Transportation Planner's Handbook on Conversion Factors for the Use of Census Data

FINAL REPORT

U.S. Department of Transportation
Federal Highway Administration

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CHAPTER 1
INTRODUCTION

The 1990 Census Transportation Planning Package (CTPP) is the latest version of a program established for the 1970 Census and continued for the 1980 Census (Urban Transportation Planning Package) in the same general format. The 1990 CTPP is produced by the Bureau of the Census and funded by the various state departments of transportation. Planning and administrative costs were funded by the Federal Highway Administration and the Federal Transit Administration. The Federal Highway Administration also provides project coordination and technical support on the use and application of the Census.

1.1 PURPOSE OF THE HANDBOOK

The goal of this handbook is to assist the transportation planner in using the 1990 Census to develop and calibrate local travel demand models. Often, collecting new data to complete the development of a local model is not an option. Therefore, planners must rely on existing data and previously completed models with little else to assist in model calibration. Regardless of what local data are available, the 1990 Census provides another source of information to assist in model development.

Potential users of the Census and the conversion factors and procedures proposed in this report need to be aware that there would appear to be a substantial variance between results obtained from the Census journey-to-work files and locally developed home interview surveys. A quick comparison was made of models as they are currently being applied across the country and the results obtained by applying the Census conversion factors suggested herein to Census journey-to-work files for those same areas.

There was a substantial difference between the results in many areas. While a few of the models developed from local home interview surveys apparently produced significantly fewer trips than would be suggested by the Census data, many others appeared to have more trips than the Census files produced. Several areas showed differences of 10 to 15 percent in total trips. Without careful comparisons of the files by individuals familiar with the models as they were developed, it is difficult to be certain that the differences are real or simply an "accounting difference". In attempting to compare data files there were several pitfalls that were encountered. For example:

- Differences in the definition of the area covered by the local models - often only parts of counties are included in the model definition and unless detailed attention is taken to make certain that the geographic coverage is identical, apparent differences can be imputed where they do not exist.

- Differences as to whether external trips were included or not and what types of externals were included.

- Differences as to whether vehicle trips or person trips were being reported.

- Differences in the definition of a home-based-work trip. Some metropolitan areas use a definition of a home-based-work trip that may ignore intermediate stops at a store, day care center or gasoline service station, thereby substantially raising the number of home-based-work trips that would be reported locally as compared to the more restrictive definition of a home-based-work trip as used in this report.

These differences were surprisingly difficult to resolve without extensive effort. It is for this reason that the metropolitan Atlanta area was selected for a comparison of local survey results with the Census. A complete home interview survey was conducted in 1990 in Atlanta and the areal and trip type definitions were well documented and understood. In Atlanta the comparisons between the Census derived trip tables and those derived from the home interview surveys were virtually identical.

Without further research, however, it can only be concluded that the planner using the Census adjustment factors suggested in this report should do so with caution. Where there is current, reliable home interview survey data available, it is recommended that this data be used as the source of first choice for local model development. Where such quality data is not available the Census factors developed in this report may be viewed as a useful means of developing a model set.

As a data source to develop a consistent set of Census conversion factors, the 1990 Nationwide Personal Transportation Survey (NPTS) was used. The first NPTS was conducted in 1969 by the U.S. Department of Transportation (DOT) to address data needs related to personal travel. The survey was conducted again in 1977, 1983 and 1990. The objective of the survey was to collect trip-based data on the nature and characteristics of personal travel on a typical travel day. The NPTS incorporates typical surveying procedures. The survey considers all persons 5 years of age and older. Those that are 14 years of age and older are surveyed directly. Those that are between 5 and 13 years are surveyed by proxy. The NPTS is conducted in all 50 states including the District of Columbia. The data is stratified by three categories: (1) the nine U.S. Bureau of Census divisions, (2) presence or absence of a fixed-guideway public transportation system, and (3) three metropolitan size categories. The number of useable households interviewed in the 1990 NPTS is 21,869.

The particular utility of the NPTS as a source of Census conversion factors is the fact that travel-to-work data is collected by the NPTS both in the format that Census data is collected and in the format employed by the home interview travel survey. This is critical to the development of the conversion factors. This allows a direct comparison of each worker's response for usual travel last week, and actual travel on the survey day. Thus an internally consistent set of conversion factors can be derived from the NPTS alone.

1.2 BACKGROUND

The Decennial Census continues to be a commonly used source of information for the travel demand forecasting process. The Census offers a "snapshot" of each decade, and allows for the assessment of trends over several decades. Information on demographic characteristics and journey-to-work data are used extensively by transportation planners to:

- Check and update existing regional travel demand forecasting models and locally collected survey results;
- Develop new work trip models, in particular, trip generation models, trip length frequency for trip distribution and work trip auto occupancy models;
- Compare percentage distributions for work trips by mode with travel demand model estimates in the trip distribution and mode choice models;
- Enhance the geographic coverage of existing regional travel forecasting models;
- Better understand travel markets in terms of the socioeconomic characteristics of commuters and residents (e.g., household size, number of workers, household income, auto ownership, race, and sex) and the geographic orientation of work trips;
- Establish residential land use patterns and characteristics in terms of housing types, occupancy, price, and other factors;
- Design new travel surveys, such as household surveys and on-board transit surveys; and
- Develop land use models such as residential location models.

The 1990 Census provides transportation planners with an additional element of data not available in any earlier Census, time of work trip departure. The new data element enables planners to analyze work trip peaking characteristics and peak spreading distributions throughout the day.

Many Census questions closely parallel those questions traditionally included in local travel surveys. However, some significant differences do exist. These differences are due to inconsistences between the definition of certain data items and survey categories, and the way questions are worded in each type of survey.

This handbook identifies the significant differences that exist between Census data and travel survey data, and the implications of using Census data for local planning purposes. The handbook outlines procedures necessary to adjust Census data for local planning and the application of Census data to the traditional 4-step travel demand modeling process. Elements of the Census that are useful to the transportation planner are discussed below.

CTPP

The **Census Transportation Planning Package (CTPP)** is a collection of Census data summary tables developed to meet the needs of transportation planners. The CTPP is primarily based on responses to the long-form Census questionnaire which is completed by one in six households. The long form includes 34 population questions for each person in the household and 19 housing questions.

Due to the scale and complexity of the data, the CTPP is divided into two **elements**: statewide and urban. The data contained in each element are comparable, and generally differ only in geographic scale. The statewide package was developed for each state and the District of Columbia. The urban package was developed for each CTPP "region" as defined by the region's Metropolitan Planning Organization (MPO).

Each element is divided into different **parts**. The statewide element is divided into six parts labeled A through F. The urban element is divided into eight parts numbered 1 through 8. (Part 5 of the urban element was not produced.) The first three parts of the statewide element (A through C) and the urban element (1 through 3) are identical in terms of cross-tabulations (the geography is different), and are the elements used in the travel demand forecasting process. The remaining parts are unique to each element.

CTPP data are tabulated based on population and household characteristics, place of work information, and work trip travel data. Tabulations for the statewide element are summarized by: state, county, and place (2,500 or more population). Tabulations for the urban element are available by transportation analysis zone (TAZ) or Census tract. The choice of whether to tabulate urban data by TAZ or Census tract was determined by the MPO in that area. The urban element data tables also include totals for the urbanized area and the Metropolitan Statistical Area (MSA).

CTPP differs from other 1990 Census products. It provides insight into travel characteristics and assists in the development of travel demand models in several ways. First, the urban element is stratified at the traffic analysis zone level. This provides greater geographic detail for user-defined areas than traditional Census products. Second, the CTPP presents many more detailed cross-tabulations than other Census products. Third, CTPP provides characteristics such as income, mode of travel and time of trip departure by place of work. Fourth, both elements provide commuter home-to-work data at a small area level of detail. Development of travel demand model socioeconomic characteristics is simplified since the CTPP data is stratified at the Minor Civil Division, Census tract, block group and Census block level. Disaggregate data

is the key to the development of detailed model zone structures and socioeconomic data is the source for deriving trip generation characteristics for each zone.

A thorough understanding of the geographic coverage of the Census data and its relationship to the travel demand model study area is essential for good model development. Comparing this relationship was critical to the development of the Census factors in this handbook. Comparison and evaluation of the two coverages will determine the compatibility between the systems and adjustments that need to be made to improve compatibility. Before applying Census trip data, it is necessary to overlay the Census boundary description with traffic analysis zone boundaries and determine the cordon of the area, as well as any distinctions that will be drawn among area types.

Geographic trip data, which is summarized in hierarchical form by the Census, is grouped by three levels:

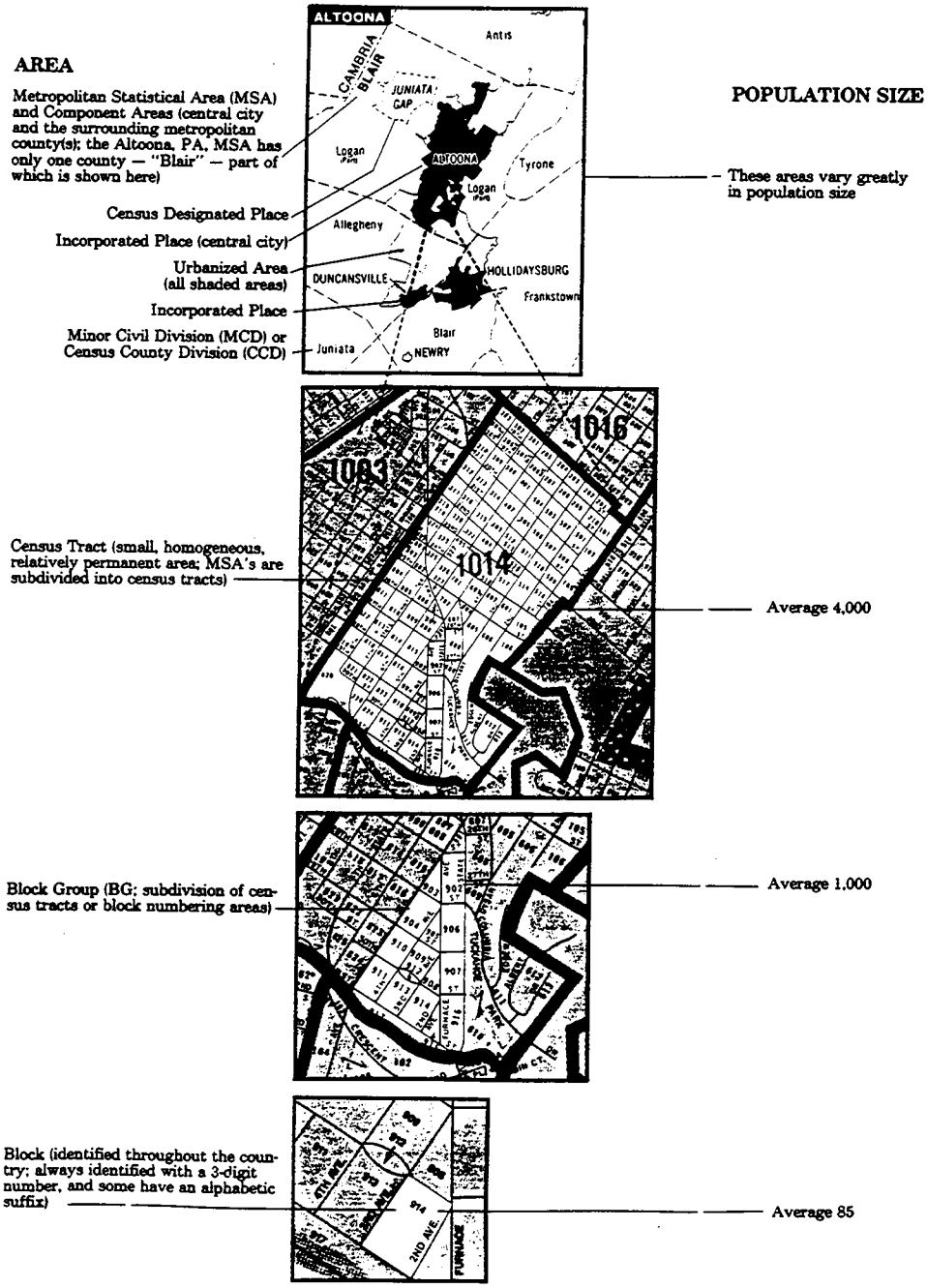
- Statewide
- Metropolitan Statistical Area (MSA)
- Urban Area as defined by Census criteria

