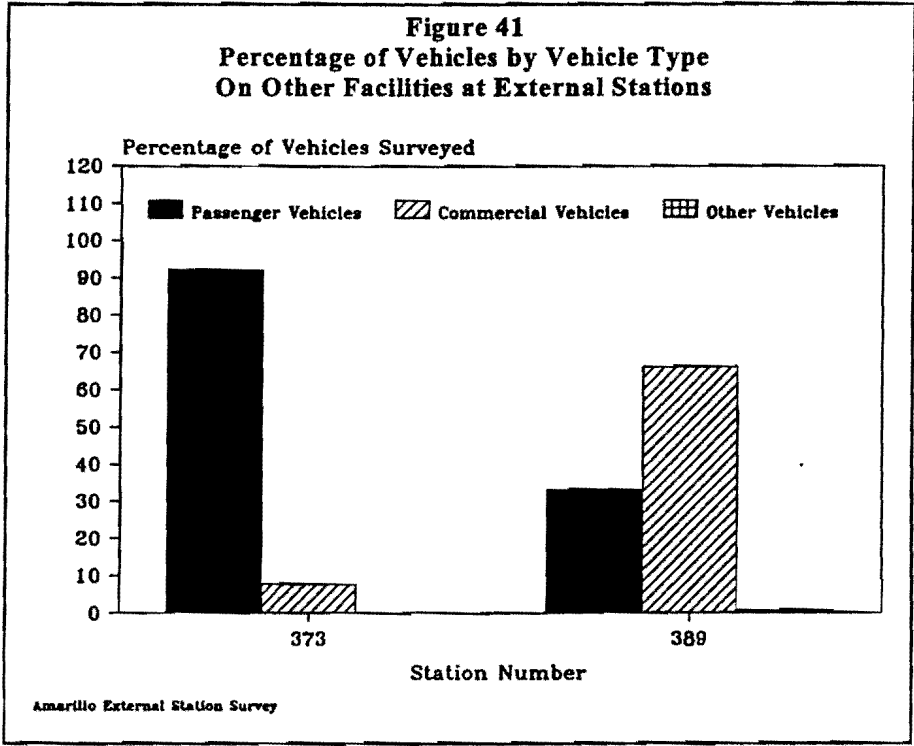


Figure 42
Trip Length Frequency Distribution
Passenger Vehicle Ext-Loc Trips

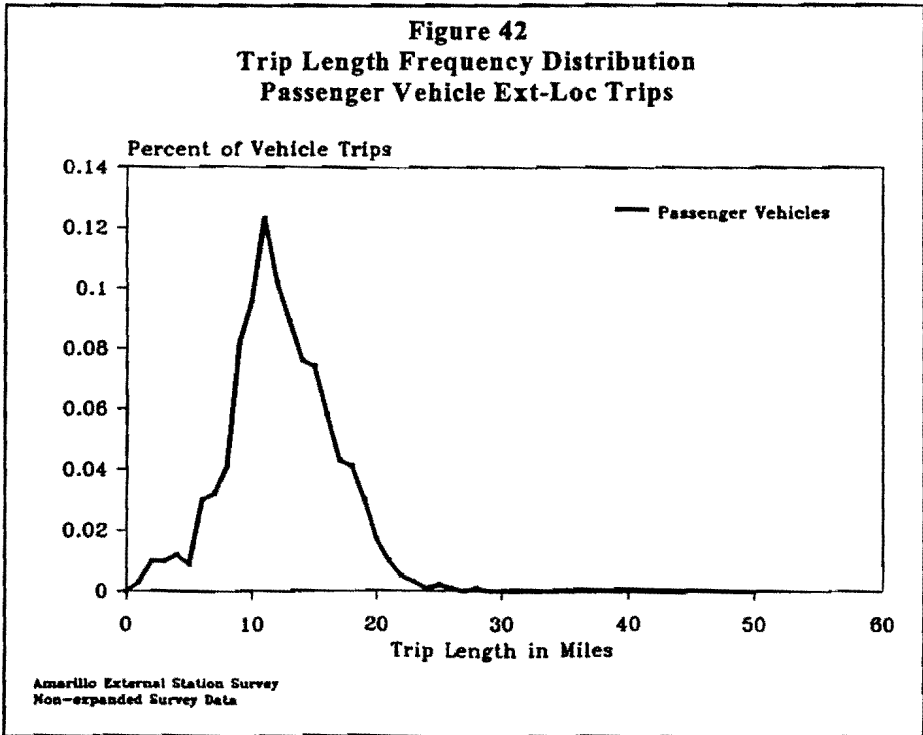
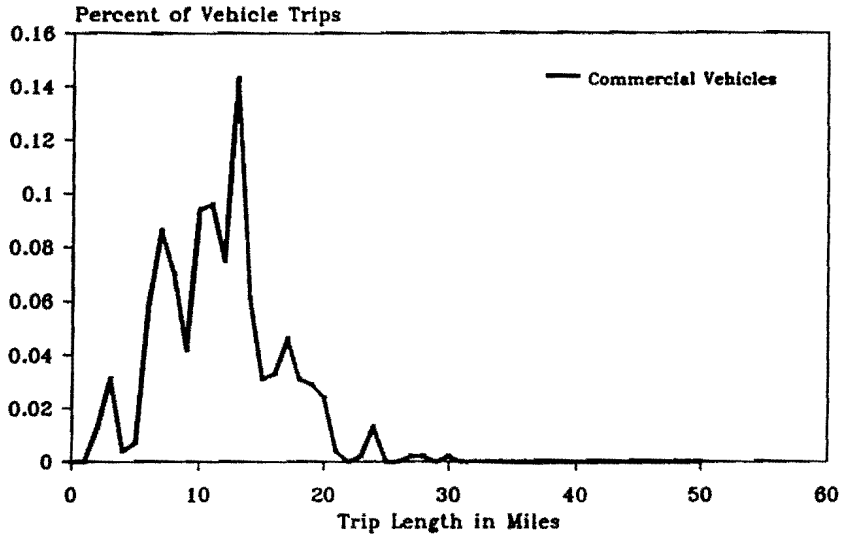
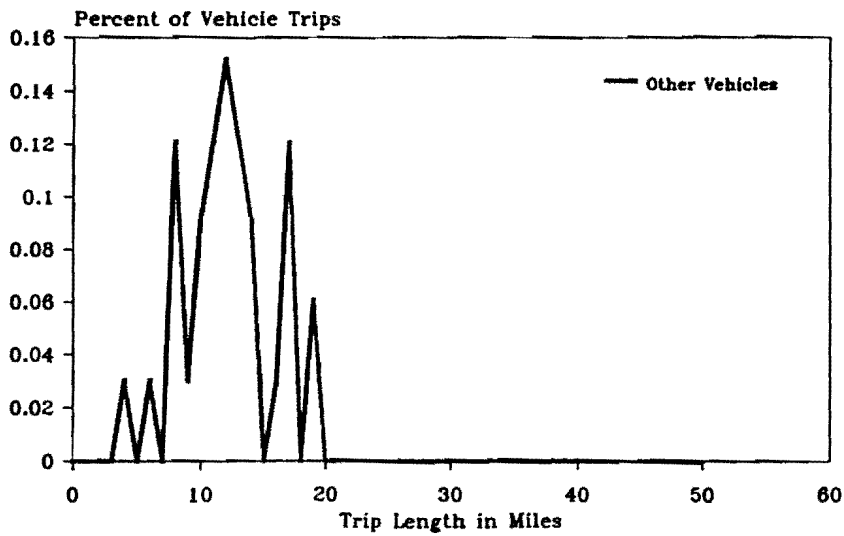


Figure 43
Trip Length Frequency Distribution
Commercial Vehicle Ext-Loc Trips



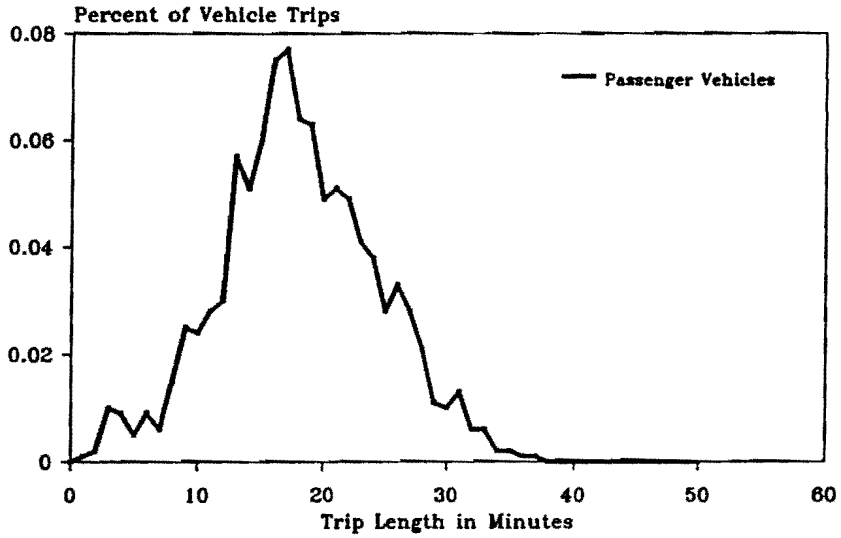
Amarillo External Station Survey
Non-expanded Survey Data

Figure 44
Trip Length Frequency Distribution
Other Vehicle Ext-Loc Trips



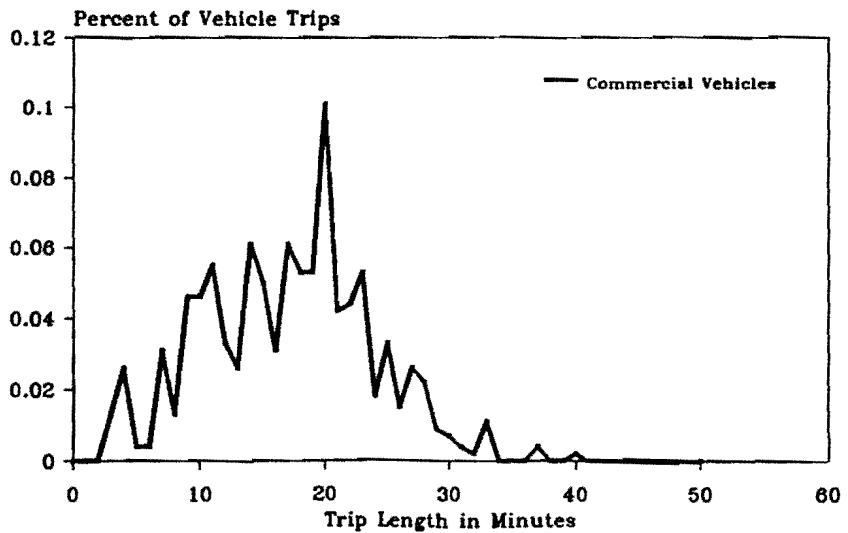
Amarillo External Station Survey
Non-expanded Survey Data

Figure 45
Trip Length Frequency Distribution
Passenger Vehicle Ext-Loc Trips



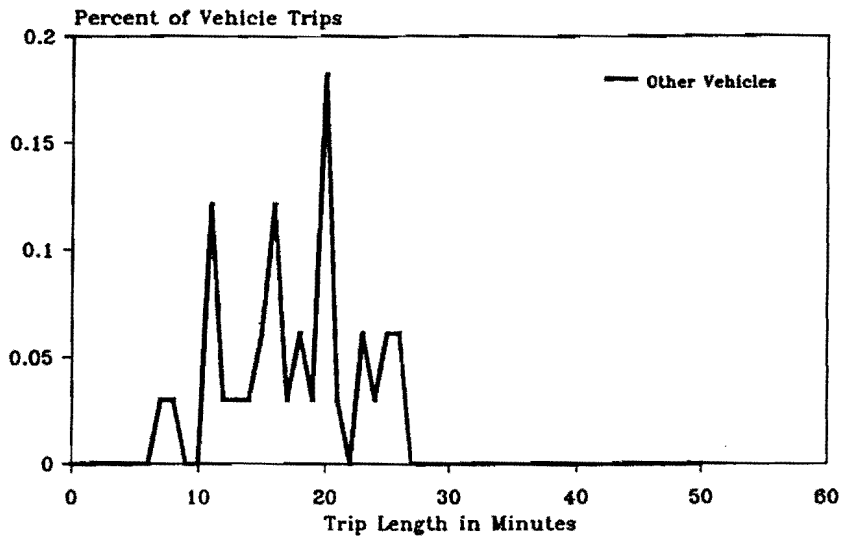
Amarillo External Station Survey
 Non-expanded Survey Data

Figure 46
Trip Length Frequency Distribution
Commercial Vehicle Ext-Loc Trips



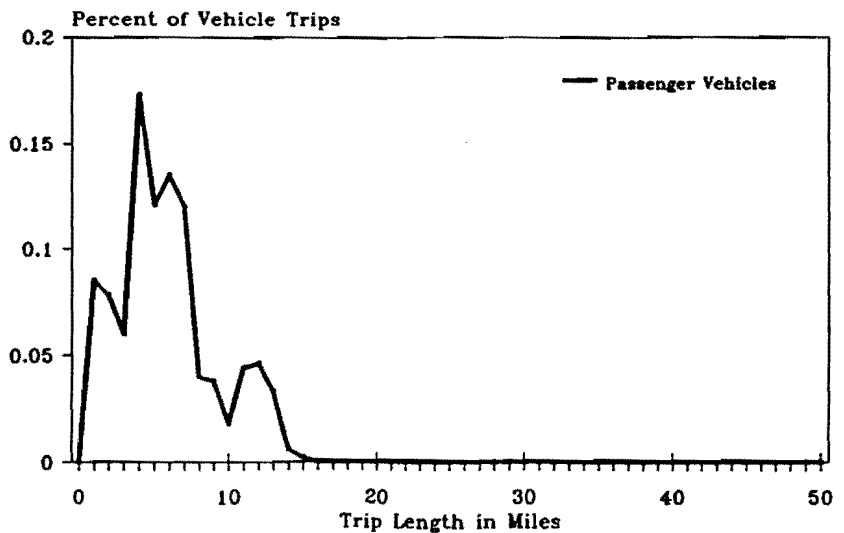
Amarillo External Station Survey
 Non-expanded Survey Data

Figure 47
Trip Length Frequency Distribution
Other Vehicle Ext-Loc Trips



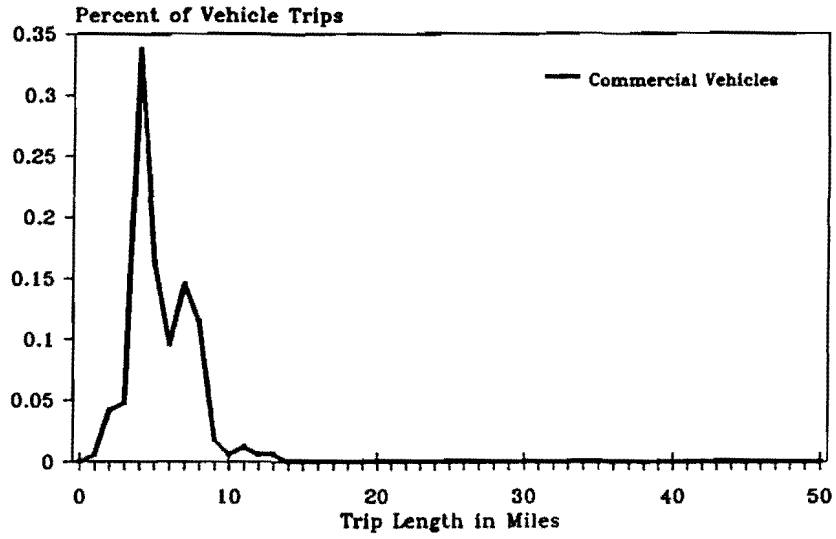
Amarillo External Station Survey
 Non-expanded Survey Data

Figure 48
Trip Length Frequency Distribution
Passenger Vehicle Ext-Loc Trips



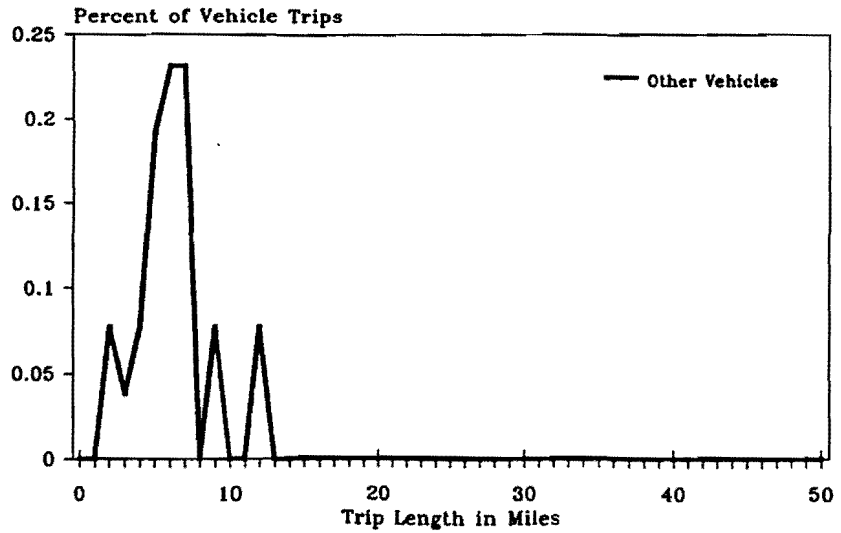
Brownsville External Station Survey
 Non-expanded Survey Data

Figure 49
Trip Length Frequency Distribution
Commercial Vehicle Ext-Loc Trips



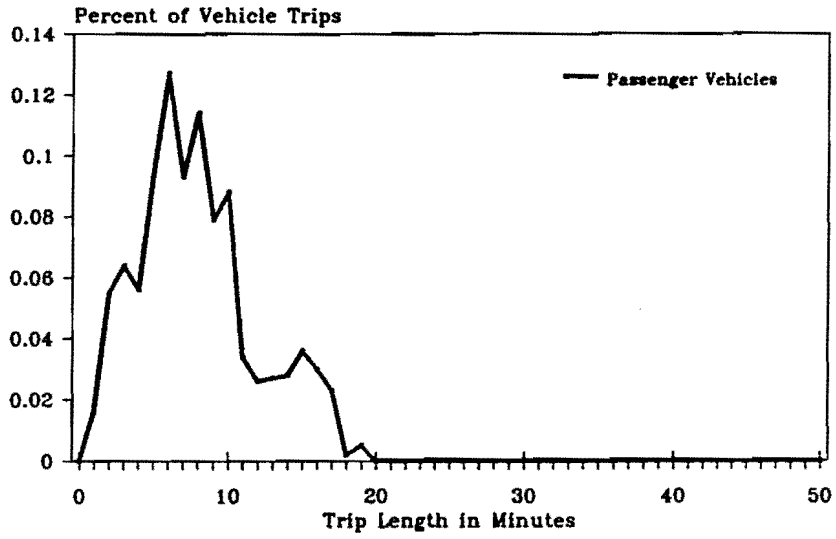
Brownsville External Station Survey
 Non-expanded Survey Data

Figure 50
Trip Length Frequency Distribution
Other Vehicle Ext-Loc Trips



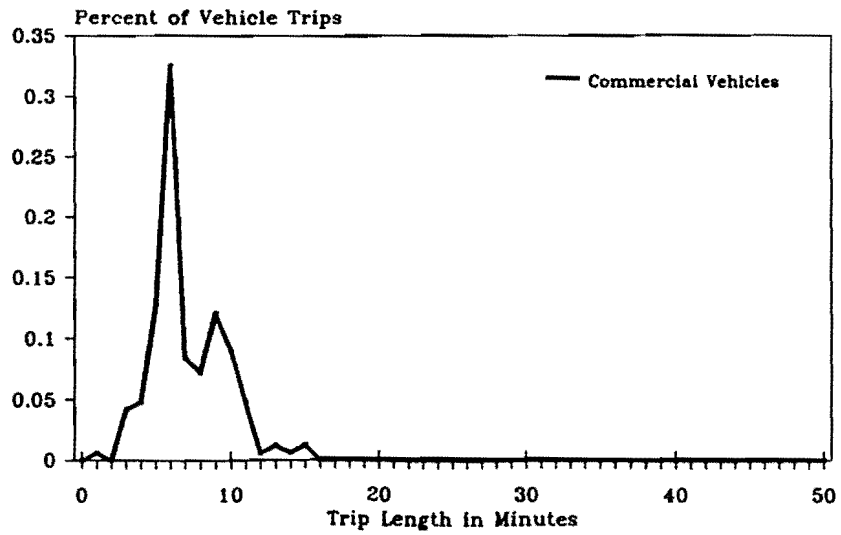
Brownsville External Station Survey
 Non-expanded Survey Data

Figure 51
Trip Length Frequency Distribution
Passenger Vehicle Ext-Loc Trips



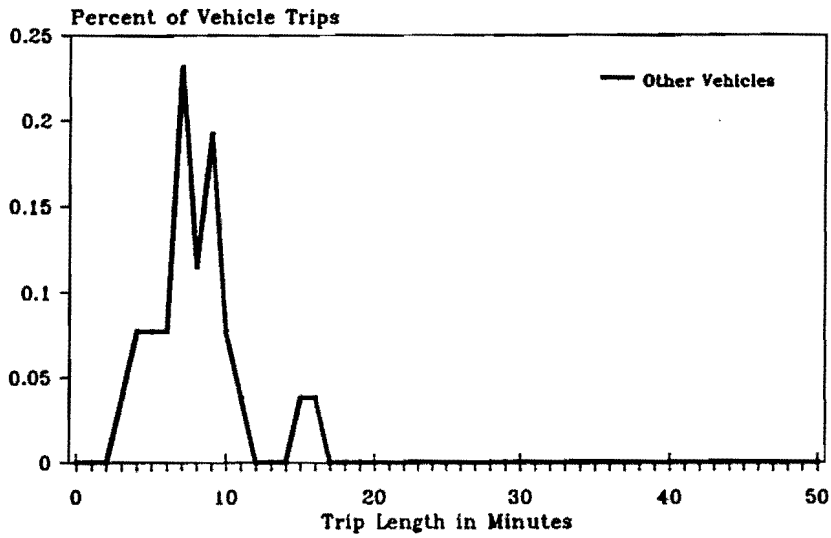
Brownsville External Station Survey
 Non-expanded Survey Data

Figure 52
Trip Length Frequency Distribution
Commercial Vehicle Ext-Loc Trips



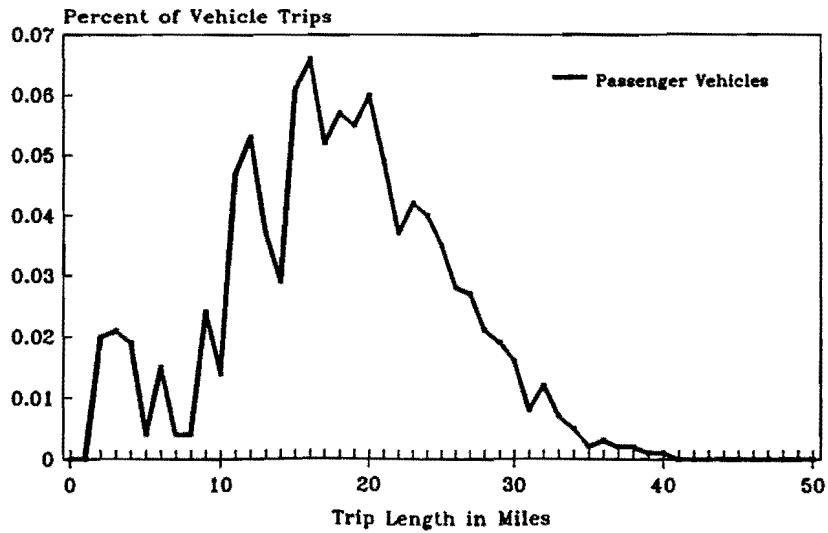
Brownsville External Station Survey
 Non-expanded Survey Data

Figure 53
Trip Length Frequency Distribution
Other Vehicle Ext-Loc Trip



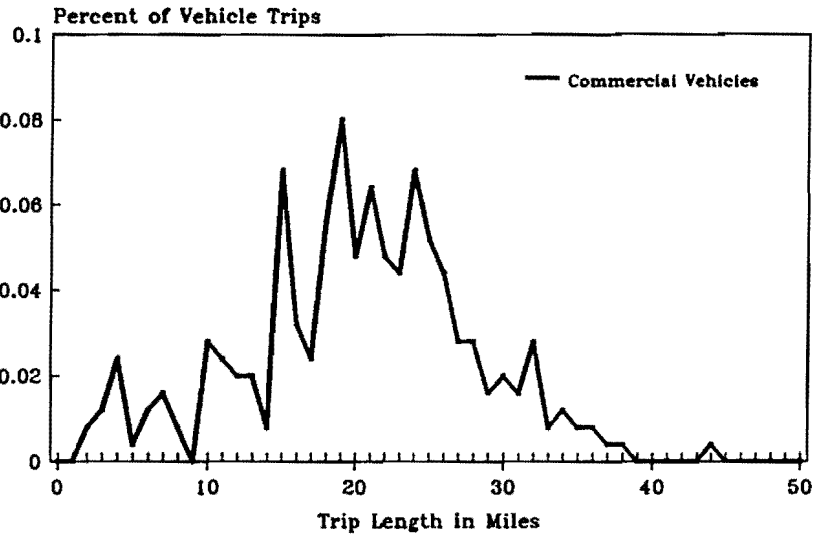
Brownsville External Station Survey
 Non-expanded Survey Data

Figure 54
Trip Length Frequency Distribution
Passenger Vehicle Ext-Loc Trips



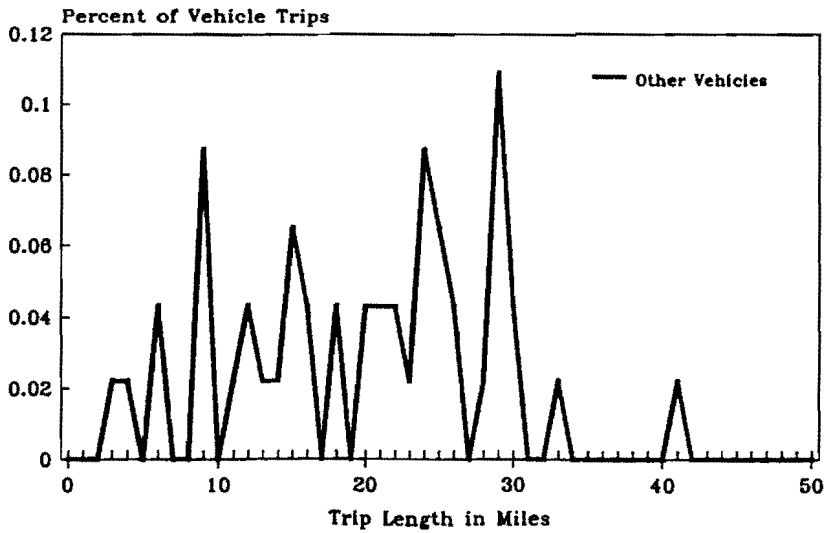
San Antonio External Station Survey
 Non-expanded Survey Data

Figure 55
Trip Length Frequency Distribution
Commercial Vehicle Ext-Loc Trips



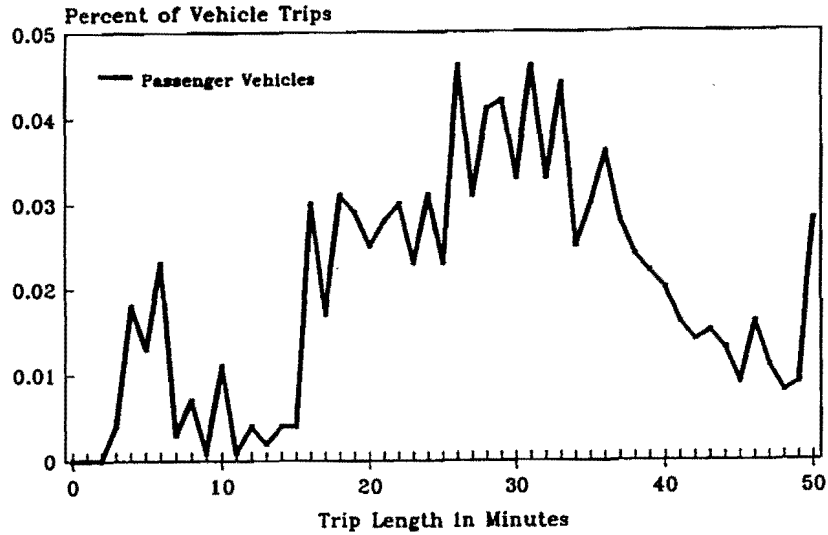
San Antonio External Station Survey
 Non-expanded Survey Data

Figure 56
Trip Length Frequency Distribution
Other Vehicle Ext-Loc Trips



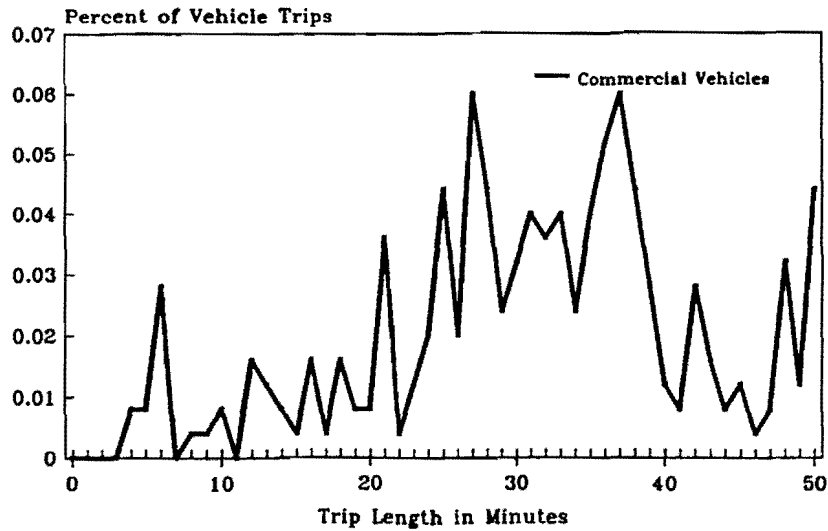
San Antonio External Station Survey
 Non-expanded Survey Data

Figure 57
Trip Length Frequency Distribution
Passenger Vehicle Ext-Loc Trips



San Antonio External Station Survey
 Non-expanded Survey Data

Figure 58
Trip Length Frequency Distribution
Commercial Vehicle Ext-Loc Trips



San Antonio External Station Survey
 Non-expanded Survey Data

Figure 59
Trip Length Frequency Distribution
Other Vehicle Ext-Loc Trips

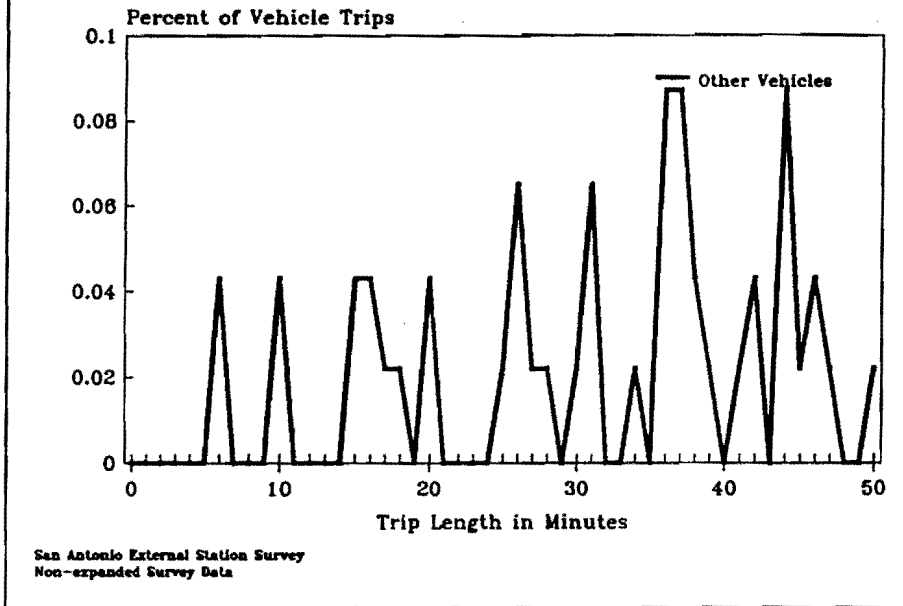


Figure 60
Trip Length Frequency Distribution
Passenger Vehicle Ext-Loc Trips

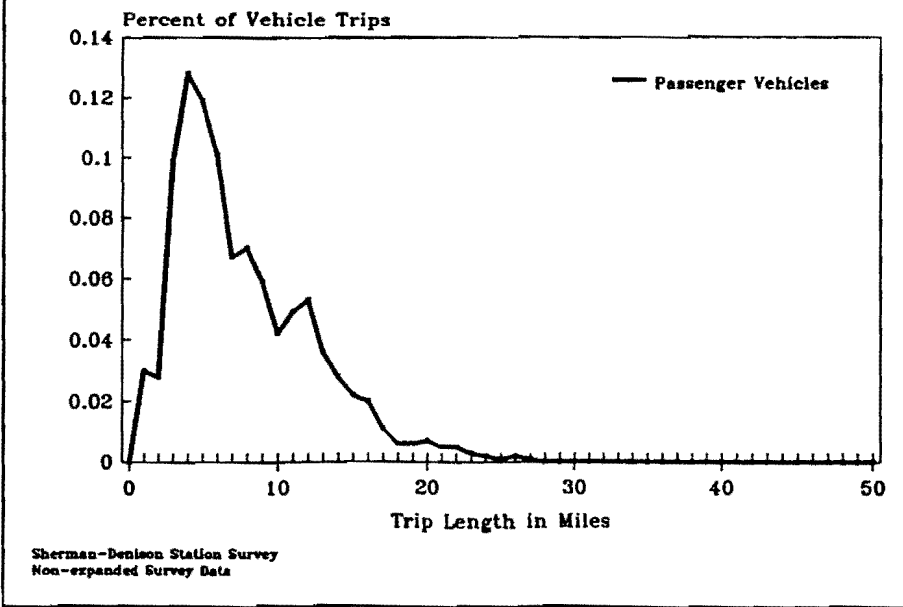
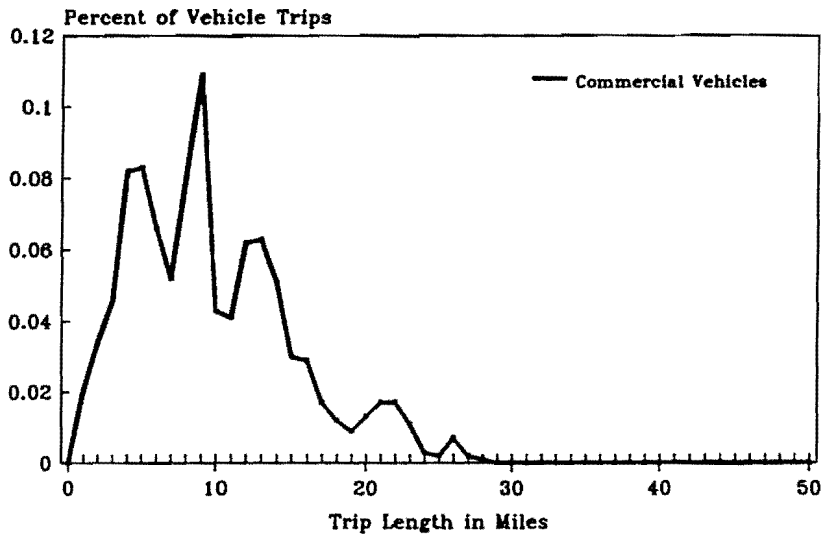
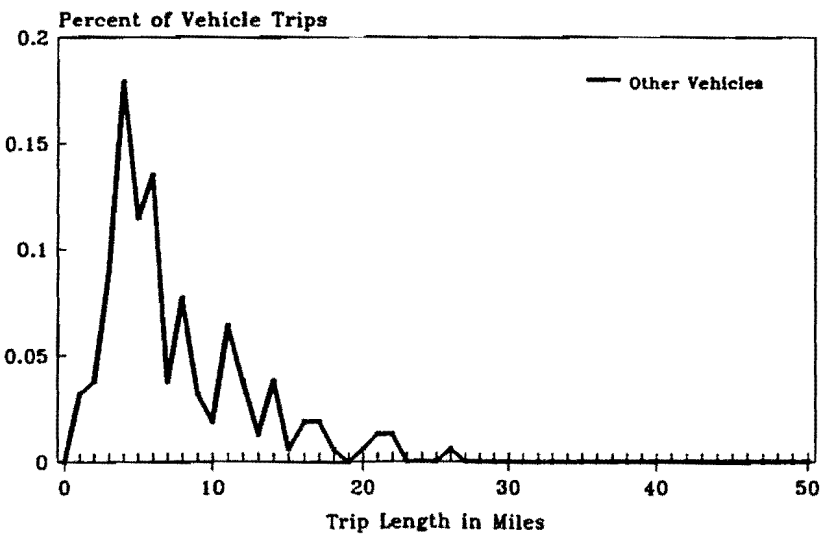


Figure 61
Trip Length Frequency Distribution
Commercial Vehicle Ext-Loc Trips



Sherman-Deinson Station Survey
 Non-expanded Survey Data

Figure 62
Trip Length Frequency Distribution
Other Vehicle Ext-Loc Trips



Sherman-Deinson Station Survey
 Non-expanded Survey Data

Figure 63
Trip Length Frequency Distribution
Passenger Vehicle Ext-Loc Trips

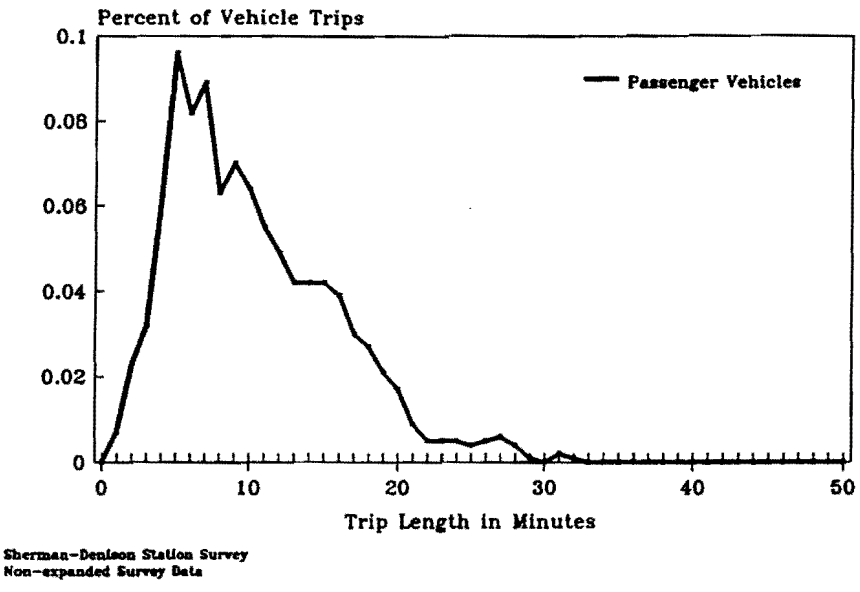


Figure 64
Trip Length Frequency Distribution
Commercial Vehicle Ext-Loc Trips

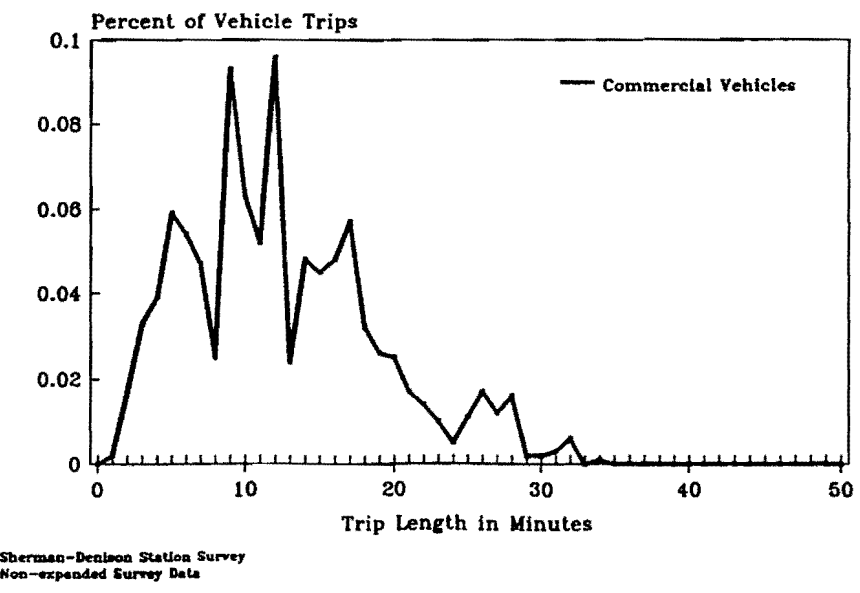


Figure 65
Trip Length Frequency Distribution
Other Vehicle Ext-Loc Trips

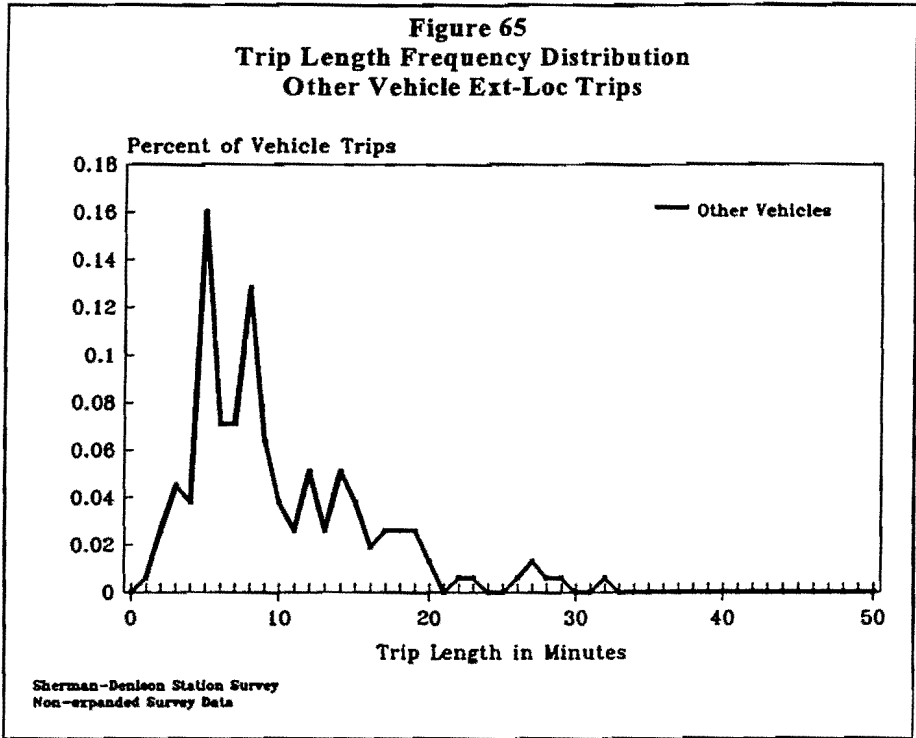


Figure 66
Trip Length Frequency Distribution
Passenger Vehicle Ext-Loc Trips

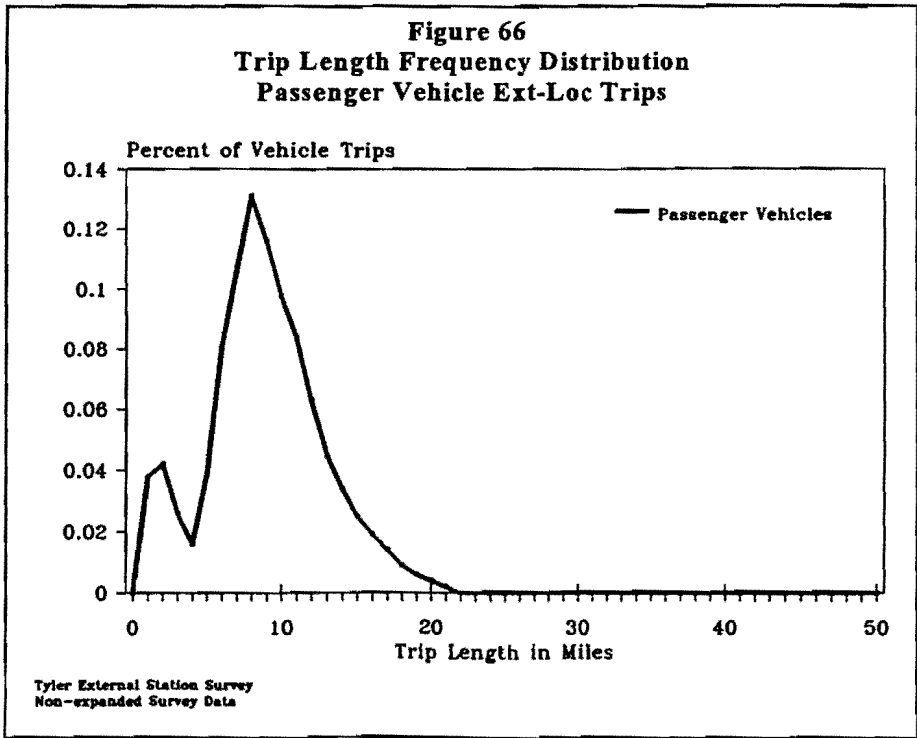
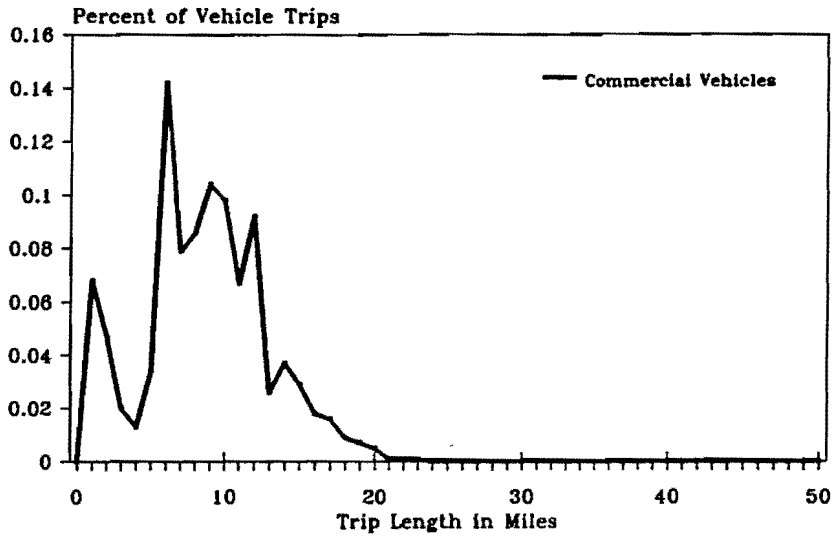
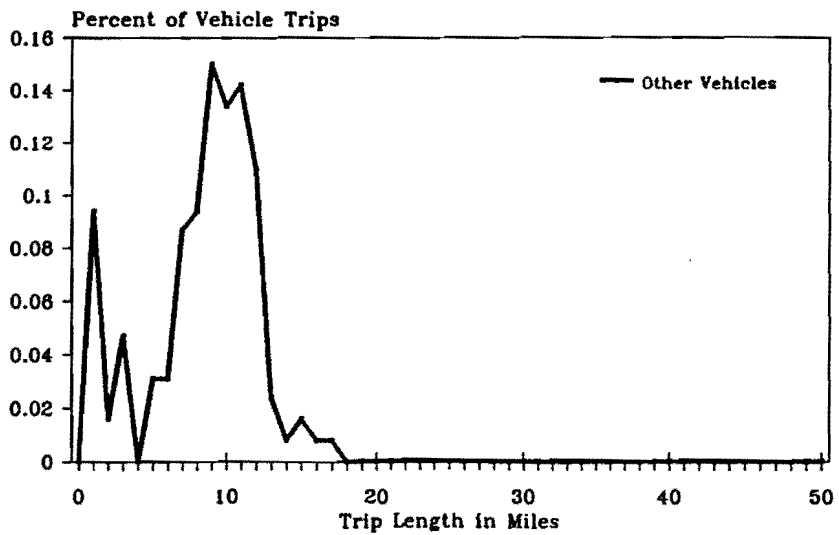


Figure 67
Trip Length Frequency Distribution
Commercial Vehicle Ext-Loc Trips



Tyler External Station Survey
 Non-expanded Survey Data

Figure 68
Trip Length Frequency Distribution
Other Vehicle Ext-Loc Trips



Tyler External Station Survey
 Non-expanded Survey Data

Figure 69
Trip Length Frequency Distribution
Passenger Vehicle Ext-Loc Trips

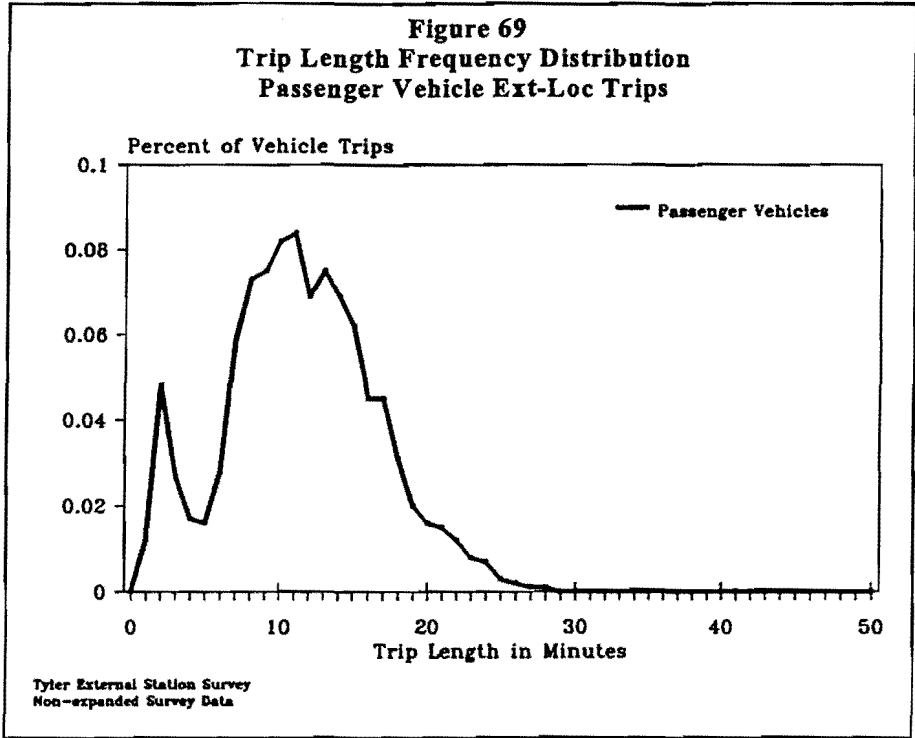


Figure 70
Trip Length Frequency Distribution
Commercial Vehicle Ext-Loc Trips

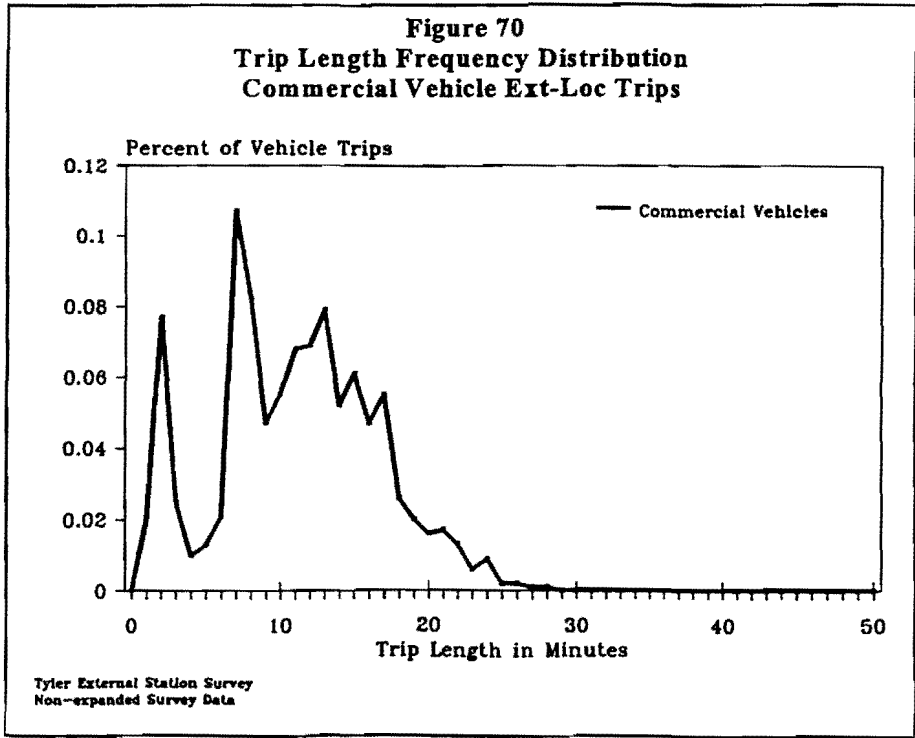
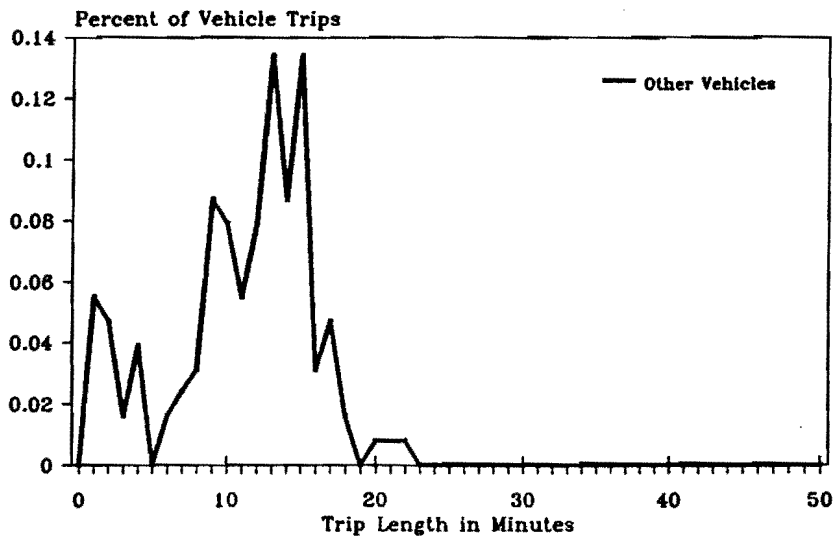


Figure 71
Trip Length Frequency Distribution
Other Vehicle Ext-Loc Trips



Tyler External Station Survey
Non-expanded Survey Data

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APPENDIX A

Household Stratification Analysis

Household Stratification Analysis

Historically, the primary variables used for estimating trip productions in Texas have been household income and vehicle availability. The most recent surveys provided additional variables which could be used for estimating trip productions. These included household size, number of persons in the household that were employed, number of licensed drivers, and others. The trip generation model currently used by TxDOT is a cross- classification model which allows up to three variables in a three-way stratification. A maximum of three variables could be identified for use in stratifying the trip rates to insure that final recommendations would be compatible with current modeling capabilities. Because these were small sample surveys, additional stratifications would increase the possibility of stratification cells with inadequate observations for development of trip rates and increase the difficulty of projecting the input variables necessary for the trip generation models. The major limitation in analyzing the different possible variables was the lack of regional population data (for each variable) by which the data could be expanded. In order to estimate the accuracy achieved with any stratification, it is necessary to have knowledge of the population in the urban area stratified in the same manner to be able to expand the survey data.

Previous research determined that nearly all urban areas use household size as one of the variables for estimating productions. This variable was selected for analysis based on that research. The other variables selected for inclusion in this analysis were household income and vehicle availability. Since vehicle availability is estimated using household income, these two variables are surrogates for each other; and the decision was made to use household income. This was consistent with earlier recommendations made to TxDOT concerning the variables for use in estimating trip productions (18). While additional variables were possible, the decision was made to use these because they had been used in other areas, and data existed which would allow reasonable estimates of the population to be developed for expansion purposes. While other variables may or may not produce more accurate estimates of trips, if those variables cannot be forecast with any level of confidence or accuracy, they offer little in the way of improving estimates of future travel.

The next question to address determined which level would yield better results. Comparative analyses were performed to identify levels which provided trip rates that were statistically identical. The analyses would identify levels which could be combined without a loss in accuracy. The issue

of whether to consider individual trip purposes also had to be addressed. It was possible that certain levels of variables would produce different results for different trip purposes. The decision was made to analyze three trip purposes for both person and auto driver trips: home based work (HBW), home based non-work (HBNW) also referred to as home based other, and non-home based (NHB). In the event results differed by trip purpose, total person trips and/or total auto driver trips would be used in this analysis to determine the appropriate levels of stratification.

Household person trip rates were then computed using the survey data from the five 1990/1991 surveys. These surveys were selected because the methods and instruments were consistent, providing a good basis for comparison between the different urban areas. The following stratifications were used in computing the observed person and auto driver trip production rates:

- Household Size
- Household Income
- Household Size by Household Income

Household sizes ranging from one to six or more persons were used. For each urban area, the trip rates for adjacent cells were compared using a z statistic at a 95 percent confidence level to determine if the trip rates were significantly different. For example, if the average home based work trip rate for a two-person household was not significantly different from a three-person household, the data (i.e., observations) for those cells could be combined and one trip rate used for both categories with no significant loss in accuracy. The results of this analysis indicated that the trip rates for five- and six-plus-person households were essentially the same for all trip purposes except home based other person trips, auto driver trips, and total person trips in Amarillo. The implication was that in nearly every urban area, the data for five- and six-plus-person households could be combined with no significant loss in accuracy.

Ten categories of household income were used since these were the categories used in the survey. Trip rates were computed for each income range and compared in the same manner as were the trip rates stratified by household size. The findings in this analysis were inconclusive with no clear pattern; this was true for total person and auto driver trips as well as the individual trip purposes. The same analysis was not performed for vehicle availability because it had only four levels, and a cursory review of the trip rates had indicated that each level produced trip rates that were significantly different from each other. With regard to the ten levels of income ranges,

numerous different combinations would produce similar trip rates; and these combinations were different among the urban areas surveyed. The decision was made to proceed to the two-way stratification analysis using household size and household income.

Trip rates in a two-way stratification must be compared by columns and rows. The initial comparison used all possible levels of household size (six levels) and household income (10 levels). Attention had to be given also to the number of observations within the cells being compared. For example, a significant difference might be found between two cells; and since one of the cells had a small number of observations, the difference shown could be biased, which then required judgment as to the interpretation of the results. After analyzing the trip rates, no clear pattern was apparent. It was also observed that using a 10 by 6 stratification produced a large number of cells with very few observations; and, in many cases, these cells were being shown as significantly different. The decision was made to begin combining some of the stratification levels to obtain enough observations to be statistically valid. This was not possible in all cases. In addition, it quickly became apparent that a decision had to be made as to the minimum number of observations desired for evaluation purposes. Typically, this value is set at 30 for most statistical analyses. In this study, the value of 30 was considered too high since it would require the combination of a large number of cells and would tend to obscure the analysis. Subsequently, for purposes of defining the most appropriate stratification levels, the minimum number of observations selected was 20. This number is arbitrary; and even with it as low as 20, several of the urban areas could not achieve this value without substantial combinations of stratification levels. Tables A-1 through A-5 present the number of observations for each cell for the ten income ranges and six household sizes for each of the five urban areas.

The data in the tables show that in some of the urban areas, several rows and columns must be combined to achieve the minimum of 20 observations per cell. Using judgment, cells were combined and are shown in Tables A-6 through A-10. The criterion for combining the cells was to use those areas which required the least amount of cell combinations to meet the minimum of 20 observations. All of the areas would then be analyzed to determine which cells had similar trip rates. The analysis consisted of comparing pairs of trip rates column by column and row by row. For example, if two trip rates, one in the first column and the second in the second column, were significantly different, then the assumption was made that the two columns could not be combined.

The same approach was used in comparing the rows of trip rates. Generally, the results were mixed, even with the category combinations. Overall, it was concluded that the categories of household size that produced the best results were sizes 1 through 5+. One additional combination was found for the income ranges.

It was found that the income ranges \$ 20,000 - \$ 29,999 and \$ 30,000 - \$ 34,999 could be combined. While the trip rates were significantly different in some of the urban areas, overall it appeared that these categories could be combined in the majority of cases since the trip rates were not significantly different.

Table A-1
Number of Surveyed Households
Amarillo 1990 Travel Survey

Household Income	Household Size						Total
	1	2	3	4	5	6+	
\$ 0 - \$ 4,999	66	28	14	5	4	4	121
\$ 5,000 - \$ 9,999	112	54	28	15	7	6	222
\$ 10,000 - \$ 14,999	97	66	40	22	14	3	242
\$ 15,000 - \$ 19,999	82	81	40	30	14	3	250
\$ 20,000 - \$ 24,999	59	104	52	42	16	10	283
\$ 25,000 - \$ 29,999	41	84	52	44	12	9	242
\$ 30,000 - \$ 34,999	32	88	57	44	21	10	252
\$ 35,000 - \$ 39,999	19	79	36	41	20	2	197
\$ 40,000 - \$ 49,999	17	101	64	68	30	12	292
\$ 50,000 Plus	20	168	100	111	36	15	450
Total	545	853	483	422	174	74	2551

Table A-2
Number of Surveyed Households
Brownsville 1990 Travel Survey

Household Income	Household Size						Total
	1	2	3	4	5	6+	
\$ 0 - \$ 4,999	48	61	58	27	21	41	256
\$ 5,000 - \$ 9,999	33	60	58	33	23	30	237
\$ 10,000 - \$ 14,999	23	39	42	26	17	21	168
\$ 15,000 - \$ 19,999	19	32	13	32	15	24	135
\$ 20,000 - \$ 24,999	23	36	28	16	23	8	134
\$ 25,000 - \$ 29,999	18	19	20	17	8	11	93
\$ 30,000 - \$ 34,999	18	17	22	18	10	7	92
\$ 35,000 - \$ 39,999	8	15	17	8	4	5	57
\$ 40,000 - \$ 49,999	7	24	19	11	8	6	75
\$ 50,000 Plus	4	32	30	31	15	8	120
Total	201	335	307	219	144	161	1367

Table A-3
Number of Surveyed Households
San Antonio 1990 Travel Survey

Household Income	Household Size						Total
	1	2	3	4	5	6+	
\$ 0 - \$ 4,999	130	66	40	29	20	13	298
\$ 5,000 - \$ 9,999	79	72	46	35	27	22	281
\$ 10,000 - \$ 14,999	75	77	43	48	29	25	297
\$ 15,000 - \$ 19,999	63	68	40	32	26	24	253
\$ 20,000 - \$ 24,999	56	68	36	57	23	8	248
\$ 25,000 - \$ 29,999	34	52	44	31	19	8	188
\$ 30,000 - \$ 34,999	28	54	42	31	19	8	182
\$ 35,000 - \$ 39,999	19	51	39	37	15	8	169
\$ 40,000 - \$ 49,999	18	76	58	46	20	8	226
\$ 50,000 Plus	14	117	72	67	28	13	311
Total	506	701	460	413	226	137	2453

Table A-4
Number of Surveyed Households
Sherman-Denison 1991 Travel Survey

Household Income	Household Size						Total
	1	2	3	4	5	6+	
\$ 0 - \$ 4,999	141	29	15	4	3	0	192
\$ 5,000 - \$ 9,999	186	65	23	8	1	1	284
\$ 10,000 - \$ 14,999	95	98	34	21	6	4	258
\$ 15,000 - \$ 19,999	54	61	31	20	11	6	183
\$ 20,000 - \$ 24,999	59	73	64	37	11	6	250
\$ 25,000 - \$ 29,999	50	61	51	44	15	4	225
\$ 30,000 - \$ 34,999	37	57	57	55	20	7	233
\$ 35,000 - \$ 39,999	29	43	38	39	12	9	170
\$ 40,000 - \$ 49,999	20	60	53	63	27	5	228
\$ 50,000 Plus	12	93	81	83	38	10	317
Total	683	640	447	374	144	52	2340

Table A-5
Number of Surveyed Households
Tyler 1991 Travel Survey

Household Income	Household Size						Total
	1	2	3	4	5	6+	
\$ 0 - \$ 4,999	109	27	12	2	2	2	154
\$ 5,000 - \$ 9,999	111	44	19	6	4	5	189
\$ 10,000 - \$ 14,999	80	77	17	11	5	0	190
\$ 15,000 - \$ 19,999	62	82	20	19	8	4	195
\$ 20,000 - \$ 24,999	58	72	32	27	8	4	201
\$ 25,000 - \$ 29,999	38	91	29	30	12	3	203
\$ 30,000 - \$ 34,999	24	68	30	36	11	6	175
\$ 35,000 - \$ 39,999	6	80	37	26	6	0	155
\$ 40,000 - \$ 49,999	15	85	40	66	12	5	223
\$ 50,000 Plus	19	140	79	74	24	3	339
Total	522	766	315	297	92	32	2024

Table A-6
Number of Surveyed Households in Combined Categories
Amarillo 1990 Travel Survey

Household Income	Household Size					Total
	1	2	3	4	5+	
\$ 0 - \$ 4,999	66	28	14	5	8	121
\$ 5,000 - \$ 9,999	112	54	28	15	13	222
\$ 10,000 - \$ 19,999	179	147	80	52	34	492
\$ 20,000 - \$ 29,999	100	188	104	86	47	525
\$ 30,000 - \$ 34,999	32	88	57	44	31	252
\$ 35,000 Plus	56	348	200	220	115	939
Total	545	853	483	422	248	2551

Table A-7
Number of Surveyed Households in Combined Categories
Brownsville 1990 Travel Survey

Household Income	Household Size					Total
	1	2	3	4	5+	
\$ 0 - \$ 4,999	48	61	58	27	62	256
\$ 5,000 - \$ 9,999	33	60	58	33	53	237
\$ 10,000 - \$ 19,999	42	71	55	58	77	303
\$ 20,000 - \$ 29,999	41	55	48	33	50	227
\$ 30,000 - \$ 34,999	18	17	22	18	17	92
\$ 35,000 Plus	19	71	66	50	46	252
Total	201	335	307	219	305	1367

Table A-8
Number of Surveyed Households in Combined Categories
San Antonio 1990 Travel Survey

Household Income	Household Size					Total
	1	2	3	4	5+	
\$ 0 - \$ 4,999	130	66	40	29	33	298
\$ 5,000 - \$ 9,999	79	72	46	35	49	281
\$ 10,000 - \$ 19,999	138	145	83	80	104	550
\$ 20,000 - \$ 29,999	90	120	80	88	58	436
\$ 30,000 - \$ 34,999	28	54	42	31	27	182
\$ 35,000 Plus	51	244	169	150	92	706
Total	516	701	460	413	363	2453

Table A-9
Number of Surveyed Households in Combined Categories
Sherman-Denison 1991 Travel Survey

Household Income	Household Size					Total
	1	2	3	4	5+	
\$ 0 - \$ 4,999	141	29	15	4	3	192
\$ 5,000 - \$ 9,999	186	65	23	8	2	284
\$ 10,000 - \$ 19,999	149	159	65	41	27	441
\$ 20,000 - \$ 29,999	109	134	115	81	36	475
\$ 30,000 - \$ 34,999	37	57	57	55	27	233
\$ 35,000 Plus	61	196	172	185	101	715
Total	683	640	447	374	196	2340

Table A-10
Number of Surveyed Households in Combined Categories
Tyler 1991 Travel Survey

Household Income	Household Size					Total
	1	2	3	4	5+	
\$ 0 - \$ 4,999	109	27	12	2	4	154
\$ 5,000 - \$ 9,999	111	44	19	6	9	189
\$ 10,000 - \$ 19,999	142	159	37	30	17	385
\$ 20,000 - \$ 29,999	96	163	61	57	27	404
\$ 30,000 - \$ 34,999	24	68	30	36	17	175
\$ 35,000 Plus	40	305	156	166	50	717
Total	522	766	315	297	124	2024

Table A-11 shows the final recommended stratifications for use in developing trip rates. Appendix B contains tables showing the statistical comparisons, column versus column and row versus row, for each area and each trip purpose. In most comparisons, at least one pair of trip rates is significantly different.

Table A-11
Recommended Stratifications for
Trip Production Rates

Household Income	Household Size				
	1	2	3	4	5+
\$ 0 - \$ 4,999					
\$ 5,000 - \$ 9,999					
\$ 10,000 - \$ 19,999					
\$ 20,000 - \$ 34,999					
\$ 35,000 Plus					

APPENDIX B

Stratification Levels Statistical Comparisons

Stratification Levels/Statistical Comparisons

This appendix presents the paired trip rate comparisons done for the recommended stratifications contained in this report. The tables which follow present the comparison in a column by column and row by row fashion. The statistic used is referred to as a z statistic (2) and is computed using the following formula:

$$Z = \frac{(x_1 - x_2) - \delta}{\sqrt{\frac{\sigma_1^2}{n_1} - \frac{\sigma_2^2}{n_2}}}$$

Where: Z = Normally distributed test statistic

x_1 = Mean trips per household for cell 1

x_2 = Mean trips per household for cell 2

δ = Difference being tested (i.e., 0)

σ_1^2 = Variance within cell 1

σ_2^2 = Variance within cell 2

n_1 = Number of observations within cell 1

n_2 = Number of observations within cell 2

If the z statistic falls outside the range -1.96 to +1.96, the difference between the two means is considered significantly different from zero. Tables B-1 through B-10 present the computed values for the z statistic comparing mean trip rates in adjacent cells stratified by household size and household income for each urban area surveyed in 1990 and 1991.

Table B-1
Adjacent Column Trip Rate Comparisons - z Statistic
Amarillo Travel Survey

Home Based Work

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-1.78	-0.18	-0.02	-0.22	-1.29	-0.70	0.47	-0.53
\$ 5,000 - \$ 9,999	-3.42	-0.58	-0.10	-0.91	-2.83	-0.47	-0.68	-0.11
\$ 10,000 - \$ 19,999	-3.42	-2.79	-1.31	1.03	-3.10	-2.06	-1.33	2.75
\$ 20,000 - \$ 34,999	-2.78	-3.72	-1.10	-2.18	-2.54	-3.22	-0.93	-1.88
\$ 35,000 Plus	-7.09	-3.30	-0.53	-1.64	-6.98	-3.50	0.05	-1.43

Home Based Non-Work

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-1.79	-1.92	-1.36	-0.31	-0.59	-1.20	-1.61	1.02
\$ 5,000 - \$ 9,999	-4.82	-1.20	-1.94	-0.95	-2.74	-0.24	-2.09	-0.23
\$ 10,000 - \$ 19,999	-4.79	-2.17	-2.23	-2.97	-2.47	-0.52	-2.25	-1.93
\$ 20,000 - \$ 34,999	-7.16	-4.09	-5.14	-4.37	-5.22	-2.09	-1.65	-3.09
\$ 35,000 Plus	-4.20	-4.78	-7.30	-4.34	-3.03	-3.04	-3.41	-2.67

Non-Home Based

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-1.39	-1.29	3.45	-2.45	-0.98	-0.54	3.09	-2.20
\$ 5,000 - \$ 9,999	-2.34	-0.97	-0.94	1.29	-1.54	-0.92	-0.40	2.18
\$ 10,000 - \$ 19,999	-2.37	0.20	-0.89	-1.70	-0.74	1.22	-1.15	-1.02
\$ 20,000 - \$ 34,999	-5.39	-0.82	-0.53	-2.75	-4.65	-0.10	1.15	-2.44
\$ 35,000 Plus	-2.51	-2.26	-4.28	-1.65	-1.97	-1.94	-2.01	-0.83

Total-All Purposes

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-2.40	-2.08	-0.50	-0.77	-1.14	-1.18	-0.91	0.25
\$ 5,000 - \$ 9,999	-5.00	-1.47	-1.73	-0.29	-3.02	-0.89	-1.83	0.52
\$ 10,000 - \$ 19,999	-5.24	-2.05	-2.13	-2.73	-2.93	-0.45	-2.22	-1.14
\$ 20,000 - \$ 34,999	-8.79	-3.88	-4.08	-4.92	-7.06	-2.25	-0.66	-3.96
\$ 35,000 Plus	-5.67	-5.23	-7.12	-4.16	-4.68	-4.18	-3.25	-2.62

Table B-2
Adjacent Row Trip Rate Comparisons -z Statistic
Amarillo Travel Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-0.89	-1.23	-0.97	-0.95	-0.86	-1.97	-2.15	-0.84	-1.77	-0.95
Inc Grp 2 vs Inc Grp 3	-3.01	-0.77	-1.26	-2.59	-0.41	-3.25	-1.33	-1.67	-1.79	0.58
Inc Grp 3 vs Inc Grp 4	-4.48	-2.66	-1.84	-1.21	-3.60	-4.02	-2.61	-2.40	-1.44	-5.60
Inc Grp 4 vs Inc Grp 5	0.36	-4.48	-2.75	-1.66	-0.41	0.44	-4.79	-3.60	-2.26	-0.91

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	0.61	-1.73	0.11	0.04	-0.24	-0.44	-1.87	-0.24	0.56	-0.96
Inc Grp 2 vs Inc Grp 3	-1.22	0.80	0.32	1.13	0.20	-1.49	0.13	-0.00	1.01	-0.07
Inc Grp 3 vs Inc Grp 4	1.63	-0.12	-0.59	-1.45	-1.01	1.36	-1.26	-1.94	-0.30	-0.44
Inc Grp 4 vs Inc Grp 5	-1.48	-1.26	-1.27	-1.99	0.01	-1.60	-1.68	-1.89	-2.96	-1.17

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-1.29	-0.91	-0.31	-3.60	0.12	-1.56	-0.89	-0.99	-4.47	0.66
Inc Grp 2 vs Inc Grp 3	-2.67	-0.94	0.51	0.75	-2.16	-2.85	-0.98	0.99	0.40	-2.89
Inc Grp 3 vs Inc Grp 4	0.33	-1.94	-2.31	-1.01	-0.65	0.70	-3.13	-3.63	-0.53	-0.76
Inc Grp 4 vs Inc Grp 5	-1.49	-0.56	-1.39	-4.72	-1.99	-1.50	-1.03	-2.17	-5.62	-2.88

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-0.47	-1.89	-0.35	-1.19	-0.31	-1.39	-1.99	-1.01	-0.77	-0.77
Inc Grp 2 vs Inc Grp 3	-3.05	-0.30	0.09	0.77	-0.89	-3.28	-0.84	0.02	0.44	-1.04
Inc Grp 3 vs Inc Grp 4	-0.19	-2.08	-2.21	-1.71	-1.66	0.02	-3.56	-4.06	-0.86	-2.17
Inc Grp 4 vs Inc Grp 5	-1.77	-2.50	-2.35	-4.33	-1.04	-1.79	-3.31	-3.62	-5.88	-2.57

Table B-3
Adjacent Column Trip Rate Comparisons - z Statistic
Brownsville Travel Survey

Home Based Work

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-0.77	-3.63	0.10	-0.49	-0.75	-1.83	0.54	-1.21
\$ 5,000 - \$ 9,999	-1.33	-2.45	0.82	-1.02	-0.59	-2.03	0.09	-0.21
\$ 10,000 - \$ 19,999	-2.56	-1.79	-1.24	0.28	-1.59	-1.74	0.20	-0.35
\$ 20,000 - \$ 34,999	-0.94	-2.57	-1.96	-2.11	-0.28	-2.10	-2.87	-0.55
\$ 35,000 Plus	-4.12	-1.19	-2.41	0.62	-3.50	-1.15	-2.28	0.20

Home Based Non-Work

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-3.66	-2.68	-0.99	-2.13	-2.55	-1.92	-0.29	-0.10
\$ 5,000 - \$ 9,999	-2.92	-2.09	-2.94	-1.55	-2.14	-0.93	-2.87	-0.11
\$ 10,000 - \$ 19,999	-3.35	-0.82	-5.26	-2.42	-0.66	-0.41	-3.38	-0.28
\$ 20,000 - \$ 34,999	-3.99	-1.04	-1.52	-4.26	-2.43	-0.98	1.17	-3.98
\$ 35,000 Plus	-1.19	-2.65	-2.59	-2.35	-0.26	-1.80	-1.05	-1.02

Non-Home Based

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-1.42	-1.43	1.08	-0.93	-1.46	-0.79	1.49	-1.07
\$ 5,000 - \$ 9,999	-2.02	-1.96	-0.73	1.48	-2.21	-1.30	-1.34	1.63
\$ 10,000 - \$ 19,999	-2.12	1.35	-1.60	0.50	-0.67	1.41	-0.58	-0.25
\$ 20,000 - \$ 34,999	-1.16	-1.62	-1.32	-1.59	-0.14	-1.38	-1.13	-1.36
\$ 35,000 Plus	-3.77	0.67	-0.99	-0.99	-2.83	1.02	-0.65	-0.69

Total-All Purposes

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-3.58	-3.35	-0.40	-1.99	-2.54	-2.09	0.22	-0.53
\$ 5,000 - \$ 9,999	-3.32	-2.99	-2.23	-0.79	-2.48	-1.88	-2.67	0.60
\$ 10,000 - \$ 19,999	-4.18	-0.27	-4.89	-1.52	-1.37	-0.07	-2.72	-0.42
\$ 20,000 - \$ 34,999	-4.04	-2.33	-2.41	-4.42	-1.91	-2.09	-0.75	-3.41
\$ 35,000 Plus	-4.37	-1.26	-2.80	-1.87	-3.08	-0.53	-1.73	-0.92

Table B-4
Adjacent Row Trip Rate Comparisons - z Statistic
Brownsville Travel Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-2.00	-3.45	-2.17	-1.06	-1.87	-1.64	-2.25	-2.36	-2.14	-1.62
Inc Grp 2 vs Inc Grp 3	-0.14	-1.35	-0.09	-2.02	-0.70	-0.68	-1.95	-1.12	-0.90	-1.07
Inc Grp 3 vs Inc Grp 4	-2.81	-0.79	-1.65	-2.27	-4.92	-2.45	-0.96	-1.34	-4.15	-4.84
Inc Grp 4 vs Inc Grp 5	1.08	-3.15	-1.90	-2.29	0.30	0.83	-3.33	-2.54	-2.03	-1.35

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-0.99	0.16	0.99	-0.72	-0.24	-1.52	-0.94	0.43	-1.45	-1.87
Inc Grp 2 vs Inc Grp 3	-0.96	-0.92	0.51	-0.86	-0.94	-2.51	-0.96	-0.36	0.00	-0.08
Inc Grp 3 vs Inc Grp 4	-0.68	-1.31	-1.34	1.93	-0.02	-0.28	-2.15	-2.37	2.13	-1.60
Inc Grp 4 vs Inc Grp 5	-1.01	0.72	-0.76	-1.48	-0.37	-1.20	0.12	-0.61	-2.56	-0.28

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-0.73	-0.59	-1.24	-2.35	-0.62	-0.47	-0.73	-1.31	-2.91	-1.62
Inc Grp 2 vs Inc Grp 3	-3.06	-3.13	0.47	-0.15	-1.90	-3.75	-3.04	-0.51	0.64	-1.97
Inc Grp 3 vs Inc Grp 4	-0.70	0.78	-2.11	-1.24	-3.28	-0.41	0.20	-2.54	-2.73	-3.69
Inc Grp 4 vs Inc Grp 5	-0.20	-4.26	-2.30	-1.78	-1.12	-0.39	-4.07	-2.29	-1.72	-1.12

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-1.63	-0.89	-0.46	-1.68	-0.69	-1.39	-1.99	-1.01	-0.77	-0.77
Inc Grp 2 vs Inc Grp 3	-2.38	-2.75	0.55	-1.09	-1.44	-3.28	-0.84	0.02	0.44	-1.04
Inc Grp 3 vs Inc Grp 4	-1.72	-0.73	-2.43	0.31	-2.75	0.02	-3.56	-4.06	-0.86	-2.17
Inc Grp 4 vs Inc Grp 5	-0.53	-3.42	-2.23	-2.64	-0.77	-1.79	-3.31	-3.62	-5.88	-2.57

Table B-5
Adjacent Column Trip Rate Comparisons -z Statistic
San Antonio Travel Survey

Home Based Work

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-2.41	-1.14	-1.25	0.30	-2.64	-1.26	0.08	-0.77
\$ 5,000 - \$ 9,999	-2.81	-1.49	-0.45	-0.52	-2.16	-0.65	0.64	-1.60
\$ 10,000 - \$ 19,999	-1.37	-3.60	0.55	-2.08	-0.33	-3.27	1.18	-1.27
\$ 20,000 - \$ 34,999	-4.80	-3.08	-1.13	2.15	-3.75	-3.13	-1.43	3.28
\$ 35,000 Plus	-5.98	-2.57	-0.98	-1.25	-5.35	-2.26	-0.62	-0.70

Home Based Non-Work

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-2.63	-3.69	0.89	-1.88	-2.18	-1.76	0.90	-1.03
\$ 5,000 - \$ 9,999	-2.74	-1.57	-0.98	-2.46	-1.80	0.15	-1.13	-0.82
\$ 10,000 - \$ 19,999	-5.62	-1.41	-3.94	-1.48	-3.69	0.62	-1.78	-0.41
\$ 20,000 - \$ 34,999	-5.32	-2.68	-3.12	-4.43	-3.59	-0.44	-1.66	-2.37
\$ 35,000 Plus	-3.50	-4.47	-6.33	-3.79	-2.26	-3.21	-3.00	-1.04

Non-Home Based

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-1.54	-1.63	-0.22	1.05	-1.33	0.10	-0.39	0.11
\$ 5,000 - \$ 9,999	0.75	1.32	-2.47	-0.63	1.18	1.48	-2.24	0.12
\$ 10,000 - \$ 19,999	-1.57	-1.00	-1.44	0.13	-0.14	-0.17	-0.89	-0.36
\$ 20,000 - \$ 34,999	-2.19	0.11	-1.48	-1.75	-1.88	0.34	-0.79	-0.68
\$ 35,000 Plus	-4.30	-1.03	-1.17	-0.90	-3.50	-0.48	-0.59	0.68

Total-All Purposes

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-3.26	-3.92	0.09	-1.25	-2.55	-1.63	0.58	-1.05
\$ 5,000 - \$ 9,999	-2.11	-1.15	-1.67	-2.04	-0.85	0.39	-1.28	-1.02
\$ 10,000 - \$ 19,999	-4.73	-2.46	-3.09	-1.20	-2.30	-0.74	-1.22	-0.76
\$ 20,000 - \$ 34,999	-6.35	-2.62	-3.25	-3.44	-4.72	-1.16	-2.00	-0.92
\$ 35,000 Plus	-7.58	-3.92	-4.75	-3.31	-6.00	-2.78	-2.21	-0.48

Table B-6
Adjacent Row Trip Rate Comparisons - z Statistic
San Antonio Travel Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-2.89	-2.44	-2.26	-0.17	-1.21	-2.95	-1.75	-0.72	-0.17	-0.70
Inc Grp 2 vs Inc Grp 3	-4.48	-1.41	-2.46	-1.09	-2.12	-5.31	-1.98	-3.32	-3.14	-1.82
Inc Grp 3 vs Inc Grp 4	-0.31	-3.28	-2.10	-3.53	0.81	-0.59	-3.72	-2.80	-5.12	-0.60
Inc Grp 4 vs Inc Grp 5	-0.50	-2.88	-1.92	-1.55	-4.06	-1.30	-4.28	-2.84	-1.74	-4.87

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-2.21	-1.62	1.34	-0.66	-0.73	-2.83	-1.77	0.41	-1.51	-1.23
Inc Grp 2 vs Inc Grp 3	-1.18	-2.06	-1.43	-2.79	-1.35	-2.45	-2.67	-1.98	-1.65	-1.15
Inc Grp 3 vs Inc Grp 4	-0.61	0.32	-0.54	0.98	-1.80	-0.98	-0.43	-1.29	-0.75	-2.55
Inc Grp 4 vs Inc Grp 5	0.23	1.80	0.51	-1.80	-0.96	0.05	1.11	-1.28	-2.21	-0.47

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-3.16	-1.49	1.46	-1.01	-2.09	-2.98	-1.13	0.28	-1.65	-1.23
Inc Grp 2 vs Inc Grp 3	-0.83	-3.18	-4.53	-2.87	-1.96	-0.95	-2.98	-3.78	-2.51	-2.98
Inc Grp 3 vs Inc Grp 4	-0.56	-0.89	0.40	0.85	-0.96	-0.25	-1.92	-0.95	-0.47	-0.64
Inc Grp 4 vs Inc Grp 5	-0.05	-2.47	-2.79	-2.52	-0.66	-0.64	-2.94	-2.96	-3.09	-0.92

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-4.10	-2.54	0.96	-0.85	-1.57	-3.77	-2.11	0.08	-1.63	-1.56
Inc Grp 2 vs Inc Grp 3	-2.45	-3.34	-4.19	-3.37	-2.26	-2.96	-3.70	-4.35	-2.99	-2.78
Inc Grp 3 vs Inc Grp 4	-0.85	-1.30	-0.68	0.36	-1.56	-0.89	-2.59	-2.26	-2.19	-2.18
Inc Grp 4 vs Inc Grp 5	-0.08	-1.49	-1.83	-2.92	-1.79	-0.88	-3.02	-3.45	-3.70	-2.16

Table B-7
Adjacent Column Trip Rate Comparisons - z Statistic
Sherman-Denison Travel Survey

Home Based Work

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-1.72	-1.29	2.30	-1.00	-1.03	-1.46	1.98	-1.00
\$ 5,000 - \$ 9,999	-1.87	-2.19	-2.01	-0.77	-0.97	-2.47	-0.89	-1.38
\$ 10,000 - \$ 19,999	-0.68	-1.43	-3.28	1.49	-0.01	-0.89	-3.65	1.76
\$ 20,000 - \$ 34,999	-0.37	-5.81	-2.56	-0.13	-0.11	-5.39	-2.45	-0.15
\$ 35,000 Plus	-3.74	-4.12	0.26	1.50	-4.00	-4.25	0.87	0.99

Home Based Non-Work

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-3.03	-2.39	0.72	0.24	-3.54	-1.62	0.68	0.43
\$ 5,000 - \$ 9,999	-3.66	-1.22	-1.50	0.65	-2.98	-0.52	-1.10	0.39
\$ 10,000 - \$ 19,999	-4.80	-2.08	-2.41	-1.67	-3.10	-0.86	-1.69	-0.59
\$ 20,000 - \$ 34,999	-7.84	-1.10	-4.07	-3.24	-5.37	0.47	-2.60	-0.58
\$ 35,000 Plus	-2.72	-6.75	-6.05	-1.83	-2.13	-5.49	-1.99	-0.60