Within the urbanized area, trip data are further stratified (in descending order) by:

- County
- Minor Civil Division (MCD) or Census County Division (CCD)
- Urban Place
- Census Tract or Block Number Area (BNA)

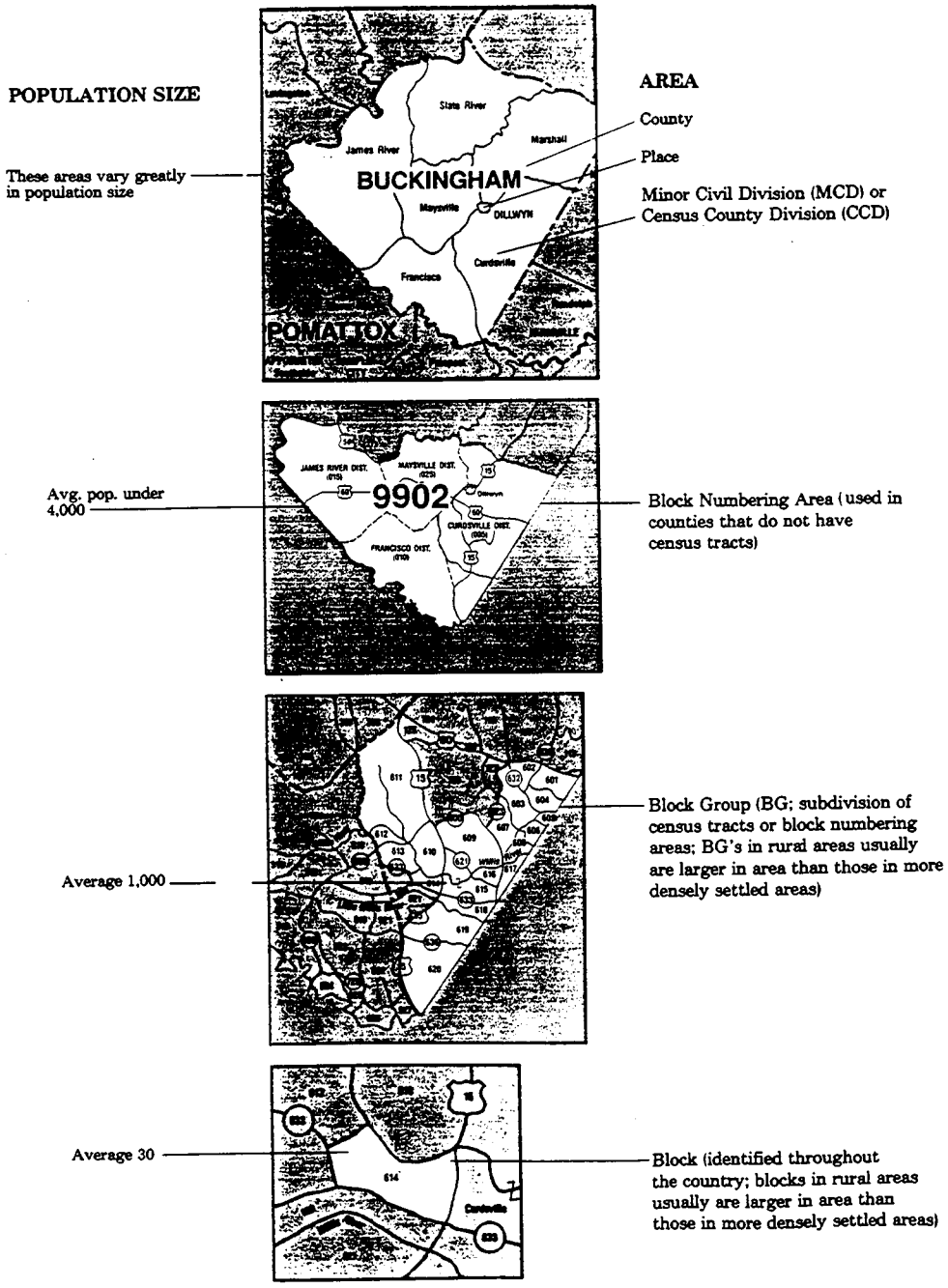
As an example, Figures 1.1 and 1.2 show the geographic subdivisions as they relate to a metropolitan and non-metropolitan county.

Figure 1.1
Geographic Subdivisions in a Metropolitan County



Source: Bureau of the Census, *Census '90 Basics.*

Figure 1.2
Geographic Subdivisions in a Non-Metropolitan County



Source: Bureau of the Census, *Census '90 Basics*.

In order to successfully apply Census journey-to-work trip data, and other socioeconomic data, traffic analysis zones developed for the travel demand model should coincide with Census boundaries at the Census tract level. For example, one or more traffic analysis zones in the travel demand model should aggregate to one Census tract. When traffic analysis zones are disaggregated into smaller zones or aggregated into larger districts, the resulting zone boundaries should conform to boundaries used by the Census. The approach simplifies the task of combining model run results with Census data for further analysis.

PUMS Data

Another Census resource which is invaluable to transportation planners is the **Public Use Microsurvey (PUMS)** data. These files consist of random samples of individual disaggregate household records. Samples are provided at the 1 percent and 5 percent levels, the latter being of greatest interest for transportation planners. In order to ensure privacy of the individual data records the identification of geographic area is limited in the latter data set to areas not smaller than 100,000 population, referred to as Public Use Microsurvey Areas (PUMAs). These areas normally consist of counties or aggregations of counties. Where counties are large enough, PUMAs consist of subdivisions of counties.

These data items provide the planner with the capability of aggregating household records in any form that is convenient for analysis. This is particularly useful in the generation of cross-classification trip generation models where information by individual travel zone is not important.

TIGER Files

Procedures are currently available to apply **Census Topologically Integrated Geographic Encoding & Referencing (TIGER)** files to help determine the traffic analysis zone (TAZ) structure for a travel demand model. All major geographic information system (GIS) packages on the market currently have import functions for TIGER files. If traffic analysis zone boundaries are properly related to Census tract boundaries, then both model run results and Census data can be imported to the GIS for analysis.

1.3 HANDBOOK ORGANIZATION

This document is divided into chapters that outline the procedures for using the 1990 Census data for travel demand forecasting, followed by a case study example of converting Census work trips to local survey data. Development of the factors relies upon the 1990 NPTS. Chapter 2 details the limitations in the Census that are related to travel demand models. These limitations are related to the way in which the Census questions are worded. This wording makes the data from the Census different from typical local survey data. Appendix A provides the questions that are at issue in the 1990 Census as well as those in the 1990 NPTS used to develop

adjustment factors. It discusses some of the inherent problems in using Census data directly and related issues that are addressed in Chapter 3.

Chapter 3 outlines the adjustment factors developed using the 1990 NPTS data. It includes four steps in the development of a composite conversion factor to adjust Census journey-to-work data. The chapter concludes with a sample calculation of a composite adjustment factor that can be used to estimate total work trips and work trips broken down by travel mode. This estimation is specific to metropolitan area size.

Chapter 4 provides a comparison of the NPTS adjustment factor to local factors developed for a case study developed in Atlanta, Georgia. Where possible, conversion factors developed from the recently completed local survey are compared to the NPTS results.

CHAPTER 2
LIMITATIONS ON CENSUS DATA

Despite the utility that the Census journey-to-work and the Public Use Microdata Samples (PUMS) data provides to transportation planners, there are a number of very significant limitations that constrain the utility of this data source for use in travel demand models. Some of these limitations can be overcome by appropriate adjustments. Others are problems that can only be documented and need to be clearly understood by practitioners. The most obvious of these problems and the ones that most practitioners will experience are discussed below.

Lack of Non-work Travel Information

The first and most obvious limitation is the focus on work trips. The Census provides no assistance in determining non-work travel. Non-work trips normally comprise 65 to 70 percent of all average weekday travel. There is normally some correlation between non-work and home-based work travel patterns. There are, however, no guarantees that the distribution pattern for non-work trips will be the same as for work trips. There are means of synthetically estimating the generation and distribution of non-work trips when planners are faced with a lack of survey data. Techniques such as those presented in the NCHRP-187, Quick-Response Urban Travel Estimation Techniques and Transferable Parameters[1] can provide assistance under these circumstances.

Focus on Workers Rather than Work Trips

From a travel demand modeling technical standpoint, the Census does not report on trips. It reports only the normal work location for each worker. This leaves the necessity to determine the number of home-based work trips per worker that are made on a typical work day. A procedure for making these adjustments is presented in Chapter 3. The nature of these adjustments are as follows:

Absenteeism

The Census only reports on workers (full and part-time) who worked at any time during the week prior to the survey. An adjustment must be made to reflect workers who may not work every day or who may not go to work on an occasional day due to illness, vacation, personal business or other similar reason.

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[1] COMSIS Corporation, Quick-Response Urban Travel Estimation Techniques and Transferable Parameters Users Guide, National Cooperative Highway Research Program Report 187, 1978

Normal Mode to Work on an Average Weekday

Because of the orientation to a worker's normal pattern of commuting, an additional adjustment must be made to reflect the difference between the worker's normal or customary mode of commuting and the mode he might have taken on any specific day of the week.

Multiple Work Trips

Some workers make more than a single trip to work each day. They may go home for lunch or they may have multiple jobs entailing more than a single home to work trip each day and the reverse.

Trip Chaining

An individual who goes to work on any given day might make intermediate stops along the way and his/her trip would not be categorized as a simple home-based work (HBW) trip. A "simple HBW" trip proceeds directly from home-to-work, or its reverse, without an intermediate stop. An adjustment must be made to reflect stops that are made on the way to work to drop a child off at school or day care, or a stop at the supermarket on the way home.

Limitation to Single Principal Mode

The Census provides no information on modal transfers which may be made on the way to work. The Census reports only on the normal mode of transportation on which the worker travels the greatest distance. Thus if a worker drives a substantial distance to a rail station and from there takes a train to work, only the auto trip would be reported in the journey-to-work files. This is likely to be a serious problem only in a limited number of major metropolitan areas with rail systems and a high percentage of transit trip making.

A modal category "other" exists in the Census information. This category does not have any specific modal designations. The individual respondent can use this category if the mode was truly unique and not listed, or if the individual was confused and did not know what type of mode was used. An example is rail modes for which definition is not always understood (i.e. railroad versus subway).

Under-Reporting of Travel

In order to validate the adjusted Census data converted to home-based work trips by mode, a representative number of metropolitan areas of various sizes were contacted and information was collected on total regional trip productions. Trip productions were taken from locally conducted travel surveys or local validated travel models. Census journey-to-work files for these same areas were then adjusted using the procedures suggested in Chapter 3. Census data was compared to the local trip productions/trips in use in these selected urban areas in terms of the following dimensions:

- Total regional person trip productions
- Distribution of trips by mode
- Geographic distribution of total person trips
- Distribution of trips by socio-economic parameters normally used for trip generation (household size and number of autos owned by household)

Chapter 4 uses Atlanta, Georgia as an example to show how to use the conversion factors with locally collected data or travel demand models.

Locally estimated total work trips in most of the cities showed an acceptable match with the number of trips estimated by Census data; i.e., the differences between the two estimates were less than 10 percent. For several other urban areas, however, the differences appeared to be greater. As explained in Chapter 1, it is expected that the differences are principally due to interpretation of data, including differences in the definition of trip purpose, geographic coverage, etc. that were not immediately obvious without careful additional scrutiny.

Census-estimated transit trip productions were commonly below locally reported linked home-based work trips. An explanation of this phenomenon could be an underestimation by the Census of transit trips within the central cities. Individuals who are transit dependent are likely to be the kinds of travelers who are most likely to be missed by the Census. Complicating the comparison is the fact that local estimates of linked home-based-work transit ridership are often only rough estimates based on fare revenues and best judgement of the percentage of transfers in the system and the percentage of trips that might be home-based-work. These estimates are often subject to substantial error making any comparisons with Census derived estimates difficult at best.

The differences in the distribution of trips by geographic area, which is important for the development of trip distribution models, were found to be very small between the Census derived distributions and the locally derived distributions. Likewise, the differences in distribution of trips by household size and by number of autos per household between the two approaches were found to be small, an important consideration in the use of Census data for the preparation of cross classification trip generation models.

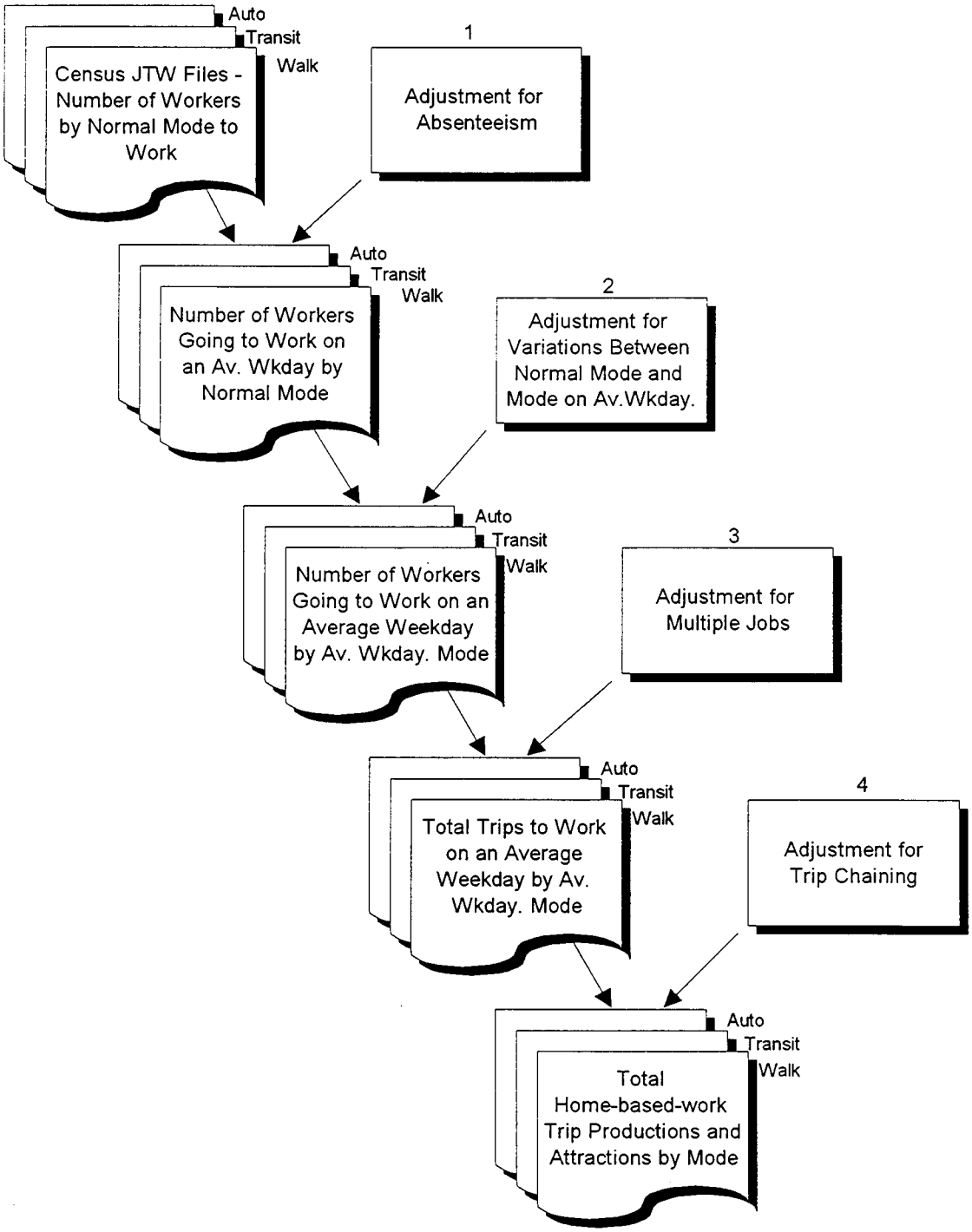
CHAPTER 3
DEVELOPMENT OF CENSUS ADJUSTMENT FACTORS FROM NPTS

The process used for adjusting Census journey-to-work files includes four steps as depicted in Figure 3.0. Each adjustment is discussed separately and consists of a set of national averages derived from the 1990 Nationwide Personal Transportation Survey (NPTS). Subsequently, these NPTS derived factors are compared to locally derived data in Chapter 4. This comparison serves to enable a better understanding of issues related to use of the conversion factors.

The NPTS proves to be a particularly useful database for deriving Census conversion factors since the sample size was large enough to permit stratification of some factors by metropolitan area size and normal travel mode. Normal mode is defined as the mode which the survey respondent indicated was their customary mode of travel to work. More important is the fact that the NPTS mode of travel was asked both in terms of an individual's normal mode-to-work during the past week, and in terms of a more conventional travel diary for all household members on a random day of the week. Thus the NPTS files contain all of the data necessary to generate conversion factors directly. Further, the definition of worker in the NPTS includes anyone who was working at all during the past week. This is consistent with the worker definition used by the Census.

This chapter discusses how to generate home-based work production/attraction trip tables starting with the mode specific data sets available from the Census journey-to-work files, either at the metropolitan area level of detail or from the statewide files. Either data set provides information on the normal mode of travel for all working individuals, whether employed full or part time, who responded that they worked at some time during the week preceding the Census. The metropolitan files normally provide the home-origin and work-destination locations at the zonal level and the state files provide this information at minor civil division or urban place level. Data tables in this chapter provide the conversion factors necessary to sequentially convert these "trip tables", extracted by mode, into the tables normally developed for use in urban travel demand modeling. Some modes were combined during the development of these factors. Appendix B provides tables stratified for all modes. The final conversion factors can be applied to Census journey-to-work files to compare the results to data obtained from a local home interview survey or transit on-board survey. In the absence of such locally derived information, adjusted Census trip tables can be used directly.

Figure 3.0
Conversion Process of Census Journey to Work to Home-Based-Work Trip Productions and Attractions



This chapter is organized into separate sections. The first four sections discuss each conversion factor. Each section begins by describing how the factor was derived from the NPTS data set. This is followed by a discussion of how the factor relates to local survey data. The final section of the chapter provides a procedure for developing composite adjustment factors.

Tables for all adjustment factors are organized into four groups of factors. First, factors are provided by urban area size and normal mode. Second, factors are provided for urban areas with populations greater than 1,000,000 that do or do not have a fixed guideway (rail) transit system. Third, a factor is provided for non-urbanized areas. Finally, the tables include factors for all modes combined for each metropolitan area size; as well as factors for all metropolitan area sizes combined for each mode.

3.1 STEP 1: ADJUSTING FOR ABSENTEEISM & NON-TRAVEL TO WORK

The term "absenteeism," as applied here, includes any reason why an individual who worked at any time during the preceding week might not have been at work during any given day of that week. The reasons might include:

- Sick time
- Vacation
- Personal business
- Free day for a person who is employed part time
- Business related travel
- Not a work day for this person.

It does not include workers who are working at home, such as those who telecommute. This worker category is not dealt with as a specific mode in the Census and is not included as one of the modes in the "other" category as defined in the Census. The "other" category is for those individuals that did not respond to the mode question. The end result of this adjustment is a set of modal tables which provide home-to-work adjustment factor matrices that correct for workers who are not at work on a typical weekday.

NPTS Adjustment

Table 3.1 provides a set of adjustment factors for absenteeism by metropolitan area size and by mode. There are apparently few differences in the rate of absenteeism by size of area and vehicular mode, even considering bicycle travel. Most areas and vehicle modes average 18-19 percent absenteeism on an typical weekday by this definition. The walk mode seems to have a higher absenteeism factor. This is most likely due to the higher percentage of individuals who have part time jobs and walk to work. Students with a neighborhood paper route are a typical example.

Table 3.1

Absenteeism by Metropolitan Area Size and "Normal" Mode (1,000,000s)						
Size of Urbanized Area (1,000's)	Went to Work on Typical Weekday	Auto	Transit	Motorcycle/ Bicycle	Walk	ALL
50-200	No	944	#	#	96	1,112
	Yes	4,422	134	49	153	4,758
	Total	5,366	191	65	249	5,871
	Yes/Total	82%	70%	76%	61%	81%
200-500	No	836	#	#	#	875
	Yes	3,635	108	#	#	3,796
	Total	4,471	113	#	68	4,671
	Yes/Total	81%	95%	#	#	81%
500-1,000	No	829	#	#	#	890
	Yes	3,671	153	#	72	3,921
	Total	4,501	170	#	103	4,811
	Yes/Total	82%	90%	#	71%	82%
>1,000 W/O	No	1,949	137	#	111	2,211
Subway	Yes	11,083	443	75	226	11,826
	Total	13,032	580	90	336	14,038
	Yes/Total	85%	76%	84%	67%	84%
>1,000 W/	No	1,884	446	#	119	2,463
Subway	Yes	10,136	2,098	81	611	12,926
	Total	12,020	2,544	95	730	15,389
	Yes/Total	84%	82%	84%	84%	84%
Not Urbanized	No	3,902	#	#	511	4,483
	Yes	19,659	173	106	628	20,567
	Total	23,561	213	137	1,140	25,050
	Yes/Total	83%	81%	78%	55%	82%
ALL	No	10,345	701	89	900	12,035
	Yes	52,606	3,109	355	1,725	57,795
	Total	62,951	3,810	444	2,625	69,830
	Yes/Total	84%	82%	80%	66%	83%

- designates insufficient data.

Appendix B.2 provides additional information about absenteeism by specific day of the week. This could be useful to areas with a more limited home interview survey that may have been conducted on a single day of the week, rather than the more typical survey which is spread over an entire week.

Locally Based Adjustment

Local home interview surveys rarely provide the data necessary to accurately estimate absenteeism as defined by the purpose for this adjustment. Trip making characteristics are recorded on a predefined survey day and neither an individual's customary mode nor whether he or she worked at all during the prior week are sought. Previous studies by local agencies have suggested that the absenteeism factor derived for their area is also in the 15-20 percent range (Mann 1985, Daily 1994). Given the utility of the Census journey-to-work files, and the improved utility which could be made of those files with the addition of an additional question or two, it is strongly recommended that future home interview surveys routinely ask these questions.

3.2 STEP 2: ADJUSTING FOR NORMAL MODE

In the Census, an individual reports on his/her usual or customary mode of travel to work. However, on any given day of the week his/her mode of travel may change. He/she may need to take public transportation while his/her car is in for service, or if the bus is normally taken, he/she may have to drive occasionally to attend late meetings or after hours social functions. As pointed out in Chapter 1, there is an apparent general undercounting of individuals whose reported "normal" mode of travel to work is transit but this issue is separate from the difference between normal mode and mode reported on any given "typical" day.

NPTS Adjustment

Table 3.2 provides an adjustment factor matrix stratified by metropolitan area size for adjusting normal mode to mode of travel on the typical travel day. The Table provides a cross matrix of how individuals reported their normal mode of travel to work by how they reported their mode of travel on the specific day requested. The last column in the chart is the ratio of the number of people reporting a mode as the mode they took on the survey day divided by the number of people reporting that same mode as their "normal" mode. This ratio is used to adjust the reported number of people reporting a mode as their normal mode. It should be noted that the factors for smaller metropolitan areas exhibit some peculiarities among transit modes. This is due to the relatively limited availability of certain transit modes in smaller metro areas.