Non-Home Based

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-2.29	-1.94	1.52	0.28	-2.30	-1.69	1.40	-0.07
\$ 5,000 - \$ 9,999	-2.51	0.33	-1.45	1.95	-2.29	0.86	-2.04	2.62
\$ 10,000 - \$ 19,999	-2.10	-1.02	-2.06	-0.81	-1.00	0.27	-2.85	-0.23
\$ 20,000 - \$ 34,999	-4.85	-0.67	-1.66	-1.93	-3.66	-0.50	-0.69	-1.22
\$ 35,000 Plus	-4.79	-1.64	-2.97	-0.60	-4.17	-1.60	-1.57	-0.06

Total-All Purposes

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-3.04	-2.66	1.53	0.18	-3.45	-2.04	1.30	0.14
\$ 5,000 - \$ 9,999	-3.90	-1.33	-2.85	1.46	-3.22	-0.79	-2.69	1.14
\$ 10,000 - \$ 19,999	-4.53	-2.18	-3.32	-1.21	-2.52	-0.69	-3.62	-0.05
\$ 20,000 - \$ 34,999	-7.79	-2.52	-3.88	-3.06	-5.33	-1.71	-2.55	-1.14
\$ 35,000 Plus	-6.14	-5.93	-5.33	-1.21	-5.31	-5.44	-1.81	-0.11

Table B-8
Adjacent Row Trip Rate Comparisons - z Statistic
Sherman-Denison Travel Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-0.82	0.12	-0.10	-3.87	-2.53	-1.11	-0.23	-0.11	-2.20	-2.53
Inc Grp 2 vs Inc Grp 3	-5.02	-2.53	-0.18	0.04	1.46	-4.90	-3.29	0.23	-0.67	1.76
Inc Grp 3 vs Inc Grp 4	-2.86	-2.52	-4.77	-1.36	-3.02	-2.72	-2.85	-6.09	-1.58	-3.55
Inc Grp 4 vs Inc Grp 5	-0.68	-4.96	-3.37	-0.50	0.99	-0.35	-5.10	-4.06	-0.66	0.47

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-4.04	0.10	1.82	-0.92	-0.27	-6.16	0.04	1.42	-0.58	-0.85
Inc Grp 2 vs Inc Grp 3	-2.69	-2.01	-1.51	0.07	-1.61	-3.28	-1.84	-1.26	-0.24	-1.19
Inc Grp 3 vs Inc Grp 4	0.22	-1.82	0.02	0.05	0.05	-0.27	-1.96	-0.12	0.28	0.50
Inc Grp 4 vs Inc Grp 5	-0.21	4.14	-1.74	-3.26	-0.66	0.15	2.85	-3.20	-2.50	-1.59

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-3.56	0.23	2.27	-1.21	1.51	-3.17	-0.20	1.88	-1.65	1.51
Inc Grp 2 vs Inc Grp 3	-3.33	-1.36	-1.90	0.31	-5.32	-4.05	-1.43	-1.86	0.59	-5.52
Inc Grp 3 vs Inc Grp 4	-1.26	-3.36	-1.26	0.42	-0.11	-0.95	-3.30	-3.20	0.45	-0.23
Inc Grp 4 vs Inc Grp 5	-0.39	-1.24	-1.82	-2.76	-0.25	-0.47	-1.79	-2.35	-3.21	-1.15

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-4.59	0.19	2.40	-2.15	-0.49	-5.48	-0.10	1.79	-1.83	-0.94
Inc Grp 2 vs Inc Grp 3	-5.03	-2.55	-2.15	0.34	-2.09	-5.70	-2.64	-1.65	0.09	-1.25
Inc Grp 3 vs Inc Grp 4	-1.68	-3.74	-1.89	-0.03	-0.45	-1.71	-3.95	-3.38	-0.06	-0.63
Inc Grp 4 vs Inc Grp 5	-0.67	0.01	-2.97	-3.66	-0.37	-0.32	-1.36	-4.57	-3.48	-1.50

Table B-9
Adjacent Column Trip Rate Comparisons - z Statistic
Tyler Travel Survey

Home Based Work

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-1.88	-0.88	-0.49	0.61	-1.76	-0.24	-0.31	0.23
\$ 5,000 - \$ 9,999	-0.43	-2.32	-0.30	0.06	-0.08	-2.11	-0.10	0.81
\$ 10,000 - \$ 19,999	-2.89	-1.00	-0.96	-0.63	-3.08	-1.16	-0.54	-0.17
\$ 20,000 - \$ 34,999	-2.24	-4.10	-0.42	-0.04	-2.09	-4.17	-0.26	0.27
\$ 35,000 Plus	-4.39	-5.39	-0.20	-2.31	-4.10	-5.12	0.00	-2.64

Home Based Non-Work

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-1.89	-0.94	-0.53	0.06	-1.91	-0.72	-0.24	0.24
\$ 5,000 - \$ 9,999	-0.81	-3.09	-2.44	1.51	-0.17	-1.88	-0.47	0.77
\$ 10,000 - \$ 19,999	-4.50	-1.16	-1.23	-2.02	-3.02	-0.44	-0.56	-0.97
\$ 20,000 - \$ 34,999	-6.84	-1.55	-3.54	-2.13	-5.47	-0.43	-1.37	-0.52
\$ 35,000 Plus	-4.28	-4.48	-6.06	-3.37	-3.47	-2.78	-2.45	-3.01

Non-Home Based

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-1.40	-0.81	0.38	0.58	-1.06	-1.08	1.21	-0.58
\$ 5,000 - \$ 9,999	-0.12	-1.65	-0.99	0.66	-0.75	-1.41	-1.15	1.43
\$ 10,000 - \$ 19,999	-2.37	-1.59	0.12	-1.31	-1.24	-1.50	0.10	-0.55
\$ 20,000 - \$ 34,999	-1.46	-1.67	-1.89	-0.04	-0.56	-1.96	-1.15	1.79
\$ 35,000 Plus	-3.04	-2.77	-2.73	-2.23	-2.60	-2.00	-1.80	-1.64

Total-All Purposes

Household Income Range	Person Trips per Household				Auto Driver Trips per Household			
	Household Size				Household Size			
	1 vs 2	2 vs 3	3 vs 4	4 vs 5+	1 vs 2	2 vs 3	3 vs 4	4 vs 5+
\$ 0 - \$ 4,999	-2.29	-1.35	-1.22	0.94	-2.17	-1.15	0.00	0.17
\$ 5,000 - \$ 9,999	-0.63	-3.32	-2.42	1.52	-0.48	-2.41	-1.05	1.60
\$ 10,000 - \$ 19,999	-4.98	-1.93	-0.97	-2.06	-3.50	-1.44	-0.44	-0.85
\$ 20,000 - \$ 34,999	-5.43	-3.10	-3.24	-1.27	-4.23	-2.97	-1.51	0.69
\$ 35,000 Plus	-6.02	-6.21	-5.15	-4.02	-5.09	-4.73	-2.36	-3.66

Table B-10
Adjacent Row Trip Rate Comparisons - z Statistic
Tyler Travel Survey

Home Based Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-2.10	0.60	-0.59	0.24	-0.71	-2.13	0.73	-0.86	-0.15	0.15
Inc Grp 2 vs Inc Grp 3	-1.65	-2.73	0.23	-0.22	-0.57	-1.25	-3.00	-0.27	-0.43	-1.58
Inc Grp 3 vs Inc Grp 4	-3.76	-2.69	-3.11	-1.74	-0.54	-4.00	-2.65	-2.92	-2.17	-0.98
Inc Grp 4 vs Inc Grp 5	1.03	-2.53	-2.47	-2.18	-2.86	0.87	-2.57	-2.10	-1.76	-3.20

Home Based Non-Work

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-1.32	1.04	-0.37	-0.97	-0.22	-2.11	0.68	-0.37	-0.15	0.02
Inc Grp 2 vs Inc Grp 3	-2.29	-3.85	0.62	2.18	-1.07	-2.23	-3.66	0.32	0.45	-1.26
Inc Grp 3 vs Inc Grp 4	0.62	-1.13	-0.08	-0.83	0.21	0.17	-1.89	-0.57	-0.73	0.10
Inc Grp 4 vs Inc Grp 5	-0.41	-0.45	-2.09	-2.71	-2.16	-0.41	-1.13	-2.61	-2.92	-3.75

Non-Home Based

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-2.01	0.36	-0.35	-1.59	-1.47	-1.77	-0.28	-0.26	-2.09	-0.48
Inc Grp 2 vs Inc Grp 3	-1.49	-2.84	-0.44	0.82	-1.04	-2.51	-2.05	-0.36	1.04	-1.18
Inc Grp 3 vs Inc Grp 4	-2.78	-1.65	-0.45	-1.66	0.21	-2.42	-1.83	-0.82	-1.56	0.45
Inc Grp 4 vs Inc Grp 5	0.67	-1.32	-1.37	-1.55	-2.61	0.37	-2.77	-1.48	-1.62	-4.01

Total-All Purposes

Household Income Range	Person Trips per Household					Auto Driver Trips per Household				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
Inc Grp 1 vs Inc Grp 2	-2.33	0.98	-0.60	-1.99	-1.17	-2.62	0.47	-0.61	-1.16	-0.18
Inc Grp 2 vs Inc Grp 3	-2.68	-4.45	0.20	2.05	-1.42	-3.05	-4.00	-0.06	0.85	-1.83
Inc Grp 3 vs Inc Grp 4	-3.02	-2.56	-1.14	-1.85	0.12	-3.00	-3.22	-1.74	-2.02	-0.06
Inc Grp 4 vs Inc Grp 5	0.57	-2.02	-2.78	-2.98	-3.31	0.31	-3.44	-3.01	-3.06	-5.51

APPENDIX C

Household Survey File Format

Household Survey File Format

The data from the household travel surveys are stored in three ASCII record formats. The first contains the household information, the second contains the age and sex for members of the household over five years of age, and the third contains information on each trip reported for each person in the household. The data for each household are entered in sequential order in the file. Processing of the data requires all records for each household be read before processing the next household. The following describes the formats for each record.

Record 1: Household Data

<u>Variable</u>	<u>Field Columns</u>			<u>Description</u>
	<u>Begins</u>	<u>Ends</u>	<u>Format</u>	
Sample	1	6	I6	Unique sample number for household.
Zone	7	10	I4	Zone number where household was located.
Per	11	13	I3	Number of persons in household.
Emp	14	15	I2	Number of employed persons in household.
Veh	16	17	I2	Number of vehicles available to household.
Income	18	19	I2	Code indicating household income. (See below for code definitions).
Null	20	21	I2	This field has either blanks or zeros in it.
Age	22	24	I3	Age of the head of the household.
License	25	27	I3	Number of licensed drivers in household.
Expand	28	39	F12.3	Household expansion factor.
Trips	40	44	I5	Number of trips reported for household. There will be one trip record for each trip reported.
Month	45	46	I2	Month of household's travel day (i.e., survey travel day).
Day	47	48	I2	Day of the month of household's travel day.
Weekday	49	50	I2	Code representing the day of the week the household's travel day fell, i.e., 1 - Monday; 2 - Tuesday; 3 - Wednesday; 4 - Thursday; 5 - Friday; Any other value day is unknown or not reported.

<u>Code</u>	<u>Income</u>	<u>Code</u>	<u>Income</u>	<u>Code</u>	<u>Income</u>
1	\$ 0 to \$ 4,999	6	\$ 25,000 to \$29,999	99	Unknown
2	5,000 to 9,999	7	30,000 to 34,999		
3	10,000 to 14,999	8	35,000 to 39,999		
4	15,000 to 19,999	9	40,000 to 49,999		
5	20,000 to 24,999	10	\$ 50,000 Plus		

Record 2: Persons Data

<u>Variable</u>	<u>Field Begins</u>	<u>Columns Ends</u>	<u>Format</u>	<u>Description</u>
Per>5	1	3	I3	Number of persons in household over 5 years of age. Equals number of age and sex data items on record.
Age 1	4	6	I3	Age of person number 1. Unknown ages were recorded as 0 or 100.
Sex 1	7	8	I2	Code indicating sex of person number 1; 1 = Male, 2 = Female, 3 = Unknown.
Age 2	9	11	I3	Age of person number 2. Unknown ages were recorded as 0 or 100.
Sex 2	12	13	I2	Code indicating sex of person number 2; 1 = Male, 2 = Female, 3 = Unknown.
"	"	"	"	"
"	"	"	"	"
"	"	"	"	"
Age 20	99	101	I3	Age of person number 20. Unknown ages were recorded as 0 or 100.
Sex 20	102	103	I2	Code indicating sex of person number 20; 1 = Male, 2 = Female, 3 = Unknown.

Note: Data are only recorded for the number of persons in the household that are over 5 years of age. Remainder of record is blank.

Record 3: Trip Data

<u>Variable</u>	<u>Field Columns</u>		<u>Format</u>	<u>Description</u>
	<u>Begins</u>	<u>Ends</u>		
Sample	1	6	I6	Unique sample number for household.
Person	7	8	I2	Person number that made trip.
Age	9	11	I3	Age of person that made trip. 0 or 100 indicates age unknown.
Person Trip	12	13	I2	Trip number for this person.
HH Trip	14	15	I2	Trip number for this household.
Purp. From	16	16	I1	Trip purpose from. See code definitions below.
Purp. To	17	17	I1	Trip purpose to. See code definitions below.
Begin	18	21	I4	Time trip began (reported military time).
End	22	25	I4	Time trip ended (reported military time).
Mode	26	27	I2	Mode of travel used for trip. See code definitions below.
Occupancy	28	29	I2	Number of occupants in vehicle (if trip was by vehicle) including driver.
Null	30	39		This field has several zeros in it. Do not use.
External	40	41	I2	Code indicating if trip was an external trip or not; 0 = Internal, 1 = External.
Rep. Time	42	49	F8.2	Reported travel time in minutes for trip. Computed from beginning and ending times for trip.
Distance	50	57	F8.2	Distance in miles for trip as measured from transportation network used for modeling in area or estimated from reported travel time.
Dist. Code	58	59	I2	Code indicating if distance for trip was from transportation network or estimated based on reported travel time; 0 = From Network, 1 = Estimated.
Time	60	67	F8.2	Travel time for trip as measured from transportation network used for modeling in area or estimated from reported travel time.
Time Code	68	69	I2	Code indicating if travel time for trip was from transportation network or estimated based on reported travel time; 0 = From Network, 1 = Estimated.

Record 3: Trip Data (Continued)

<u>Variable</u>	<u>Field Columns</u>			<u>Description</u>
	<u>Begins</u>	<u>Ends</u>	<u>Format</u>	
Parking	70	75	F6.2	Cost for parking.
Fare Cost	76	81	F6.2	Fare paid for transit if trip was made by transit.
Origin	82	86	I5	Zone number where trip originated. External locations coded as 9999. Unknown internal zones coded as 8888.
Destination	87	91	I5	Zone number where trip ended. External locations coded as 9999. Unknown internal zones coded as 8888.

Trip Purpose Codes

<u>Code</u>	<u>Purpose</u>
1	Return home or home
2	Go to work or work related
3	School
4	Social/recreation/shop/eat
5	Pick up/drop off passenger
6	Change travel mode
7	Other
8	Refused/unknown

Mode of Travel Codes

<u>Code</u>	<u>Mode</u>
1	Driver (car/truck/van/motorcycle)
2	Passenger (car/truck/van/motorcycle)
3	Walk
4	Bicycle
5	Bus/Transit
6	School Bus
7	Taxi
8	Commercial Vehicle (>1 Ton)
9	Other
99	Refused/Unknown

APPENDIX D

**Distributions of Persons by Age Group
Person Trips Per Person
Auto Driver Trips Per Person**

and

**Proportions of Persons Reporting Zero Trips
1990/91 Household Travel Surveys**

Figure D-1
 Distribution of Males by Age Group
 Census vs. Expanded Survey

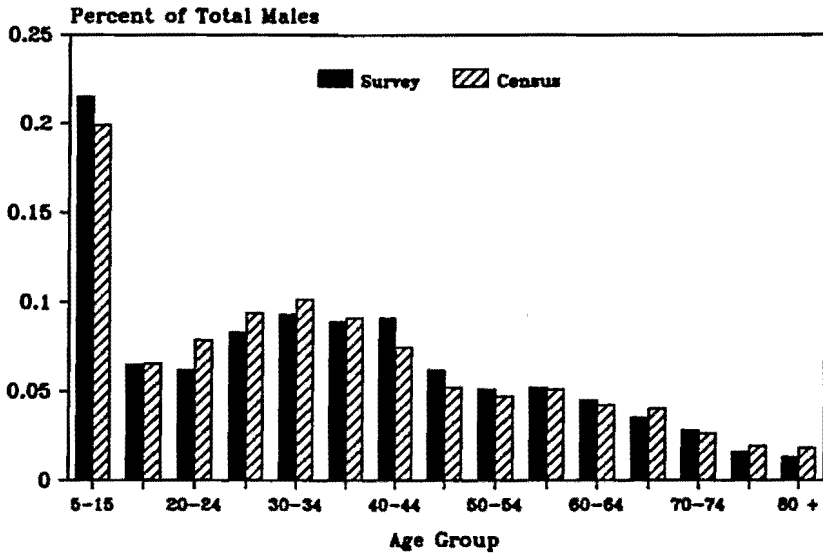


Figure D-2
 Distribution of Females by Age Group
 Census vs. Expanded Survey

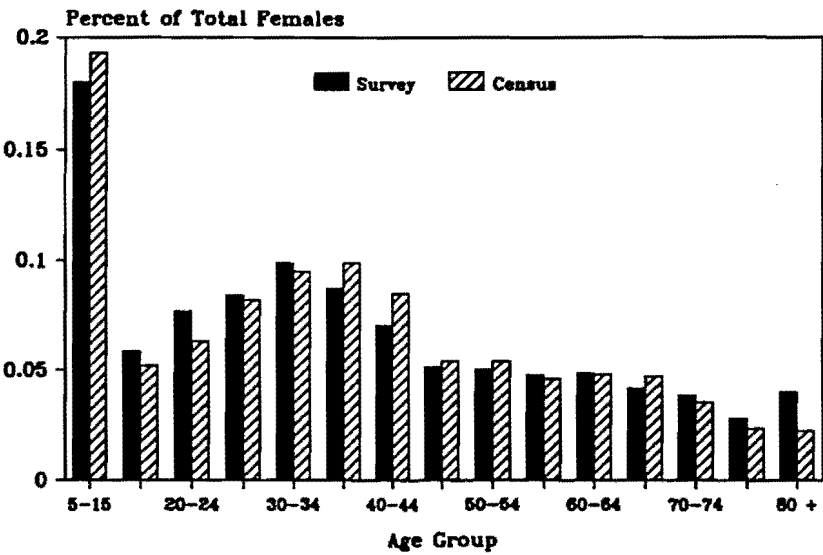


Figure D-3
 Distribution of Males by Age Group
 Census vs. Expanded Survey

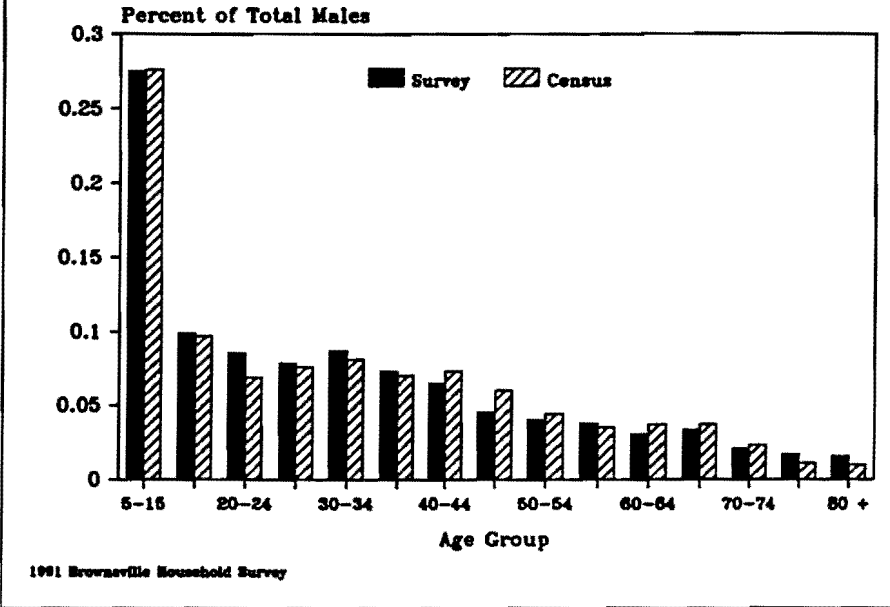


Figure D-4
 Distribution of Females by Age Group
 Census vs. Expanded Survey

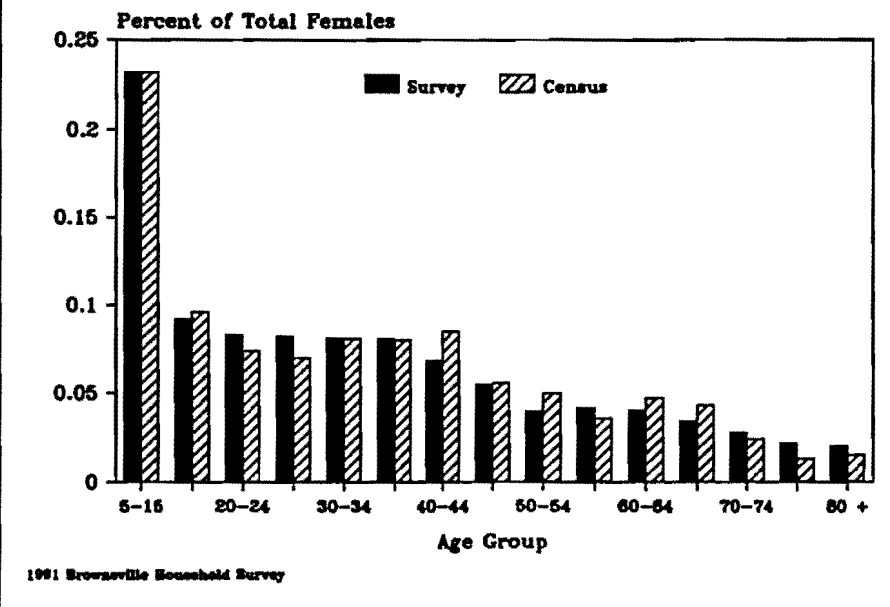
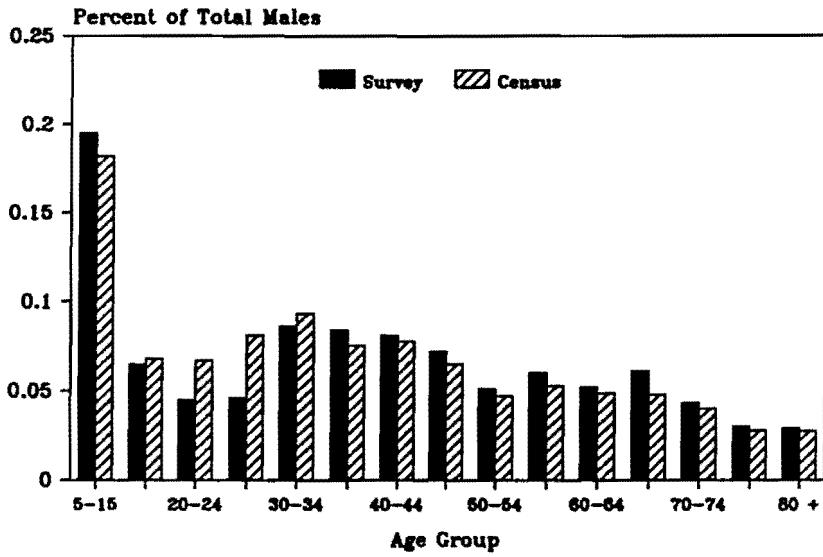
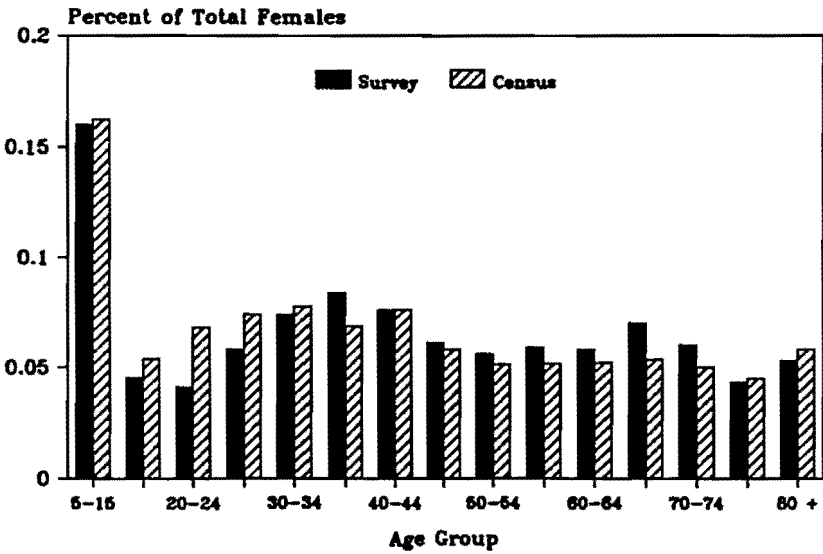


Figure D - 5
 Distribution of Males by Age Group
 Census vs. Expanded Survey



1991 Sherman-Deinon Household Survey

Figure D - 6
 Distribution of Females by Age Group
 Census vs. Expanded Survey



1991 Sherman-Deinon Household Survey

Figure D - 7
 Distribution of Males by Age Group
 Census vs. Expanded Survey

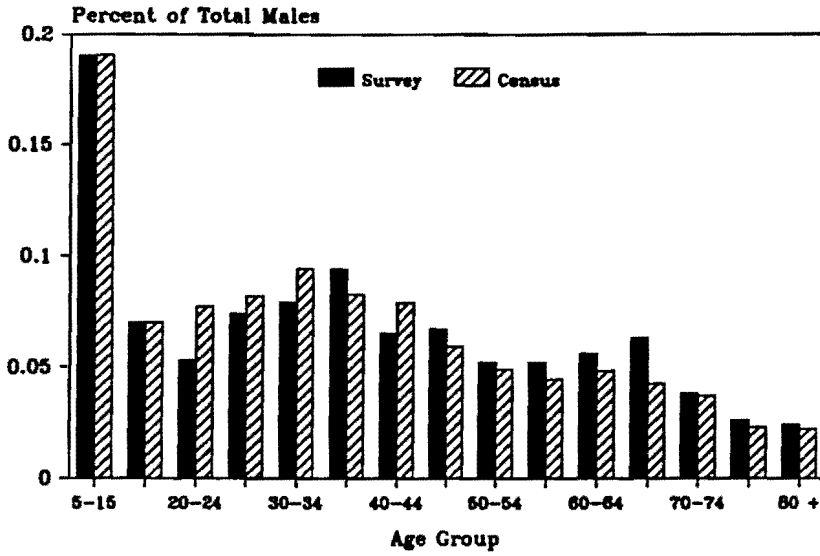


Figure D - 8
 Distribution of Females by Age Group
 Census vs. Expanded Survey

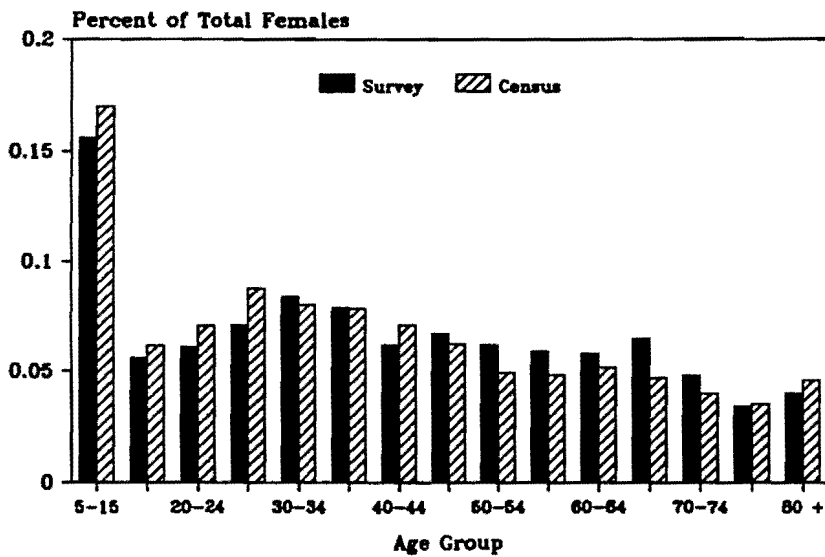
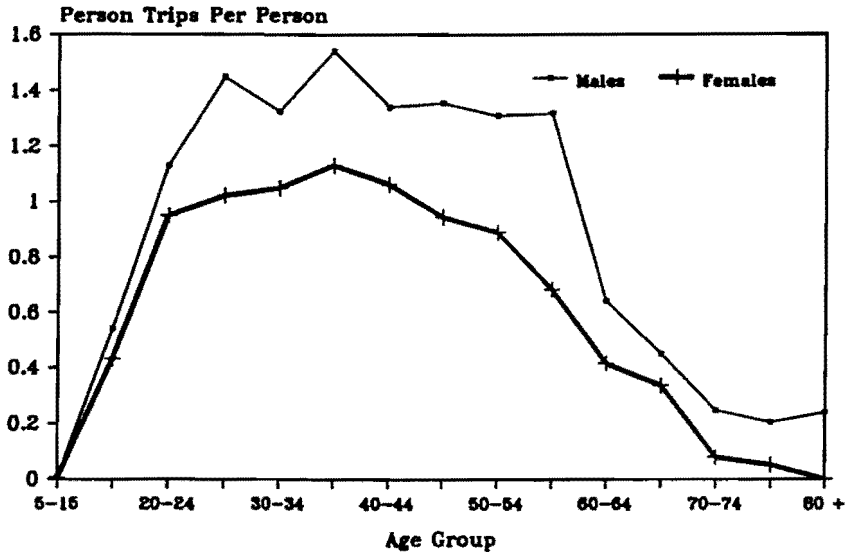
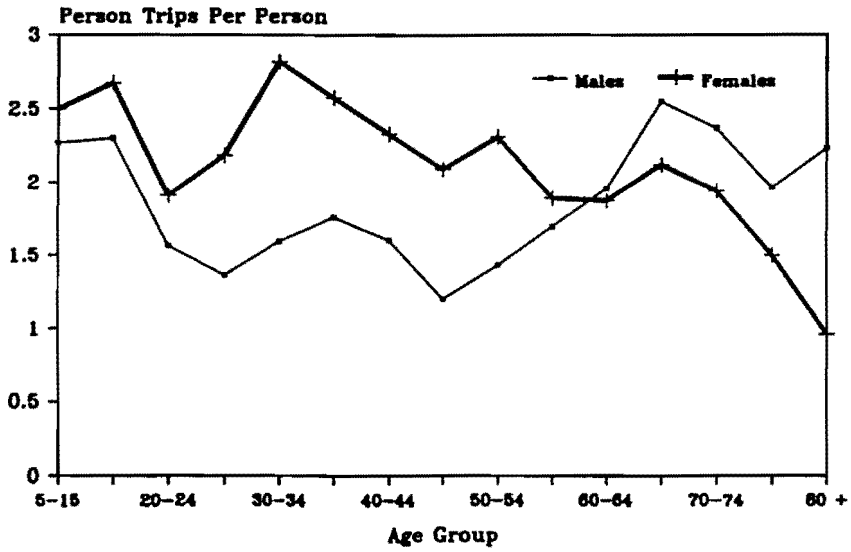


Figure D - 9
Home Based Work
Person Trips Per Person



1990 Amarillo Household Survey

Figure D - 10
Home Based Non-Work
Person Trips Per Person



1990 Amarillo Household Survey

Figure D - 11
 Non-Home Based
 Person Trips Per Person

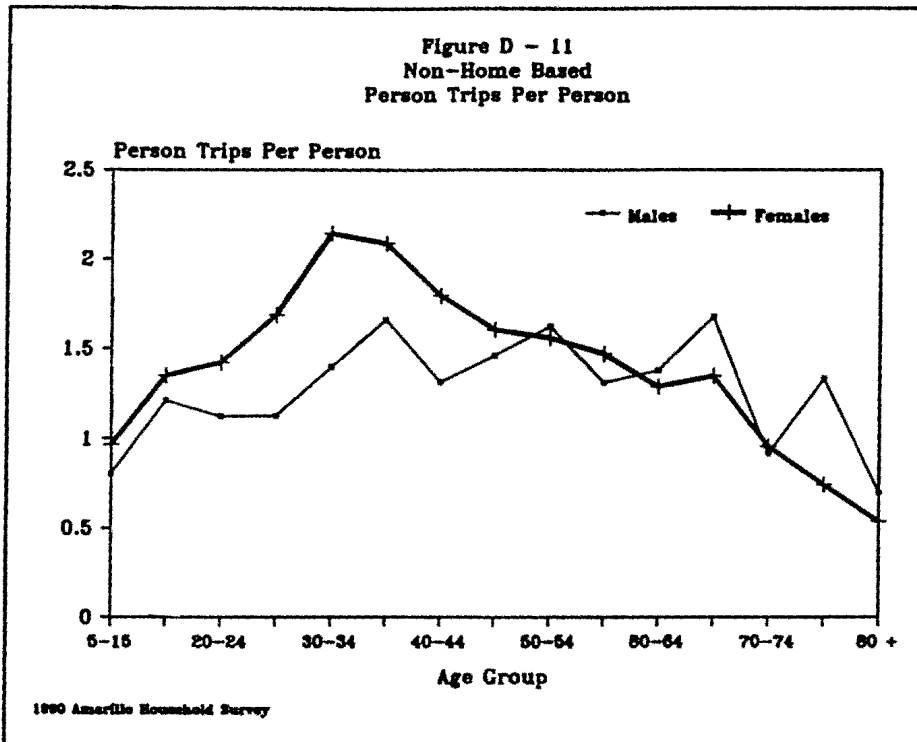


Figure D - 12
 All Purposes Combined
 Person Trips Per Person

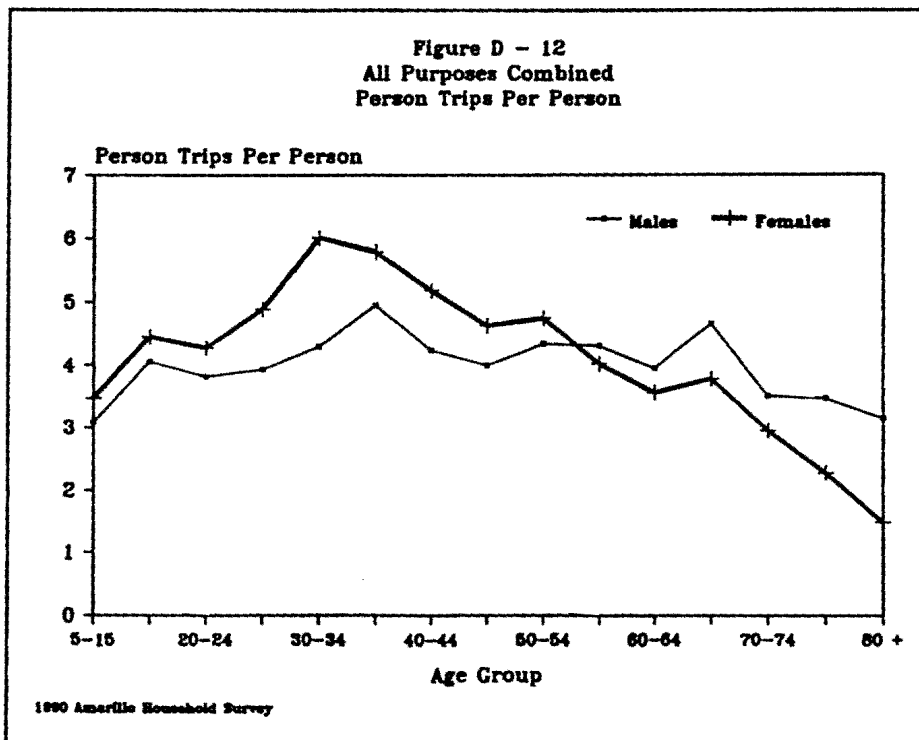


Figure D - 13
Home Based Work
Auto Driver Trips Per Person

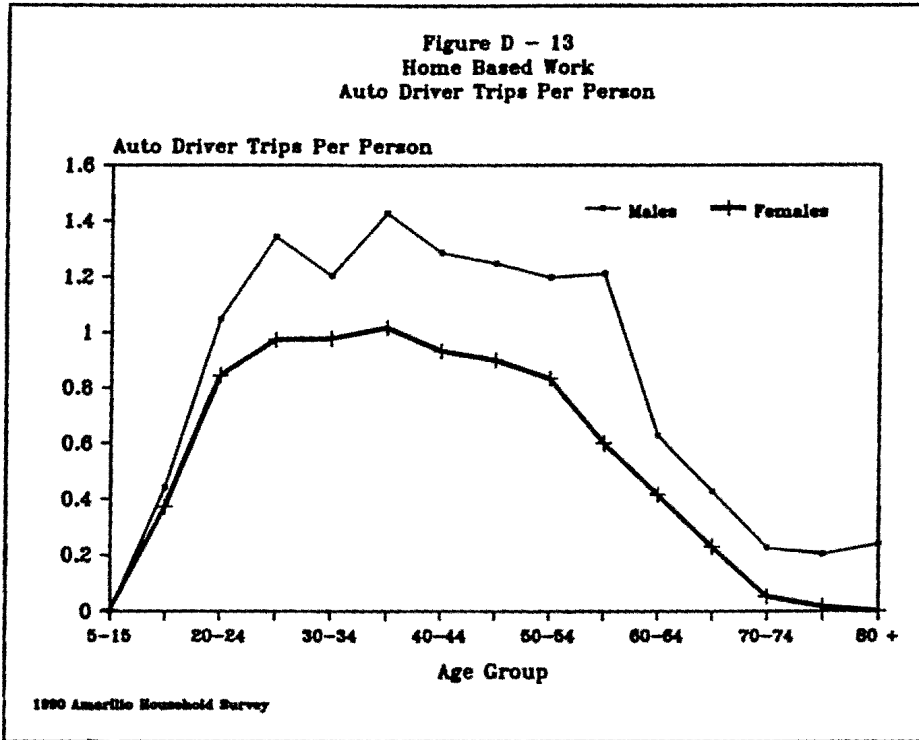


Figure D - 14
Home Based Non-Work
Auto Driver Trips Per Person

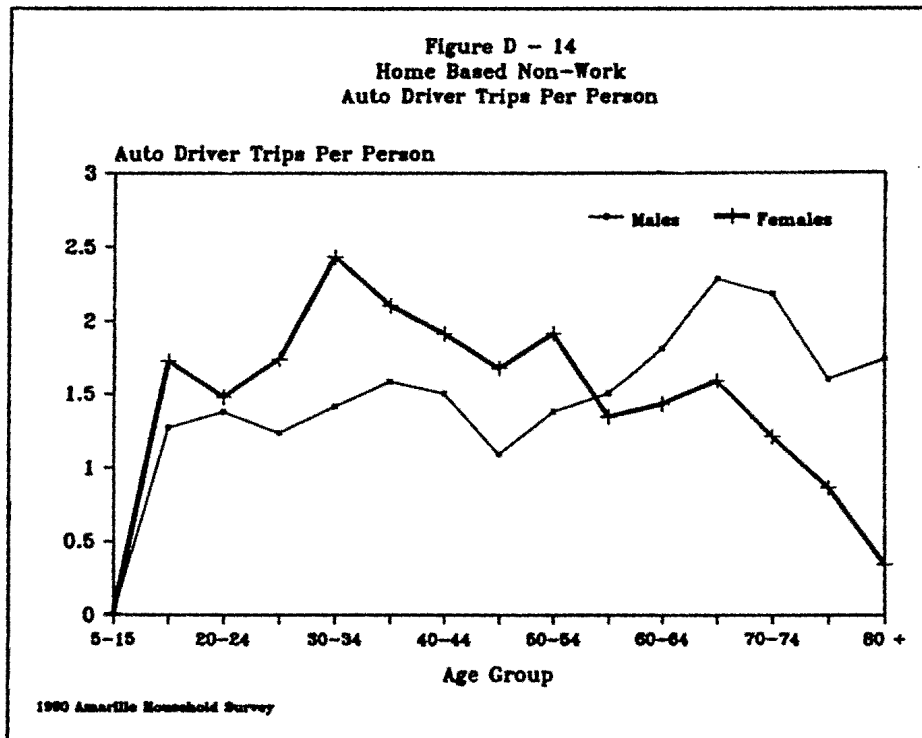


Figure D - 15
 Non-Home Based
 Auto Driver Trips Per Person

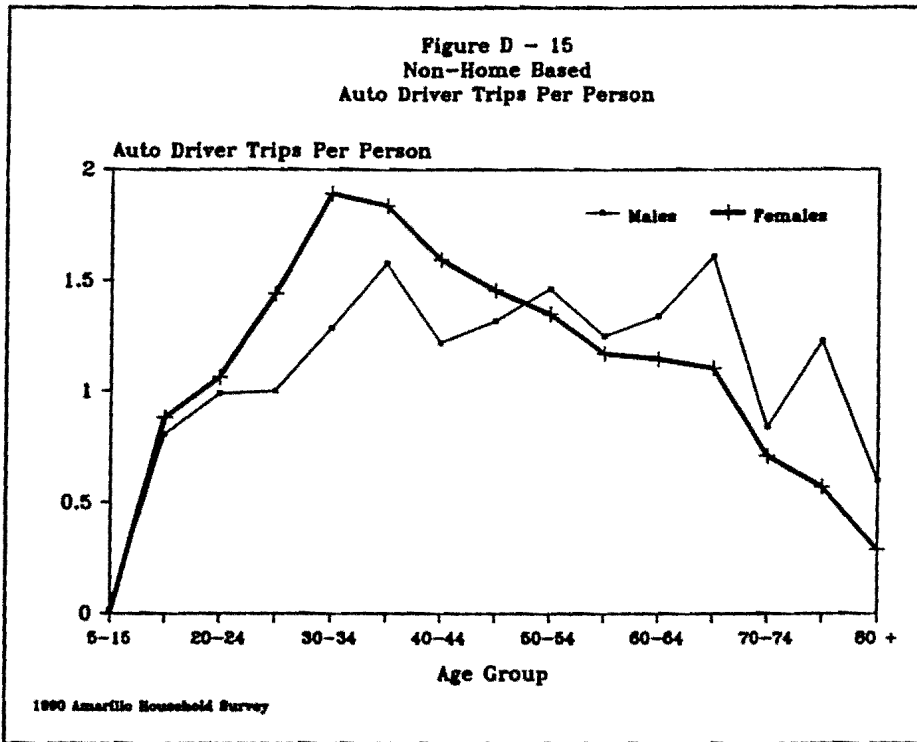


Figure D - 16
 All Purposes Combined
 Auto Driver Trips Per Person

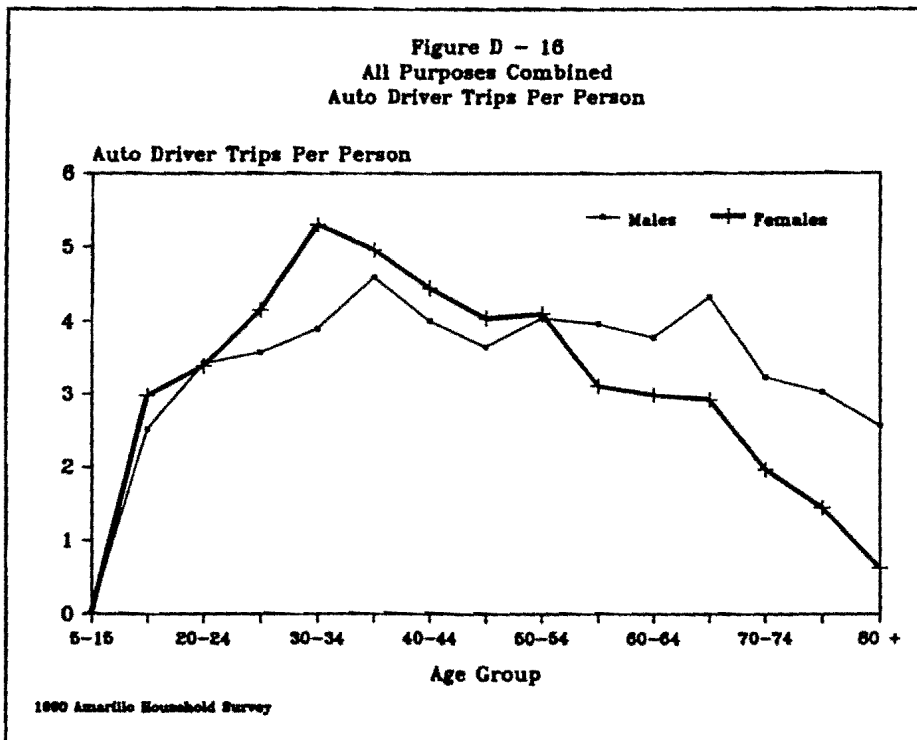


Figure D - 17
 Proportion of Persons in Each Age Group
 Recording Zero Home Based Work Trips