Locally Based Adjustment

Given the lack of information on normal mode in home interview surveys, there is little information available to make local adjustments to the data from the Census database to represent mode of travel on a typical day. Formulas have been derived to estimate this adjustment (Mann, 1985), but the factors are subject to a number of assumptions that can raise issues related to the accuracy of the process.

This adjustment may vary significantly between metropolitan areas. For example, in areas where there is a truly regional transit system, which is widely accepted by a broad spectrum of the population, such as the Washington Metrorail System, it is to be expected that the occasional user may be much more common than in areas where public transportation is less well accepted.

In an area such as Washington, D.C., for example, it is to be expected that this factor would be greater than 1.0 in contrast to the apparent national average of 0.87.

Table 3.2

Work Trips
"Normal Mode" to Mode on Travel Day Adjustment
(Annual Trips in Millions)

Mode on Survey Day

Metro Area Size		Auto	Transit	Motorcycle/ Bicycle	Walk	Normal Total	Survey Day Total	Adjustment Factor to Survey Day
	Normal Mode							
50-200K	Auto	1,469	#	#	#	1,479	1,481	1.00
	Transit	#	40	#	#	43	40	0.93
	Motor/Bicycle	#	#	#	#	#	18	#
	Walk	#	#	#	30	39	47	1.21
	Total	1,481	40	18	47	1,584	1,584	1.00
	Normal Mode							
200-500K	Auto	1,238	#	#	#	1,243	1,248	1.00
	Transit	#	24	#	#	33	25	0.77
	Motor/Bicycle	#	#	#	#	#	#	#
	Walk	#	#	#	#	#	15	#
	Total	1,248	25	#	15	1,297	1,297	1.00
	Normal Mode							
500-1000K	Auto	1,195	#	#	#	1,198	1,202	1.00
	Transit	#	42	#	#	51	44	0.87
	Motor/Bicycle	#	#	#	#	#	#	#
	Walk	#	#	#	22	26	27	1.05
	Total	1,202	44	#	27	1,284	1,284	1.00
	Normal Mode							
1 MIL+	Auto	3,641	#	18	#	3,686	3,688	1.00
W/O	Transit	#	114	#	#	159	129	0.81
Subway	Motor/Bicycle	#	#	25	#	25	43	1.71
	Walk	#	#	#	66	84	95	1.13
	Total	3688	129	43	95	3954	3954	1.00
	Normal Mode							
1Mil+	Auto	3,319	28	#	#	3,364	3,404	1.01
W/Subway	Transit	64	543	#	64	721	615	0.85
	Motor/Bicycle	#	#	#	#	29	#	#
	Walk	#	#	#	193	193	280	1.45
	Total	3,404	615	#	280	4,314	4,314	1.00
	Normal Mode							
Not	Auto	6,556	#	#	33	6,611	6,631	1.00
Urbanized	Transit	20	27	#	#	53	43	0.81
	Motor/Bicycle	#	#	22	#	40	31	0.78
	Walk	43	#	#	186	231	228	0.99
	Total	6,631	43	31	228	6,933	6,933	1.00
	Normal Mode							
All Areas	Auto	17,417	55	30	78	17,580	17,655	1.00
	Transit	130	833	#	100	1,068	899	0.84
	Motor/Bicycle	31	#	88	#	125	122	0.98
	Walk	76	#	#	509	592	690	1.17
	Total	17,655	899	122	690	19,365	19,365	1.00

- designates insufficient data.

3.3 STEP 3: ADJUSTING FOR MULTIPLE TRIPS TO WORK

The adjustments described in Steps 1 and 2 only deal with the initial home-to-work trip, and the return trip, for each worker. A further adjustment should be made to the Census database to reflect multiple trips to and from work. This adjustment deals with both the individual who holds multiple jobs and returns home between jobs, and the individual who occasionally makes multiple trips to the same place of work from home. A typical example of the latter is an individual who returns home for lunch.

NPTS Adjustment

Table 3.3 provides estimates of the number of individuals making home to work trips and the total number of home to work trips that they made. Each table represents one urban area size designation. The ratio of these two numbers comprises an adjustment factor that should be applied to the trip tables to reflect the multiple work trips per worker. These data are stratified by size of metropolitan area. As might be expected, non-metropolitan areas and smaller metropolitan areas tend to have a higher incidence of multiple trip making, possibly reflecting the ease by which a worker can get home for lunch in the middle of the day, while metropolitan areas in excess of one million population tend to have lower rates of multiple home to work trip making.

Locally Derived Adjustment

The daily travel diary format of most home interview surveys readily provides the opportunity to derive the incidence of multiple home to work trips per worker. The analysis of trip making of each individual provides the origin and destination of each trip. This allows for the stratification of multiple work trips by individual.

3.4 STEP 4: ADJUSTING FOR TRIP CHAINING

The Census does not distinguish between workers who make a trip directly from home-to-work, (a home-based work trip as defined by travel demand models) and workers who find it necessary to stop between home-and-work or work-and-home. The latter phenomenon is referred to as trip chaining. The trip chaining phenomenon is thought by many planners to result in an underestimation of overall trip generation by collapsing multiple trips in a chain into a single trip. Conversely, the number of strictly home-based work trips obtained from surveys may be overestimated since individuals tend to omit information about stops along the way to work or home. An individual completing a daily trip log survey may, for example, easily overlook a trip in which a stop was made at the dry cleaners on the way to work. This would constitute a home-based-other (home-cleaners) trip and a non-home based (cleaner-work) trip in the usual typology

Table 3.3

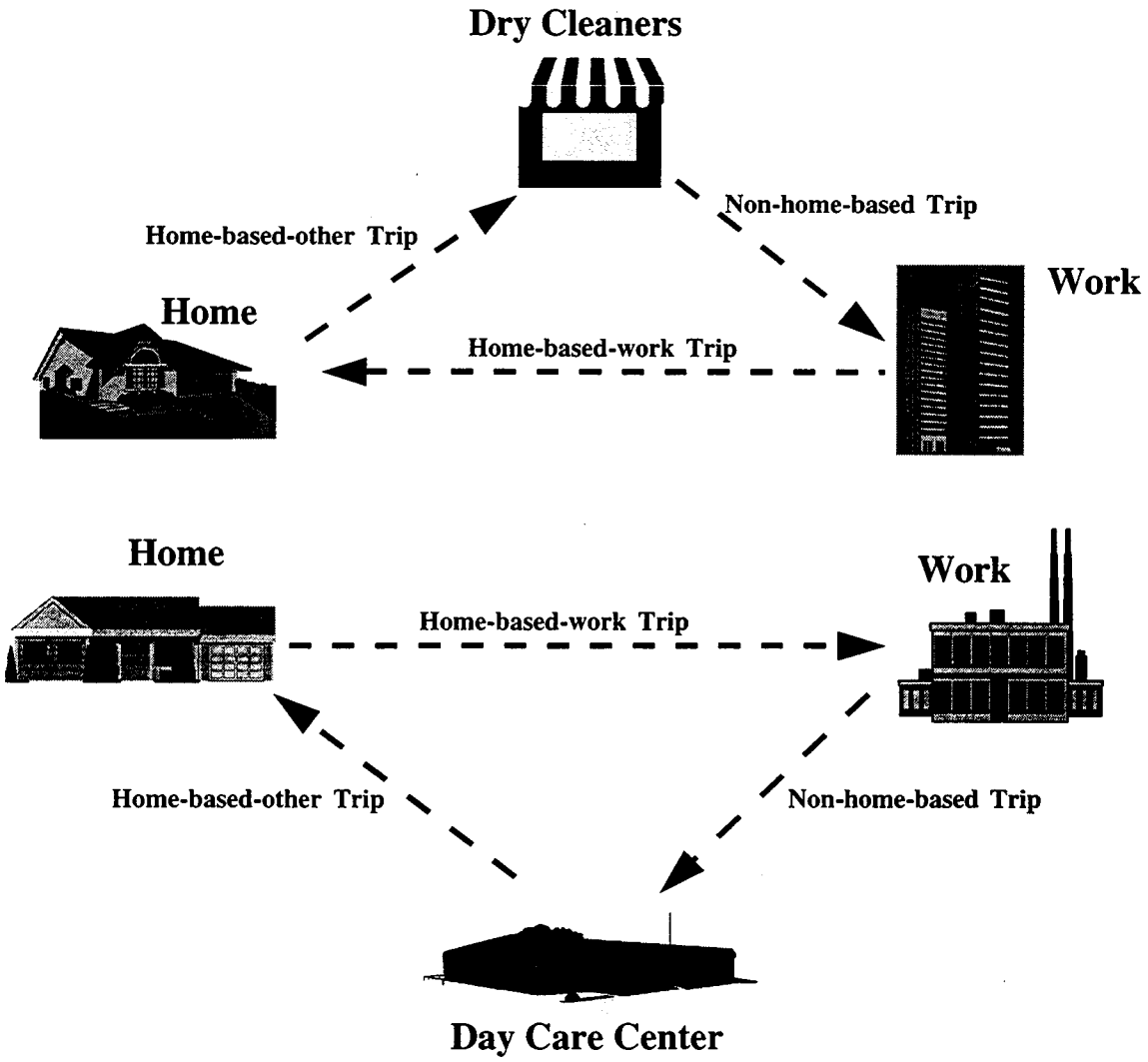
Work Trips
Adjustment for Multiple Trips per Day
(1,000,000s of Annual Trips)

		First Trip Daily (Trip Makers)			Total All Trips			Adjustment for Multiple Home Based Work Trips		
		WEEKEND	WEEKDAY	ALL	WEEKEND	WEEKDAY	ALL	WEEKEND	WEEKDAY	ALL
Size of urbanized area (1,000's)	Mode	Home to Work Total First Home Based Work			Home to Work Total All Home Based Work			Home to Work Total All Home Based Work		
50-200	Auto	369	3,094	3,463	382	3,228	3,610	1.03	1.04	1.04
	Transit	#	76	80	#	76	80	#	1.00	1.00
	Cycle	#	38	40	#	38	40	#	1.00	1.00
	Walk	#	90	99	#	94	104	#	1.05	1.04
	ALL	385	3,298	3,682	397	3,437	3,834	1.03	1.04	1.04
200-500	Auto	330	2,575	2,905	339	2,732	3,071	1.03	1.06	1.06
	Transit	#	52	52	#	52	52	#	1.00	1.00
	Cycle	#	17	21	#	17	21	#	1.00	1.00
	Walk	21	47	68	21	51	72	1.00	1.08	1.06
	ALL	355	2,697	3,052	364	2,858	3,222	1.03	1.06	1.06
500-1,000	Auto	280	2,536	2,816	297	2,623	2,921	1.06	1.03	1.04
	Transit	#	79	79	#	79	79	#	1.00	1.00
	Cycle	#	21	27	#	21	27	#	1.00	1.00
	Walk	6	56	61	6	59	65	1.00	1.06	1.06
	ALL	292	2,692	2,983	309	2,782	3,091	1.06	1.03	1.04
>1,000 W/O Subway	Auto	1,011	7,701	8,712	1,052	7,962	9,014	1.04	1.03	1.03
	Transit	#	257	270	#	262	275	#	1.02	1.02
	Cycle	#	67	88	#	79	100	#	1.18	1.14
	Walk	40	191	231	40	206	246	1.00	1.08	1.07
	ALL	1,085	8,234	9,320	1,126	8,509	9,636	1.04	1.03	1.03
>1,000 W/ Subway	Auto	910	7,158	8,069	938	7,383	8,321	1.03	1.03	1.03
	Transit	100	1,237	1,337	108	1,246	1,354	1.07	1.01	1.01
	Cycle	#	28	28	#	35	35	#	1.23	1.23
	Walk	69	610	678	69	631	700	1.00	1.04	1.03
	ALL	1,080	9,033	10,112	1,115	9,295	10,410	1.03	1.03	1.03
Not Urbanized	Auto	1,641	13,643	15,284	1,727	14,420	16,147	1.05	1.06	1.06
	Transit	#	81	93	#	87	99	#	1.07	1.06
	Cycle	#	75	81	#	75	81	#	1.00	1.00
	Walk	77	437	513	83	462	544	1.08	1.06	1.06
	ALL	1,737	14,236	15,973	1,828	15,043	16,872	1.05	1.06	1.06
ALL	Auto	4,541	36,708	41,249	4,735	38,348	43,083	1.04	1.04	1.04
	Transit	130	1,782	1,911	137	1,802	1,939	1.06	1.01	1.01
	Cycle	40	247	287	40	266	306	1.00	1.07	1.06
	Walk	222	1,429	1,651	228	1,502	1,731	1.03	1.05	1.05
	ALL	4,933	40,165	45,098	5,140	41,918	47,059	1.04	1.04	1.04

- designates insufficient data.

of trip types commonly used in travel demand modeling. In the absence of such detail, this chained trip would have been recorded as a home-based work trip. Figure 3.4 illustrates a common set of trip chains associated with home to work trips and the reverse.

Figure 3.4
Examples of Work Related Trip Chaining



Trip chaining behavior is not captured in the Census files since detailed travel diaries are not completed for the Census. All that is known is the location of home and work for the worker. Therefore, in order to provide data compatible with the travel demand forecasting format of home-based work trips, an independent estimate of the incidence of trip chaining is a necessary adjustment that must be made to Census trip files.

NPTS Adjustment

The adjustment for trip chaining is best understood by comparing the directional movement of trips between work and home to the home-based work trip totals. Table 3.4 compares the total of all "home to work" trips and all "work to home" trips with the total number of "home-based-work" trips as defined above, in order to generate an adjustment factor. The resulting ratio of direct home-based-work trips divided by the total number of home to work and work to home trips provides a means by which the census trip tables can be adjusted to reflect true home-based work trips, excluding intermediate stops or trip chains. The bottom of Table 3.4 lists the final adjustment factors. Also of note, the adjustment for trip chaining includes the adjustment for trips returning home from work. Since journey-to-work only addresses home-to-work, the adjustment factor expands the journey-to-work so that is represents the traditional home-based-work modeling definitions.

Local Area Adjustment

Trip chaining is a phenomenon that can be captured from the typical local home interview survey. Analysis of individual trip making data can identify true home-to-work trips and differentiate them from trips that are made in a chain starting at the home and eventually ending at work.

There is a growing concern among some transportation planners that the conventional home interview survey may underestimate trip chaining. Without a more structured method of facilitating the survey, respondents may tend to forget many of the routine intermediate stops that are often made during the trip to-or-from work. The method which is currently being recommended is an "activity-based" survey in which survey respondents are asked to think in terms of all of the activities they had to perform during the survey day as opposed to thinking of them in terms of trips. It is felt by some that this will result in a more complete picture of all trips taken on any given day. None of the local surveys selected for use in this document were in the activity based format.

Table 3.4

Work Trips
Adjustment for Trip Chaining
(1,000,000s of Annual Trips)

Direct Home to Work Trips

Metro Area Size (1,000's)	Auto	Transit	Motorcycle/ Bicycle	Walk	ALL
50 -200	1,559	43	18	51	1,671
200-500	1,313	28	#	#	1,365
500-1,000	1,244	42	#	29	1,326
>1,000 W/OSubway	3,842	135	45	97	4,124
>1,000 W/Subway	3,538	644	#	293	4,487
Not Urbanized	6,964	49	38	239	7,290
ALL	18,461	940	133	725	20,259

Direct Work to Home Trips

Metro Area Size (1,000's)	Auto	Transit	Motorcycle/ Bicycle	Walk	ALL
50 -200	1,209	30	#	41	1,301
200-500	991	#	#	33	1,054
500-1,000	986	32	#	29	1,055
>1,000 W/OSubway	3,008	116	28	80	3,238
>1,000 W/Subway	2,801	520	#	230	3,565
Not Urbanized	5,500	35	27	205	5,767
ALL	14,495	755	104	618	15,972

Total Home Based Work Trips

Metro Area Size (1,000's)	Auto	Transit	Motorcycle/ Bicycle	Walk	ALL
50 -200	2,768	72	35	91	2,973
200-500	2,303	50	20	51	2,421
500-1,000	2,230	75	19	58	2,382
>1,000 W/OSubway	6,850	250	73	176	7,361
>1,000 W/Subway	6,339	1,164	26	523	8,051
Not Urbanized	12,464	84	65	444	13,057
ALL	32,956	1,695	238	1,343	36,231

- designates insufficient data.

Table 3.4
(Continued)

Work Trips
Adjustment for Trip Chaining
(1,000,000s of Annual Trips)

Total All Home to Work Trips

Metro Area Size (1,000's)	Auto	Transit	Motorcycle/ Bicycle	Walk	ALL
50 -200	1,753	43	20	61	1,877
200-500	1,455	30	#	33	1,528
500-1,000	1,395	45	#	36	1,489
>1,000 W/OSubway	4,284	139	45	103	4,570
>1,000 W/Subway	3,911	675	22	329	4,938
Not Urbanized	7,848	50	38	254	8,190
ALL	20,647	981	147	815	22,590

Total All Work to Home Trips

Metro Area Size (1,000's)	Auto	Transit	Motorcycle/ Bicycle	Walk	ALL
50 -200	1,749	36	20	53	1,861
200-500	1,453	26	#	37	1,527
500-1,000	1,405	34	#	29	1,480
>1,000 W/OSubway	4,283	130	31	105	4,551
>1,000 W/Subway	3,993	610	20	330	4,953
Not Urbanized	7,821	38	39	240	8,138
ALL	20,706	875	130	794	22,504

Total all Trips Between Work & Home

Metro Area Size (1,000's)	Auto	Transit	Motorcycle/ Bicycle	Walk	ALL
50 -200	3,502	79	39	113	3,738
200-500	2,908	56	22	69	3,056
500-1,000	2,801	79	21	65	2,967
>1,000 W/OSubway	8,567	269	76	208	9,120
>1,000 W/Subway	7,905	1,285	41	659	9,890
Not Urbanized	15,670	88	77	494	16,328
ALL	41,353	1,856	277	1,609	45,095

- designates insufficient data.

Table 3.4
(Continued)

Work Trips
Adjustment for Trip Chaining
(1,000,000s of Annual Trips)

Adjustment for Trip Chaining - Home to Work

Metro Area Size (1,000's)	Auto	Transit	Motorcycle/ Bicycle	Walk	ALL
50 -200	0.89	1.00	0.91	0.83	0.89
200-500	0.90	0.93	#	#	0.89
500-1,000	0.89	0.94	#	0.80	0.89
>1,000 W/OSubway	0.90	0.97	1.00	0.94	0.90
>1,000 W/Subway	0.90	0.95	#	0.89	0.91
Not Urbanized	0.89	0.97	1.00	0.94	0.89
ALL	0.89	0.96	0.91	0.89	0.90

Adjustment for Trip Chaining - Work to Home

Metro Area Size (1,000's)	Auto	Transit	Motorcycle/ Bicycle	Walk	ALL
50 -200	0.69	0.82	#	0.78	0.70
200-500	0.68	#	#	0.89	0.69
500-1,000	0.70	0.94	#	1.00	0.71
>1,000 W/OSubway	0.70	0.89	0.91	0.76	0.71
>1,000 W/Subway	0.70	0.85	#	0.70	0.72
Not Urbanized	0.70	0.92	0.71	0.85	0.71
ALL	0.70	0.86	0.80	0.78	0.71

Total Adjustment for Trip Chaining

Metro Area Size (1,000's)	Auto	Transit	Motorcycle/ Bicycle	Walk	ALL
50 -200	1.58	1.82	#	1.61	1.59
200-500	1.58	#	#	#	1.58
500-1,000	1.59	1.89	#	1.80	1.60
>1,000 W/OSubway	1.60	1.86	1.91	1.70	1.61
>1,000 W/Subway	1.61	1.81	#	1.59	1.63
Not Urbanized	1.59	1.89	1.71	1.80	1.60
ALL	1.59	1.82	1.71	1.67	1.61

- designates insufficient data.

3.5 CALCULATION OF A COMPOSITE ADJUSTMENT FACTOR

Individual adjustment factors calculated in Steps 1-4 can be combined to reflect one adjustment factor for each of the Census journey-to-work files. Table 3.5 shows the combined calculation of composite factors for each of the area types.

Table 3.5

APPLICATION OF CENSUS ADJUSTMENT FACTORS
Census "Workers" to Daily Home-Based-Work Trips

Metro Area Size		Adjustment Factors: Absenteeism × by	Mode Shift × by	Multiple Trips × by	Chaining × by	Total Adjustment
50-200K	Auto	0.82	1.00	1.04	1.58	**1.35**
	Transit	0.70	0.93	1.00	1.82	**1.18**
	Motorcycle/Bicycle	0.76	0.98	1.00	1.71	**1.27**
	Walk	0.61	1.21	1.05	1.61	**1.25**
200-500K	Auto	0.81	1.00	1.06	1.58	**1.36**
	Transit	0.95	0.77	1.00	1.82	**1.33**
	Motorcycle/Bicycle	0.80	0.98	1.00	1.71	**1.34**
	Walk	0.66	1.17	1.08	1.67	**1.39**
500-1000K	Auto	0.82	1.00	1.03	1.59	**1.34**
	Transit	0.90	0.87	1.00	1.89	**1.48**
	Motorcycle/Bicycle	0.80	0.98	1.00	1.71	**1.34**
	Walk	0.71	1.05	1.06	1.80	**1.42**
1 MIL + w/o Subway	Auto	0.85	1.00	1.03	1.60	**1.40**
	Transit	0.76	0.81	1.02	1.86	**1.17**
	Motorcycle/Bicycle	0.84	0.98[1]	1.18	1.91	**1.86**
	Walk	0.67	1.13	1.08	1.70	**1.39**
1 MIL + with Subway	Auto	0.84	1.01	1.03	1.61	**1.41**
	Transit	0.82	0.85	1.01	1.81	**1.27**
	Motorcycle/Bicycle	0.84	0.98	1.23	1.71	**1.73**
	Walk	0.84	1.45	1.04	1.59	**2.01**
Not Urbanized	Auto	0.83	1.00	1.06	1.59	**1.40**
	Transit	0.81	0.81	1.07	1.89	**1.33**
	Motorcycle/Bicycle	0.78	0.78	1.00	1.71	**1.04**
	Walk	0.55	0.99	1.06	1.80	**1.04**
All Areas	Auto	0.84	1.00	1.04	1.59	**1.39**
	Transit	0.82	0.84	1.01	1.82	**1.27**
	Motorcycle/Bicycle	0.80	0.98	1.07	1.71	**1.43**
	Walk	0.66	1.17	1.05	1.67	**1.35**

1. Adjusted to All Area average for lack of sufficient data

CHAPTER 4
COMPARISON OF NPTS ADJUSTMENT FACTORS TO URBAN AREA DATA - ATLANTA, GEORGIA CASE STUDY

This chapter provides a direct comparison of the application of Census data as adjusted using the factors suggested in Chapter 3 to the actual four step model process as developed and calibrated in the greater Atlanta area for the Georgia Department of Transportation. Atlanta was chosen for study for several reasons. First, it is typical of a large growing metropolitan area with a full range of transit modes. Second, the models developed for Atlanta were based on a full range of carefully developed surveys undertaken in 1990 to be contemporary with the Census. Third, the analysts doing the comparison were intimately involved with the development of the models for Atlanta limiting the possibility that there might be inconsistencies in definitions that could bias the comparison; e.g., area coverage or trip type definitions.

The comparison follows the conventional four-step modeling process and applies the Census data as it might be used to develop model components in the absence of locally collected survey data.