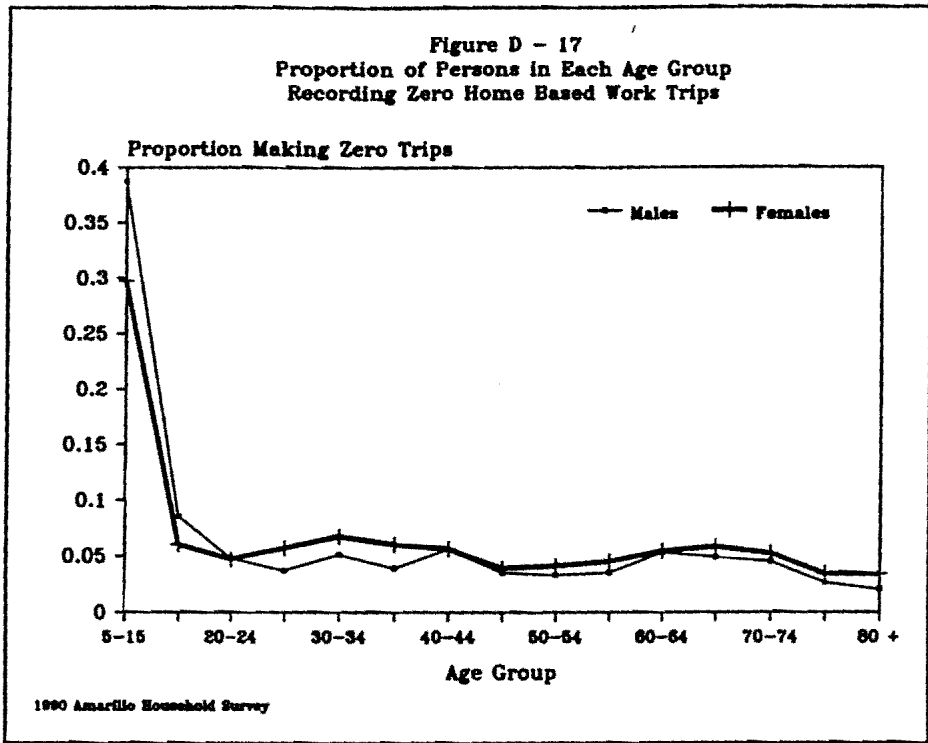


Figure D - 18
 Proportion of Persons in Each Age Group
 Recording Zero Home Based Non-Work Trips

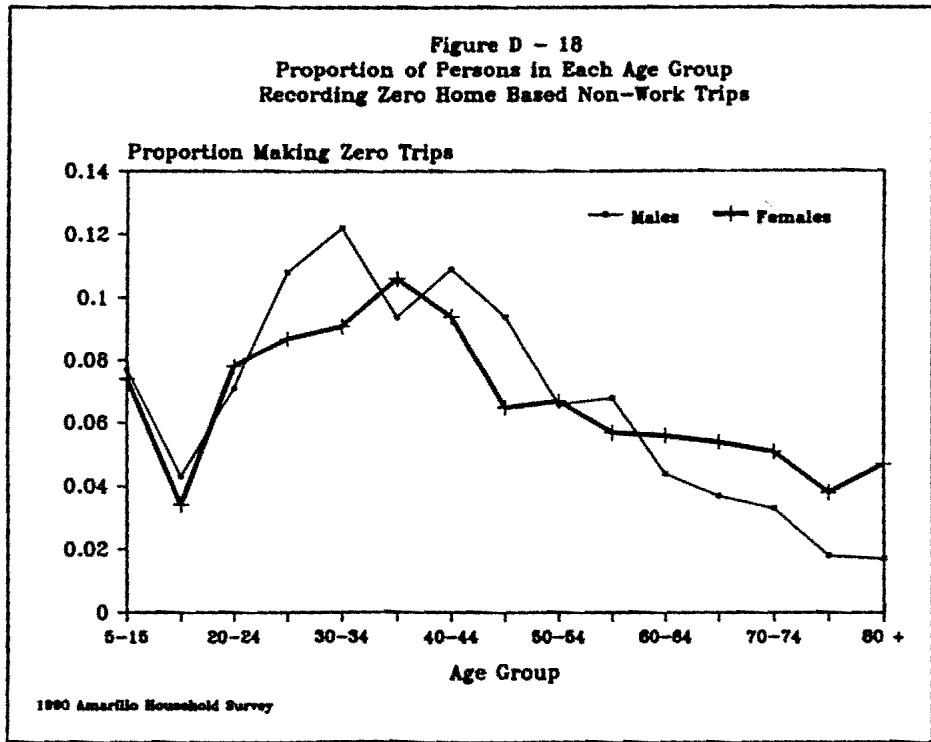
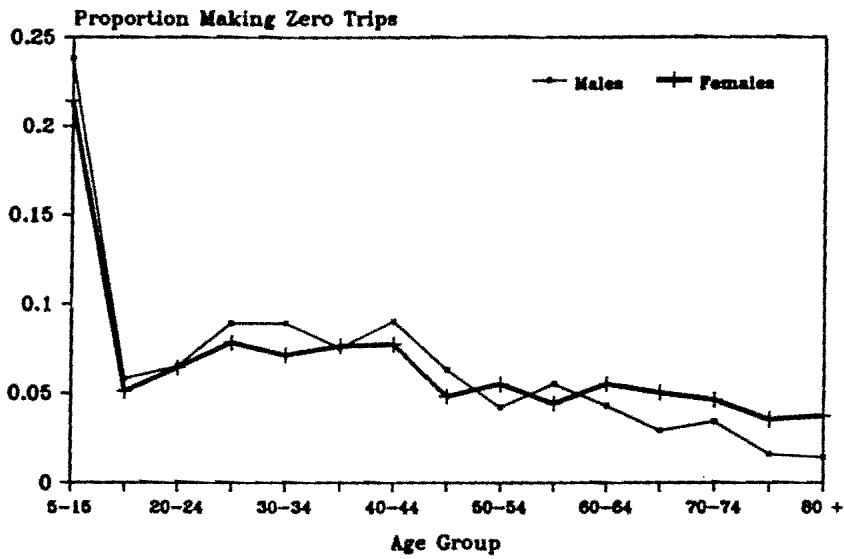
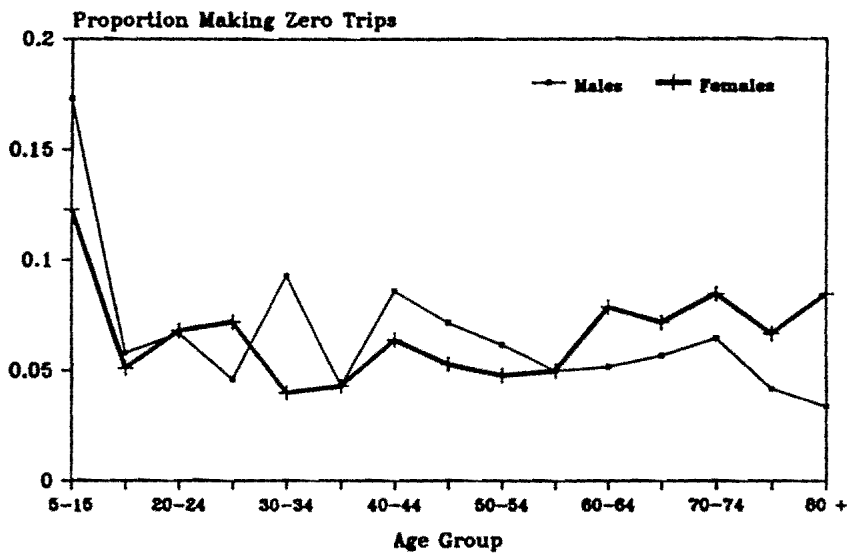


Figure D - 19
 Proportion of Persons in Each Age Group
 Recording Zero Non-Home Based Trips



1980 Amarillo Household Survey

Figure D - 20
 Proportion of Persons in Each Age Group
 Recording Zero Trips - All Purposes



1980 Amarillo Household Survey

Figure D-21
Home Based Work
Person Trips Per Person

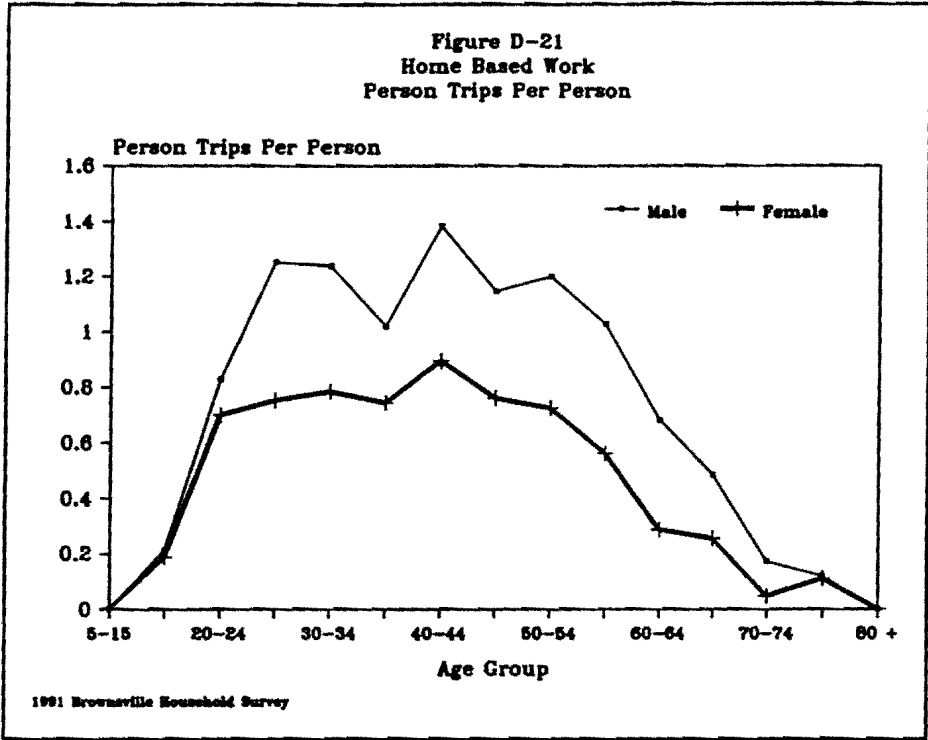


Figure D-22
Home Based Non-Work
Person Trips Per Person

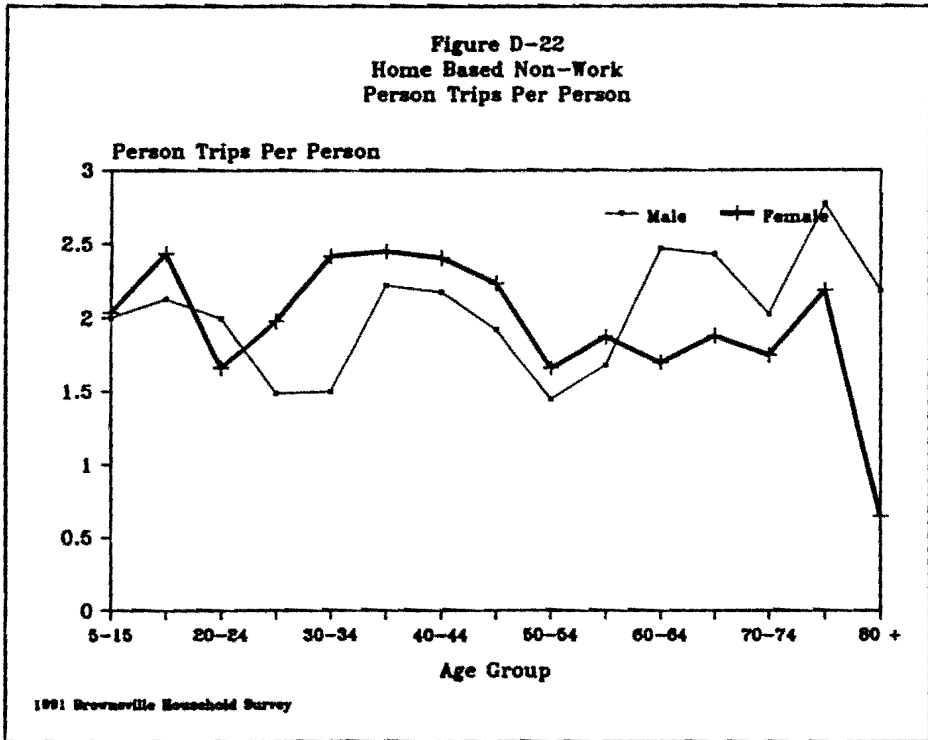


Figure D-23
Non-Home Based
Person Trips Per Person

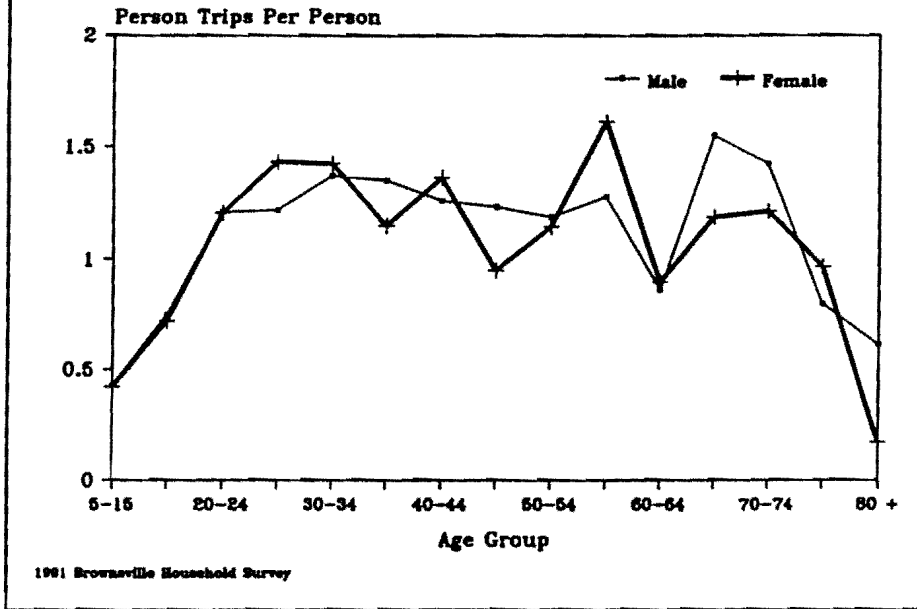


Figure D-24
All Purposes Combined
Person Trips Per Person

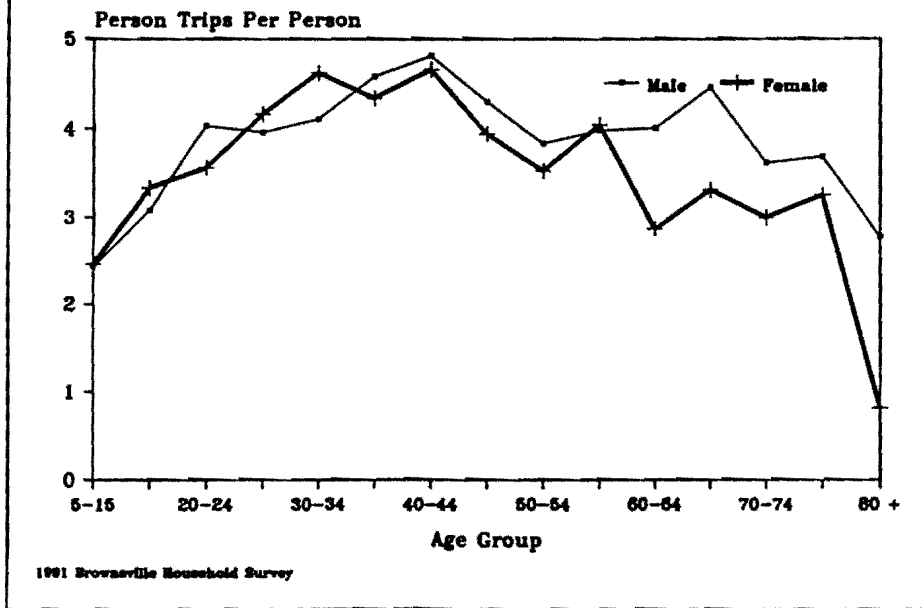


Figure D-25
Home Based Work
Auto Driver Trips Per Person

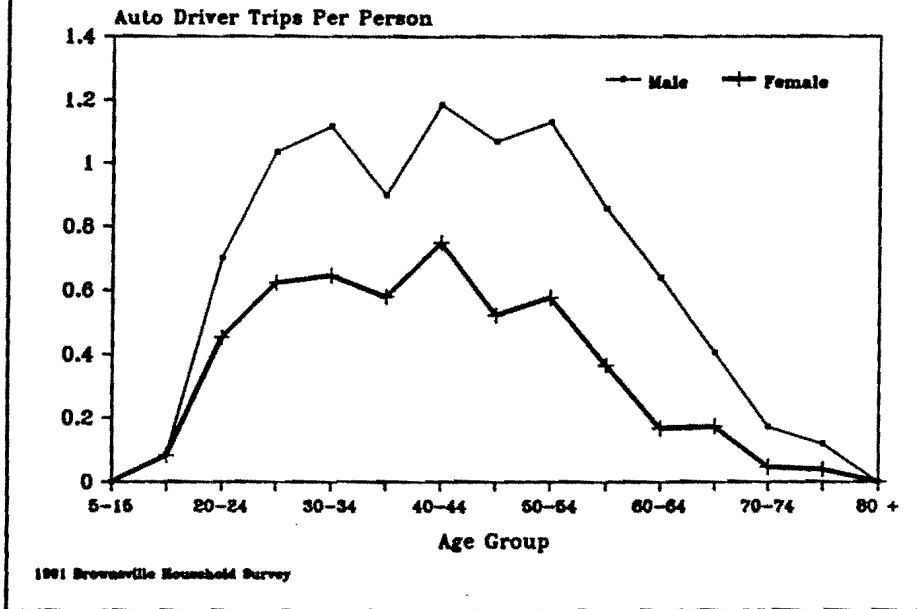


Figure D-28
Home Based Non-Work
Auto Driver Trips Per Person

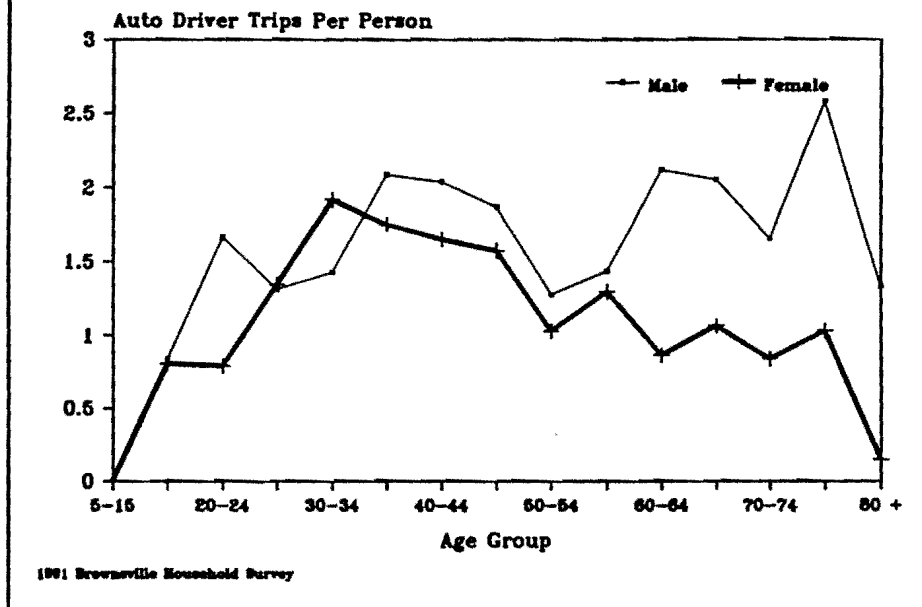


Figure D-27
 Non-Home Based
 Auto Driver Trips Per Person

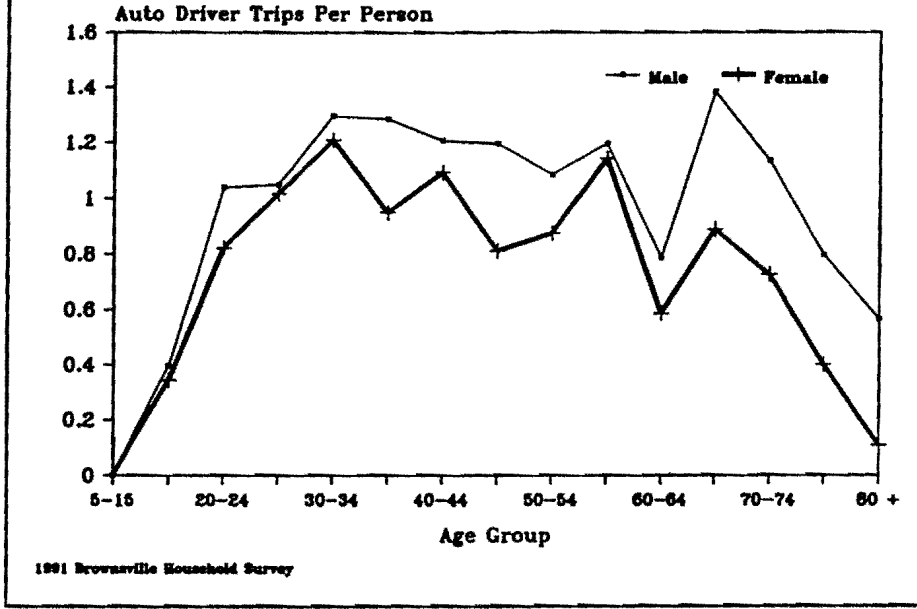


Figure D-28
 All Purposes Combined
 Auto Driver Trips Per Person

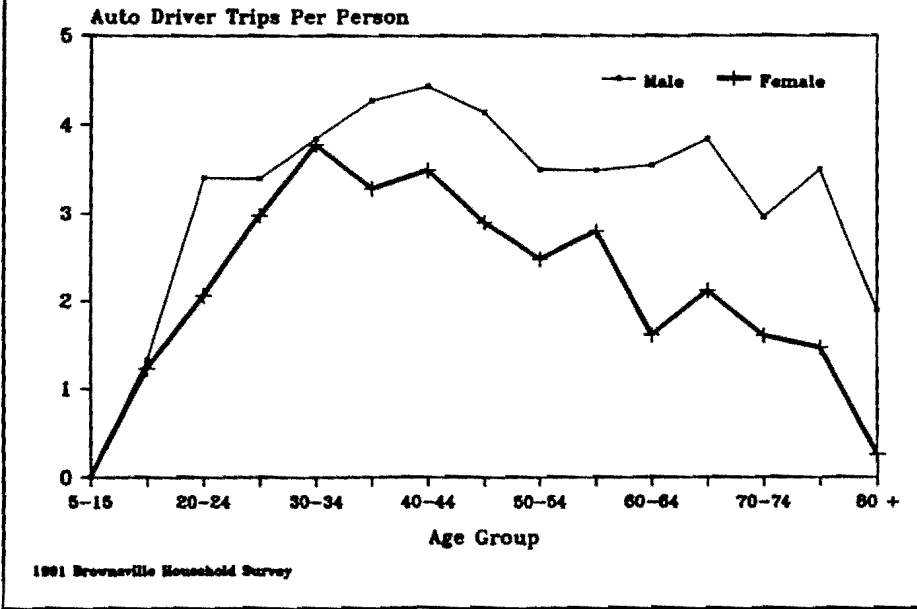


Figure D-29
 Percentage of Persons in Each Age Group
 Recording Zero Home Based Work Trips

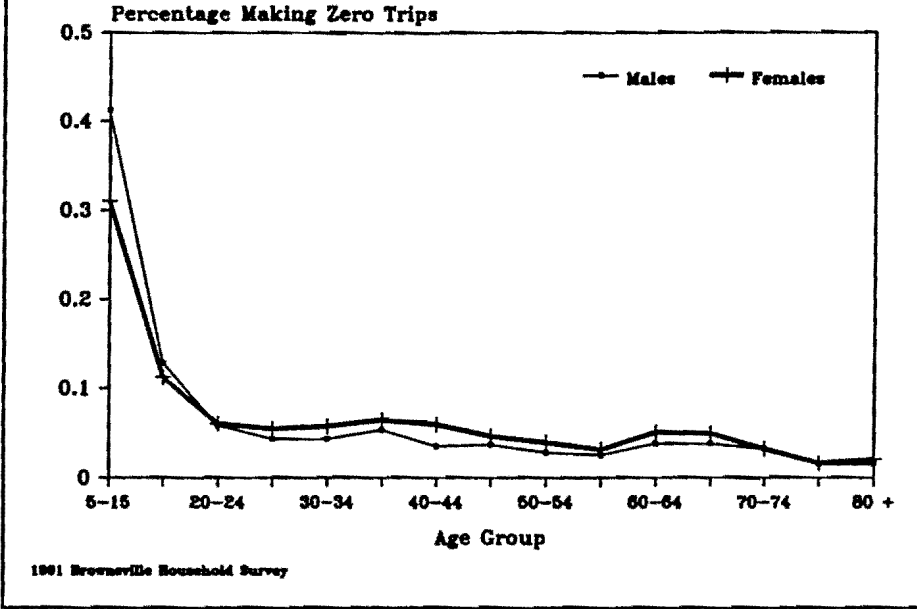


Figure D-30
 Percentage of Persons in Each Age Group
 Recording Zero Home Based Non-Work Trips

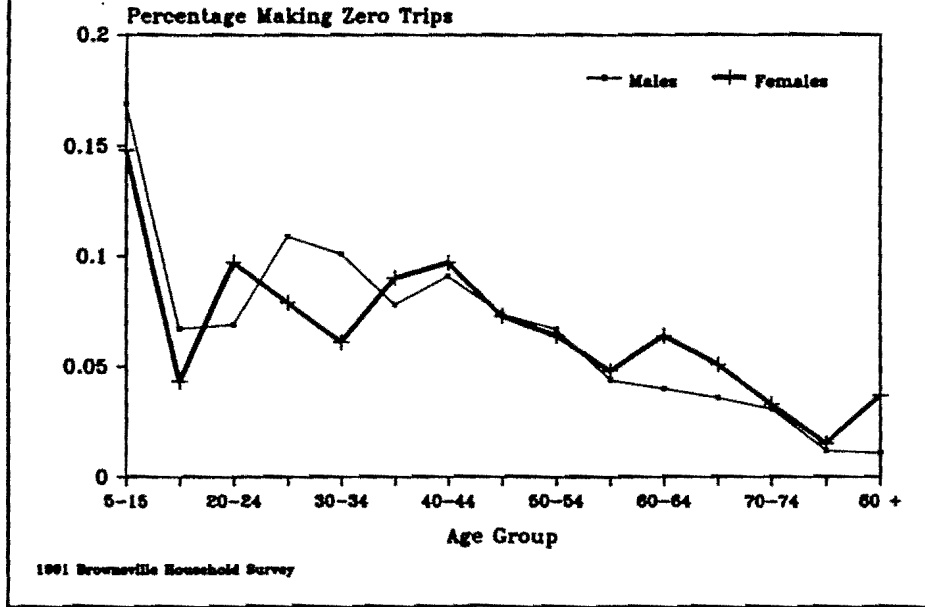


Figure D-31
 Percentage of Persons in Each Age Group
 Recording Zero Non-Home Based Trips

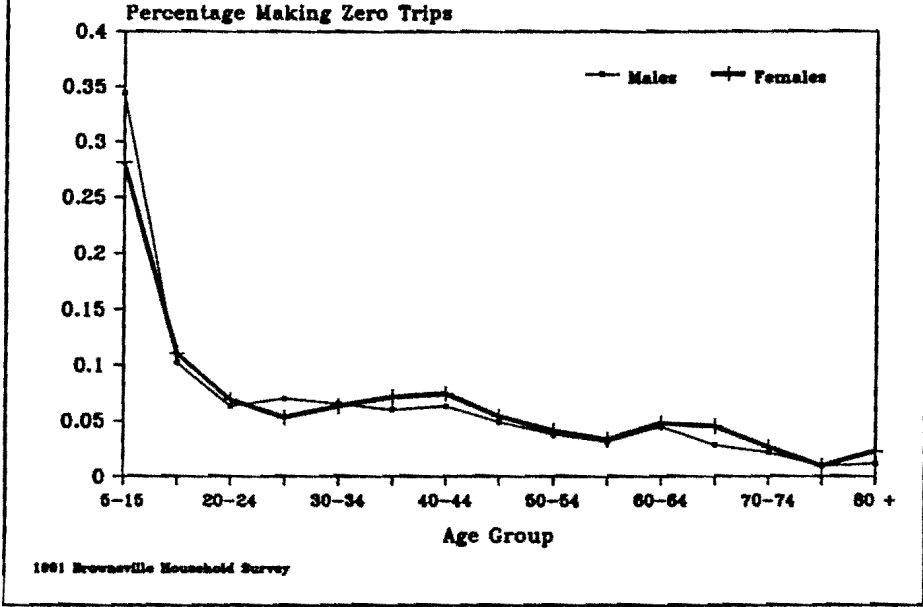


Figure D-32
 Percentage of Persons in Each Age Group
 Recording Zero Trips - All Purposes

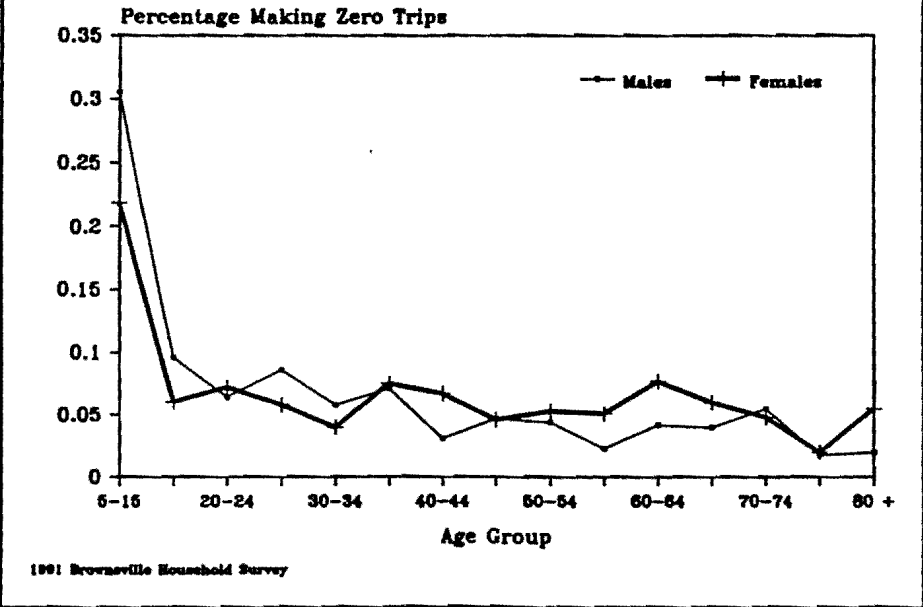


Figure D-33
Home Based Work
Person Trips Per Person

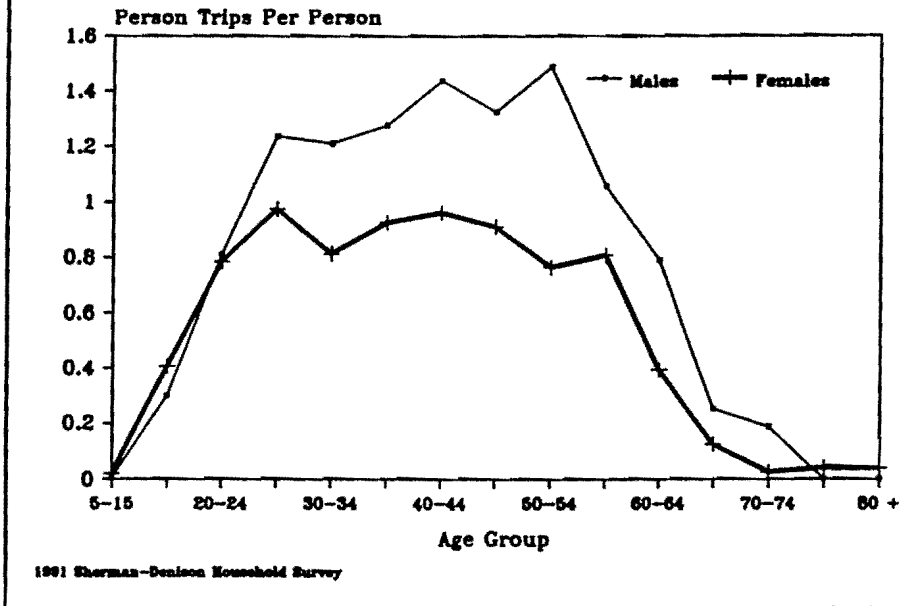


Figure D-34
Home Based Non-Work
Person Trips Per Person

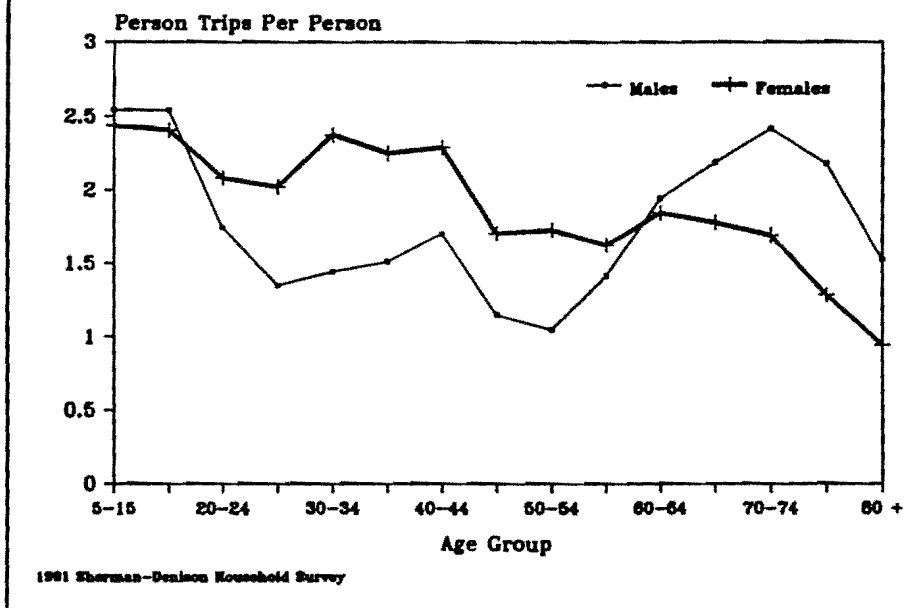


Figure D-35
 Non-Home Based
 Person Trips Per Person

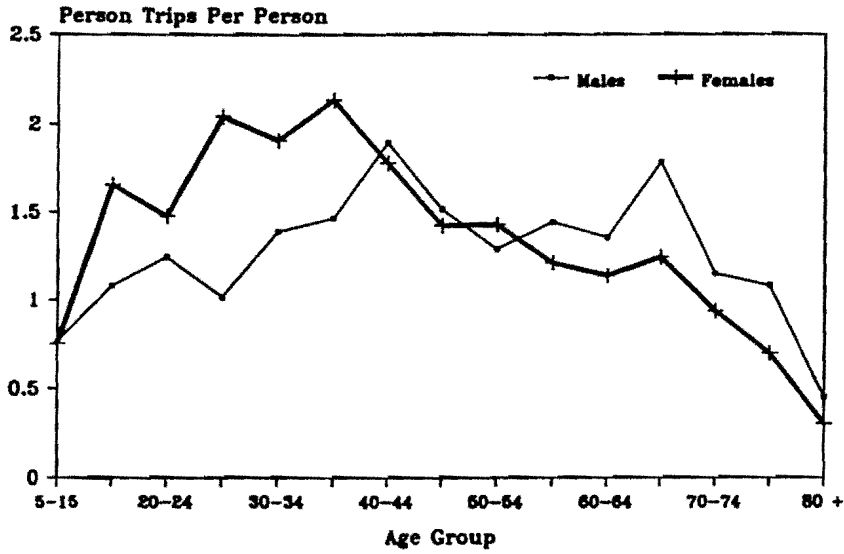


Figure D-36
 All Purposes Combined
 Person Trips Per Person

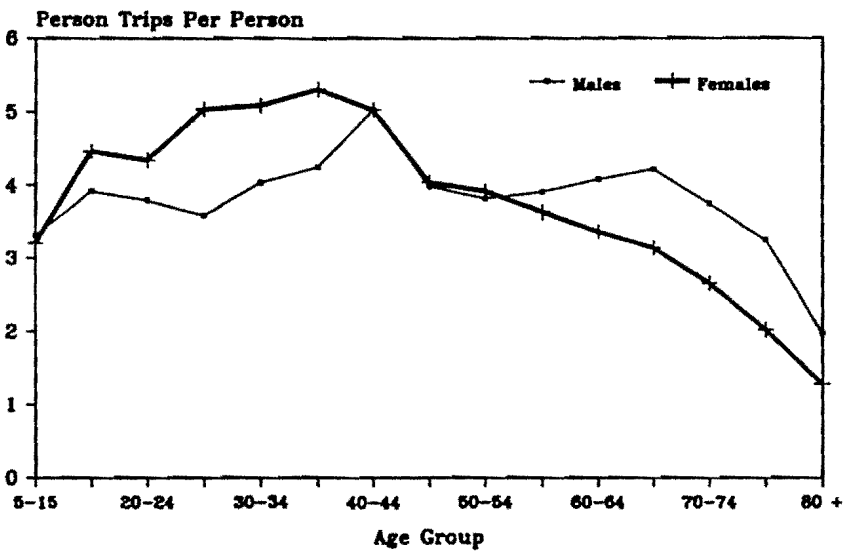


Figure D-37
Home Based Work
Auto Driver Trips Per Person

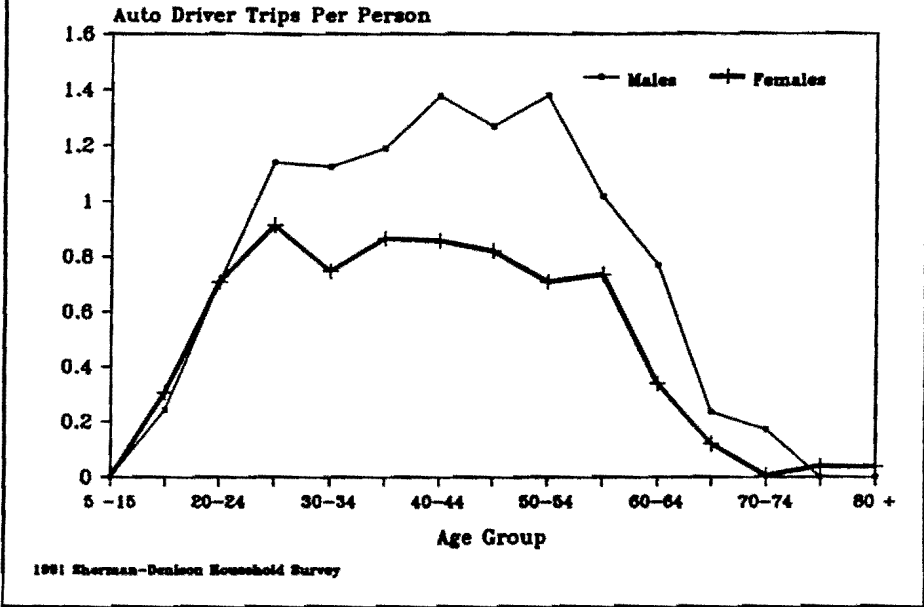


Figure D-38
Home Based Non-Work
Auto Driver Trips Per Person

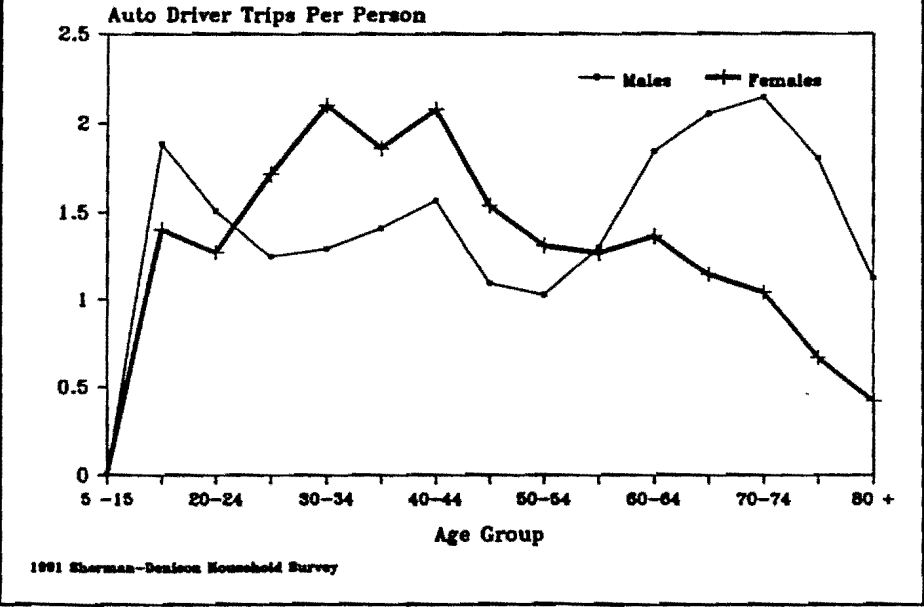


Figure D-39
 Non-Home Based
 Auto Driver Trips Per Person

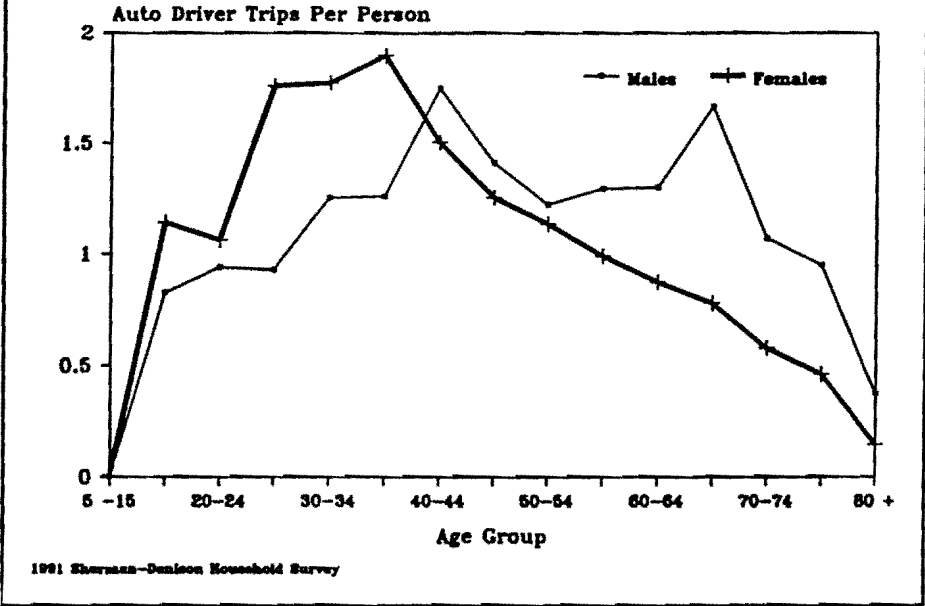


Figure D-40
 All Purposes Combined
 Auto Driver Trips Per Person

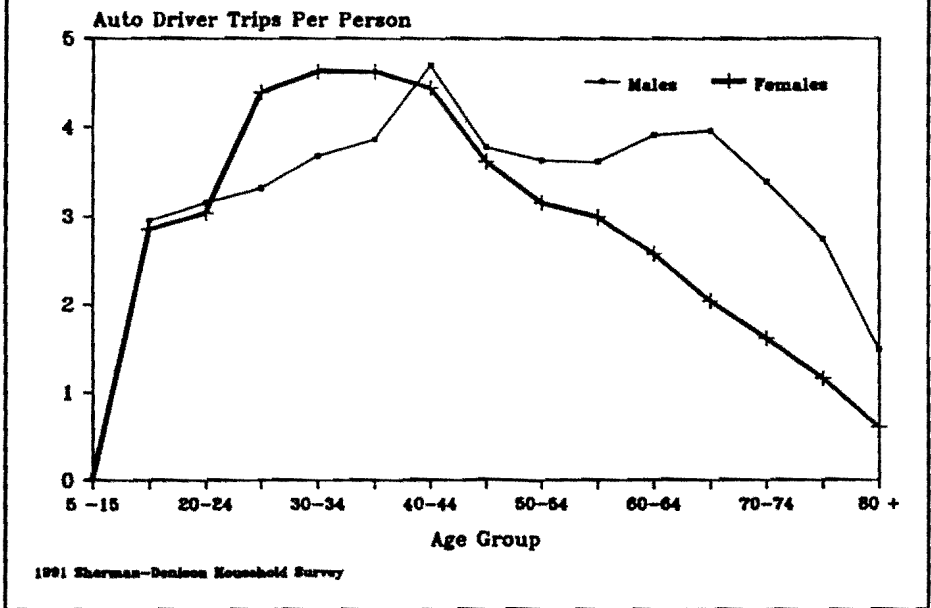


Figure D-41
 Proportion of Persons in Each Age Group
 Recording Zero Home Based Work Trips