A number of other metropolitan areas were reviewed and analyzed as part of this study. Appendix C lists these areas and their current survey schedules.

4.1 TRIP GENERATION

The trip production models used by Atlanta are typical of what is considered to be good practice today. The model as currently applied is a cross-classification model that uses four categories of household size and four categories of auto ownership. The model was developed from relationships derived from a 1990 home interview survey conducted in the Atlanta metropolitan area.

A similar model was derived for comparison purposes from the 1990 Census Public Use Microsurvey (PUMS) files, for the Atlanta region, using identical definitions of household size and autos per household. A trip "production" is normally defined as a trip which begins or ends at home by a member of the household. Consequently, the Census is an excellent source of this data. The resulting Census derived model is compared with the model derived from local surveys in Table 4.1. The PUMS data sets are random samples of disaggregate Census data and as such are extremely useful products that complement the CTPP. These data sets provide ultimate flexibility in generating any possible cross section of data collected by the Census. Since PUMS data sets are derived from the same set of Census questions as the journey-to-work tabulations; this data must be adjusted using the same adjustment factors recommended for the journey-to-work files.

Trip attraction models are normally derived as a statistical function of employment. The Census, unfortunately, can be of little help in this area as employment by place of work is not reported by the Census.

Table 4.1
Trip Generation by Socio-economic Classification
HBW Person Trips
Atlanta

Survey

Persons per Household	Autos per Household 0	1	2	3	4+
1	0.16	0.82	1.02	0.82	0.86
2	0.27	0.99	1.77	1.86	1.94
3	0.37	1.71	2.29	2.70	3.06
4+	1.56	1.90	2.18	2.93	3.43

Census PUMS Data

Persons per Household	Autos per Household 0	1	2	3	4+
1	0.43	1.02	1.06	1.01	0.91
2	0.95	1.39	2.01	1.99	1.98
3	1.12	1.67	2.28	2.79	2.87
4+	1.04	1.88	2.30	2.86	3.42

Survey/Census Difference

Persons per Household	Autos per Household 0	1	2	3	4+
1	-0.27	-0.20	-0.04	-0.19	-0.05
2	-0.68	-0.40	-0.24	-0.13	-0.04
3	-0.75	0.04	0.01	-0.09	0.19
4+	0.52	0.02	-0.12	0.07	0.01

Percent Difference

Persons per Household	Autos per Household 0	1	2	3	4+
1	-170%	-25%	-4%	-24%	-6%
2	-251%	-40%	-14%	-7%	-2%
3	-203%	2%	0%	-3%	6%
4+	33%	1%	-5%	3%	0%

For most cells in the matrix the comparison is excellent with comparatively little variation between the two models. For zero auto households and for the two smallest household sizes the differences are more substantial. Viewing the progression of trip generation rates by auto ownership and household size in each row and column, there would appear to be irregularities in the progressions of both models, which might suggest the utility of using some composite of both models in a further refinement. Some cells also contain small sample sizes contributing to the differences.

Aggregate comparisons of the numbers of trips generated by the two models, illustrated in the row and column totals of Table 4.2, show an excellent match with an overall difference across the metropolitan area of only about four percent. Differences by county are almost as good with few differences in county to county movements exceeding five percent.

Census derived estimates for the inner most counties, Fulton and Dekalb tend to be lower than the survey derived estimates. Conversely, the more rural counties tended to be somewhat overestimated. This difference between the inner and the more rural counties is predictable. A separate home interview survey conducted for the rural counties in 1993 showed lower overall trip generation per household than the survey of the inner counties in the region conducted in 1990. These same conclusions are supported by NPTS data.

The Census PUMS data is a powerful, inexpensive tool for metropolitan transportation planners that should not be ignored in the development of such trip generation models. Even if locally based survey data is available, comparisons with this readily available resource will provide an excellent quality control on the model to be developed.

4.2 TRIP DISTRIBUTION

One of the most powerful applications of the Census journey-to-work files is often in the validation of the regional work trip distribution model. While local home interview surveys can be useful in many aspects of model development, typically there is not enough data acquired to provide accurate estimates of trip distribution at the county level in an area the size of the Atlanta region, much less at the traffic analysis district or zone level. Normally such surveys for an area this size might contain 1,500 to 4,000 completed household records. The magnitude of the Census data make it particularly useful in this context.

Table 4.2 compares the trip distribution of the gravity model for Atlanta aggregated to the county level with a comparable distribution of trips extracted from the 1990 journey-to-work files for Atlanta and expanded by the factors suggested in this report. The maximum differences between the two distributions are in the range of 10 to 15 percent with the vast majority of the cells having differences of less than 5 percent.

Clearly, the use of Census data is appropriate for this purpose, even if the total trips as derived from the Census are to be factored to match regional totals derived locally.

Table 4.2
Regional Distribution
Atlanta Home-Based-Work Trip Productions - By All Modes

(Thousands of Trips)

Total Person Trip Productions Estimated from Census Data

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External		14.2	47.8	29.8	5.2	5.9	79.6	28.5	4.8	7.8	223.4
Clayton	2.7	58.1	3.3	11.8	0.3	2.9	46.3	1.9	2.9	0.5	130.6
Cobb	13.4	8.5	167.5	24.0	3.7	0.2	111.0	8.6	0.1	0.4	337.5
DeKalb	7.3	10.6	13.3	178.9	0.4	0.3	151.2	29.2	0.6	2.9	394.7
Douglas	2.7	1.6	8.3	2.6	15.5	0.1	18.6	0.7	0.1	0.0	50.1
Fayette	2.3	11.4	0.9	1.3	0.1	13.2	12.5	0.3	0.5	0.0	42.4
Fulton	8.3	19.1	26.1	55.6	0.8	1.2	284.7	17.3	0.4	0.6	414.2
Gwinnet	9.1	3.6	9.0	71.7	0.2	0.1	51.8	124.5	0.2	1.8	272.0
Henry	1.7	11.2	0.7	5.0	0.0	0.3	9.2	0.7	11.1	0.5	40.4
Rockdale	3.2	1.4	0.6	10.1	0.1	0.0	6.0	1.9	0.4	14.3	38.1
Total	50.7	139.7	277.5	390.8	26.3	24.1	770.7	213.6	21.2	28.9	1,943.6

Total Person Trip Productions Estimated From the Local Model

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External		13.9	50.0	29.9	5.2	5.7	79.6	28.5	4.4	8.0	225.1
Clayton	2.7	59.5	3.3	12.4	0.3	2.9	49.7	1.9	2.9	0.5	136.2
Cobb	13.5	8.7	170.4	25.0	3.8	0.2	114.2	8.8	0.1	0.4	345.1
DeKalb	7.0	11.9	13.3	187.1	0.4	0.3	169.0	29.5	0.6	3.0	422.0
Douglas	2.7	1.8	8.4	2.7	15.8	0.1	19.2	0.7	0.1	0.0	51.7
Fayette	2.3	11.7	0.9	1.3	0.1	13.4	12.8	0.3	0.5	0.0	43.4
Fulton	8.1	21.7	26.5	64.8	0.8	1.1	308.8	17.4	0.4	0.6	450.3
Gwinnet	9.1	3.9	9.2	73.7	0.2	0.1	54.9	126.7	0.2	1.8	279.9
Henry	1.7	11.4	0.8	5.1	0.0	0.3	9.4	0.7	11.3	0.5	41.2
Rockdale	3.2	1.5	0.7	10.4	0.1	0.0	6.3	1.9	0.4	14.6	39.0
Total	50.3	145.9	283.6	412.3	26.7	24.2	823.8	216.6	21.0	29.5	2,033.8

Census Based Estimate - Local Model Based Estimate

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External		0.3	-2.2	-0.1	0.0	0.2	0.0	0.0	0.4	-0.2	-1.7
Clayton	0.0	-1.3	0.0	-0.6		0.0	-3.4	0.0	-0.1	0.0	-5.5
Cobb	-0.1	-0.2	-2.9	-1.0	-0.1	0.0	-3.2	-0.2		0.0	-7.6
DeKalb	0.3	-1.2	-0.1	-8.2	0.0	0.0	-17.8	-0.3	0.0	-0.1	-27.3
Douglas	0.0	-0.2	-0.2	-0.1	-0.3		-0.6	0.0			-1.5
Fayette	-0.1	-0.3	0.0	0.0		-0.2	-0.3		0.0		-0.9
Fulton	0.2	-2.6	-0.4	-9.2	0.1	0.0	-24.1	-0.1	0.0	0.0	-36.1
Gwinnet	0.0	-0.3	-0.2	-2.0		0.0	-3.1	-2.2		0.0	-7.9
Henry	0.0	-0.3	0.0	-0.1		0.0	-0.2	0.0	-0.2	0.0	-0.8
Rockdale	-0.1	0.0	0.0	-0.2		0.0	-0.3	-0.1		-0.3	-0.9
Total	0.3	-6.2	-6.0	-21.5	-0.4	-0.1	-53.0	-2.9	0.1	-0.6	-90.2

Difference in Estimates / Local Model Based Estimate

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External		2%	-4%	0%	-1%	3%			9%	-2%	-1%
Clayton	0%	-2%	0%	-5%	-2%	-2%	-7%	-2%	-3%	-7%	-4%
Cobb	-1%	-2%	-2%	-4%	-2%	5%	-3%	-3%	-3%	-2%	-2%
DeKalb	4%	-11%	0%	-4%	7%	2%	-11%	-1%	-1%	-2%	-6%
Douglas	-1%	-13%	-2%	-4%	-2%	-1%	-3%	-3%	-1%	-4%	-3%
Fayette	-2%	-2%	-4%	-3%	-2%	-2%	-2%	-2%	-4%	-5%	-2%
Fulton	3%	-12%	-2%	-14%	8%	1%	-8%	-1%	2%	4%	-8%
Gwinnet	0%	-8%	-3%	-3%	-3%	3%	-6%	-2%	-3%	-3%	-3%
Henry	0%	-2%	-3%	-2%	-3%	1%	-2%	-3%	-2%	-3%	-2%
Rockdale	-2%	-2%	-3%	-2%	-3%	3%	-4%	-3%	-1%	-2%	-2%
Total	1%	-4%	-2%	-5%	-1%	0%	-6%	-1%	1%	-2%	-4%

4.3 MODE CHOICE

Another valuable application of Census data could be the development, and/or validation of a region's mode choice model. Unfortunately, it would appear to be in the area of identification of mode of travel that the Census journey-to-work data may be weakest. In most of the cities reviewed, there were significant differences between transit trips as reported by the Census and those reported by transit operating agencies, with substantial underestimates of transit ridership commonplace with Census data. The situation is even worse when estimates by transit submodes are considered. These problems are particularly apparent in the Atlanta area where regional bus trips appear to be greatly overestimated while trips on the regional rail system, MARTA, are underestimated.

Tables 4.3.1 through 4.3.3 provide a comparison of total transit trips for the Atlanta area, bus trips and rail trips, respectively, as derived from the Census journey-to-work files and expanded by the conversion factors suggested by this report, with totals as reported by on-board surveys completed by MARTA, the regional transit operator, supplemented by data from the Cobb County transit system. The comparison is quite disappointing. Total transit trips as reported by the Census and adjusted are 36 percent lower than those reported locally.

Part of this is to be expected and can be explained by the instructions in the Census to report a trip made by more than one mode as the mode on which the greatest time was spent. Thus a long drive access trip to a MARTA Rail station and a comparatively shorter rail trip would be recorded as an auto trip by the Census. That same trip would be reported as a transit trip in most urban planning models, including Atlanta's.

The differences between these sources is even greater by submode. It appears that bus is substantially over reported while rail trips are under reported. Part of this can, again, be explained by the Census rule of reporting the mode on which one spent the most time on a trip using both bus and rail, but the magnitude of the differences cannot be accounted for entirely from this source.