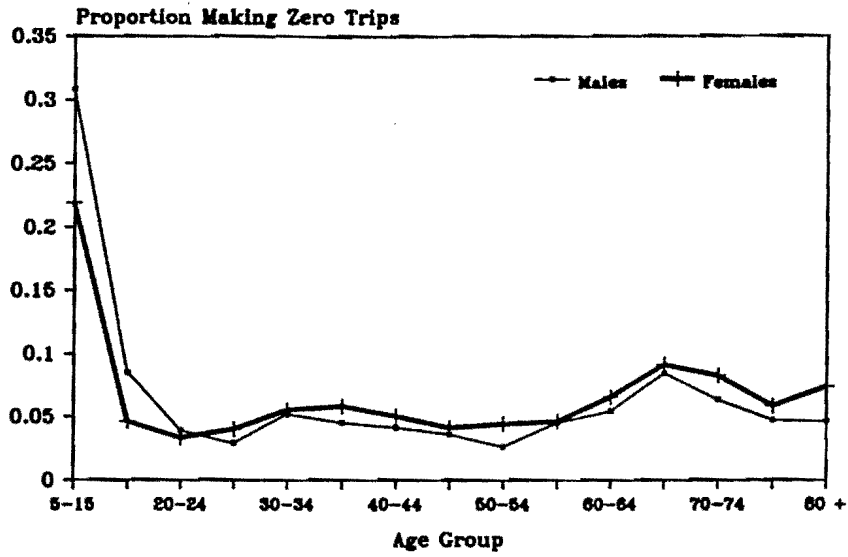


Figure D-42
 Proportion of Persons in Each Age Group
 Recording Zero Home Based Non-Work Trips

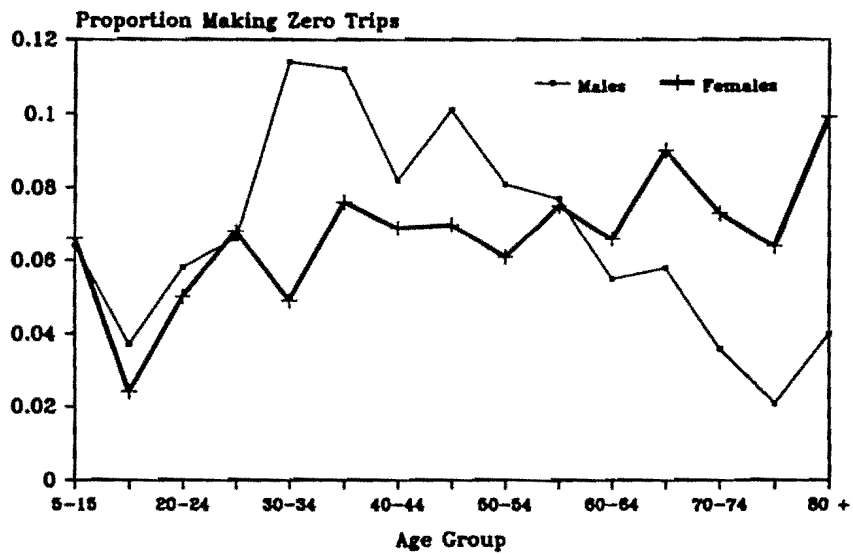


Figure D-43
 Proportion of Persons in Each Age Group
 Recording Zero Non-Home Based Trips

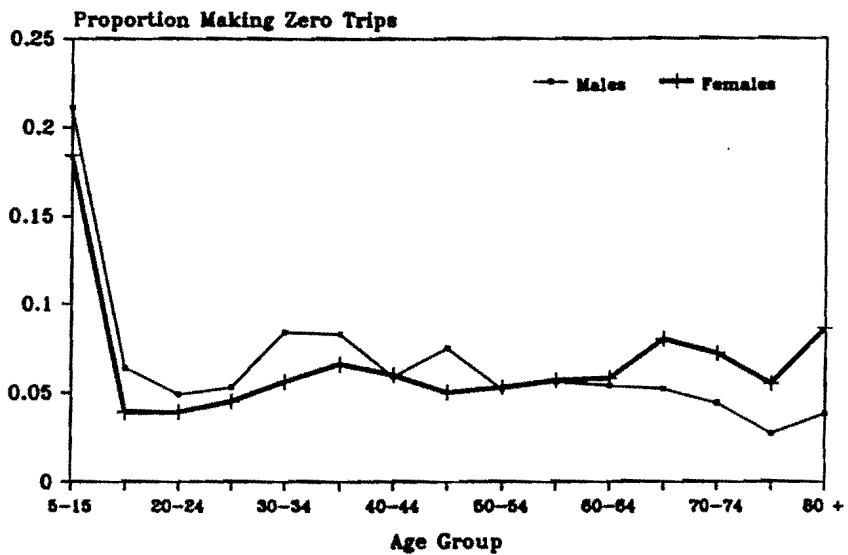


Figure D-44
 Proportion of Persons in Each Age Group
 Recording Zero Trips - All Purposes

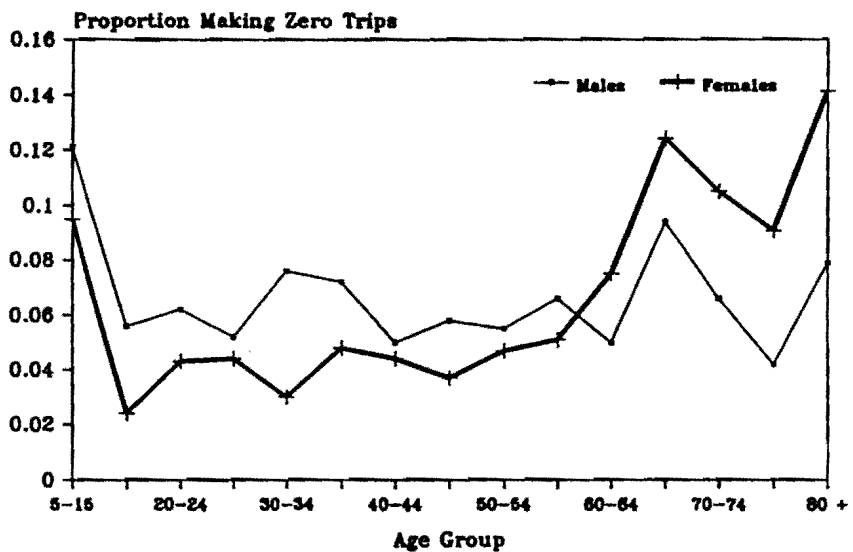


Figure D - 45
Home Based Work
Person Trips Per Person

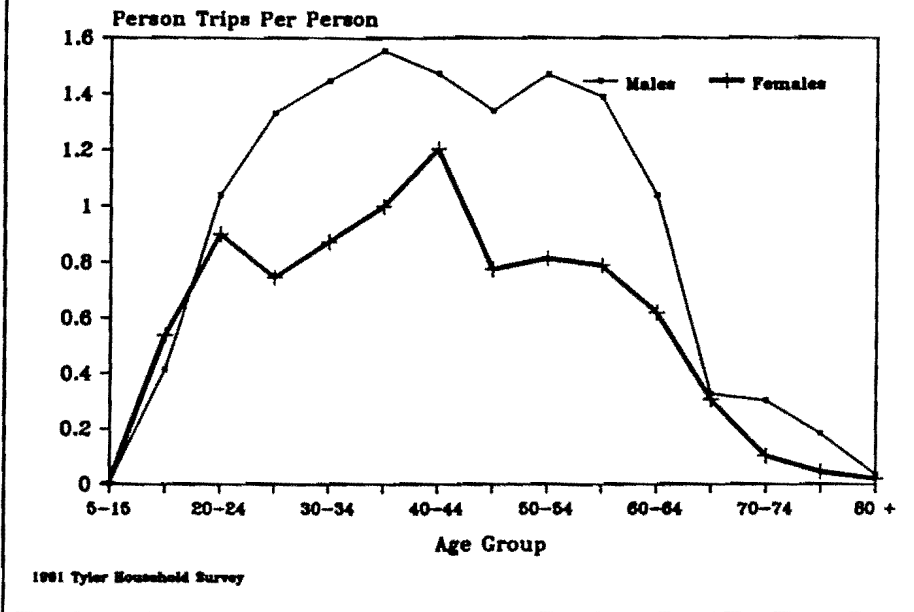


Figure D - 46
Home Based Non-Work
Person Trips Per Person

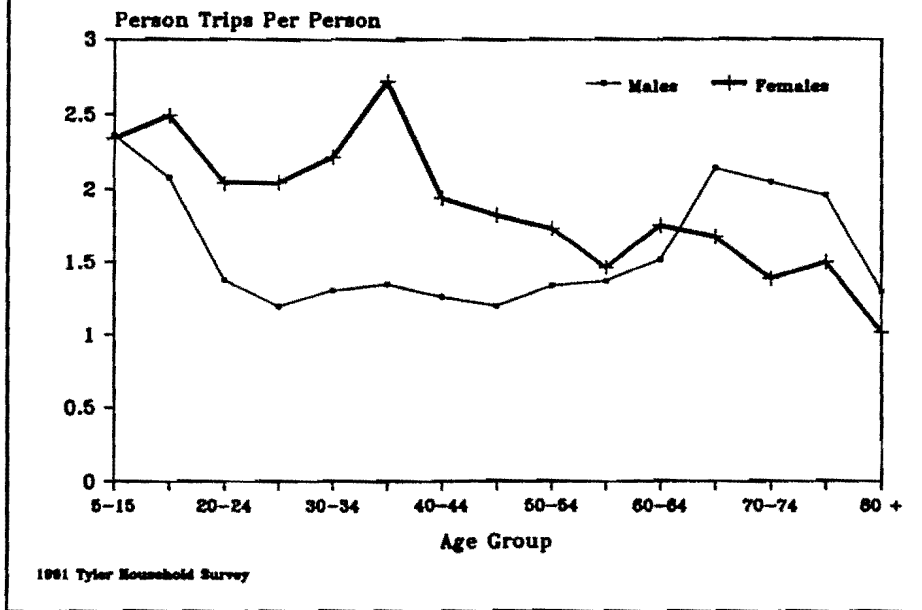
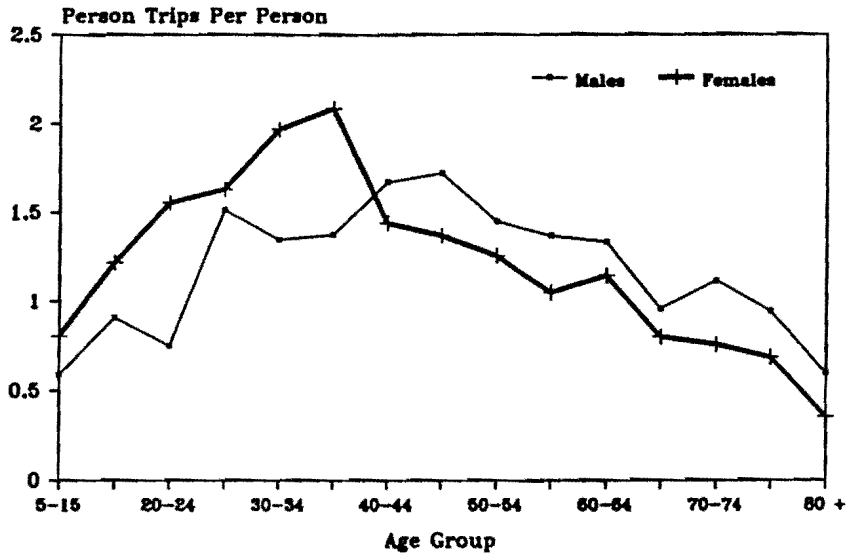
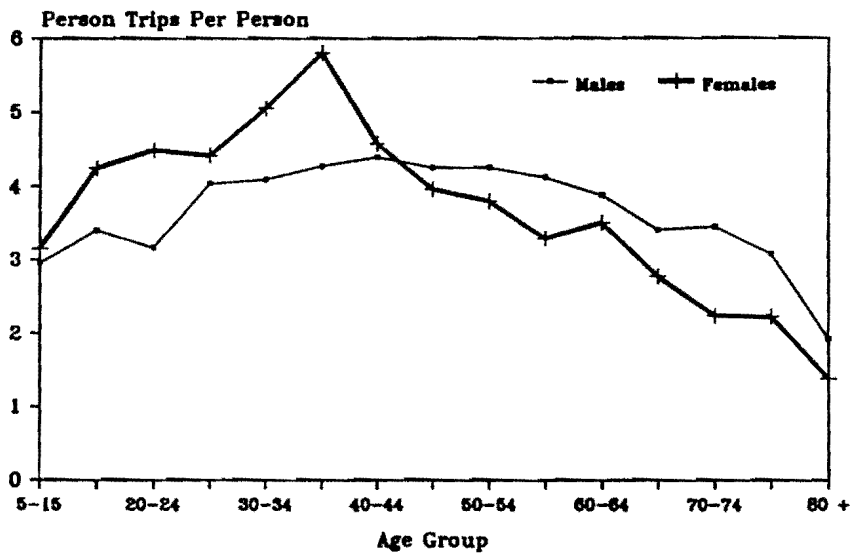


Figure D - 47
 Non-Home Based
 Person Trips Per Person



1991 Tyler Household Survey

Figure D - 48
 All Purposes Combined
 Person Trips Per Person



1991 Tyler Household Survey

Figure D - 49
Home Based Work
Auto Driver Trips Per Person

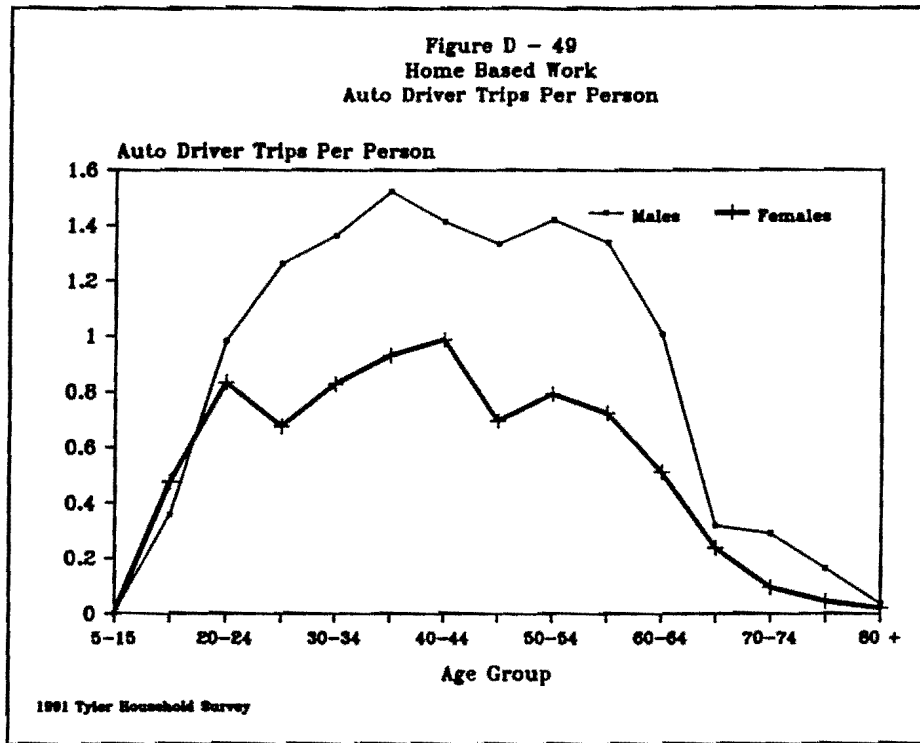


Figure D - 50
Home Based Non-Work
Auto Driver Trips Per Person

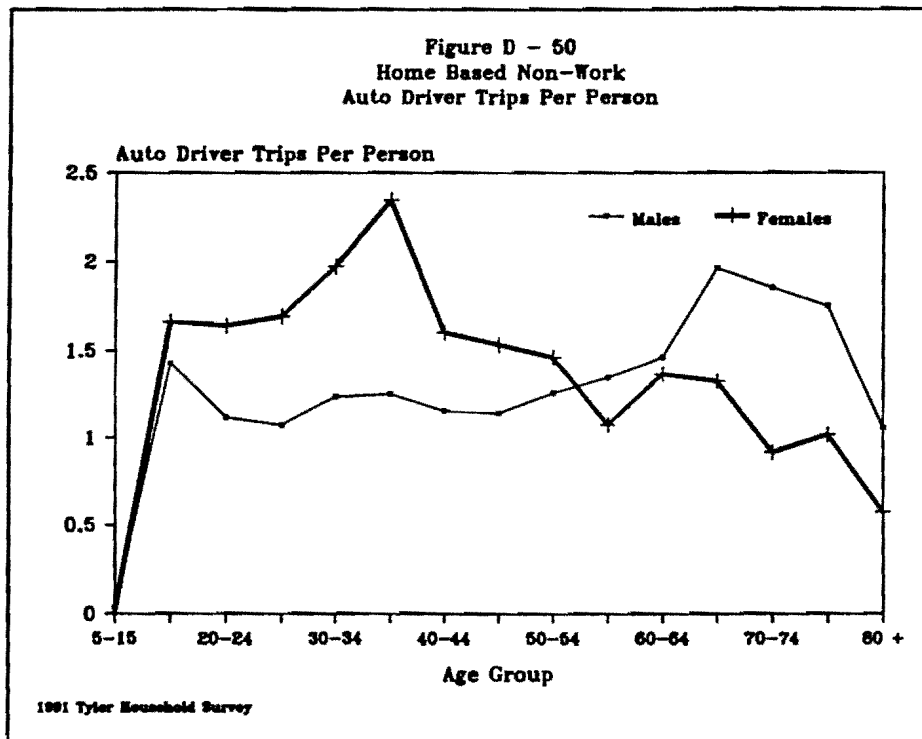


Figure D - 51
 Non-Home Based
 Auto Driver Trips Per Person

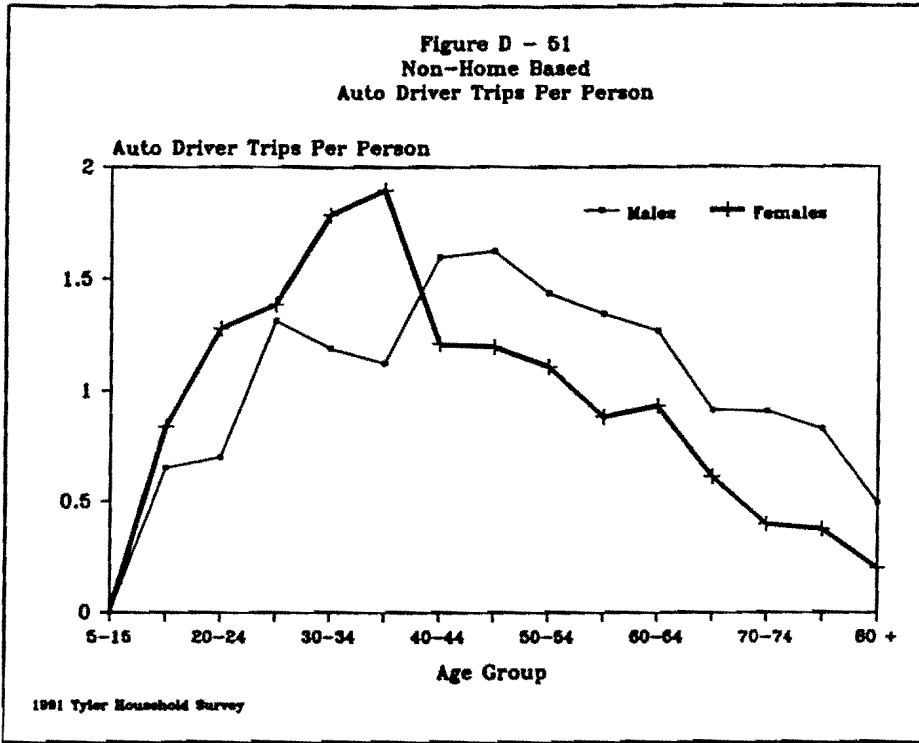


Figure D - 52
 All Purposes Combined
 Auto Driver Trips Per Person

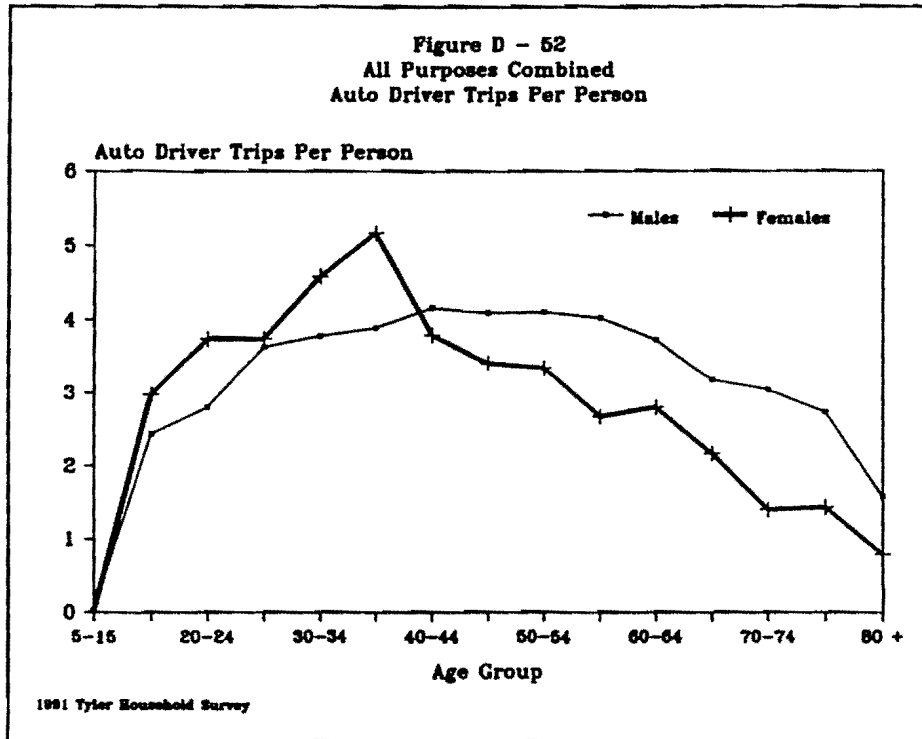


Figure D - 53
 Proportion of Persons in Each Age Group
 Recording Zero Home Based Work Trips

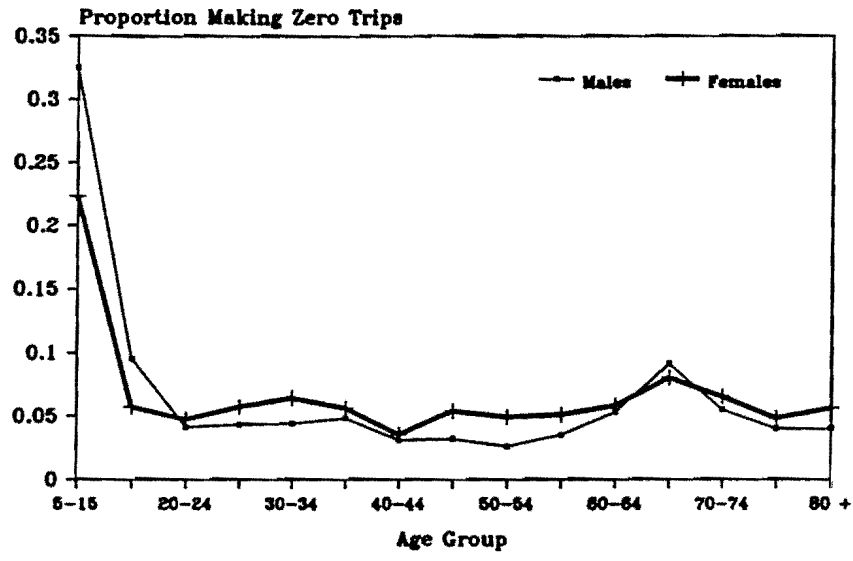


Figure D - 54
 Proportion of Persons in Each Age Group
 Recording Zero Home Based Non-Work Trips

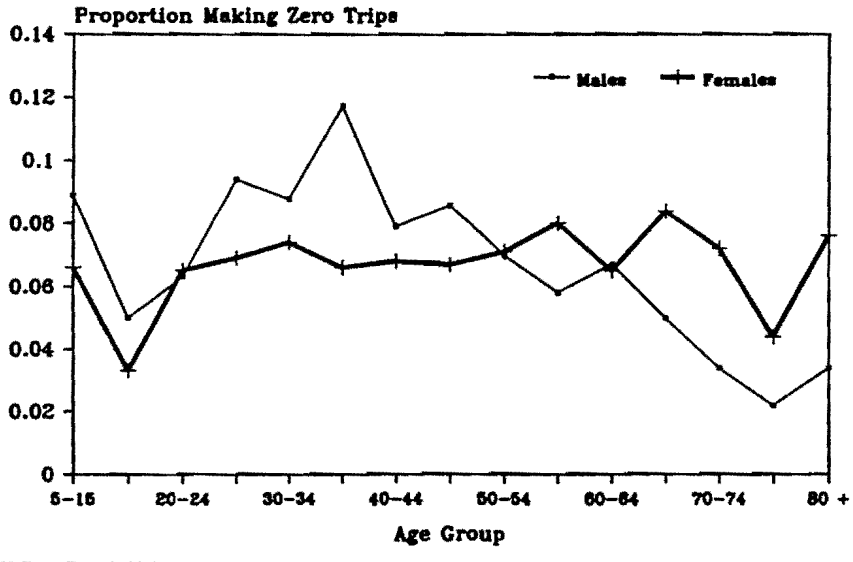
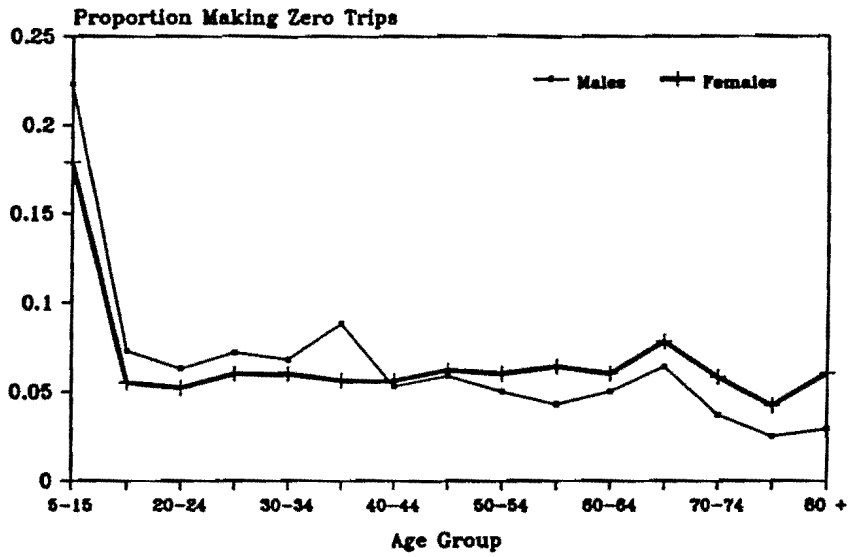
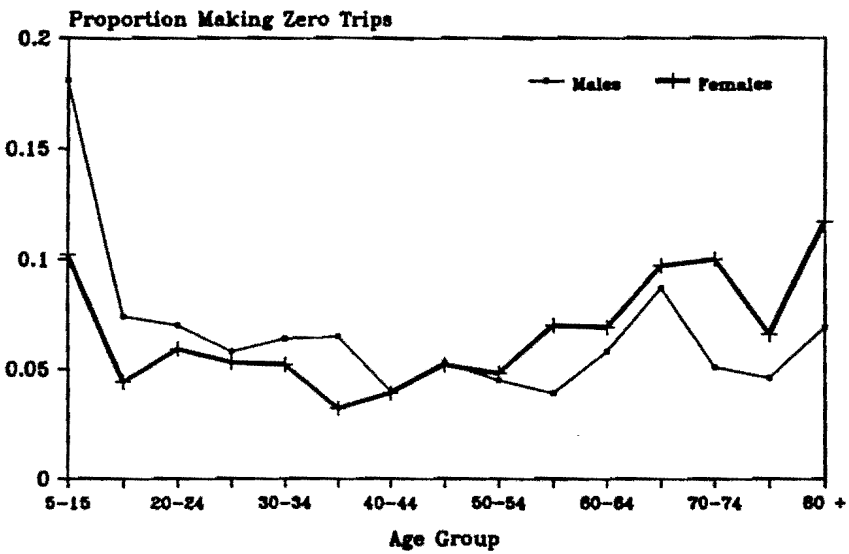


Figure D - 55
 Proportion of Persons in Each Age Group
 Recording Zero Non-Home Based Trips



1981 Tyler Household Survey

Figure D - 56
 Proportion of Persons in Each Age Group
 Recording Zero Trips - All Purposes



1981 Tyler Household Survey

APPENDIX E

Methodology for Smoothing Household Trip Rates

Methodology for Smoothing Household Trip Rates

Because surveys were small sample surveys and the trip rates were stratified by household size and household income, the resulting trip rates were found to have some inconsistencies and some of the stratification cells had a limited number of observations. For the two-way stratification being used, it was expected that trip rates would increase as household size increased and also as household income increased. For the most part, this was observed in the stratified trip rates. (See Tables through in the main body of the report). Inconsistencies and cells with few observations are typically adjusted by some method of smoothing the trip rates and/or combining the data for adjacent cells within the stratifications.

A methodology was subsequently developed to smooth the raw trip rates observed in the surveys. The methodology was based on the following assumptions:

- Trip rates are expected to increase or remain stable as household size and household income increases; and
- The estimates of the weighted average trip rates by row (household income categories) and column (household size categories) are the best available, and the smoothed (i.e., adjusted) trip rates should replicate those estimates as closely as possible.
- The total weighted average trips per household is the best estimate available and should be the same for both the raw and smoothed trip rates.

Using the above assumptions, a methodology was developed to smooth the trip rates while insuring that the weighted averages by row and column for each urban area produced the same (or as close as possible) number of trips as produced from the survey. The methodology consists of the following steps:

1. A linear logarithm curve fit is done on each row of trip rates and the resulting coefficients saved;
2. A linear logarithm curve fit is done on each column of trip rates and the resulting coefficients saved;
3. Using the coefficients from Steps 1 and 2, two estimates of each cell's trip rate are computed and averaged to develop an initial seed estimate of trip rates;
4. Using the initial seed estimate of trip rates and the urban area's distribution of

households by size and income, the average trip rate is computed for each row and each column;

5. The average trip rate for each row is compared to the average trip rate for the survey for each row. An adjustment factor is computed and applied to the row's trip rates to force the row's average trip rate to agree with the average trip rate from the survey;
6. The average trip rate for each column is compared with the average trip rate from the survey for each column. An adjustment factor is computed and applied to the column's trip rates to force the column's average trip rate to agree with the average trip rate from the survey; and
7. Steps 5 and 6 are repeated until both the row and column averages agree with the survey averages.

The result is generally a set of trip rates which increase as household size and income increase and yield the same average trip rate for each row and column as obtained from the survey. There were some exceptions where the procedure did not balance, and it failed to achieve increasing rates in each direction. In some of the urban areas it was necessary to combine the data for some of the cells to achieve reasonable results. This was done for cells which were not significantly different in terms of the trip rates and for those cells where no observations were found. These modifications were only done in those cases where the procedure failed to produce the desired results.

One other modification was found necessary in some cases. Since person trips and auto driver trips were done separately, the auto driver trip rate in certain cells exceeded the person trip rate. Since this is not theoretically possible, it was necessary to adjust one or the other to maintain theoretical consistency. This was done manually based on the relationship observed from the survey raw data.

The final adjustment made to the smoothed trip rates was to force the weighted average of the total trips per household to be the same as observed in the survey. This insured that the overall results of the smoothing of the trip rates would produce the same results as the survey.

APPENDIX F

Average Vehicle Occupancies and Person Trip Conversion Factors

Table F-1
Average Vehicle Occupancies and Person Trip Conversion Factors by Trip Purpose
San Antonio

Home Based Work

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
\$ 0 - \$ 4999	1.000	1.000	1.304	1.500	1.000	3.429	1.619	1.348	2.625	1.556
\$ 5000 - \$ 9999	1.000	1.204	1.000	1.143	1.115	1.591	1.750	1.829	2.572	1.634
\$ 10000 - \$ 19999	1.065	1.022	1.148	1.132	1.178	1.203	1.368	1.305	1.443	1.528
\$ 20000 - \$ 34999	1.036	1.067	1.046	1.144	1.099	1.153	1.216	1.166	1.1213	1.305
\$ 35000 Plus	1.016	1.044	1.087	1.102	1.106	1.000	1.055	1.067	1.090	1.143

Home Based Non-Work

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
\$ 0 - \$ 4999	1.173	1.397	1.969	.909	2.104	3.288	2.535	3.438	5.334	4.328
\$ 5000 - \$ 9999	1.097	1.481	1.554	2.197	2.104	1.764	1.792	3.000	2.662	3.504
\$ 10000 - \$ 19999	1.178	1.486	1.714	2.097	2.275	1.204	1.526	2.225	2.513	3.113
\$ 20000 - \$ 34999	1.176	1.398	1.681	1.835	2.089	1.109	1.333	1.782	2.003	2.379
\$ 35000 Plus	1.169	1.248	1.418	1.693	1.981	1.072	1.241	1.405	1.859	2.340

Non-Home Based

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
\$ 0 - \$ 4999	1.320	1.423	1.933	1.846	2.357	2.040	1.615	2.800	2.692	2.143
\$ 5000 - \$ 9999	1.373	1.532	1.733	2.067	2.075	1.325	1.532	2.333	1.866	2.575
\$ 10000 - \$ 19999	1.337	1.605	1.533	1.879	2.168	1.126	1.502	1.852	1.967	1.697
\$ 20000 - \$ 34999	1.275	1.435	1.473	1.627	2.168	1.180	1.240	1.277	1.459	1.796
\$ 35000 Plus	1.205	1.270	1.478	1.493	1.852	1.084	1.136	1.225	1.321	1.691

Total-All Purposes

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
\$ 0 - \$ 4999	1.202	1.324	1.814	1.790	1.838	2.929	2.124	2.873	4.081	3.263
\$ 5000 - \$ 9999	1.215	1.431	1.409	1.984	1.862	1.537	1.721	2.557	2.541	2.885
\$ 10000 - \$ 19999	1.210	1.430	1.495	1.824	1.989	1.175	1.488	1.847	2.118	2.327
\$ 20000 - \$ 34999	1.178	1.324	1.420	1.566	1.914	1.144	1.273	1.445	1.587	2.004
\$ 35000 Plus	1.140	1.193	1.337	1.467	1.698	1.057	1.144	1.241	1.479	1.827

Table F-2
Average Vehicle Occupancies and Person Trip Conversion Factors by Trip Purpose
Amarillo

Home Based Work

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.083	0.999	1.446	1.002	1.000	1.748	1.817	1.224	2.007	1.335
\$ 5000 - \$ 9999	1.000	1.109	1.322	1.001	1.412	1.119	1.217	1.286	1.053	1.295
\$ 10000 - \$ 19999	1.016	1.062	1.179	1.214	1.264	1.041	1.080	1.195	1.163	1.659
\$ 20000 - \$ 34999	1.040	1.038	1.060	1.106	1.411	1.067	1.077	1.102	1.113	1.131
\$ 35000 Plus	1.000	1.038	1.069	1.100	1.150	1.091	1.042	1.022	1.058	1.072

Home Based Non-Work

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.212	1.213	1.818	1.567	3.000	1.470	1.837	2.152	1.467	2.964
\$ 5000 - \$ 9999	1.076	1.566	1.760	2.015	2.308	1.182	1.597	1.929	1.815	2.246
\$ 10000 - \$ 19999	1.104	1.371	1.640	1.905	2.237	1.127	1.444	1.813	1.790	2.064
\$ 20000 - \$ 34999	1.104	1.319	1.583	2.002	2.227	1.119	1.298	1.512	2.047	2.241
\$ 35000 Plus	1.061	1.307	1.421	1.637	1.907	1.041	1.237	1.409	1.803	1.986

Non-Home Based

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.293	1.999	1.842	0.000	2.668	1.220	1.413	1.895	0.000	1.585
\$ 5000 - \$ 9999	1.122	1.625	1.806	1.972	2.170	1.093	1.375	1.368	1.744	2.335
\$ 10000 - \$ 19999	1.444	1.369	1.584	1.878	2.330	1.044	1.362	1.686	1.523	1.745
\$ 20000 - \$ 34999	1.223	1.347	1.514	1.741	2.207	1.109	1.198	1.303	1.623	1.721
\$ 35000 Plus	1.117	1.325	1.535	1.593	1.719	1.072	1.148	1.186	1.448	1.547

Total-All Purposes

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.225	1.470	1.770	1.531	2.652	1.420	1.686	1.934	1.562	2.392
\$ 5000 - \$ 9999	1.081	1.502	1.699	1.847	2.127	1.143	1.459	1.609	1.678	2.085
\$ 10000 - \$ 19999	1.225	1.306	1.498	1.727	2.144	1.079	1.339	1.608	1.562	1.915
\$ 20000 - \$ 34999	1.129	1.268	1.425	1.689	2.025	1.101	1.210	1.335	1.678	1.827
\$ 35000 Plus	1.072	1.242	1.367	1.499	1.678	1.064	1.153	1.227	1.507	1.639

**Table F-3
Average Vehicle Occupancies and Person Trip Conversion Factors by Trip Purpose
Brownsville**

Home Based Work

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.197	1.178	1.039	0.999	1.263	1.397	1.267	1.962	2.553	1.631
\$ 5000 - \$ 9999	1.076	1.000	1.213	1.257	1.094	1.305	1.581	1.535	1.290	1.546
\$ 10000 - \$ 19999	1.000	1.080	1.073	1.217	1.153	1.000	1.258	1.220	1.537	1.378
\$ 20000 - \$ 34999	1.033	1.182	1.120	1.168	1.108	1.066	1.195	1.250	1.084	1.305
\$ 35000 Plus	1.000	1.074	1.095	1.177	1.160	1.000	1.118	1.115	1.111	1.051

Home Based Non-Work

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.130	1.440	1.720	1.946	2.023	2.652	2.165	2.103	2.373	3.416
\$ 5000 - \$ 9999	1.058	1.386	1.940	1.736	1.974	1.617	1.650	1.971	1.786	2.274
\$ 10000 - \$ 19999	1.341	1.531	1.644	1.980	1.947	1.024	1.599	1.719	2.025	2.510
\$ 20000 - \$ 34999	1.103	1.406	1.643	2.006	1.975	1.095	1.376	1.384	2.201	2.086
\$ 35000 Plus	1.340	1.437	1.466	2.173	1.879	1.036	1.266	1.406	1.781	2.070

Non-Home Based

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.001	2.105	1.569	1.849	2.290	1.728	1.475	1.824	2.233	2.134
\$ 5000 - \$ 9999	1.101	1.442	2.055	1.862	2.150	1.701	1.384	1.812	1.477	1.600
\$ 10000 - \$ 19999	1.276	1.482	1.633	1.842	1.842	1.000	1.401	1.430	1.863	1.579
\$ 20000 - \$ 34999	1.402	1.388	1.570	1.551	1.655	1.065	1.261	1.315	1.367	1.450
\$ 35000 Plus	1.410	1.299	1.515	1.528	1.754	1.000	1.207	1.298	1.368	1.455

Total-All Purposes

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.103	1.600	1.605	1.845	1.958	2.231	1.907	2.022	2.371	2.935
\$ 5000 - \$ 9999	1.070	1.340	1.818	1.708	1.869	1.561	1.569	1.833	1.636	2.044
\$ 10000 - \$ 19999	1.271	1.435	1.504	1.819	1.786	1.011	1.465	1.518	1.905	2.098
\$ 20000 - \$ 34999	1.198	1.361	1.514	1.610	1.685	1.078	1.309	1.335	1.593	1.714
\$ 35000 Plus	1.318	1.300	1.399	1.695	1.672	1.019	1.209	1.300	1.467	1.624

Table F-4
Average Vehicle Occupancies and Person Trip Conversion Factors by Trip Purpose
Sherman-Denison

Home Based Work

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
\$ 0 - \$ 4999	1.107	1.197	1.180	0.000	0.991	1.219	2.000	1.178	0.000	1.000
\$ 5000 - \$ 9999	1.304	0.999	1.054	1.092	1.000	1.000	1.613	1.163	1.545	1.000
\$ 10000 - \$ 19999	1.023	1.152	1.277	1.120	1.612	1.023	1.174	1.341	1.147	1.226
\$ 20000 - \$ 34999	1.014	1.080	1.063	1.127	1.268	1.037	1.080	1.101	1.099	1.094
\$ 35000 Plus	1.016	1.048	1.075	1.091	1.078	1.096	1.043	1.027	1.082	1.032

Home Based Non-Work

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
\$ 0 - \$ 4999	1.306	1.535	1.518	1.599	2.996	3.306	1.428	1.714	1.799	2.194
\$ 5000 - \$ 9999	1.092	1.307	1.372	1.551	2.000	1.342	1.395	1.646	2.517	1.499
\$ 10000 - \$ 19999	1.070	1.320	1.447	1.722	1.603	1.125	1.362	1.659	1.704	2.297
\$ 20000 - \$ 34999	1.043	1.385	1.458	1.737	1.918	1.063	1.338	1.571	1.800	2.475
\$ 35000 Plus	1.057	1.196	1.365	1.558	1.685	1.123	1.198	1.332	1.808	2.064

Non-Home Based

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
\$ 0 - \$ 4999	1.147	1.677	1.839	1.799	1.000	1.517	1.548	1.379	1.399	1.000
\$ 5000 - \$ 9999	1.150	1.520	1.352	2.302	0.000	1.318	1.370	1.601	1.363	0.000
\$ 10000 - \$ 19999	1.195	1.318	1.479	1.639	1.747	1.062	1.278	1.740	1.418	1.711
\$ 20000 - \$ 34999	1.165	1.519	1.396	1.558	1.828	1.110	1.256	1.304	1.443	1.651
\$ 35000 Plus	1.153	1.240	1.348	1.399	1.537	1.112	1.173	1.175	1.348	1.457

Total-All Purposes

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5+	1	2	3	4	5+
\$ 0 - \$ 4999	1.222	1.565	1.624	1.668	1.997	2.375	1.500	1.521	1.667	1.597
\$ 5000 - \$ 9999	1.126	1.362	1.303	1.822	1.500	1.310	1.400	1.539	1.849	1.250
\$ 10000 - \$ 19999	1.110	1.298	1.432	1.568	1.658	1.085	1.312	1.637	1.490	1.933
\$ 20000 - \$ 34999	1.080	1.389	1.337	1.522	1.731	1.074	1.269	1.361	1.505	1.858
\$ 35000 Plus	1.083	1.176	1.283	1.398	1.511	1.113	1.148	1.198	1.481	1.644

Table F-5
Average Vehicle Occupancies and Person Trip Conversion Factors by Trip Purpose
Tyler

Home Based Work

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.058	0.999	1.627	0.999	1.001	1.059	1.065	1.502	1.996	1.000
\$ 5000 - \$ 9999	1.077	1.126	1.000	1.000	1.333	1.025	1.189	1.191	1.286	2.164
\$ 10000 - \$ 19999	1.113	1.070	1.133	1.140	1.297	1.113	1.049	1.000	1.140	1.296
\$ 20000 - \$ 34999	1.042	1.027	1.083	1.108	1.174	1.033	1.048	1.031	1.049	1.108
\$ 35000 Plus	1.000	1.028	1.096	1.082	1.086	1.000	1.039	1.069	1.089	1.027

Home Based Non-Work

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.611	1.513	1.926	1.333	3.111	1.597	1.641	1.666	2.000	3.222
\$ 5000 - \$ 9999	1.132	1.137	1.557	2.429	1.900	1.171	1.372	1.596	3.191	3.250
\$ 10000 - \$ 19999	1.086	1.346	1.637	1.791	2.581	1.163	1.326	1.506	1.779	2.452
\$ 20000 - \$ 34999	1.149	1.283	1.488	1.977	2.316	1.066	1.203	1.388	1.885	2.456
\$ 35000 Plus	1.060	1.260	1.371	1.724	1.876	1.119	1.140	1.304	1.748	1.801

Non-Home Based

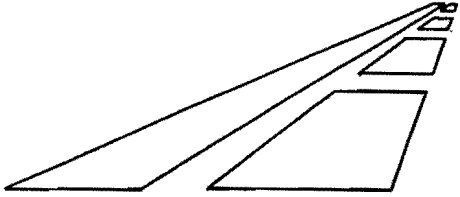
Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.595	1.579	2.683	0.999	1.499	1.460	1.474	1.209	2.992	1.500
\$ 5000 - \$ 9999	1.290	1.166	1.972	1.181	2.001	1.406	1.111	1.287	1.136	2.001
\$ 10000 - \$ 19999	1.204	1.341	1.391	1.510	2.091	1.102	1.332	1.275	1.227	1.750
\$ 20000 - \$ 34999	1.333	1.362	1.376	1.603	2.228	1.113	1.285	1.214	1.389	1.924
\$ 35000 Plus	1.238	1.221	1.411	1.478	1.570	1.048	1.096	1.181	1.337	1.450

Total-All Purposes

Household Income Range	Average Vehicle Occupancy					Person Trip Conversion Factors				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.532	1.425	2.148	1.223	2.313	1.484	1.479	1.482	2.112	2.375
\$ 5000 - \$ 9999	1.170	1.146	1.583	1.680	1.847	1.218	1.253	1.417	2.020	2.667
\$ 10000 - \$ 19999	1.131	1.289	1.444	1.555	2.158	1.134	1.272	1.317	1.467	1.985
\$ 20000 - \$ 34999	1.198	1.250	1.333	1.619	1.985	1.077	1.193	1.226	1.495	1.950
\$ 35000 Plus	1.117	1.190	1.307	1.481	1.581	1.068	1.101	1.197	1.443	1.495

APPENDIX G

Technical Memorandum Trip Length Frequency Distribution



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May 22, 1995

MEMORANDUM

To: Deborah W. Morris, P.E.
Paul Tiley
Ray Miller
Zach Graham

From: David F. Pearson

Subject: Improved Trip Length Frequency Distribution Model

The purpose of this memorandum is to transmit the results of our analysis under tasks B-7 and B-30 in Project 10995. Task B-7 was to evaluate the ability of the Improved Trip Length Frequency Distribution Model (ITLFDM) to estimate the observed trip length frequency distributions by trip purpose from the 1990 and 1991 travel surveys and the trip length frequency distribution from the 1990 Census Journey to Work data. Task B-30 was to perform a comparative assessment of the 1990 Census Journey to Work trip length frequency distribution and the home based work trip data from the 1990 and 1991 travel surveys.