Clearly there is no substitute for locally derived transit data for the estimation or validation of a model capable of estimating modal choice. However, where an adequate on-board survey providing true origins and destinations of trips, not just station of boarding and alighting, is not available, the Census may be useful to provide a crude estimate of the distribution of trips. This distribution could then can be factored to an estimate of total linked home-based-work transit trips provided by local transit operators. If all else fails, the Federal Transit Administration Section 15 data source can supply estimates of total daily **unlinked** transit trips. Estimates of the percent all trips which are home-based work and the percent of transfers on the system can normally be estimated by the transit operator or derived from other similar transit systems nationally.

Table 4.3.1
Regional Distribution
Atlanta Home-Based-Work Trip Productions - All Transit Sub-Modes

(Thousands of Trips)

Transit Trip Productions Estimated from Census Data

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External		0.1	0.1	0.1		0.0	1.0	0.0			1.3
Clayton		0.1	0.1	0.1			1.2	0.0			1.5
Cobb	0.1	0.1	0.9	0.0			1.2				2.3
DeKalb	0.3	0.5	0.5	9.9	0.0		19.4	0.4		0.0	31.1
Douglas	0.0		0.0		0.0		0.1				0.2
Fayette						0.1	0.1				0.1
Fulton	0.3	1.3	1.4	6.2	0.1		43.6	0.5		0.0	53.3
Gwinnet	0.1	0.0	0.0	0.0			1.0	0.3			1.4
Henry	0.0	0.0		0.0			0.0		0.1		0.1
Rockdale				0.0			0.0			0.0	0.1
Total	0.7	2.2	3.0	16.4	0.1	0.1	67.7	1.3	0.1	0.1	91.6

Transit Trip Productions Estimated From the Local Model

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External											
Clayton		0.2	0.0	0.4			3.6	0.0		0.0	4.2
Cobb		0.0		0.4			1.7				2.1
DeKalb		1.6	0.2	14.1			34.0	0.1			50.0
Douglas		0.2		0.1			0.3				0.6
Fayette											
Fulton		3.9	1.3	14.4			64.0	0.2			83.8
Gwinnet		0.2		0.3			2.6				3.2
Henry											
Rockdale							0.1				0.1
Total		6.1	1.5	29.7			106.4	0.3		0.0	144.0

Census Based Estimate - Local Model Based Estimate

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External		0.1	0.1	0.1		0.0	1.0	0.0			1.3
Clayton		0.0	0.1	-0.3			-2.4	0.0		0.0	-2.6
Cobb	0.1	0.0	0.9	-0.4			-0.5				0.2
DeKalb	0.3	-1.0	0.3	-4.2	0.0		-14.6	0.4		0.0	-18.8
Douglas	0.0	-0.2	0.0	-0.1	0.0		-0.2				-0.4
Fayette						0.1	0.1				0.1
Fulton	0.3	-2.6	0.1	-8.2	0.1		-20.5	0.3		0.0	-30.5
Gwinnet	0.1	-0.2	0.0	-0.3			-1.6	0.3			-1.7
Henry	0.0	0.0		0.0			0.0		0.1		0.1
Rockdale				0.0			-0.1			0.0	0.0
Total	0.7	-3.9	1.5	-13.3	0.1	0.1	-38.7	0.9	0.1	0.1	-52.4

Difference in Estimates / Local Model Based Estimate

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External											
Clayton		-17%	349%	-76%			-67%	7%		-100%	-63%
Cobb		69%		-91%			-27%				9%
DeKalb		-65%	118%	-30%			-43%	595%			-38%
Douglas		-100%		-100%			-68%				-73%
Fayette											
Fulton		-68%	10%	-57%			-32%	116%			-36%
Gwinnet		-92%		-86%			-61%				-54%
Henry											
Rockdale							-74%				-28%
Total		-65%	101%	-45%			-36%	304%		373%	-36%

Table 4.3.2
Regional Distribution
Atlanta Home-Based-Work Trip Productions - Bus Transit

(Thousands of Trips)

Bus Trip Productions Estimated from Census Data

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External		0.1	0.1	0.1		0.0	3	0.0			0.9
Clayton		0.1	0.1	0.1			0.4				0.7
Cobb	0.0	0.1	0.9	0.0			0.9				1.9
DeKalb	0.1	0.2	0.5	9.3	0.0		12.8	0.3		0.0	23.3
Douglas			0.0		0.0		0.0				0.1
Fayette						0.1	0.0				0.1
Fulton	0.2	1.0	1.2	5.4	0.1		36.0	0.4		0.0	44.3
Gwinnet	0.0			0.0			0.1	0.3			0.5
Henry		0.0		0.0			0.0		0.1		0.1
Rockdale				0.0			0.0			0.0	0.1
Total	0.4	1.5	2.8	14.9	0.1	0.1	50.9	1.0	0.1	0.1	71.8

Bus Trip Productions Estimated From the Local Model

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External											
Clayton											
Cobb							0.0				0.0
DeKalb			0.2	6.5			5.9				12.5
Douglas											
Fayette											
Fulton		0.5		2.6			12.0				15.1
Gwinnet				0.2							0.2
Henry											
Rockdale											
Total		0.5	0.2	9.2			17.9				27.8

Census Based Estimate - Local Model Based Estimate

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External		0.1	0.1	0.1		0.0	0.6	0.0			0.9
Clayton		0.1	0.1	0.1			0.4				0.7
Cobb	0.0	0.1	0.9	0.0			0.8				1.9
DeKalb	0.1	0.2	0.3	2.8	0.0		6.9	0.3		0.0	10.8
Douglas			0.0		0.0		0.0				0.1
Fayette						0.1	0.0				0.1
Fulton	0.2	0.4	1.2	2.8	0.1		24.1	0.4		0.0	29.2
Gwinnet	0.0			-0.1			0.1	0.3			0.3
Henry		0.0		0.0			0.0		0.1		0.1
Rockdale				0.0			0.0			0.0	0.1
Total	0.4	1.0	2.6	5.6	0.1	0.1	33.1	1.0	0.1	0.1	44.0

Census Based Estimate / Local Model Based Estimate

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External											
Clayton											
Cobb							1997%				4518%
DeKalb			193%	43%			118%				86%
Douglas											
Fayette											
Fulton		85%		110%			201%				194%
Gwinnet				-79%							140%
Henry											
Rockdale											
Total		189%	1669%	61%			185%				158%

Table 4.3.3
Regional Distribution
Atlanta Home-Based-Work Trip Productions - Rail Transit

(Thousands of Trips)

Rail Trip Productions Estimated from Census Data

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External		0.0	0.0	0.0			0.4	0.0			0.4
Clayton		0.0	0.0	0.0			0.8	0.0			0.8
Cobb	0.0		0.0	0.0			0.4				0.4
DeKalb	0.1	0.3	0.1	0.6			6.7	0.1			7.9
Douglas	0.0						0.1				0.1
Fayette							0.1				0.1
Fulton	0.1	0.3	0.1	0.8			7.5	0.1			9.0
Gwinnet	0.0	0.0	0.0	0.0			0.9	0.0			1.0
Henry	0.0						0.0				0.0
Rockdale											
Total	0.4	0.6	0.3	1.5			16.8	0.3			19.7

Rail Trip Productions Estimated From the Local Model

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External											
Clayton		0.2	0.0	0.4			3.6	0.0		0.0	4.2
Cobb		0.0		0.4			1.7				2.1
DeKalb		1.6	0.1	7.6			28.1	0.1			37.4
Douglas		0.2		0.1			0.3				0.6
Fayette											
Fulton		3.4	1.3	11.9			52.1	0.2			68.8
Gwinnet		0.2		0.1			2.6				3.0
Henry											
Rockdale							0.1				0.1
Total		5.6	1.4	20.4			88.5	0.3		0.0	116.1

Census Based Estimate - Local Model Based Estimate

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External		0.0	0.0	0.0			0.4	0.0			0.4
Clayton		-0.2	0.0	-0.3			-2.8	0.0		0.0	-3.3
Cobb	0.0	0.0	0.0	-0.4			-1.3				-1.7
DeKalb	0.1	-1.2	0.0	-7.0			-21.5	0.0			-29.6
Douglas	0.0	-0.2		-0.1			-0.2				-0.5
Fayette							0.1				0.1
Fulton	0.1	-3.1	-1.1	-11.1			-44.5	-0.1			-59.7
Gwinnet	0.0	-0.2	0.0	-0.1			-1.7	0.0			-2.0
Henry	0.0						0.0				0.0
Rockdale							-0.1				-0.1
Total	0.4	-4.9	-1.1	-18.9			-71.7	0.0		0.0	-96.4

Census Based Estimate / Local Model Based Estimate

	External	Clayton	Cobb	DeKalb	Douglas	Fayette	Fulton	Gwinnet	Henry	Rockdale	Total
External											
Clayton		-94%	42%	-96%			-79%	7%		-100%	-80%
Cobb		-100%		-98%			-77%				-80%
DeKalb		-80%	-35%	-92%			-76%	18%			-79%
Douglas		-100%		-100%			-76%				-84%
Fayette											
Fulton		-91%	-88%	-93%			-86%	-42%			-87%
Gwinnet		-92%		-96%			-66%				-67%
Henry											
Rockdale							-100%				-100%
Total		-88%	-80%	-93%			-81%	-16%		-100%	-83%

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APPENDIX A

Appendix A provides a comparison of the specific questions asked by the 1990 Census and the questions asked by the 1990 Personnel Transportation Survey (NPTS), which were used to develop the conversion factors.

CENSUS QUESTIONS RELATED TO TRANSPORTATION PLANNING

The Census transportation planning information is derived from additional survey questions as described on the Census "long form". The long form is prepared by one in every six households. The additional questions gather information on items such as travel mode, travel time, and location of employment, which local transportation planners use to calibrate or validate travel demand models.

The following is a partial listing of the questions asked in the 1990 Census long form that are related to transportation planning, followed by a discussion of the differences between Census survey questions and local travel survey questions.

Question 21a. *Did this person work at any time LAST WEEK?*

Yes - Fill this circle if this person worked full time or part time. (Count part-time work such as delivering papers, or helping without pay in a family business or farm. Also count active duty in the Armed Forces.)

No - Fill this circle if this person did not work, or did on own housework, school work, or volunteer work.

Question 21b. *How many hours did this person work LAST WEEK (at all jobs)? Subtract any time off: add overtime or extra hours worked.*

- All of the travel survey questions assumed direct trips from residence to work place and did not request information regarding indirect work trips which include stops at day care and shopping centers.

- In Question 21a, asking whether the person worked <u>any</u> <u>time</u> last week inherently overestimates the work force for any given typical day. The same question asked for the previous day would result in greater absenteeism for illness, vacation, etc. Question 21b

provides an indication of the percentage of individuals working less than forty hours a week. Individuals that work a full week provide an accurate reply. Those who respond with less than 40 hours tend to estimate their response by rounding to the nearest half (4 hour) or full day (8 hour) increment.

Question 22. *At what location did this person work LAST WEEK? If this person worked at more than one location, print where he or she worked most last week.*

Address, City or Town or Post Office

Is the work location inside the limits of the city or town?

County, State, Zip Code

- Question 22 acknowledges that some workers go to different work locations on any given day. Unfortunately, the questions only request where he or she worked most last week. This results in three other work situations that can occur. First, a worker reports to a "central" location, which is where they report for work and then travel to a second location such as field office or construction site. Second, a work location other than the central place of work could have been given if the individual was on work travel and was not at his central place of work that week. Third, when a worker held two jobs, the second job location was not recorded. Census surveys fail to account for the effect of these three work place situations. Excluding these additional work trips in the region could result in some under-reporting of travel volumes.