Task B-7: Accuracy of The ITLFDM

The ITLFDM was run using the observed average trip length for each trip purpose from the 1990 and 1991 travel surveys and the observed maximum separation at which trips occurred. The ITLFDM was then run using the average home to work trip length from the 1990 Census Journey to Work data. The trip lengths were obtained from the skim tree zone to zone unedited travel times. The 1990 and 1991 travel survey data is expanded data for survey trips that were geo-coded. Trips with estimated travel times were not used in these analyses.

The observed trip length frequency distributions from the travel surveys and the census journey to work data were compared to the distribution estimated from the ITLFDM for each trip purpose. Tables G-1 and G-2 present the resulting correlation coefficients and average trip lengths from the person and auto driver trip distributions for each urban area. The average trip length from the ITLFDM matches the observed average trip lengths with the exception of the San Antonio home based work (HBW) and census journey to work (J2W) data. The correlation coefficients exceed 0.96 for all trip purposes in every urban area except San Antonio.

Figures G-1 through G-40 present plots of the ITLFDM distributions and the observed distributions. Figures G-1 through G-8 show the results for San Antonio. These data indicate that the ITLFDM did not perform very well for San Antonio. It appears that the ITLFDM produces reasonably good results for urban areas where the average trip length is under 10 minutes. The more the average trip length exceeds 10 minutes, the less accurate the ITLFDM results. For example, the HBW average trip length observed in the San Antonio travel survey was 16.245 minutes. The estimate from the ITLFDM was 15.852 minutes, an under estimate of 2.4 percent. The average home to work trip length from the census J2W data was 24.811 minutes. The estimate from the ITLFDM was 23.448 minutes, an under estimate of over 5 percent. It appears that trip length frequency distributions with averages over 10 minutes should be estimated using a different mathematical distribution than that currently used in the ITLFDM.

An evaluation of Figures G-1 through G-8 for San Antonio indicates the distribution from the ITLFDM does not match the observed distributions in the lower time ranges. The ITLFDM appears to over estimate the percentage of trips under 3 to 4 minutes and under estimates the percentages from 3 or 4 to around 10 minutes. As can be seen in the plots, this varies. While the correlation coefficients exceeded 0.9 (except for the J2W data), the data reflected in Figures G-1 through G-8 do not indicate very good estimates.

While the ITLFDM did not seem to produce very good results for San Antonio, the model appears to have done reasonably well for the other four urban areas. This may be due to the fact that these four areas were relatively small and in all cases the average trip lengths were less than 10 minutes. Overall, the model appears to produce reasonable estimates of the observed trip length frequency distributions for all trip purposes and also matches the census J2W data very well.

Task B-30: Comparative Assessment of Census J2W

The survey data from the 1990 and 1991 travel surveys were compiled to produce a home to work trip length frequency distribution which would be comparable to the home to work trip length frequency distribution from the 1990 census. Tables G-3 and G-4 present a comparison of the journey to work data and the household travel survey data in terms of the total expanded trips, the average trip lengths, and the correlation coefficient computed from a comparison of the trip length frequency distributions. The trip length frequency distributions are presented in Figures G-41 through G-50.

The data in Tables G-3 and G-4 indicate that the travel surveys matched the census journey to work data in terms of the average trip lengths fairly well for all of the urban areas except San Antonio. It appears there may have been a problem with the geo-coding of the survey data in San Antonio. A problem may have also existed in Tyler as indicated by Figures G-47 and G-48 which show a severe spike in the trip length frequency distribution around 5 minutes. These problems may stem from errors in the geo-coding or from actual sampling bias where the households that were surveyed were concentrated in certain areas. The trip length frequency distribution (TLFD) from the survey in San Antonio does not match that from the census journey to work data and this implies that the TLFD from the survey data should be adjusted for all trip purposes. A similar situation seems to exist for the Tyler study area.

The differences shown in Tables G-3 and G-4 relative to the total home to work trips may be due to problems in the data used to compute the expansions for the household surveys. In Brownsville, for example, the total number of households used to compute the expansion factors for the survey was 26,519. This may be less than those surveyed in the census due to a difference in the geographical area. The survey estimates of trips would also be expected to be less than the census because only trips that could be geo-coded were used in compiling the TLF_D. The differences shown for San Antonio, Sherman-Denison, and Tyler may be due to differences in the geographical area being surveyed relative to the expansion factors computed for the household surveys.

Findings and Recommendations

Based on the analysis and data presented in this memorandum, the following findings and recommendations are made:

- The ITLFD model produces reasonable estimates of the TLF_D for small urban areas with average trip lengths under 10 minutes.
- Additional research should be funded to develop more appropriate tools for the estimation and forecasting of TLF_D for medium to large size urban areas where the average trip lengths may be expected to exceed 10 minutes.
- The observed trip length frequency distributions for home to work trips from San Antonio and Tyler did not match those from the 1990 census journey to work data. The observed TLF_D for Amarillo, Brownsville, and Sherman-Denison match that from the census journey to work very well. The large discrepancy for San Antonio may be due to multiple reasons. More work is needed in the analysis of the survey data to identify problems with geo-coding and/or possible survey bias.
- The average trip length for home based work auto driver trips in San Antonio should be 24.8 minutes and not 16.2 minutes as observed in the San Antonio household travel survey. Assuming a proportional relationship, the average trip length for home based non-work auto driver trips should be 16.8 minutes and for non-home based auto driver trips 17.8 minutes.
- The average trip length for home based work auto driver trips in Tyler should be 8.1 minutes and not 7.0 as observed in the Tyler household survey. Again assuming a proportional relationship, the average home based non-work auto driver trip length should be 6.2 minutes and for non-home based auto driver trips 5.7 minutes.
- Consideration should be given to the use of friction factors in lieu of trip length frequency distributions in travel demand modeling. These friction factors would be calibrated using trip length frequency distributions from the travel surveys and then held constant for future projections. Research should be undertaken to address the question of whether these calibrated friction factors are transferable between similar type urban areas.

Table G-1
Estimated and Observed
Trip Length Frequency Distributions
Person Trips

Urban Area	Data Source	Trip Purpose	Correlation Coefficient	Average Trip Length (Minutes)		Percent Error
				Survey	ITLFDM	
San Antonio	1990 Travel Survey	HBW	0.9377	15.816	15.502	- 1.99 %
		HBNW	0.9322	10.382	10.354	- 0.27 %
		NHB	0.9215	11.332	11.232	- 0.88 %
	Census ¹	Home to Work	0.8623	24.179	23.019	- 4.80 %
Amarillo	1990 Travel Survey	HBW	0.9892	9.423	9.411	- 0.13 %
		HBNW	0.9582	5.950	5.955	0.08 %
		NHB	0.9922	6.016	6.039	0.38 %
	Census	Home to Work	0.9905	9.085	9.028	- 0.63 %
Brownsville	1991 Travel Survey	HBW	0.9814	6.239	6.205	- 0.54 %
		HBNW	0.9931	5.143	5.119	- 0.47 %
		NHB	0.9878	4.632	4.623	- 0.19 %
	Census	Home to Work	0.9892	6.524	6.507	- 0.26 %
Sherman-Denison	1991 Travel Survey	HBW	0.9900	9.237	9.183	- 0.58 %
		HBNW	0.9753	6.847	6.848	0.01 %
		NHB	0.9802	6.275	6.287	0.19 %
	Census	Home to Work	0.9880	8.846	8.776	- 0.79 %
Tyler	1991 Travel Survey	HBW	0.9666	6.966	6.942	- 0.34 %
		HBNW	0.9796	5.251	5.252	0.02 %
		NHB	0.9867	4.901	4.904	0.06 %
	Census	Home to Work	0.9860	8.003	7.961	- 0.52 %

¹1990 Census Journey to Work data from the Census Transportation Planning Package

Table G-2
Estimated and Observed
Trip Length Frequency Distributions
Auto Driver Trips

Urban Area	Data Source	Trip Purpose	Correlation Coefficient	Average Trip Length		Percent Error
				Survey	ITLFDM	
San Antonio	1990 Travel Survey	HBW	0.9165	16.245	15.852	- 2.42 %
		HBNW	0.9202	10.972	10.891	- 0.74 %
		NHB	0.9032	11.628	11.487	- 1.21 %
	Census ²	Home to Work	0.8327	24.811	23.448	- 5.49 %
Amarillo	1990 Travel Survey	HBW	0.9906	9.272	9.262	- 0.11 %
		HBNW	0.9749	6.060	6.066	0.01 %
		NHB	0.9933	6.137	6.160	0.37 %
	Census	Home to Work	0.9905	9.108	9.049	- 0.65 %
Brownsville	1991 Travel Survey	HBW	0.9793	6.383	6.340	- 0.67 %
		HBNW	0.9929	5.102	5.068	- 0.67 %
		NHB	0.9879	4.654	4.645	- 0.19 %
	Census	Home to Work	0.9888	6.628	6.608	- 0.30 %
Sherman-Denison	1991 Travel Survey	HBW	0.9888	9.344	9.282	- 0.66 %
		HBNW	0.9672	7.021	7.018	- 0.04 %
		NHB	0.9787	6.327	6.331	0.06 %
	Census	Home to Work	0.9883	8.947	8.868	- 0.88 %
Tyler	1991 Travel Survey	HBW	0.9649	6.979	6.955	- 0.34 %
		HBNW	0.9869	5.380	5.381	0.02 %
		NHB	0.9894	4.903	4.906	0.06 %
	Census	Home to Work	0.9857	8.092	8.045	- 0.58 %

²1990 Census Journey to Work data from the Census Transportation Planning Package

**Table G-3
Person Trips Comparative Analysis
Census Journey to Work Data
& Household Travel Surveys**

Urban Area	Number of Person Trips			Average Trip Length (Minutes)			TLFD Correlation Coefficient
	Census ³	Survey	Pct Dif	Census	Survey	Pct Dif	
San Antonio	371,073	384,796	3.7 %	24.18	15.79	-34.7 %	0.7895
Amarillo	69,398	65,297	- 5.9 %	9.07	9.45	4.2 %	0.9920
Brownsville	49,641	23,259	-53.1 %	6.52	6.18	- 5.2 %	0.9647
Sherman-Denison	23,530	28,028	19.1 %	8.85	9.30	5.1 %	0.9848
Tyler	39,247	51,125	30.3 %	8.00	7.00	-12.5 %	0.9329

**Table G-4
Auto Driver Trips Comparative Analysis
Census Journey to Work Data
& Household Travel Surveys**

Urban Area	Number of Auto Driver Trips			Average Trip Length (Minutes)			TLFD Correlation Coefficient
	Census	Survey	Pct Dif	Census	Survey	Pct Dif	
San Antonio	310,002	325,672	5.1 %	24.81	16.23	-34.6 %	0.7716
Amarillo	62,679	60,070	- 4.2 %	9.10	9.32	2.4 %	0.9924
Brownsville	41,036	19,112	-53.4 %	6.63	6.31	- 4.8 %	0.9657
Sherman-Denison	21,314	26,007	22.0 %	8.95	9.41	5.1 %	0.9823
Tyler	35,825	47,909	33.7 %	8.09	7.00	-13.5 %	0.9223

³Census Journey to Work

Figure G-1
Home Based Work Person
Trip Length Frequency Distribution

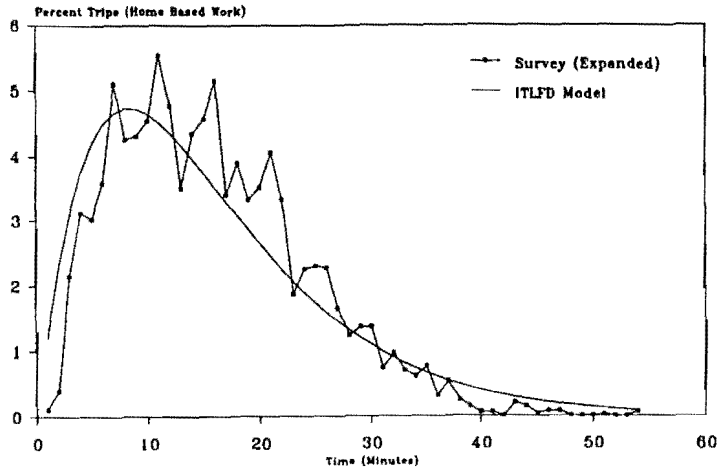


Figure G-2
Home Based Non-Work Person
Trip Length Frequency Distribution

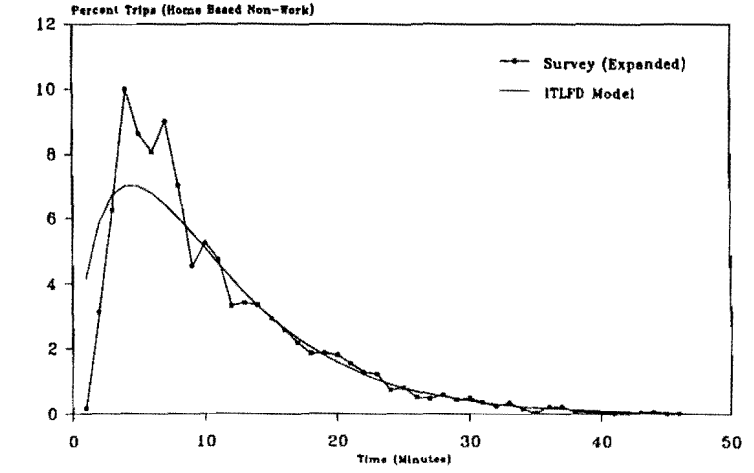


Figure G-3
Non-Home Based Person
Trip Length Frequency Distribution

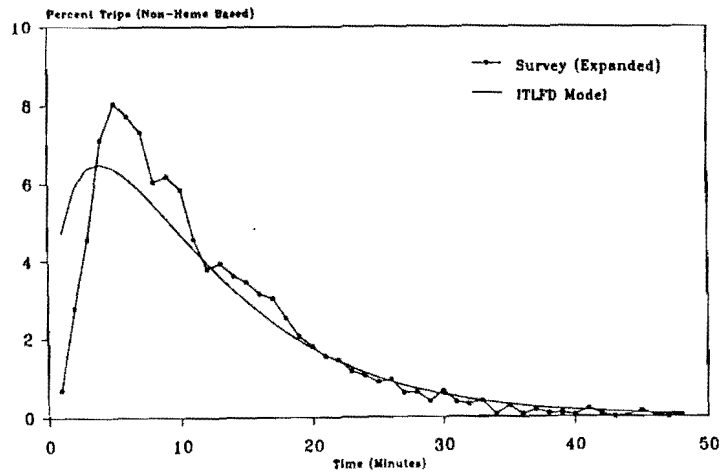


Figure G-4
Home to Work Person
Trip Length Frequency Distribution

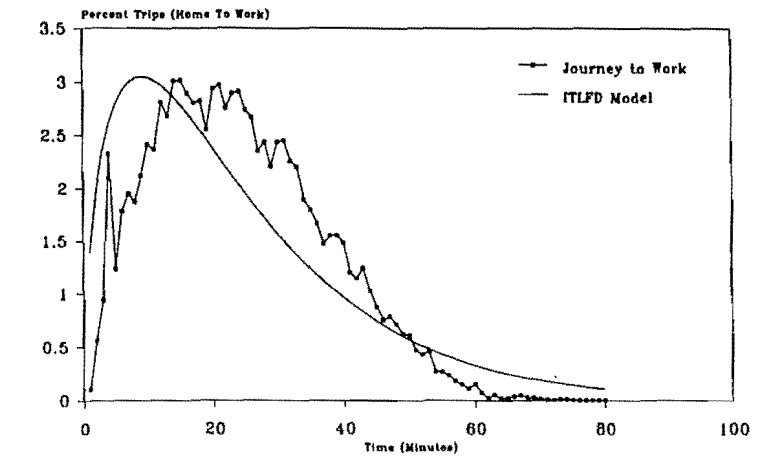
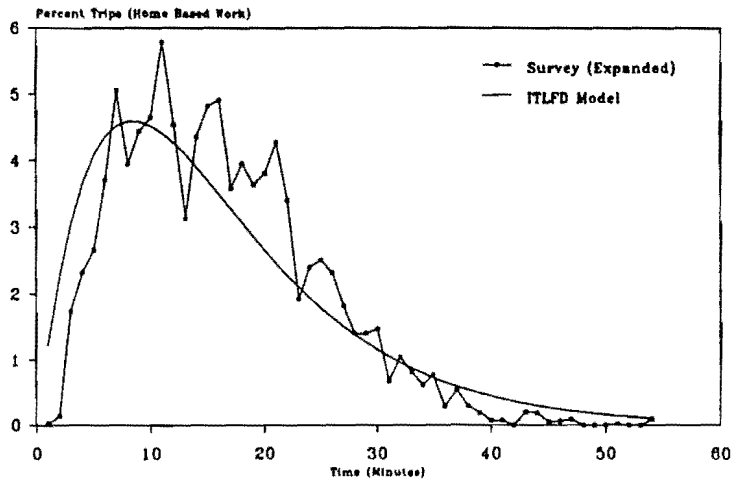
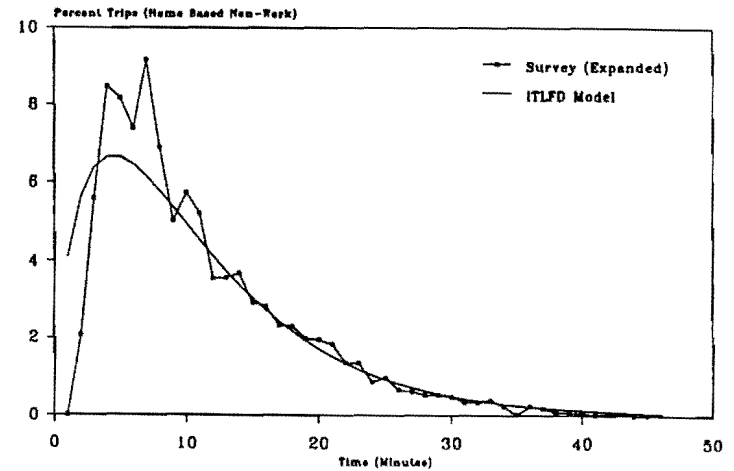


Figure G-5
Home Based Work Auto Driver
Trip Length Frequency Distribution



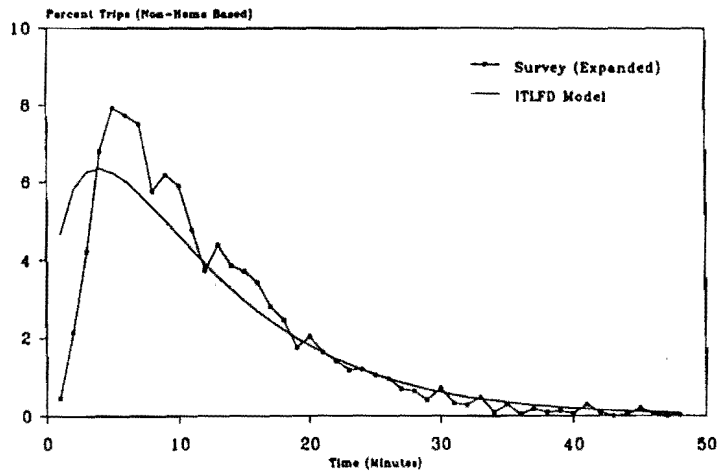
San Antonio ITLFD Fit

Figure G-6
Home Based Non-Work Auto Driver
Trip Length Frequency Distribution



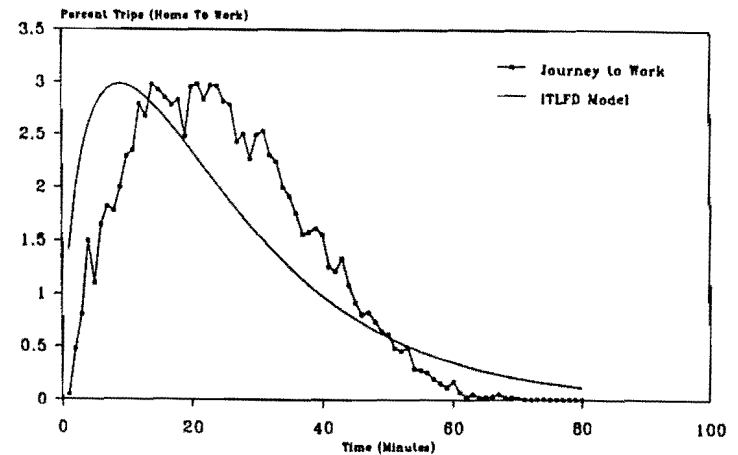
San Antonio ITLFD Fit

Figure G-7
Non-Home Based Auto Driver
Trip Length Frequency Distribution



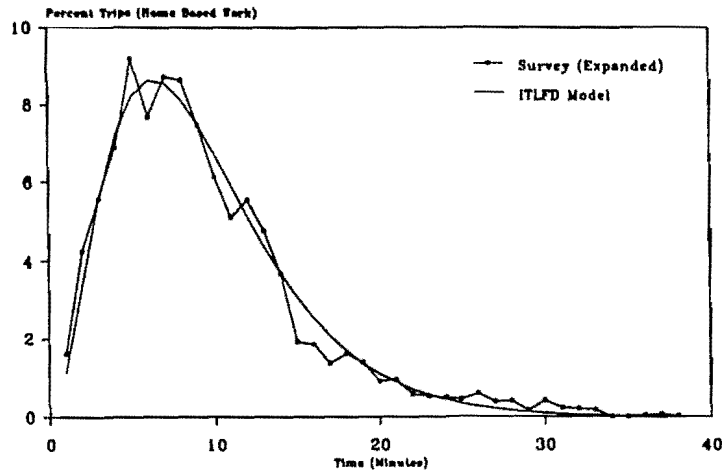
San Antonio ITLFD Fit

Figure G-8
Home to Work Auto Driver
Trip Length Frequency Distribution



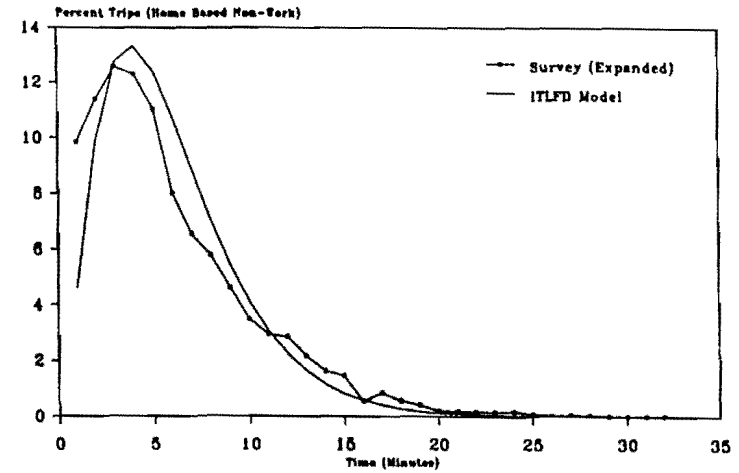
San Antonio ITLFD Fit
 On Journey to Work Data

Figure G-9
Home Based Work Person
Trip Length Frequency Distribution



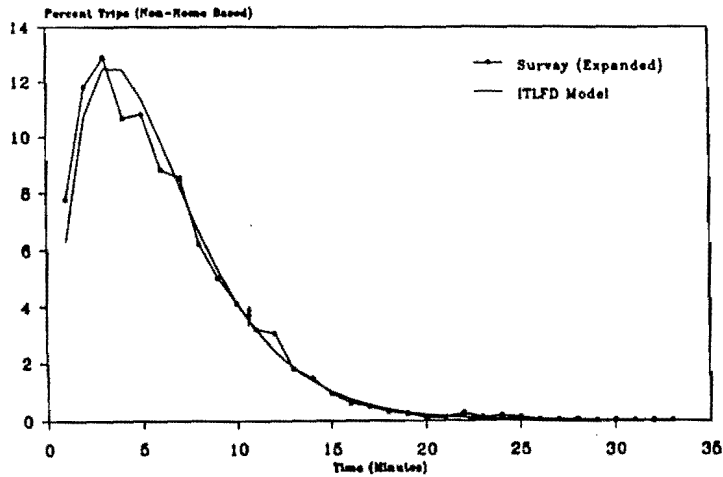
Amarillo ITLFD Model Fit

Figure G-10
Home Based Non-Work Person
Trip Length Frequency Distribution



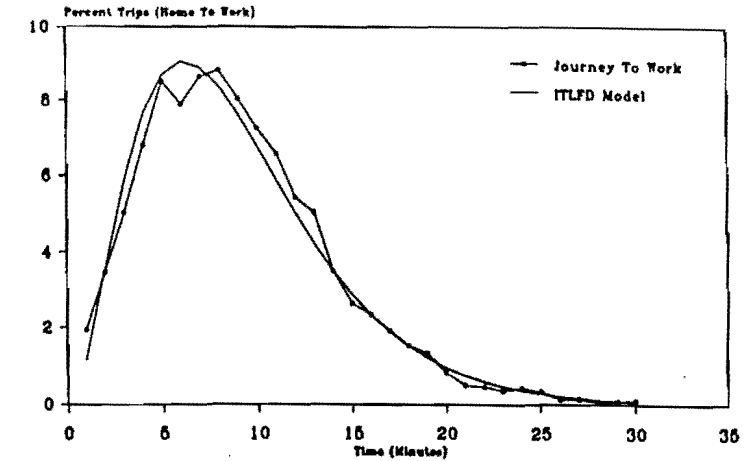
Amarillo ITLFD Model Fit

Figure G-11
Non-Home Based Person
Trip Length Frequency Distribution



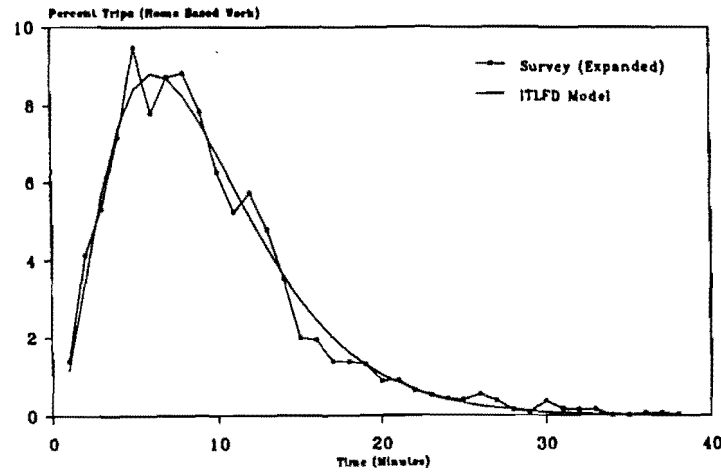
Amarillo ITLFD Model Fit

Figure G-12
Home to Work Person
Trip Length Frequency Distribution



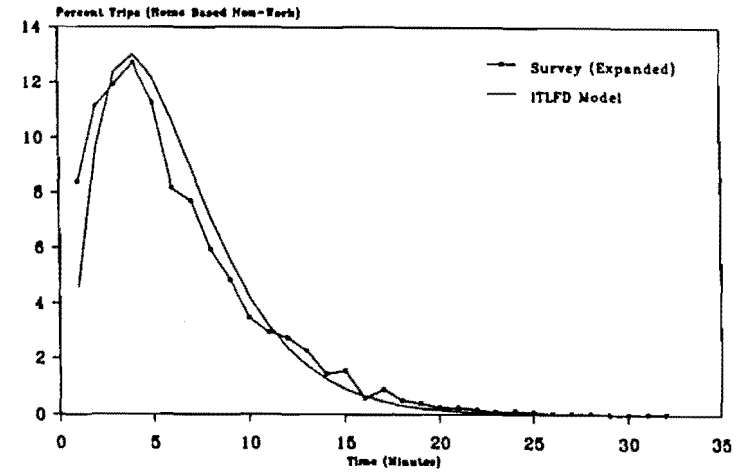
Amarillo ITLFD Model Fit
 On Census Journey To Work Data

Figure G-13
Home Based Work Auto Driver
Trip Length Frequency Distribution



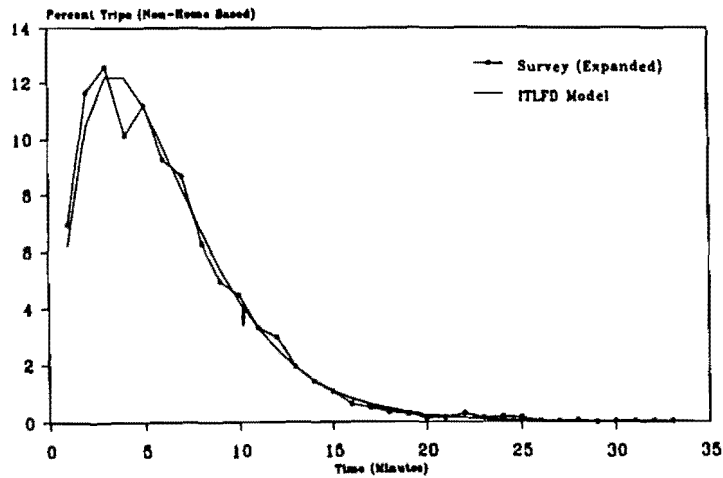
Amarillo ITLFD Model

Figure G-14
Home Based Non-Work Auto Driver
Trip Length Frequency Distribution



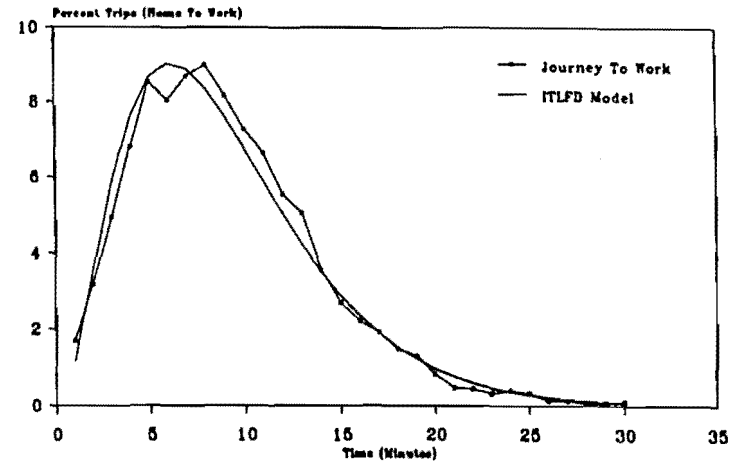
Amarillo ITLFD Model

Figure G-15
Non-Home Based Auto Driver
Trip Length Frequency Distribution



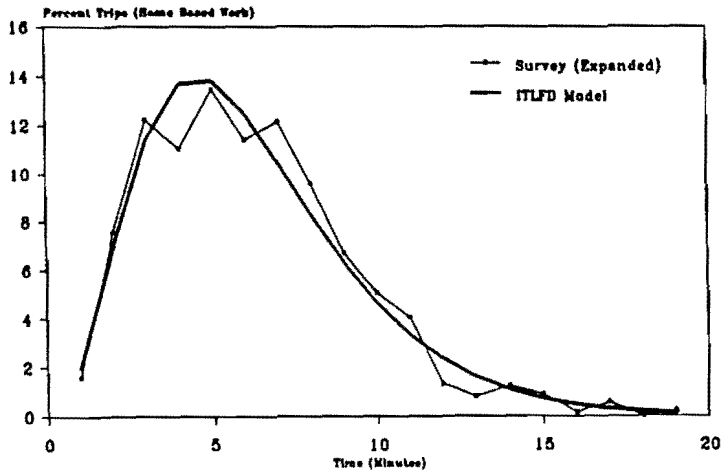
Amarillo ITLFD Model

Figure G-16
Home to Work Auto Driver
Trip Length Frequency Distribution



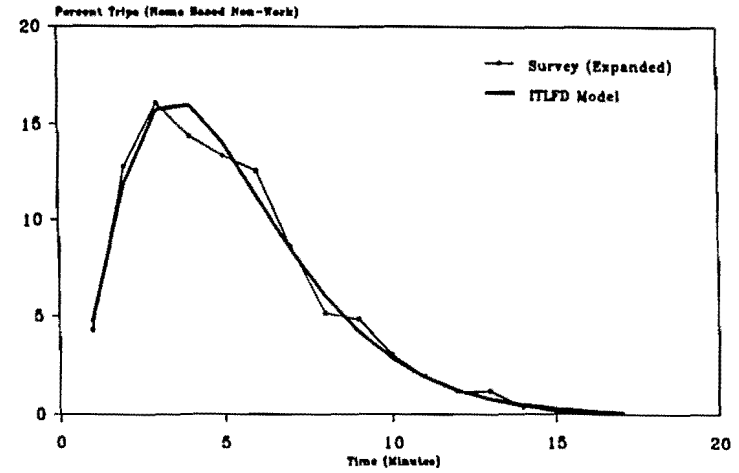
Amarillo ITLFD Model
 On Census Journey to Work Data

Figure G-17
Home Based Work Person
Trip Length Frequency Distribution



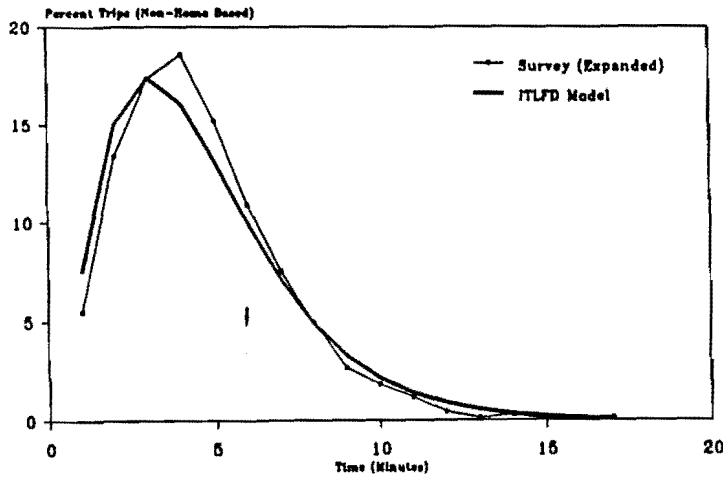
Brownsville ITLFD Model Fit

Figure G-18
Home Based Non-Work Person
Trip Length Frequency Distribution



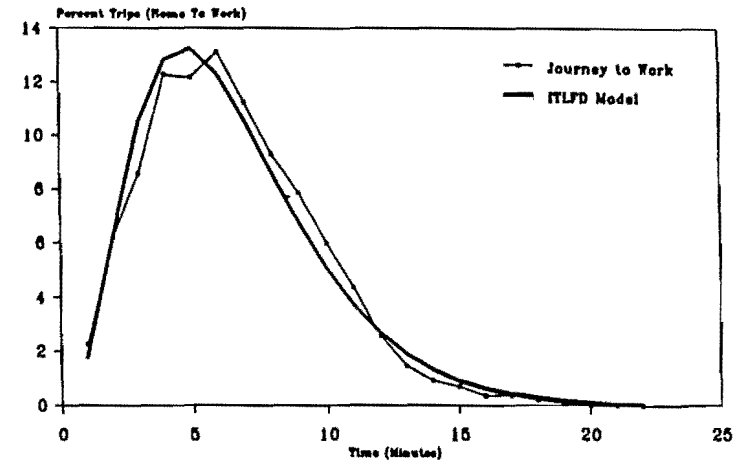
Brownsville ITLFD Model Fit

Figure G-19
Non-Home Based Person
Trip Length Frequency Distribution



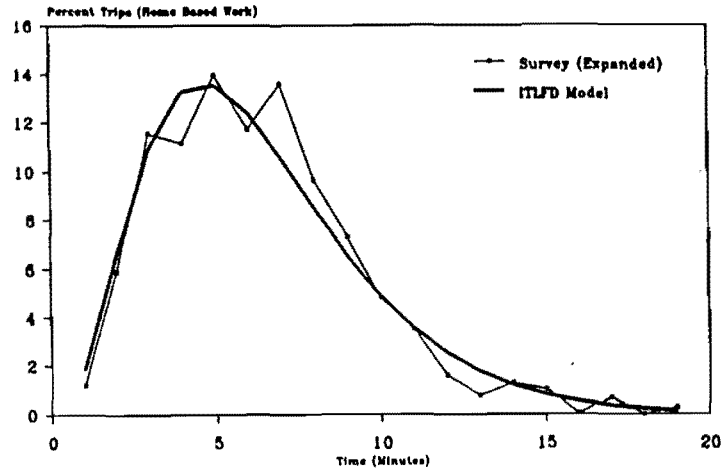
Brownsville ITLFD Model Fit

Figure G-20
Home to Work Person
Trip Length Frequency Distribution



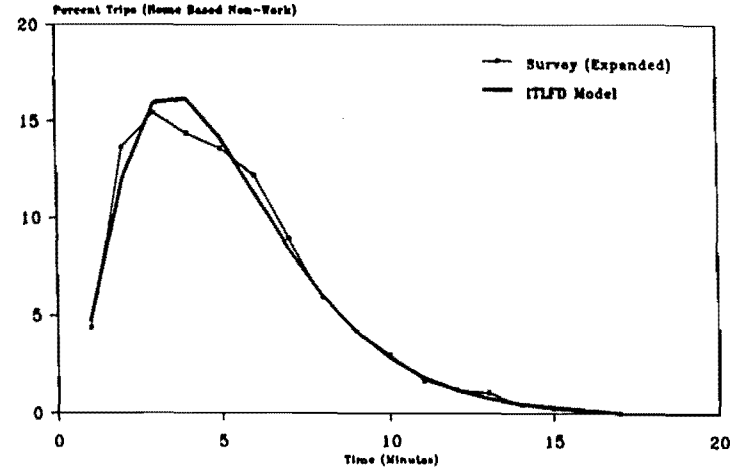
Brownsville ITLFD Model Fit
 On Journey to Work Data

Figure G-21
Home Based Work Auto Driver
Trip Length Frequency Distribution



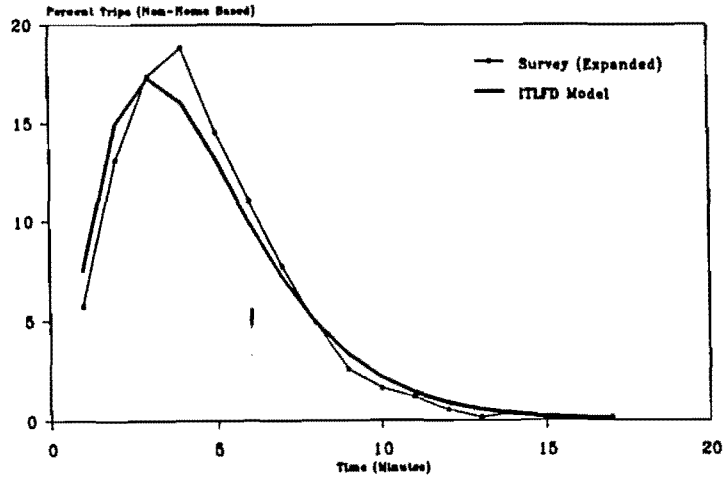
Brownsville ITLFD Fit

Figure G-22
Home Based Non-Work Auto Driver
Trip Length Frequency Distribution



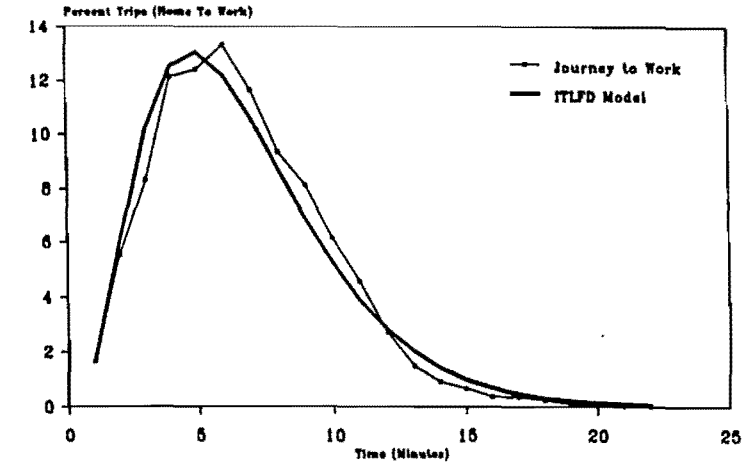
Brownsville ITLFD Fit

Figure G-23
Non-Home Based Auto Driver
Trip Length Frequency Distribution



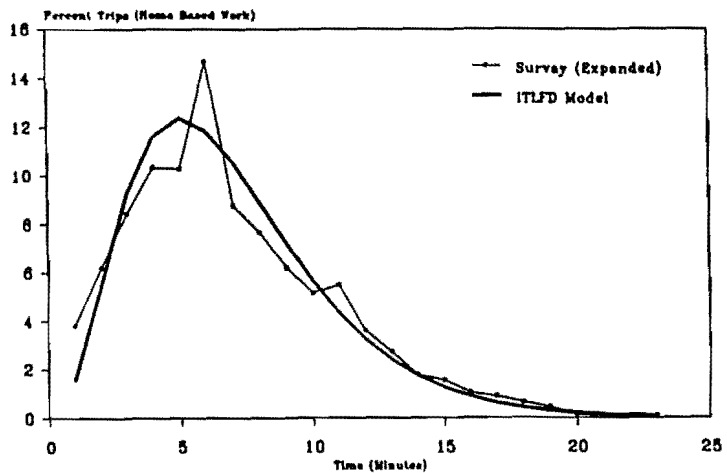
Brownsville ITLFD Fit

Figure G-24
Home to Work Auto Driver
Trip Length Frequency Distribution



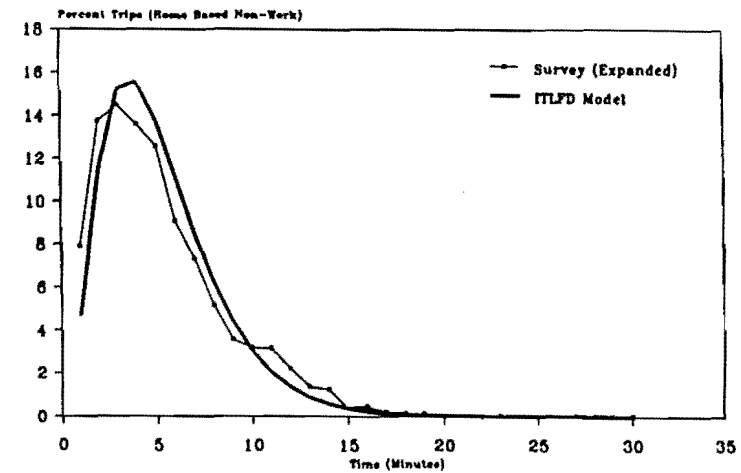
Brownsville ITLFD Fit
 On Journey to Work Data

Figure G-25
Home Based Work Person
Trim Length Frequency Distribution



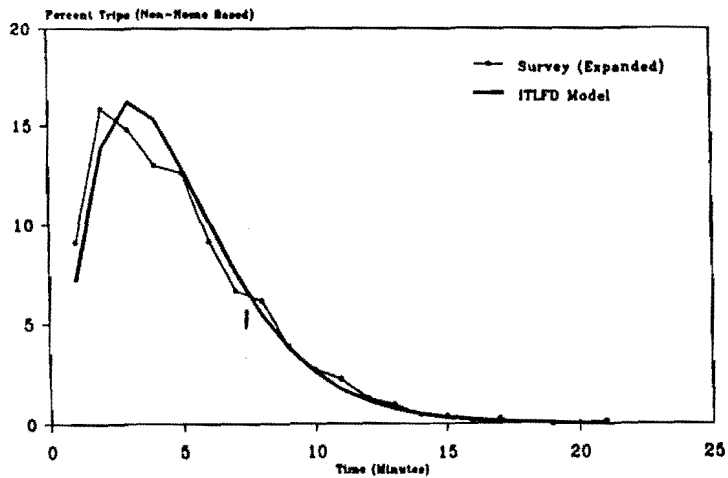
Tyler ITLFD Fit

Figure G-26
Home Based Non-Work Person
Trip Length Frequency Distribution



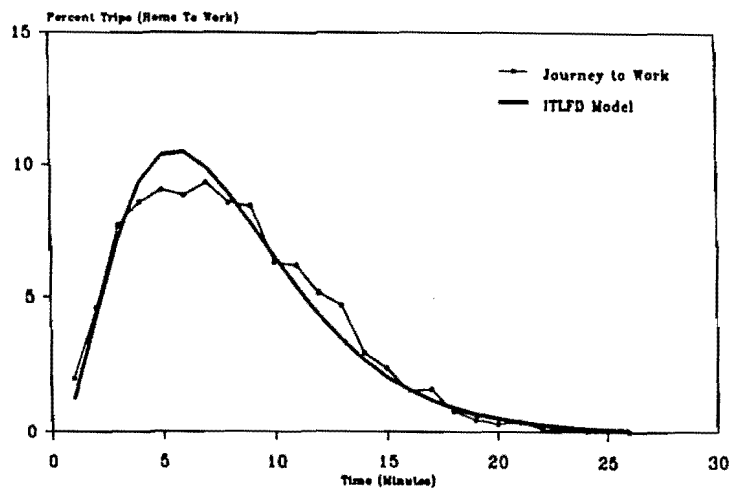
Tyler ITLFD Fit

Figure G-27
Non-Home Based Person
Trip Length Frequency Distribution



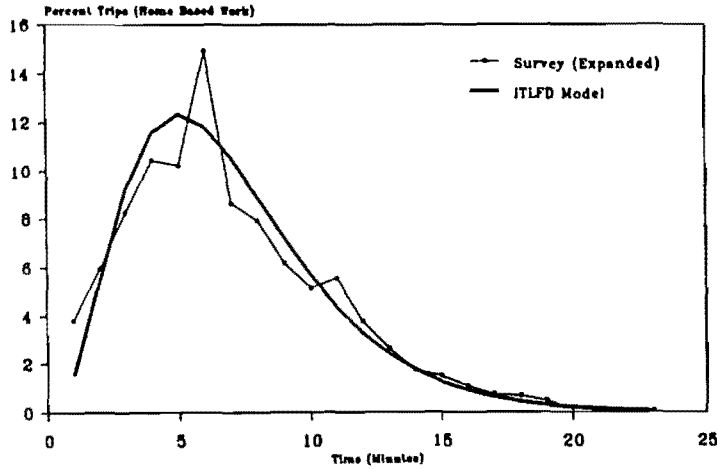
Tyler ITLFD Fit

Figure G-28
Home to Work Person
Trip Length Frequency Distribution



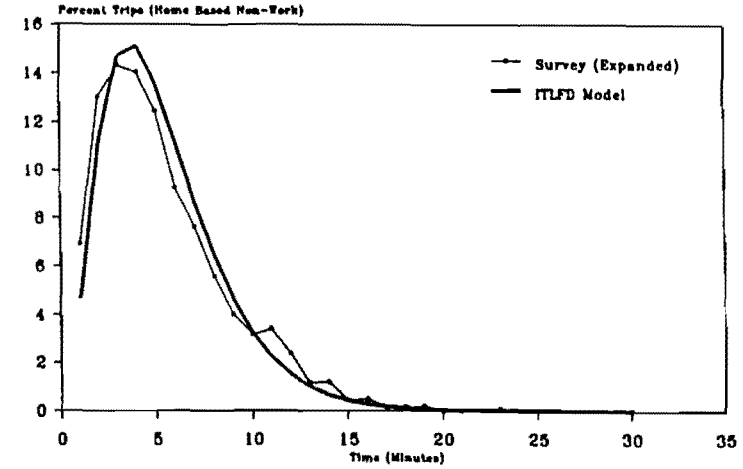
Tyler ITLFD Fit
 On Journey to Work Data

Figure G-29
Home Based Work Auto Driver
Trip Length Frequency Distribution



Tyler ITLFD Model

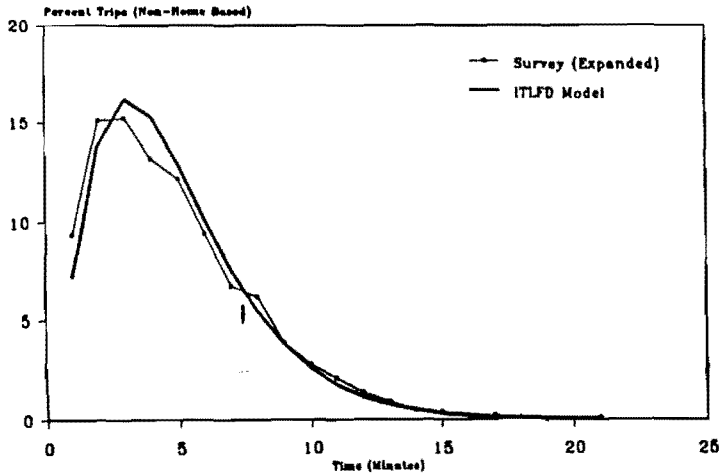
Figure G-30
Home Based Non-Work Auto Driver
Trip Length Frequency Distribution



Tyler ITLFD Model

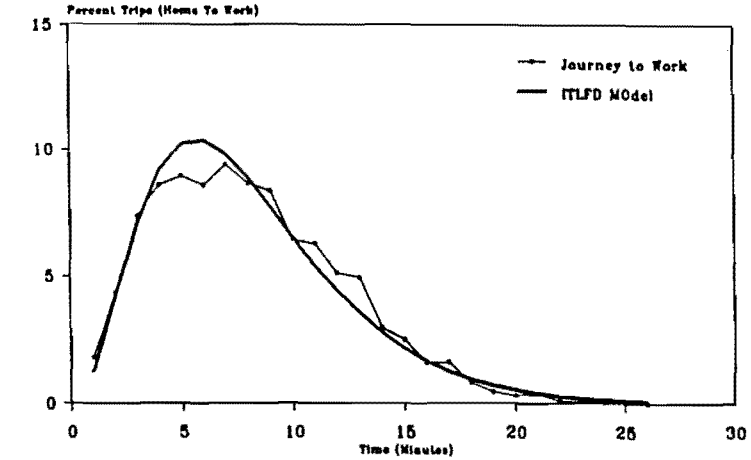
G-16

Figure G-31
Non-Home Based Auto Driver
Trip Length Frequency Distribution



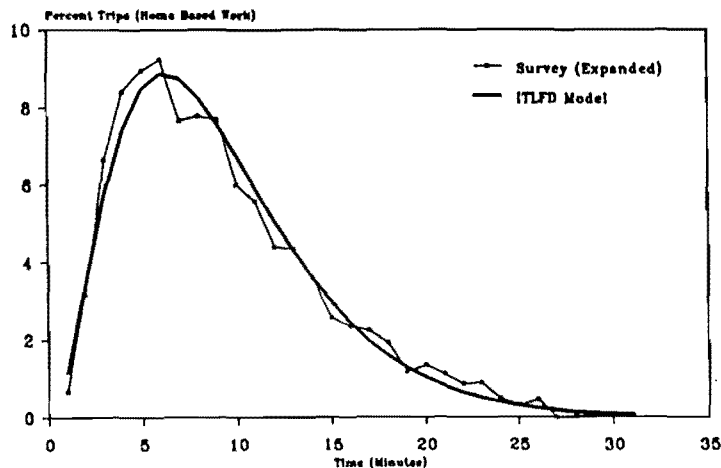
Tyler ITLFD Model

Figure G-32
Home to Work Auto Driver
Trip Length Frequency Distribution



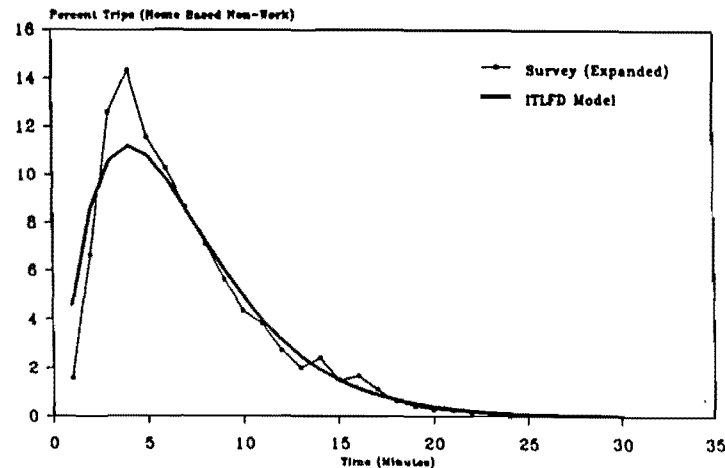
Tyler ITLFD Model
 On Journey to Work Data

Figure G-33
Home Based Work Person
Trip Length Frequency Distribution



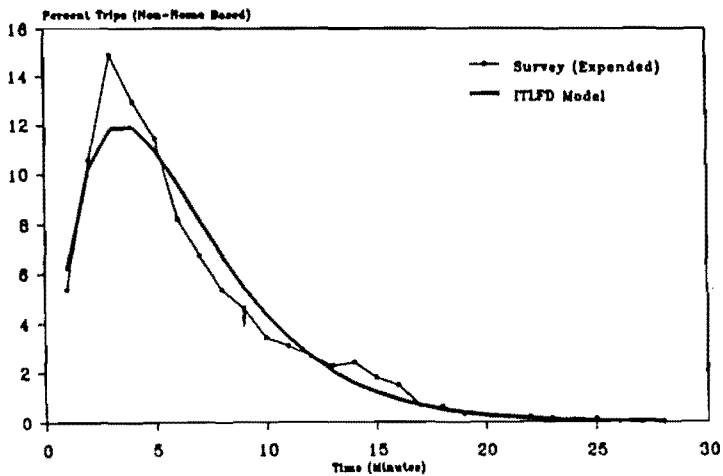
Sherman-Deane ITLFD Fit

Figure G-34
Home Based Non-Work Person
Trip Length Frequency Distribution



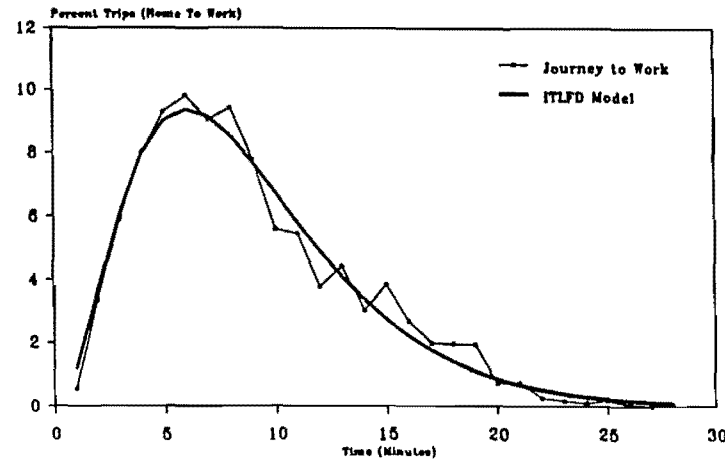
Sherman-Deane ITLFD Fit

Figure G-35
Non-Home Based Person
Trip Length Frequency Distribution



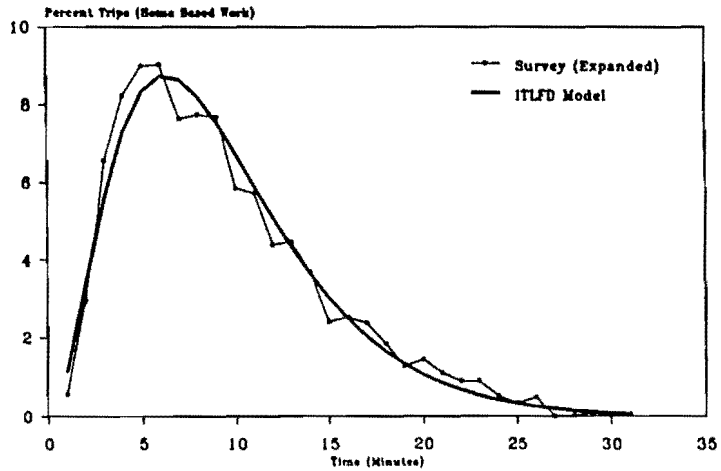
Sherman-Deane ITLFD Fit

Figure G-36
Home to Work Person
Trip Length Frequency Distribution



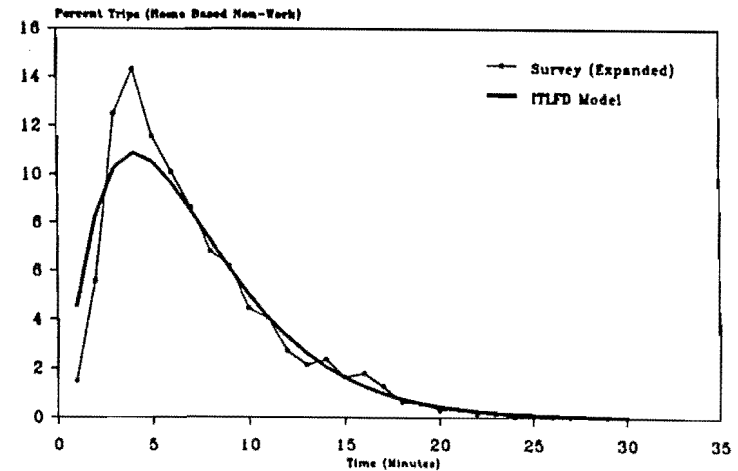
Sherman-Deane ITLFD Fit
 On Journey to Work Data

Figure G-37
Home Based Work Auto Driver
Trip Length Frequency Distribution



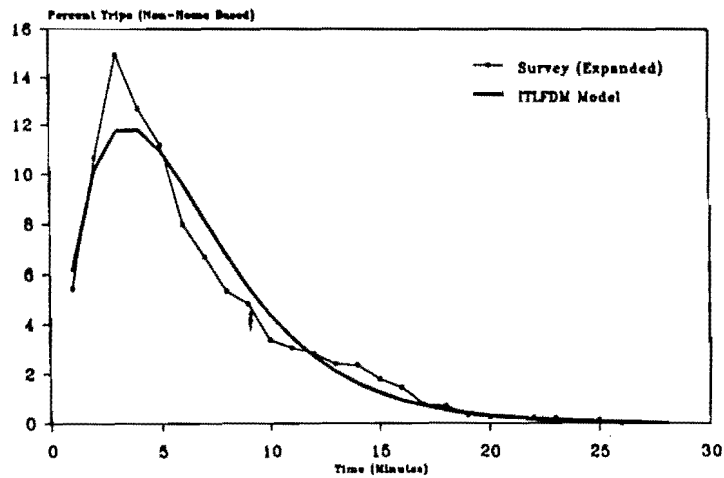
Sherman-Denison ITLFD Fit

Figure G-38
Home Based Non-Work Auto Driver
Trip Length Frequency Distribution



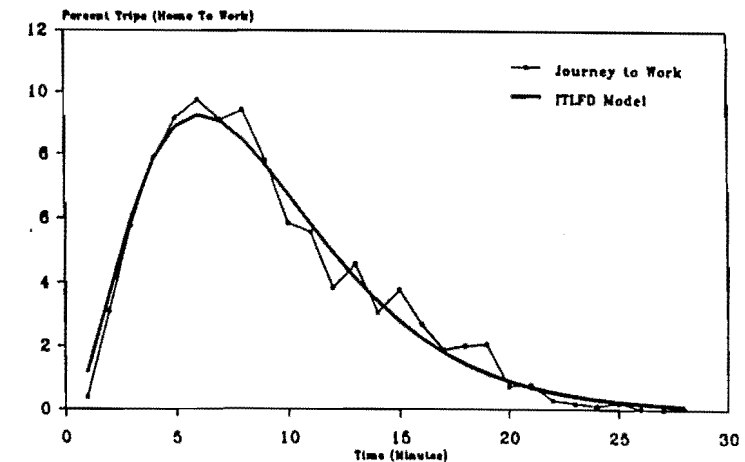
Sherman-Denison ITLFD Fit

Figure G-39
Non-Home Based Auto Driver
Trip Length Frequency Distribution



Sherman-Denison ITLFD Fit

Figure G-40
Home to Work Auto Driver
Trip Length Frequency Distribution



Sherman-Denison ITLFD Fit
 On Journey to Work Data

APPENDIX H

**Household Surveys
Trip Production Rates
Coefficients of Variation**

Table H-1
Trip Production Rates Coefficients of Variation by Trip Purpose
San Antonio

Home Based Work

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.976	2.025	1.513	1.837	1.273	5.289	2.478	1.940	2.212	1.766
\$ 5000 - \$ 9999	1.646	1.317	0.953	1.032	1.001	2.246	1.914	1.626	1.653	1.516
\$ 10000 - \$ 19999	1.001	1.139	0.705	0.758	0.721	1.221	1.337	0.862	0.973	0.866
\$ 20000 - \$ 34999	0.836	0.882	0.623	0.641	0.753	0.953	1.002	0.705	0.719	0.845
\$ 35000 Plus	0.897	0.760	0.638	0.622	0.664	0.897	0.795	0.689	0.678	0.688

Home Based Non-Work

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.147	1.100	0.764	0.741	0.798	2.403	1.871	1.396	1.723	1.528
\$ 5000 - \$ 9999	0.966	1.203	0.796	0.892	0.537	1.516	1.566	1.357	1.325	1.186
\$ 10000 - \$ 19999	0.935	0.909	0.821	0.637	0.583	1.131	1.132	1.123	1.040	0.967
\$ 20000 - \$ 34999	1.039	0.911	0.844	0.712	0.562	1.138	0.927	1.077	0.880	0.807
\$ 35000 Plus	1.014	1.004	0.803	0.655	0.680	1.088	1.005	0.887	0.788	0.929

Non-Home Based

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.259	1.985	1.428	1.313	1.252	3.218	2.918	2.039	1.717	2.095
\$ 5000 - \$ 9999	1.886	1.881	1.999	1.234	1.817	2.344	2.380	2.562	1.370	2.357
\$ 10000 - \$ 19999	1.490	1.409	1.341	1.434	1.391	1.654	1.517	1.697	1.668	1.496
\$ 20000 - \$ 34999	1.251	1.244	1.352	1.104	1.361	1.254	1.310	1.376	1.041	1.358
\$ 35000 Plus	0.995	1.086	1.181	0.998	1.167	1.046	1.118	1.237	1.082	1.265

Total-All Purposes

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.058	0.988	0.634	0.615	0.683	2.316	1.772	1.163	1.316	1.178
\$ 5000 - \$ 9999	1.019	0.947	0.666	0.750	0.608	1.557	1.316	1.158	1.063	1.047
\$ 10000 - \$ 19999	0.714	0.758	0.607	0.681	0.539	0.924	0.906	0.779	0.902	0.735
\$ 20000 - \$ 34999	0.669	0.630	0.611	0.534	0.562	0.738	0.659	0.695	0.560	0.641
\$ 35000 Plus	0.535	0.598	0.602	0.528	0.557	0.578	0.604	0.629	0.565	0.669

Table H-2
Trip Production Rates Coefficients of Variation by Trip Purpose
Amarillo

Home Based Work

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.201	1.491	1.534	1.224	2.002	3.013	1.964	1.825	2.008	1.860
\$ 5000 - \$ 9999	1.858	1.159	1.596	0.760	0.587	2.000	1.306	1.416	0.841	0.698
\$ 10000 - \$ 19999	1.212	1.275	0.929	0.626	0.829	1.261	1.312	0.986	0.748	1.013
\$ 20000 - \$ 34999	0.887	1.083	0.737	0.761	0.627	0.964	1.114	0.811	0.802	0.682
\$ 35000 Plus	0.768	0.752	0.591	0.604	0.686	0.856	0.778	0.612	0.625	0.704

Home Based Non-Work

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.028	0.843	0.732	0.605	0.848	1.461	1.187	0.902	0.732	0.847
\$ 5000 - \$ 9999	1.193	0.731	0.807	0.769	0.539	1.385	0.948	0.916	0.738	0.759
\$ 10000 - \$ 19999	0.961	0.935	0.871	0.763	0.645	1.060	1.018	0.983	0.798	0.700
\$ 20000 - \$ 34999	1.229	0.896	0.737	0.684	0.627	1.353	0.956	0.835	0.823	0.724
\$ 35000 Plus	1.134	0.840	0.739	0.624	0.529	1.120	0.855	0.785	0.759	0.646

Non-Home Based

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.720	1.756	0.938	1.231	0.964	1.812	2.007	1.169	0.000	1.205
\$ 5000 - \$ 9999	1.729	1.385	1.252	0.978	1.352	1.793	1.474	1.335	0.839	1.085
\$ 10000 - \$ 19999	1.375	1.385	1.352	1.451	1.017	1.441	1.270	1.330	1.576	1.082
\$ 20000 - \$ 34999	1.304	1.168	1.127	1.022	0.862	1.379	1.198	1.208	1.092	0.799
\$ 35000 Plus	1.352	0.950	0.985	0.824	0.705	1.431	0.950	0.963	0.865	0.808

Total-All Purposes

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.918	0.806	0.604	0.512	0.796	1.326	1.195	0.793	0.639	0.707
\$ 5000 - \$ 9999	1.095	0.689	0.691	0.702	0.489	1.251	0.887	0.682	0.581	0.630
\$ 10000 - \$ 19999	0.733	0.784	0.683	0.691	0.559	0.811	0.764	0.719	0.757	0.578
\$ 20000 - \$ 34999	0.681	0.680	0.582	0.507	0.508	0.742	0.712	0.627	0.544	0.499
\$ 35000 Plus	0.773	0.562	0.526	0.505	0.419	0.821	0.547	0.521	0.520	0.458

Table H-3
Trip Production Rates Coefficients of Variation by Trip Purpose
Brownsville

Home Based Work

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.795	3.098	1.320	1.455	1.425	3.518	3.677	1.996	2.707	1.884
\$ 5000 - \$ 9999	1.883	1.349	1.193	1.107	1.063	2.369	1.818	1.455	1.333	1.359
\$ 10000 - \$ 19999	1.792	1.154	0.837	0.787	0.924	1.792	1.302	0.938	1.052	1.165
\$ 20000 - \$ 34999	0.801	1.124	0.809	0.679	0.604	0.858	1.201	0.894	0.666	0.606
\$ 35000 Plus	1.338	0.820	0.756	0.600	0.701	1.338	0.870	0.792	0.649	0.691

Home Based Non-Work

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.231	1.161	0.826	0.877	0.611	3.072	1.732	1.251	1.487	1.250
\$ 5000 - \$ 9999	1.090	0.927	0.889	0.682	0.802	1.576	1.136	1.067	0.799	1.056
\$ 10000 - \$ 19999	0.805	0.891	0.821	0.325	0.574	0.838	1.040	0.945	0.753	0.800
\$ 20000 - \$ 34999	0.973	0.796	0.913	0.819	0.529	1.076	0.812	0.931	0.909	0.667
\$ 35000 Plus	0.893	0.871	0.704	0.757	0.617	0.870	0.852	0.778	0.811	0.721

Non-Home Based

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.914	3.093	1.441	2.012	1.618	2.856	3.146	1.756	1.825	1.627
\$ 5000 - \$ 9999	1.697	1.924	1.583	1.270	1.269	2.327	1.958	1.335	1.344	1.273
\$ 10000 - \$ 19999	1.301	1.158	1.158	1.320	1.144	1.301	1.174	1.140	1.246	1.141
\$ 20000 - \$ 34999	0.972	0.934	1.033	0.906	1.095	1.053	0.978	1.009	0.902	1.069
\$ 35000 Plus	1.156	0.986	0.936	0.907	0.922	1.156	1.082	0.998	0.960	0.886

Total-All Purposes

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.113	1.169	0.733	0.896	0.617	2.406	1.717	1.055	1.424	1.090
\$ 5000 - \$ 9999	0.963	0.845	0.811	0.604	0.726	1.442	1.018	0.858	0.661	0.925
\$ 10000 - \$ 19999	0.687	0.682	0.623	0.553	0.525	0.707	0.716	0.593	0.619	0.645
\$ 20000 - \$ 34999	0.632	0.505	0.635	0.495	0.490	0.712	0.523	0.652	0.543	0.522
\$ 35000 Plus	0.655	0.611	0.569	0.532	0.566	0.662	0.629	0.564	0.543	0.557

Table H-4
Trip Production Rates Coefficients of Variation by Trip Purpose
Sherman-Denison

Home Based Work

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	5.495	2.315	1.630	0.000	1.400	6.204	3.067	1.892	0.000	1.400
\$ 5000 - \$ 9999	4.584	2.415	1.292	0.688	0.334	4.584	2.635	1.354	1.208	0.334
\$ 10000 - \$ 19999	1.675	1.825	1.431	0.842	0.988	1.704	1.989	1.450	0.893	1.028
\$ 20000 - \$ 34999	1.344	1.327	0.807	0.688	0.663	1.390	1.399	0.839	0.742	0.730
\$ 35000 Plus	1.034	0.948	0.723	0.731	0.762	1.086	0.952	0.723	0.745	0.778

Home Based Non-Work

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.427	1.211	0.646	0.658	0.719	3.131	1.283	1.010	1.039	1.020
\$ 5000 - \$ 9999	1.071	0.920	0.703	1.157	0.558	1.420	1.095	0.931	0.907	0.334
\$ 10000 - \$ 19999	1.045	0.945	0.748	0.622	0.763	1.151	0.998	0.998	0.761	0.830
\$ 20000 - \$ 34999	1.012	0.766	0.775	0.653	0.588	1.077	0.800	0.895	0.735	0.748
\$ 35000 Plus	1.082	0.891	0.723	0.624	0.683	1.147	0.905	0.782	0.715	0.782

Non-Home Based

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	3.967	1.893	1.081	1.170	0.939	5.637	1.821	1.445	1.039	0.939
\$ 5000 - \$ 9999	1.736	1.488	1.309	1.349		1.975	1.609	1.287	1.013	0.000
\$ 10000 - \$ 19999	1.480	1.345	1.571	1.099	0.947	1.517	1.424	1.270	1.067	0.918
\$ 20000 - \$ 34999	1.192	1.006	1.213	1.093	1.012	1.255	1.074	1.313	1.148	0.999
\$ 35000 Plus	1.021	0.972	1.028	0.835	0.903	1.061	0.950	1.058	0.889	0.910

Total-All Purposes

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.652	1.296	0.646	0.737	0.725	3.380	1.259	1.028	1.041	0.859
\$ 5000 - \$ 9999	1.080	0.927	0.618	0.672	0.469	1.364	1.048	0.704	0.549	0.334
\$ 10000 - \$ 19999	0.851	0.802	0.766	0.595	0.654	0.909	0.859	0.825	0.621	0.719
\$ 20000 - \$ 34999	0.703	0.628	0.660	0.569	0.559	0.753	0.670	0.703	0.599	0.534
\$ 35000 Plus	0.596	0.629	0.561	0.490	0.578	0.661	0.633	0.547	0.528	0.571

Table H-5
 Trip Production Rates Coefficients of Variation by Trip Purpose
 Tyler

Home Based Work

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	3.213	1.819	1.356	1.004	1.109	3.251	1.943	1.974	1.001	1.109
\$ 5000 - \$ 9999	2.211	2.200	1.134	0.747	1.670	2.263	2.464	1.245	1.043	1.224
\$ 10000 - \$ 19999	1.654	1.395	1.151	0.952	0.905	1.770	1.430	1.151	0.967	1.165
\$ 20000 - \$ 34999	1.032	1.207	0.702	0.607	0.969	1.068	1.228	0.709	0.639	1.007
\$ 35000 Plus	1.378	0.948	0.709	0.735	0.656	1.378	0.964	0.701	0.747	0.678

Home Based Non-Work

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.514	1.327	1.271	0.669	0.492	2.208	1.284	1.542	1.003	0.659
\$ 5000 - \$ 9999	1.155	1.215	0.856	0.485	0.612	1.379	1.352	1.272	0.887	1.158
\$ 10000 - \$ 19999	0.926	0.832	0.978	0.749	0.698	1.038	0.913	1.074	0.790	0.734
\$ 20000 - \$ 34999	0.942	0.792	0.810	0.711	0.709	0.980	0.826	0.757	0.780	0.834
\$ 35000 Plus	1.050	0.754	0.682	0.606	0.622	1.138	0.782	0.727	0.747	0.623

Non-Home Based

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.427	1.863	1.672	0.340	1.001	3.083	2.274	1.557	1.001	1.226
\$ 5000 - \$ 9999	1.737	1.725	1.522	0.861	1.051	2.026	1.838	1.591	0.874	1.184
\$ 10000 - \$ 19999	1.552	1.556	1.186	1.381	1.028	1.681	1.652	1.244	1.383	1.178
\$ 20000 - \$ 34999	1.202	1.532	1.066	1.031	1.286	1.246	1.390	1.118	1.111	1.106
\$ 35000 Plus	1.172	1.089	0.978	1.047	0.734	1.249	1.133	0.978	1.025	0.809

Total-All Purposes

Household Income Range	Coefficients of Variation - Person Trips					Coefficients of Variation - Auto Driver Trips				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.517	1.144	0.888	0.162	0.432	2.085	1.191	1.041	0.559	0.614
\$ 5000 - \$ 9999	1.071	1.146	0.779	0.386	0.476	1.261	1.277	0.987	0.580	0.829
\$ 10000 - \$ 19999	0.800	0.758	0.719	0.670	0.623	0.923	0.798	0.782	0.672	0.703
\$ 20000 - \$ 34999	0.614	0.741	0.593	0.586	0.702	0.648	0.686	0.583	0.576	0.686
\$ 35000 Plus	0.703	0.553	0.504	0.526	0.447	0.774	0.578	0.512	0.583	0.433

APPENDIX I

Through Trip Tables

**Table I-1
Through Trip Table
Amarillo External Station Survey**

Origin Station	Destination Station																			Total
	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	
372			12	6	4	50	140	1,157	4		2	3	452	2	3		9		10	1,854
373					4								7							11
374	12			11	17		35	6	6			6	251				12		3	359
375	6		11																	17
376	4	4	17				43				2	15	503			4	57	4		653
377	50							7					10				3			70
378	140		35		43			13				3	653			2	3,434		7	4,330
379	1,157		6			7	13					11	40		3		777		10	2,024
380	4		6							4	6	36	60	2			7			125
381									4			4	5			2	2			17
382	2				2				6			130	8		6		2		3	159
383	3		6		15		3	11	36	4	130		8							216
384	452	7	251		503	10	653	40	60	5	8	8		14	110	13	133	4	24	2,295
385	2								2				14		8	24	14		7	71
386	3							3			6		110	8					6	136
387					4		2			2			13	24			4			49
388	9		12		57	3	3,434	777	7	2	2		133	14		4			3	4,457
389					4								4							8
390	10		3				7	10			3		24	7	6		3			73
Total	1,854	11	359	17	653	70	4,330	2,024	125	17	159	216	2,295	71	136	49	4,457	8	73	16,924

**Table I-2
Through Trip Table
Brownsville External Station Survey**

Origin Station	Destination Station									
	141	142	143	144	145	146	147	148	149	Total
141	0	7	60	697	28	8	0	140	0	940
142	7	0	99	297	17	4	0	24	0	448
143	60	99	0	53	5	11	0	40	3	271
144	697	297	53	0	64	4	0	38	11	1,164
145	28	17	5	64	0	5	0	5	0	124
146	8	4	11	4	5	0	0	35	19	86
147	0	0	0	0	0	0	0	0	0	0
148	140	24	40	38	5	35	0	0	0	282
149	0	0	3	11	0	19	0	0	0	33
Total	940	448	271	1,164	124	86	0	282	33	3,348

**Table I-3
Through Trip Table
San Antonio External Station Survey**

Origin Station	Destination Station																
	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	Subtotal
600	0	33	156	3	0	64	9	118	6	3,294	324	6	321	4	8	5	4,351
601	33	0	8	0	0	8	0	0	0	8	0	0	8	0	0	0	65
602	156	8	0	2	0	0	4	8	3	118	59	3	87	0	4	3	455
603	3	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	7
604	0	0	0	0	0	13	0	8	0	0	0	0	4	0	0	0	25
605	64	8	0	0	13	0	0	18	0	0	0	0	0	0	0	0	103
606	9	0	4	0	0	0	0	1	0	4	1	0	0	0	0	0	19
607	118	0	8	0	8	18	1	0	0	0	0	0	0	0	1	0	154
608	6	0	3	0	0	0	0	0	0	3	1	0	0	0	0	0	13
609	3,294	8	118	2	0	0	4	0	3	0	0	3	0	0	4	2	3,438
610	324	0	59	0	0	0	1	0	1	0	0	1	0	0	1	1	388
611	6	0	3	0	0	0	0	0	0	3	1	0	0	0	0	0	13
612	321	8	87	0	4	0	0	0	0	0	0	0	0	0	0	0	420
613	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
614	8	0	4	0	0	0	0	1	0	4	1	0	0	0	0	0	18
615	5	0	3	0	0	0	0	0	0	2	1	0	0	0	0	0	11
Subtotal	4,351	65	455	7	25	103	19	154	13	3,438	388	13	420	4	18	11	

**Table I-3 (Continued)
Through Trip Table
San Antonio External Station Survey**

Origin Station	Destination Station																Subtotal	Total
	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	633		
600	1,904	25	5	6	12	472	0	8	50	3	266	11	163	1	3	0	2,929	7,280
601	24	0	0	0	0	0	0	0	6	0	41	0	8	0	16	0	95	160
602	431	13	3	3	6	284	0	4	6	2	1,959	6	52	1	2	0	2,772	3,227
603	1	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	4	11
604	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	4	8	33
605	54	1	0	0	0	9	0	0	0	0	108	0	0	0	0	0	172	275
606	4	0	0	0	0	1	0	0	0	0	14	0	5	0	0	0	24	43
607	49	1	0	0	1	8	4	4	0	0	50	1	20	0	0	0	138	292
608	2	0	0	0	0	1	0	0	0	0	3	0	1	0	0	0	7	20
609	19	12	3	3	6	172	0	12	0	20	956	5	234	1	2	0	1,445	4,883
610	10	3	1	1	1	26	0	5	6	0	60	1	71	0	0	0	185	573
611	2	0	0	0	0	1	0	0	0	0	2	0	1	0	0	0	6	19
612	40	1	0	0	1	0	0	0	69	0	26	0	20	0	0	0	157	577
613	4	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	11	15
614	3	0	0	0	0	1	0	0	0	0	4	0	1	0	0	0	9	27
615	2	0	0	0	0	1	0	0	0	0	2	0	1	0	0	0	6	17
Subtotal	2,549	56	12	13	27	984	4	33	137	25	3,497	24	577	3	23	4		

Table I-3 (Continued)
Through Trip Table
San Antonio External Station Survey

Origin Station	Destination Station																
	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	Subtotal
616	1,904	24	431	1	0	54	4	49	2	19	10	2	40	4	3	2	2,549
617	25	0	13	0	0	1	0	1	0	12	3	0	1	0	0	0	56
618	5	0	3	0	0	0	0	0	0	3	1	0	0	0	0	0	12
619	6	0	3	0	0	0	0	0	0	3	1	0	0	0	0	0	13
620	12	0	6	0	0	0	0	1	0	6	1	0	1	0	0	0	27
621	472	0	284	1	0	9	1	8	1	172	26	1	0	7	1	1	984
622	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	4
623	8	0	4	0	0	0	0	4	0	12	5	0	0	0	0	0	33
624	50	6	6	0	0	0	0	0	0	0	6	0	69	0	0	0	137
625	3	0	2	0	0	0	0	0	0	20	0	0	0	0	0	0	25
626	266	41	1,959	2	4	108	14	50	3	956	60	2	26	0	4	2	3,497
627	11	0	6	0	0	0	0	1	0	5	1	0	0	0	0	0	24
628	163	8	52	0	0	0	5	20	1	234	71	1	20	0	1	1	577
629	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	3
630	3	16	2	0	0	0	0	0	0	2	0	0	0	0	0	0	23
633	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4
Subtotal	2,929	95	2,772	4	8	172	24	138	7	1,445	185	6	157	11	9	6	
Total	7,280	160	3,227	11	33	275	43	292	20	4,883	573	19	577	15	27	17	

**Table I-3 (Continued)
Through Trip Table
San Antonio External Station Survey**

Origin Station	Destination Station																Subtotal	Total
	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	633		
616	0	11	2	2	5	51	0	0	6	1	224	5	55	0	1	0	363	2,912
617	11	0	0	0	0	3	0	0	1	0	11	0	3	0	0	0	29	85
618	2	0	0	0	0	1	0	4	0	0	2	0	1	0	0	0	10	22
619	2	0	0	0	0	1	0	0	0	0	2	0	1	0	0	0	6	19
620	5	0	0	0	0	2	0	0	0	0	15	0	1	0	0	0	23	50
621	51	3	1	1	2	0	4	0	6	1	0	1	46	0	1	0	117	1,101
622	0	0	0	0	0	4	0	0	4	0	12	0	0	0	0	0	20	24
623	0	0	4	0	0	0	0	0	0	0	8	0	0	0	0	0	12	45
624	6	1	0	0	0	6	4	0	0	0	6	0	0	0	0	0	23	160
625	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	3	28
626	224	11	2	2	15	0	12	8	6	1	0	5	10	0	11	0	307	3,804
627	5	0	0	0	0	1	0	0	0	0	5	0	1	0	0	0	12	36
628	55	3	1	1	1	46	0	0	0	0	10	1	0	0	0	0	118	695
629	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
630	1	0	0	0	0	1	0	0	0	0	11	0	0	0	0	0	13	36
633	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Subtotal	363	29	10	6	23	117	20	12	23	3	307	12	118	0	13	0		
Total	2,912	85	22	19	50	1,101	24	45	160	28	3,804	36	695	3	36	4		26,476

**Table I-4
Through Trip Table
Sherman-Denison External Station Survey**

Origin Station	Destination Station												Subtotal
	274	275	276	277	278	279	280	281	282	283	284	285	
274	0	0	0	0	0	0	0	3	0	0	0	0	3
275	0	0	0	6	0	0	2	6	0	4	7	0	25
276	0	0	0	1	0	0	1	13	0	1	1	0	17
277	0	6	1	0	0	0	3	28	6	0	12	0	56
278	0	0	0	0	0	0	1	12	0	0	1	0	14
279	0	0	0	0	0	0	0	3	0	0	0	0	3
280	0	2	1	3	1	0	0	15	16	0	36	0	74
281	3	6	13	28	12	3	15	0	7	10	223	3	323
282	0	0	0	6	0	0	16	7	0	5	20	0	54
283	0	4	1	0	0	0	0	10	5	0	9	0	29
284	0	7	1	12	1	0	36	223	20	9	0	0	309
285	0	0	0	0	0	0	0	3	0	0	0	0	3
286	1	5	2	6	2	1	4	30	2	1	6	0	60
287	0	0	0	0	0	0	0	2	0	0	0	0	2
288	0	0	0	0	0	0	0	8	0	0	1	0	9
289	1	1	6	3	5	1	5	1,160	0	0	4	1	1,187
290	0	0	0	0	0	0	2	0	0	0	1	0	3
291	0	0	0	5	0	0	5	2	0	0	0	0	12
292	4	20	16	139	14	3	104	4,567	26	25	53	3	4,974
293	0	0	0	0	0	0	0	3	0	0	0	0	3
294	0	0	0	0	0	0	0	3	0	0	0	0	3
295	0	0	0	0	0	0	1	15	0	0	2	0	18
296	0	14	0	18	0	0	6	17	3	0	11	0	69
297	1	19	5	44	5	1	36	628	11	9	84	1	844
Total	10	84	46	271	40	9	237	6,758	96	64	471	8	

Table I-4 (Continued)
Through Trip Table
Sherman-Denison External Station Survey

Origin Station	Destination Station												Subtotal	Total
	286	287	288	289	290	291	292	293	294	295	296	297		
274	1	0	0	1	0	0	4	0	0	0	0	1	7	10
275	5	0	0	1	0	0	20	0	0	0	14	19	59	84
276	2	0	0	6	0	0	16	0	0	0	0	5	29	46
277	6	0	0	3	0	5	139	0	0	0	18	44	215	271
278	2	0	0	5	0	0	14	0	0	0	0	5	26	40
279	1	0	0	1	0	0	3	0	0	0	0	1	6	9
280	4	0	0	5	2	5	104	0	0	1	6	36	163	237
281	30	2	8	1,160	0	2	4,567	3	3	15	17	628	6,435	6,758
282	2	0	0	0	0	0	26	0	0	0	3	11	42	96
283	1	0	0	0	0	0	25	0	0	0	0	9	35	64
284	6	0	1	4	1	0	53	0	0	2	11	84	162	471
285	0	0	0	1	0	0	3	0	0	0	0	1	5	8
286	0	0	1	16	0	3	70	0	0	2	33	693	818	878
287	0	0	0	1	0	0	2	0	0	0	0	1	4	6
288	1	0	0	3	0	0	9	0	0	0	0	3	16	25
289	16	1	3	0	3	0	19	1	1	7	41	57	149	1,336
290	0	0	0	3	0	27	171	0	0	12	6	1	220	223
291	3	0	0	0	27	0	0	0	0	10	2	2	44	56
292	70	2	9	19	171	0	0	3	3	26	73	348	724	5,698
293	0	0	0	1	0	0	3	0	0	0	0	1	5	8
294	0	0	0	1	0	0	3	0	0	0	0	1	5	8
295	2	0	0	7	12	10	26	0	0	0	0	6	63	81
296	33	0	0	41	6	2	73	0	0	0	0	20	175	244
297	693	1	3	57	1	2	348	1	1	6	20	0	1,133	1,977
Total	878	6	25	1,336	223	56	5,698	8	8	81	244	1,977		18,634

**Table I-5
Through Trip Table
Tyler External Station Survey**

Origin Station	Destination Station																
	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	Subtotal
229	0	0	0	0	0	0	7	0	41	0	0	14	0	0	34	0	96
230	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	4
231	0	0	0	0	0	0	0	2	0	0	0	4	2	0	0	0	8
232	0	0	0	0	0	0	2	3	33	2	2	28	2	0	29	0	101
233	0	0	0	0	0	0	0	1	3	0	0	3	0	0	0	0	7
234	0	0	0	0	0	0	3	13	27	0	0	13	0	10	20	0	86
235	7	0	0	2	0	3	0	108	9	4	0	0	0	0	0	0	133
236	0	0	2	3	1	13	108	0	22	0	0	12	0	0	3	0	164
237	41	0	0	33	3	27	9	22	0	162	21	54	12	2	5	0	391
238	0	0	0	2	0	0	4	0	162	0	173	211	51	15	80	3	701
239	0	0	0	2	0	0	0	0	21	173	0	11	2	0	12	0	221
240	14	2	4	28	3	13	0	12	54	211	11	0	49	13	4	2	420
241	0	2	2	2	0	0	0	0	12	51	2	49	0	32	35	12	199
242	0	0	0	0	0	10	0	0	2	15	0	13	32	0	16	0	88
243	34	0	0	29	0	20	0	3	5	80	12	4	35	16	0	10	248
244	0	0	0	0	0	0	0	0	0	3	0	2	12	0	10	0	27
Subtotal	96	4	8	101	7	86	133	164	391	701	221	420	199	88	248	27	

**Table I-5 (Continued)
Through Trip Table
Tyler External Station Survey**

Origin Station	Destination Station																Subtotal	Total
	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260		
229	0	0	89	0	7	0	0	7	0	7	0	0	7	0	0	7	124	220
230	0	0	0	0	2	0	0	2	0	0	2	0	0	0	0	0	6	10
231	0	0	6	0	0	0	0	0	0	4	0	0	2	0	4	4	20	28
232	0	0	210	0	12	2	9	36	0	12	0	2	7	0	2	3	295	396
233	0	0	8	0	3	0	0	1	0	4	0	0	3	0	0	0	19	26
234	0	0	27	0	40	3	13	23	0	30	0	0	7	0	7	13	163	249
235	0	0	0	0	15	0	0	0	0	7	3	0	6	4	0	4	39	172
236	2	0	6	0	0	0	0	0	0	0	0	0	3	0	0	0	11	175
237	0	0	72	4	37	0	38	120	0	114	2	2	42	2	61	47	541	932
238	0	0	21	0	4	2	1	5	0	4	0	0	2	0	4	0	43	744
239	0	0	9	0	2	0	0	16	0	9	0	0	2	0	2	2	42	263
240	2	6	31	2	40	2	19	124	7	161	3	0	30	4	24	27	482	902
241	4	0	25	0	13	0	5	9	0	13	2	0	11	0	10	3	95	294
242	0	0	13	0	3	0	1	0	0	10	0	0	0	0	7	0	34	122
243	7	2	60	2	46	7	11	54	3	98	2	0	26	2	63	39	422	670
244	0	0	7	0	0	0	0	0	0	5	0	0	0	0	0	2	14	28
Subtotal	15	8	584	8	224	16	97	397	10	478	14	4	148	12	184	151		

**Table I-5 (Continued)
Through Trip Table
Tyler External Station Survey**

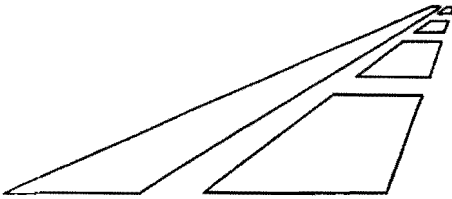
Origin Station	Destination Station																
	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	Subtotal
245	0	0	0	0	0	0	0	2	0	0	0	2	4	0	7	0	15
246	0	0	0	0	0	0	0	0	0	0	0	6	0	0	2	0	8
247	89	0	6	210	8	27	0	6	72	21	9	31	25	13	60	7	584
248	0	0	0	0	0	0	0	0	4	0	0	2	0	0	2	0	8
249	7	2	0	12	3	40	15	0	37	4	2	40	13	3	46	0	224
250	0	0	0	2	0	3	0	0	0	2	0	2	0	0	7	0	16
251	0	0	0	9	0	13	0	0	38	1	0	19	5	1	11	0	97
252	7	2	0	36	1	23	0	0	120	5	16	124	9	0	54	0	397
253	0	0	0	0	0	0	0	0	0	0	0	7	0	0	3	0	10
254	7	0	4	12	4	30	7	0	114	4	9	161	13	10	98	5	478
255	0	2	0	0	0	0	3	0	2	0	0	3	2	0	2	0	14
256	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	4
257	7	0	2	7	3	7	6	3	42	2	2	30	11	0	26	0	148
258	0	0	0	0	0	0	4	0	2	0	0	4	0	0	2	0	12
259	0	0	4	2	0	7	0	0	61	4	2	24	10	7	63	0	184
260	7	0	4	3	0	13	4	0	47	0	2	27	3	0	39	2	151
Subtotal	124	6	20	295	19	163	39	11	541	43	42	482	95	34	422	14	
Total	220	10	28	396	26	249	172	175	932	744	263	902	294	122	670	41	

**Table I-5 (Continued)
Through Trip Table
Tyler External Station Survey**

Origin Station	Destination Station																Subtotal	Total
	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260		
245	0	17	184	2	71	2	5	83	5	14	0	0	7	4	2	0	396	411
246	17	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	19	27
247	184	2	0	4	39	6	15	127	11	79	10	0	47	4	54	107	689	1,273
248	2	0	4	0	8	0	3	10	4	8	0	0	2	0	2	0	43	51
249	71	0	39	8	0	5	3	40	9	20	0	3	8	0	5	52	263	487
250	2	0	6	0	5	0	9	2	6	0	0	0	2	0	0	2	34	50
251	5	0	15	3	3	9	0	73	215	48	5	0	8	1	10	33	428	525
252	83	0	127	10	40	2	73	0	759	571	58	14	172	29	67	7,355	9,360	9,757
253	5	0	11	4	9	6	215	759	0	38	1	4	2	0	8	70	1,132	1,142
254	14	0	79	8	20	0	48	571	38	0	53	3	56	11	38	748	1,687	2,165
255	0	0	10	0	0	0	5	58	1	53	0	12	10	0	10	20	179	193
256	0	0	0	0	3	0	0	14	4	3	12	0	5	0	0	26	67	71
257	7	0	47	2	8	2	8	172	2	56	10	5	0	17	48	290	674	822
258	4	0	4	0	0	0	1	29	0	11	0	0	17	0	19	6	91	103
259	2	0	54	2	5	0	10	67	8	38	10	0	48	19	0	119	382	566
260	0	0	107	0	52	2	33	7,355	70	748	20	26	290	6	119	0	8,828	8,979
Subtotal	396	19	689	43	263	34	428	9,360	1,132	1,687	179	67	674	91	382	8,828		
Total	411	27	1,273	51	487	50	525	9,757	1,142	2,165	193	71	822	103	566	8,979		31,866

APPENDIX J

Technical Memorandum Modified Trip Production Rates



TEXAS TRANSPORTATION INSTITUTE

TRANSPORTATION PLANNING PROGRAM

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TEXAS 707, BUILDING A, SUITE 200

September 1, 1997

MEMORANDUM

To: Ken Mora, Project Director
Zack Graham

From: David Pearson, TTI

Subject: Modified Trip Production Rates

The purpose of this memo is to transmit recommended trip production rates for Amarillo, Brownsville, San Antonio, Sherman-Denison, and Tyler and document the methodology used to develop the rates. This memo documents the results of work performed under Sub-Task 1.5: Estimating Missing Trips, Interagency Cooperation Contract- Special Data Requirements for Transportation Analysis.

Objective

The objective of the work under Sub-Task 1.5 was to examine the travel surveys, determine if a means existed to identify missing trips, and then develop a methodology for modifying the trip production rates to account for these trips.

Background

A comprehensive effort was undertaken by the Texas Department of Transportation (TxDOT) in 1990 to update the travel demand modeling data being used in Texas. The initial effort in 1990 and 1991 was the funding of travel surveys in five urban areas, Amarillo, Brownsville, San Antonio, Sherman-Denison, and Tyler. Following the completion of those surveys, TxDOT contracted with TTI to evaluate the data and prepare trip production rates for use in travel demand models. In the course of that evaluation, a number of recommendations for revisions to the survey methodologies and procedures were made. The initial findings from the application of the trip production rates in several urban areas were the overall trips being produced resulted in estimates of vehicle miles of travel that were lower than that being observed. It was generally concluded that the trip production rates being developed from the travel surveys were low, especially for home based non-work and non-home based trips. It was believed that these types of trips were being under reported in the surveys.

Analysis

The results of the evaluation of the 1990-91 travel surveys led to revised procedures and instruments which were implemented in travel surveys done in 1993, 1994, and 1995. The areas surveyed were Beaumont-Port Arthur (1993), El Paso (1994), and Houston (1995). The data from

these surveys were evaluated, edited, and corrected extensively. Following those surveys, an effort was begun to identify missing trips and determine if the data from earlier surveys could be adjusted to account for these trips.

Two approaches were examined to find or identify missing (under reported) trips. One was a comparison of the expanded data from the work place surveys with that from the household surveys. A comparison was made using data from the Beaumont-Port Arthur and El Paso surveys. Table J-1 presents the results which indicate a relatively good agreement between the expanded auto driver productions and attractions for home based work trips and significant imbalances in the results for home based non-work and non-home based. When the expanded productions and attractions were used to estimate total vehicle miles of travel (taking into consideration the vehicle miles of travel due to other sources) and the results were compared to estimates from the Federal Highway Administration Highway Performance Management System (HPMS), the vehicle miles of travel (VMT) based on household productions was less than the HPMS estimate and the VMT based on work place attractions was higher. The implication was that the productions were under estimated and the attractions were over estimated. The decision was made to look at another means for identifying missing or under reported trips.

Table J-1
Trip Productions and Attractions by Trip Purpose
Beaumont-Port Arthur and El Paso

Urban Area	Trip Purpose	Auto Driver Productions	Auto Driver Attractions	Difference
Beaumont-Port Arthur	Home Based Work	175,510	173,199	- 1.3 %
	Home Based Non-Work	321,713	725,959	125.7 %
	Non-Home Based	189,047	387,027	104.7 %
	All Purposes	686,270	1,286,185	87.4 %
El Paso	Home Based Work	267,234	270,035	1.1 %
	Home Based Non-Work	417,609	1,075,609	157.6 %
	Non-Home Based	254,817	498,115	95.5 %
	All Purposes	939,660	1,843,759	96.2 %

The second approach was to examine the household trip data for persons stratified by age cohort. Through extensive post data editing and evaluation, it was believed that the majority of invalid zero trip households had been identified and removed from the analysis of trip rates. It was, however, felt that a significant potential for under reporting of trips or refusal to participate still existed at the individual level within surveyed households. To examine this, the trips per person rates were developed for Beaumont-Port Arthur, El Paso, and the Houston-Galveston region for persons stratified by age cohort. These rates were computed in two ways. The first was the total observed trips divided by the total persons observed in each age cohort. This rate is referred to as the overall trip rate. The second was the total observed trips divided by the

persons observed that made at least one trip. This rate is referred to as the average trip rate. The first rate included those individuals that made no trips while the second rate represented the average trips per person for only persons that traveled. The variances of the trip rates were also computed.

**Table J-2
Expanded Person Trips Per Person
Beaumont-Port Arthur Household Survey**

Age Cohort	Person Trips Per Person							
	Overall	Variance	Confidence Interval		Average	Variance	Confidence Interval	
			Low	High			Low	High
5 - 15	3.208	2.943	3.114	3.302	3.285	2.759	3.193	3.377
16 - 19	3.621	6.085	3.345	3.897	3.901	5.460	3.629	4.173
20 - 24	3.720	9.425	3.377	4.063	4.375	8.212	4.027	4.723
25 - 29	3.854	8.336	3.560	4.148	4.373	7.186	4.082	4.664
30 - 34	4.177	11.533	3.875	4.479	4.913	9.944	4.609	5.217
35 - 39	4.265	10.181	4.000	4.530	4.791	8.912	4.528	5.054
40 - 44	4.572	11.971	4.256	4.888	5.104	10.644	4.789	5.419
45 - 49	4.108	10.781	3.806	4.410	4.582	9.850	4.277	4.887
50 - 54	3.633	8.110	3.345	3.921	4.242	6.882	3.955	4.529
55 - 59	3.587	8.121	3.279	3.895	4.403	6.369	4.101	4.705
60 - 64	3.447	8.519	3.126	3.768	4.437	6.564	4.117	4.757
65 - 69	3.458	8.448	3.150	3.766	4.393	6.619	4.086	4.700
70 - 74	3.392	8.822	3.027	3.757	4.505	6.691	4.139	4.871
75 - 79	2.982	6.725	2.586	3.378	4.241	4.202	3.868	4.614
80 +	1.661	3.908	1.365	1.957	3.227	2.522	2.895	3.559

Tables J-2 through J-4 present the observed person trips per person for the three urban areas with the observed variances and 95 percent confidence intervals. It was noted that, statistically, the overall and average trip rates were significantly different for all but three age cohorts. This reflects the impact of including persons that reported zero trips on the trip rates. It was concluded that the true trip rate for each age cohort was likely to fall between the overall and average rate. A more accurate estimate of this true rate could be obtained if a means were found to adjust the observed trip rate to account for persons that made trips but for one reason or another did not report them.

**Table J-3
Expanded Person Trips Per Person
El Paso Household Survey**

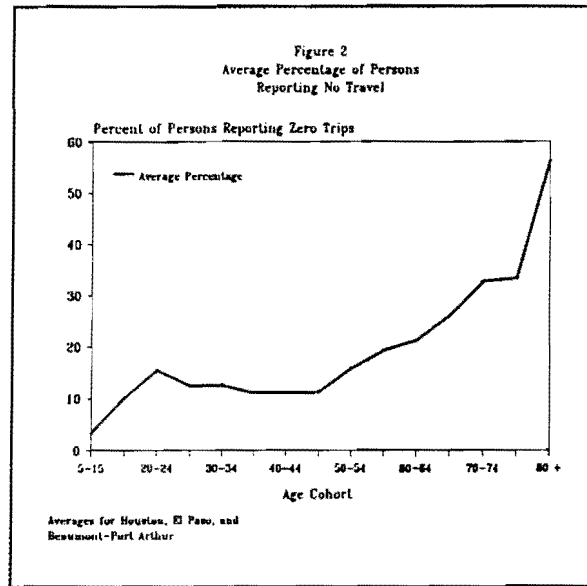
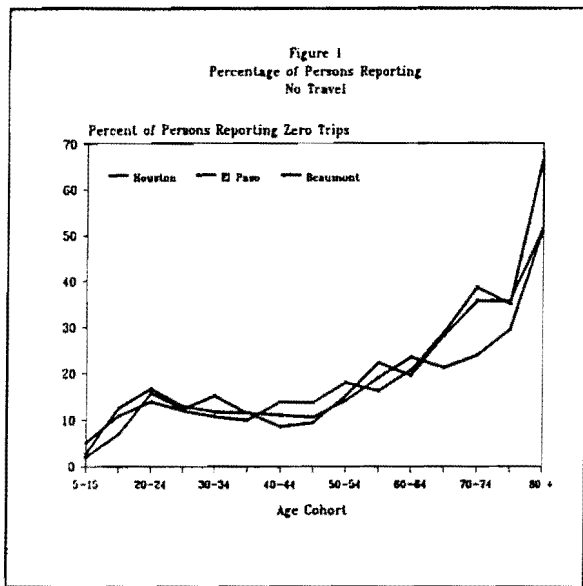
Age Cohort	Person Trips Per Person							
	Overall	Variance	Confidence Interval		Average	Variance	Confidence Interval	
			Low	High			Low	High
5 - 15	3.080	3.136	2.998	3.162	3.246	2.765	3.167	3.325
16 - 19	3.400	5.720	3.216	3.584	3.813	4.840	3.633	3.993
20 - 24	3.569	7.892	3.337	3.801	4.154	6.754	3.922	4.386
25 - 29	3.815	8.753	3.559	4.071	4.339	7.678	4.083	4.594
30 - 34	4.297	10.031	4.060	4.534	4.801	8.786	4.567	5.035
35 - 39	4.334	10.501	4.080	4.587	4.802	9.386	4.549	5.055
40 - 44	4.089	12.465	3.813	4.365	4.748	11.343	4.464	5.032
45 - 49	3.688	8.513	3.431	3.945	4.293	7.311	4.037	4.549
50 - 54	3.548	9.008	3.243	3.853	4.356	7.535	4.047	4.665
55 - 59	3.453	7.754	3.163	3.743	4.160	6.395	3.870	4.450
60 - 64	3.241	7.790	2.920	3.542	4.154	6.184	3.830	4.478
65 - 69	3.091	9.253	2.717	3.465	4.486	7.159	4.090	4.882
70 - 74	2.783	10.248	2.320	3.246	4.655	8.412	4.113	5.197
75 - 79	2.946	9.437	2.318	3.574	4.593	7.108	3.913	5.273
80 +	1.105	3.989	0.703	1.507	3.750	3.602	3.047	4.453

The percentage of persons making no trips in each cohort were computed for each of the three urban areas. Figure 1 presents a plot of these percentages. The first item of interest was the similarity of the curves for all three urban areas. This implies that on an average day, the percentage of persons in each cohort making no trips is approximately the same for any urban area. It also implies that if the observed percentages are incorrect due to under reporting, etc., the error introduced is a systematic error which is the same for all surveyed urban areas. Examination of Figure 1 also reveals some illogical data points. The percentage of persons making zero trips increase for the first three cohorts, then decline (generally) for the next five cohorts, and then increase for the remaining cohorts. This does not seem reasonable. For example, the percentage of persons in the 20 to 24 age group making no trips is higher than the percentage of persons in the 45 to 49 age group. This means that a person aged 20 to 24 is less likely to travel (on an average day) than a person aged 45 to 49. The conclusion was made, based on examination of the data in Figure 1, that persons in the age groups 16 to 34 were most likely under reporting travel in the surveys.

**Table J-4
Expanded Person Trips Per Person
Houston Galveston Household Survey**

Age Cohort	Person Trips Per Person							
	Overall	Variance	Confidence Interval		Average	Variance	Confidence Interval	
			Low	High			Low	High
5 - 15	3.245	3.227	3.146	3.344	3.337	3.012	3.240	3.434
16 - 19	3.318	4.917	3.078	3.558	3.767	3.886	3.539	3.995
20 - 24	3.398	8.251	3.110	3.686	4.069	7.146	3.776	4.362
25 - 29	3.753	7.937	3.493	4.013	4.387	6.493	4.132	4.641
30 - 34	4.092	9.529	3.843	4.341	4.617	8.325	4.369	4.865
35 - 39	4.251	9.380	4.007	4.495	4.871	7.725	4.634	5.108
40 - 44	4.529	11.008	4.240	4.818	5.004	9.781	4.717	5.291
45 - 49	4.060	8.696	3.788	4.332	4.532	7.565	4.264	4.800
50 - 54	3.712	8.462	3.418	4.006	4.419	6.945	4.128	4.710
55 - 59	3.416	8.646	3.052	3.780	4.425	6.725	4.059	4.791
60 - 64	3.593	9.070	3.191	3.995	4.512	7.234	4.110	4.914
65 - 69	3.426	9.557	3.014	3.838	4.774	6.864	4.362	5.186
70 - 74	3.112	8.807	2.610	3.614	4.685	5.854	4.182	5.188
75 - 79	2.800	8.997	2.143	3.457	4.308	7.315	3.573	5.043
80 +	1.842	4.992	1.262	2.422	3.621	3.315	2.958	4.284

Due to the similarity between the data for the three urban areas, the decision was made to average the percentages of the three urban areas for each age cohort. The result is shown in Figure 2. An exponential curve was then fitted to the data points, excluding the data for age cohorts 16-19, 20-24, 25-29, and 30-34. Persons in these age cohorts were considered the most likely to have under reporting in terms of travel. The resulting curve is shown in Figure 3 plotted with the observations for the three urban areas.

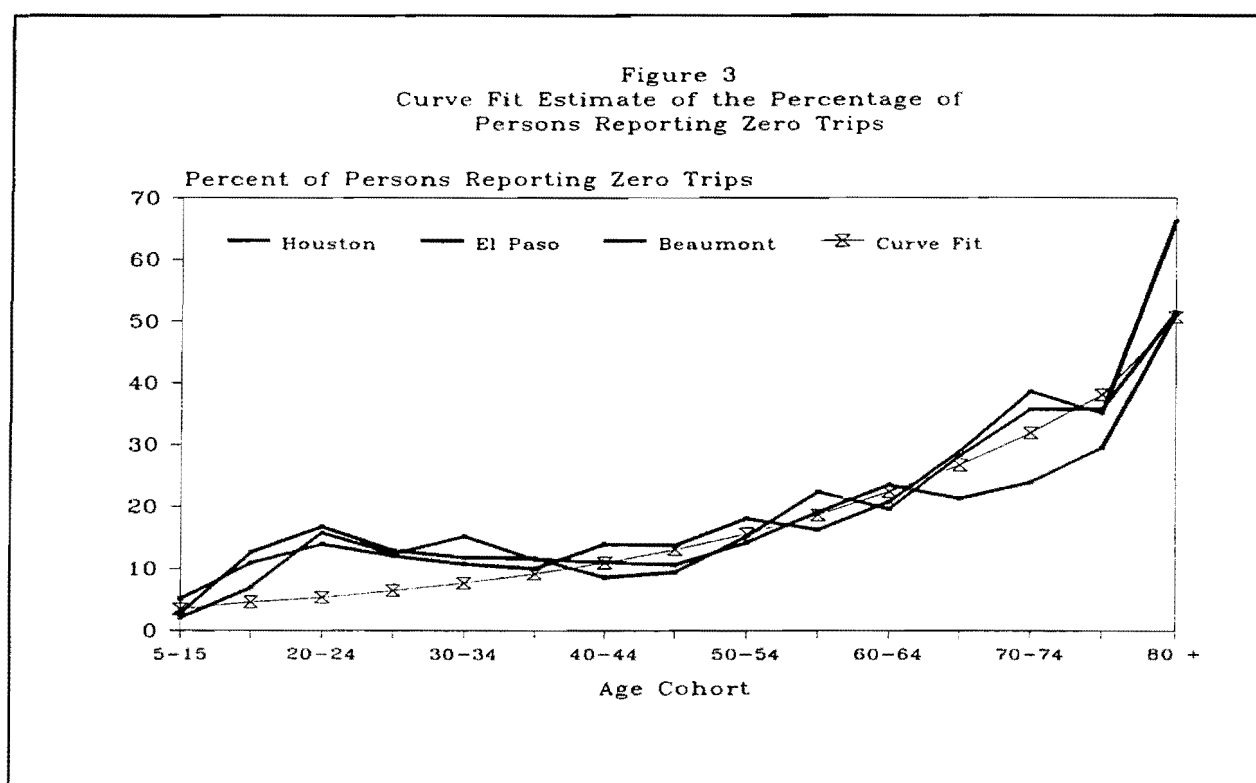


The curve shown in Figure 3 is considered the basis for estimating the percentage of persons making zero trips by age cohort. The next step was to use that for adjusting the person trip rates in the urban areas surveyed in 1990 and 1991. The steps in this adjustment area as follows:

1. Compute the observed percentage of persons making zero trips by age cohort based on the expanded data.
2. Compute the difference in the percentage observed from step 1 and the percentage estimated using the fitted curve in Figure 3.
3. Apply the difference in the two percentages to the expanded number of persons in each age cohort to estimate the number of persons that made trips but were recorded as making no trips. If the difference is negative, then no adjustment is made to the trip rate for that cohort.
4. Multiply the number of persons computed in step 3 by the average trips per person for those persons reporting trips in each age cohort. This estimates the number of missing trips for each age cohort.
5. Add the result from step 4 to the estimated total trips for each age cohort and divide the total by the number of persons estimated in the age cohort. This results in an adjusted person trip rate for each age cohort.
6. Using data from the 1990 census, multiply the adjusted person trip rate by the total persons in each age cohort. These are then summed to compute the total person trips for the area.
7. The trip rates originally developed for each urban area are multiplied by the 1990 distribution of households by income and size for each trip purpose. The total

trips for each trip purpose are then computed.

8. The total home based work trips computed in step 7 are subtracted from the total trips estimated in step 6.
9. The resulting trips in step 8 are divided by the sum of the home based non-work and non-home based trips computed in step 7. The result is an adjustment factor.
10. The stratified home based non-work and non-home based trip rates used in step 7 are multiplied by the adjustment factor computed in step 9. This is done for both person and auto driver trips. The result is adjusted trip rates for home based non-work and non-home based trips.



It will be noted that no adjustment is made to the home based work trip rates. The reason is that the comparison between trip productions and attractions shown in Table 1 indicated the estimates of home based work trips was reasonable. The adjustment were then applied only to the home based non-work and non-home based trip rates.

The resulting recommended trip rates for Amarillo, Brownsville, San Antonio, Sherman-Denison, and Tyler are shown in Tables J-5 through J-9. While it is felt these rates account for non-participating individuals in the travel surveys, it is noted that the problem with under reporting of trips may still exist.

If you have any questions or need any additional information, please call me at (409) 845-9933.

Table J-5
Modified Smoothed Trip Production Rates by Trip Purpose
1990 Amarillo Household Survey

Home Based Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.327	0.672	0.841	0.897	1.050	0.182	0.406	0.602	0.652	0.702
\$ 5000 - \$ 9999	0.490	0.960	1.268	1.370	1.590	0.420	0.799	1.085	1.132	1.264
\$ 10000 - \$ 19999	0.756	1.323	1.729	1.853	2.125	0.735	1.153	1.469	1.512	1.633
\$ 20000 - \$ 34999	1.085	1.838	2.399	2.571	2.939	1.012	1.709	2.208	2.319	2.539
\$ 35000 Plus	1.329	2.173	2.823	3.015	3.431	1.263	2.116	2.720	2.864	3.129

Home Based Non-Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.704	3.625	5.017	8.082	11.853	1.250	2.200	2.815	4.216	4.919
\$ 5000 - \$ 9999	1.879	3.702	5.194	8.409	12.172	1.558	2.498	3.115	4.426	5.374
\$ 10000 - \$ 19999	1.990	3.752	5.304	8.614	12.373	1.702	2.547	3.118	4.443	5.506
\$ 20000 - \$ 34999	2.086	3.792	5.402	8.794	12.549	1.850	2.724	3.312	4.461	5.636
\$ 35000 Plus	2.446	3.829	5.481	8.940	12.692	2.311	3.296	3.968	5.244	6.710

Non-Home Based

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.070	1.397	1.592	1.826	2.079	0.797	1.087	1.205	1.332	1.403
\$ 5000 - \$ 9999	1.309	2.031	2.362	2.848	3.558	1.107	1.510	1.649	1.824	2.017
\$ 10000 - \$ 19999	1.595	2.642	3.098	3.881	4.859	1.449	2.016	2.209	2.453	2.761
\$ 20000 - \$ 34999	1.807	3.118	3.674	4.704	5.894	1.779	2.509	2.756	3.070	3.489
\$ 35000 Plus	2.494	3.870	4.582	5.945	7.459	2.332	3.350	3.700	4.138	4.737

Total-All Purposes

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	3.101	5.694	7.450	10.805	14.982	2.229	3.693	4.622	6.200	7.024
\$ 5000 - \$ 9999	3.678	6.693	8.824	12.627	17.320	3.085	4.807	5.849	7.382	8.655
\$ 10000 - \$ 19999	4.341	7.717	10.131	14.348	19.357	3.886	5.716	6.796	8.408	9.900
\$ 20000 - \$ 34999	4.978	8.748	11.475	16.069	21.382	4.641	6.942	8.276	9.850	11.664
\$ 35000 Plus	6.269	9.872	12.886	17.900	23.582	5.906	8.762	10.388	12.246	14.576

Table J-6
Modified Smoothed Trip Production Rates by Trip Purpose
1991 Brownsville Household Survey

Home Based Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.166	0.409	0.804	0.882	1.032	0.154	0.242	0.408	0.496	0.513
\$ 5000 - \$ 9999	0.523	0.892	1.313	1.574	1.699	0.407	0.621	0.855	1.050	1.112
\$ 10000 - \$ 19999	0.633	1.090	1.534	1.891	2.015	0.551	0.836	1.129	1.407	1.472
\$ 20000 - \$ 34999	0.964	1.694	2.332	2.919	3.097	0.901	1.405	1.894	2.382	2.488
\$ 35000 Plus	1.169	2.040	2.766	3.487	3.683	1.168	1.871	2.522	3.189	3.328

Home Based Non-Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.562	3.752	5.462	8.869	12.747	0.589	1.688	2.431	3.491	3.802
\$ 5000 - \$ 9999	1.990	4.196	5.746	9.137	12.935	1.307	2.415	3.244	4.341	5.133
\$ 10000 - \$ 19999	2.997	4.476	5.924	9.306	13.054	2.184	2.868	3.526	4.456	5.344
\$ 20000 - \$ 34999	3.878	4.721	6.080	9.455	13.157	2.850	3.414	4.071	4.996	6.117
\$ 35000 Plus	4.594	4.921	6.207	9.574	13.241	3.460	3.924	4.577	5.495	6.801

Non-Home Based

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.555	1.114	1.532	1.714	1.738	0.183	0.376	0.467	0.549	0.633
\$ 5000 - \$ 9999	0.907	1.790	1.963	2.387	2.664	0.907	1.360	1.414	1.604	1.757
\$ 10000 - \$ 19999	1.590	2.752	2.789	3.387	3.787	1.540	2.175	2.215	2.480	2.683
\$ 20000 - \$ 34999	2.318	3.849	3.941	4.902	5.607	2.164	3.076	3.173	3.553	3.854
\$ 35000 Plus	3.026	5.652	5.696	7.078	8.106	2.954	4.119	4.278	4.762	5.157

Total-All Purposes

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.283	5.275	7.798	11.465	15.517	0.926	2.306	3.306	4.536	4.948
\$ 5000 - \$ 9999	3.420	6.878	9.022	13.098	17.298	2.621	4.396	5.513	6.995	8.002
\$ 10000 - \$ 19999	5.220	8.318	10.247	14.584	18.856	4.275	5.879	6.870	8.343	9.499
\$ 20000 - \$ 34999	7.160	10.264	12.353	17.276	21.861	5.915	7.895	9.138	10.931	12.459
\$ 35000 Plus	8.789	12.613	14.669	20.139	25.030	7.582	9.914	11.377	13.446	15.286

Table J-7
 Modified Smoothed Trip Production Rates by Trip Purpose
 1990 San Antonio-Bexar County Household Travel Survey

Home Based Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.164	0.574	0.937	1.307	1.364	0.053	0.299	0.591	0.611	0.829
\$ 5000 - \$ 9999	0.530	1.020	1.405	1.640	1.707	0.325	0.574	0.794	0.819	0.864
\$ 10000 - \$ 19999	0.950	1.551	2.005	2.190	2.267	0.748	1.150	1.496	1.534	1.539
\$ 20000 - \$ 34999	1.219	1.901	2.399	2.535	2.622	1.052	1.594	2.045	2.106	2.113
\$ 35000 Plus	1.445	2.370	3.039	3.210	3.380	1.445	2.223	2.853	2.958	2.968

Home Based Non-Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.616	3.150	4.499	6.768	9.653	0.569	1.019	1.264	1.474	1.854
\$ 5000 - \$ 9999	1.747	3.266	4.780	7.261	10.435	0.981	1.543	1.826	2.279	2.754
\$ 10000 - \$ 19999	1.830	3.339	4.957	7.573	10.928	1.548	2.282	2.641	3.347	3.978
\$ 20000 - \$ 34999	1.902	3.403	5.113	7.846	11.359	1.766	2.664	3.097	3.995	4.737
\$ 35000 Plus	1.961	3.456	5.239	8.067	11.709	1.814	2.824	3.307	4.322	5.131

Non-Home Based

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.630	0.686	0.803	1.046	1.080	0.165	0.255	0.412	0.512	0.613
\$ 5000 - \$ 9999	1.123	1.408	1.569	1.952	2.189	0.639	0.962	1.173	1.446	1.694
\$ 10000 - \$ 19999	1.768	2.465	2.793	3.471	4.004	1.145	1.561	1.815	2.251	2.671
\$ 20000 - \$ 34999	1.978	2.515	2.841	3.525	4.108	1.513	1.932	2.142	2.642	3.097
\$ 35000 Plus	2.187	3.209	3.633	4.503	5.282	2.035	2.479	2.675	3.316	3.931

Total-All Purposes

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.410	4.410	6.239	9.121	12.097	0.787	1.573	2.267	2.597	3.296
\$ 5000 - \$ 9999	3.400	5.694	7.754	10.853	14.331	1.945	3.079	3.793	4.544	5.312
\$ 10000 - \$ 19999	4.548	7.355	9.755	13.234	17.199	3.441	4.993	5.952	7.132	8.188
\$ 20000 - \$ 34999	5.099	7.819	10.353	13.906	18.089	4.331	6.190	7.284	8.743	9.947
\$ 35000 Plus	5.593	9.035	11.911	15.780	20.317	5.294	7.526	8.835	10.596	12.030

Table J-8
Modified Smoothed Trip Production Rates by Trip Purpose
1991 Sherman-Denison Household Survey

Home Based Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.076	0.300	0.559	0.727	0.831	0.066	0.189	0.441	0.640	0.802
\$ 5000 - \$ 9999	0.259	0.691	1.128	1.367	1.448	0.185	0.446	0.845	1.026	1.098
\$ 10000 - \$ 19999	0.549	1.002	1.532	1.802	1.852	0.495	0.692	1.190	1.366	1.376
\$ 20000 - \$ 34999	0.870	1.449	2.123	2.465	2.538	0.928	1.215	2.033	2.284	2.300
\$ 35000 Plus	1.527	1.820	2.583	2.963	3.033	1.390	1.661	2.698	2.974	2.995

Home Based Non-Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.284	2.862	3.677	4.716	5.607	0.739	1.618	2.259	2.489	2.509
\$ 5000 - \$ 9999	1.531	3.373	4.969	6.575	8.025	1.152	2.225	2.996	3.507	3.535
\$ 10000 - \$ 19999	1.697	3.810	6.253	8.331	10.262	1.690	2.999	3.936	4.711	4.851
\$ 20000 - \$ 34999	1.809	4.123	6.528	8.822	10.955	1.878	3.115	4.002	4.857	5.057
\$ 35000 Plus	1.898	4.397	6.625	9.072	11.342	1.898	3.288	4.265	5.283	5.603

Non-Home Based

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.736	1.474	2.290	2.495	2.525	0.428	1.109	1.787	2.034	2.086
\$ 5000 - \$ 9999	0.868	1.980	2.731	3.467	3.863	0.692	1.450	1.971	2.412	2.474
\$ 10000 - \$ 19999	1.292	2.628	3.390	4.464	5.086	1.189	1.977	2.422	2.990	3.056
\$ 20000 - \$ 34999	1.801	3.269	3.993	5.364	6.171	1.717	2.592	2.989	3.717	3.803
\$ 35000 Plus	2.466	3.848	4.587	6.265	7.280	2.229	3.337	3.766	4.729	4.875

Total-All Purposes

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.096	4.636	6.526	7.938	8.963	1.233	2.915	4.487	5.163	5.397
\$ 5000 - \$ 9999	2.658	6.045	8.828	11.409	13.336	2.028	4.121	5.813	6.944	7.106
\$ 10000 - \$ 19999	3.538	7.441	11.175	14.597	17.200	3.374	5.668	7.548	9.067	9.283
\$ 20000 - \$ 34999	4.480	8.841	12.643	16.651	19.664	4.523	6.922	9.023	10.857	11.159
\$ 35000 Plus	5.891	10.065	13.796	18.300	21.655	5.517	8.285	10.729	12.986	13.473

Table J-9
Modified Smoothed Trip Production Rates by Trip Purpose
1991 Tyler Household Survey

Home Based Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.247	0.576	0.978	1.228	1.323	0.283	0.436	0.654	0.729	0.799
\$ 5000 - \$ 9999	0.387	0.718	1.162	1.347	1.451	0.351	0.571	0.880	0.944	1.035
\$ 10000 - \$ 19999	0.616	1.062	1.688	1.905	2.106	0.579	0.974	1.516	1.618	1.820
\$ 20000 - \$ 34999	0.951	1.534	2.340	2.658	2.975	0.904	1.493	2.314	2.455	2.785
\$ 35000 Plus	1.165	1.962	3.091	3.421	3.881	1.074	1.891	2.976	3.172	3.641

Home Based Non-Work

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	1.296	2.736	3.989	7.026	8.494	0.985	1.563	1.945	2.437	2.656
\$ 5000 - \$ 9999	1.443	3.127	4.455	7.684	9.847	1.168	1.877	2.271	2.834	3.279
\$ 10000 - \$ 19999	1.983	3.379	4.674	7.897	10.348	1.625	2.608	3.116	3.876	4.588
\$ 20000 - \$ 34999	2.090	3.448	4.708	7.944	10.664	1.736	2.807	3.333	4.143	4.981
\$ 35000 Plus	2.198	4.098	5.594	9.374	12.805	2.108	3.597	4.308	5.385	6.570

Non-Home Based

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	0.791	0.971	1.361	1.719	1.967	0.522	0.707	1.062	1.187	1.245
\$ 5000 - \$ 9999	1.092	1.579	2.204	2.934	3.585	0.877	1.212	1.703	2.034	2.133
\$ 10000 - \$ 19999	1.463	2.114	2.918	3.921	4.852	1.265	1.673	2.281	2.747	2.896
\$ 20000 - \$ 34999	1.875	2.641	3.597	4.850	6.032	1.670	2.124	2.837	3.423	3.613
\$ 35000 Plus	2.155	3.310	4.571	6.231	7.829	2.151	2.902	3.922	4.796	5.125

Total-All Purposes

Household Income Range	Person Trips Per Household					Auto Driver Trips Per Household				
	Household Size					Household Size				
	1	2	3	4	5 +	1	2	3	4	5 +
\$ 0 - \$ 4999	2.334	4.283	6.328	9.973	11.784	1.750	2.706	3.661	4.353	4.700
\$ 5000 - \$ 9999	2.922	5.424	7.821	11.965	14.883	2.396	3.660	4.854	5.812	6.447
\$ 10000 - \$ 19999	4.062	6.555	9.280	13.723	17.306	3.469	5.255	6.913	8.241	9.304
\$ 20000 - \$ 34999	4.916	7.623	10.645	15.452	19.671	4.310	6.424	8.484	10.021	11.379
\$ 35000 Plus	5.518	9.370	13.256	19.026	24.515	5.333	8.390	11.206	13.353	15.336