Question 23a. *How did this person usually get to work LAST WEEK? If this person usually used more than one method of transportation during the trip, fill the circle of the one used for most of the distance.*

- *Car, truck, or van*
- *Bus or trolley bus*
- *Streetcar or trolley car*
- *Subway or elevated*
- *Railroad*
- *Taxicab*
- *Motorcycle*
- *Bicycle*
- *Walked*
- *Worked at home*
- *Ferryboat*
- *Other method*

Question 23b. *How many people, including this person, usually rode to work in the car, truck, or van LAST WEEK?*

- *Drove alone*
- *2 people*
- *3 people*
- *4 people*
- *5 people*
- *6 people*
- *7 to 9 people*
- *10 or more people*

- Question 23a of the 1990 Census asked how the person "usually" got to work the previous week. Inquiries on the usual day appear to result in mode estimates which are high for transit and slightly high for the automobile as compared to the questions customarily asked in local travel surveys which ask how the person got to work "yesterday." By asking mode of travel for a usual day last week, Census surveys tend to underestimate single occupancy vehicle use and overestimate the use of transit and carpools.

Question 24a. *What time did this person usually leave home to go to work LAST WEEK?*

Question 24b. *How many minutes did it usually take this person to get from home to work LAST WEEK?*

- The response to question 24a only provides the work departure time for the "usual" work trip. The individual typically rounds this number to the nearest quarter hour. Similarly, the response to question 24b only provides travel time for the "usual" work day. The minutes are typically rounded to the nearest five minute increment.

To provide a quick reference to the differences in definitions between Census Transportation Planning data and local travel survey data, a comparison is provided as follows:

Comparison of Survey Coverage by Category

Data Category	Census Transportation Planning	Local Travel Survey
Trip Type	Work Trip	All Trips
Job Type	Primary Job	All Jobs
Work Trip Type	Journey-to-Work	Daily Home-based-Work Trips
Time Period	Usual Day	Yesterday
Travel Mode	Mode for Longest Distance	All Modes used for Trip
Occupancy	Drive Alone/Carpool	Driver/Passenger

Recognizing these differences between CTPP data and local travel survey data is the first step in understanding the need for Census conversion factors.

NATIONWIDE PERSONAL TRANSPORTATION SURVEY (NPTS) QUESTIONS

This section describes four factors necessary to adjust Census travel survey results to account for situations not covered by the Census questions. The four factors account for: absenteeism, mode of travel on a typical day as opposed to "normal" mode, multiple work trips and trip chaining. These factors are derived from the 1990 NPTS questions as listed in this section. This section does not detail the four factors but lists the questions in the NPTS as they relate to each factor. The NPTS questions used are listed below for each factor along with a brief description of how they were used. Other questions used for stratification are also listed. The variable name as it appears in the NPTS data set is also provided for reference purposes. Chapter 3 outlines the development of four separate sets of conversion factors for the 1990 Census.

Absenteeism

E1. What (were you/was PERSON) doing most of last week -- working, keeping house, going to school, or doing something else? [DOLASTWK]

E2. Did (you/PERSON) do any work last week, not counting work around the house? [ANYWORK]

E3. Did (you/PERSON) have a job or business from which (you were/PERSON) was) temporarily absent last week? [ABSNTJOB]

Question E1 provides the baseline of individuals that are part of the work force in the previous week. From that baseline, questions E2 and E3 permit the estimation of the individuals that where absent the previous week.

Mode of Travel

E5. What was the main means of transportation (you/PERSON) used to get to work last week; that is, the one used for most of the distance? [WRKTRANS]

H15. How did (you/PERSON) get to (DESTINATION)? That is, what means of transportation did (you/PERSON) use for this trip? [IF MORE THAN ONE MODE, CODE THE ONE USED FOR LONGEST DISTANCE.] [TRPTRANS]

Question E5 identifies the transportation mode used get to work typically. Question H15 is the question related to the actual survey day and provides the actual mode on any given day. The comparative analysis between typical mode and actual survey day mode shows mode shifts.

Multiple Work Trips

H3. When (you/PERSON) left (DESTINATION) where did (you/PERSON) go next? [TRPDST]

H6. Did the trip to (FIRST DESTINATION) begin at home? [TRIPORIG]

H7. What was the main purpose of the trip to (DESTINATION)? [WHYTRP]

Questions H3 and H7 both ask about the trip DESTINATION and Question H6 asks about the first trip ORIGIN. Knowing the purpose at either end of the trip allows the estimation of multiple work purposes for each trip.

Trip Chaining

The following questions were used from the first three factors: TRAVDAY, H3-TRPDST, H6-TRIPORIG and H7-WHYTRP.

The evaluation of trip origin and trip destination by purpose permits the determination of work trips that are part of a work trip chain. Reviewing the work trips to-and-from work for the entire survey day allows for the estimation of production-attraction trip factors.

Stratifying Variables

Size of urban area. [URBNSIZE]

This variable allows for the stratification of the five conversion factors by urban area size. Urban area categories were defined as follows: 50,000-200,000, 200,001-500,000, 500,001-1,000,000 and 1,000,001+. Estimates for the factors were made for non-urbanized areas as well.

Urban areas with 1,000,0001+ were split between those cities with and without subway/elevated rail. Cities that were considered in the subway/elevated rail category were:

- Atlanta, GA
- Baltimore, MD
- Boston, MA
- Chicago, Il-Northwestern, IN
- Cleveland, OH
- Miami, FL
- New York, NY-Northeastern, NJ
- Philadelphia, PA
- San Francisco-Oakland, CA
- Seattle-Everett, WA (Planned)
- Washington, DC

APPENDIX B
ADJUSTMENT FACTORS FOR INDIVIDUAL MODES

Adjustment factors as developed in Chapter 3 represent an aggregation of certain modes. This was required because of the very small sample size in some of the modal categories. This appendix provides the complete detail for each mode in the NPTS. Aggregation of modal data in Chapter 3 is as follows:

Auto - Auto, Taxi

Transit - Bus/Trolley-Bus, Subway, Railroad

Bicycle - Motorcycle, Bicycle

Walk - Walk

Other - Other

A modal category "other" exists in the Census information. This category does not have any specific modal designations. The individual respondent can use this category if the mode was truly unique and not listed, or if the individual was confused and did not know what type of modes were used. An example is rail modes for which definitions are not always understood (i.e. railroad versus subway).

The sections of this appendix are as follows:

B.1 - Absenteeism
B.2 - Absenteeism by Day of Week
B.3 - Normal Mode
B.4 - Multiple Trips
B.5 - Trip Chaining

Table B.1

Absenteeism by Metropolitan Area Size and "Normal" Mode (1,000,000s)

Size of Urbanized Area (1,000's)	Went to Work Last Week?	Auto	Bus/ Trolley-Bus	Subway/ Elevated	Railroad	Taxi	Motorcycle	Bicycle	Walk	ALL
50-200	No	944	#	#	#	#	#	#	96	1,112
	Yes	4,422	122	#	#	#	#	#	153	4,758
	Total	5,366	175	#	#	#	#	#	249	5,871
	Yes/Total	82%	70%	#	#	#	#	#	61%	81%
200-500	No	836	#	#	#	#	#	#	#	875
	Yes	3,635	102	#	#	#	#	#	#	3,796
	Total	4,471	108	#	#	#	#	#	68	4,671
	Yes/Total	81%	95%	#	#	#	#	#	#	81%
500-1,000	No	829	#	#	#	#	#	#	#	890
	Yes	3,671	152	#	#	#	#	#	72	3,921
	Total	4,501	169	#	#	#	#	#	103	4,811
	Yes/Total	82%	90%	#	#	#	#	#	71%	82%
>1,000 W/O	No	1,949	128	#	#	#	#	#	111	2,211
Subway	Yes	11,083	437	#	#	#	#	60	226	11,826
	Total	13,032	565	#	#	#	#	64	336	14,038
	Yes/Total	85%	77%	#	#	#	#	93%	67%	84%
>1,000 W/	No	1,884	218	170	45	#	#	#	119	2,463
Subway	Yes	10,136	864	900	284	50	#	69	611	12,926
	Total	12,020	1,082	1,070	330	62	#	84	730	15,389
	Yes/Total	84%	80%	84%	86%	81%	#	82%	84%	84%
Not Urbanized	No	3,902	#	#	#	#	#	#	511	4,483
	Yes	19,659	103	35	#	#	#	57	628	20,567
	Total	23,561	126	46	#	#	62	75	1,140	25,050
	Yes/Total	83%	82%	76%	#	#	#	77%	55%	82%
ALL	No	10,345	445	187	51	#	#	57	900	12,035
	Yes	52,606	1,780	947	292	90	129	226	1,725	57,795
	Total	62,951	2,224	1,134	343	108	161	283	2,625	69,830
	Yes/Total	84%	80%	84%	85%	83%	80%	80%	66%	83%

#- designates insufficient data.

Table B.2

Absenteeism by Day of Week and Metropolitan Area Size (Percent at Work)

Size of urbanized area (1,000's)		Auto		Bus/Trolley-Bus		Subway/Elevated		Railroad		Taxi	
		% @ Work	% of Ave. Wkdy	% @ Work	% of Ave. Wkdy	% @ Work	% of Ave. Wkdy	% @ Work	% of Ave. Wkdy	% @ Work	% of Ave. Wkdy
50-200	SUNDAY	23%				#		#		#	
	MONDAY	80%	98%	#	#	#	#	#	#	#	#
	TUESDAY	83%	101%	#	#	#	#	#	#	#	#
	WEDNESDAY	80%	97%	#	#	#	#	#	#	#	#
	THURSDAY	87%	105%	#	#	#	#	#	#	#	#
	FRIDAY	81%	98%	#	#	#	#	#	#	#	#
	SATURDAY	30%		#		#		#		#	
	Av. Weekday	82%		70%		12%		0%		100%	
200-500	SUNDAY	19%		#		#		#		#	
	MONDAY	83%	102%	#	#	#	#	#	#	#	#
	TUESDAY	82%	101%	#	#	#	#	#	#	#	#
	WEDNESDAY	81%	100%	#	#	#	#	#	#	#	#
	THURSDAY	87%	106%	#	#	#	#	#	#	#	#
	FRIDAY	74%	91%	#	#	#	#	#	#	#	#
	SATURDAY	37%		#		#		#		#	
	Av. Weekday	81%		95%		100%		#		#	
500-1,000	SUNDAY	19%		#		#		#		#	
	MONDAY	79%	97%	#	#	#	#	#	#	#	#
	TUESDAY	75%	92%	92%	102%	#	#	#	#	#	#
	WEDNESDAY	83%	102%	#	#	#	#	#	#	#	#
	THURSDAY	85%	104%	#	#	#	#	#	#	#	#
	FRIDAY	86%	105%	#	#	#	#	#	#	#	#
	SATURDAY	38%		#		#		#		#	
	Av. Weekday	82%		90%		100%		0%		100%	
>1,000 W/O Subway	SUNDAY	26%		#		#		#		#	
	MONDAY	79%	92%	91%	118%	#	#	#	#	#	#
	TUESDAY	87%	103%	74%	96%	#	#	#	#	#	#
	WEDNESDAY	85%	100%	86%	111%	#	#	#	#	#	#
	THURSDAY	89%	105%	#	#	#	#	#	#	#	#
	FRIDAY	85%	100%	#	#	#	#	#	#	#	#
	SATURDAY	36%		#		#		#		#	
	Av. Weekday	85%		77%		67%		#		0%	
>1,000 W/ Subway	SUNDAY	20%		#		27%		#		#	
	MONDAY	80%	95%	65%	82%	83%	98%	72%	83%	#	#
	TUESDAY	89%	105%	74%	93%	78%	93%	85%	99%	#	#
	WEDNESDAY	87%	103%	85%	106%	96%	115%	92%	106%	#	#
	THURSDAY	83%	98%	83%	105%	89%	106%	92%	107%	#	#
	FRIDAY	84%	99%	90%	113%	78%	93%	97%	113%	#	#
	SATURDAY	34%		27%		29%		#		#	
	Av. Weekday	84%		80%		84%		86%		81%	

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Table B.2
(Continued)

Absenteeism by Day of Week and Metropolitan Area Size
(Percent at Work)

Size of urbanized area (1,000's)		Auto		Bus/Trolley-Bus		Subway/Elevated		Railroad		Taxi	
		% @ Work	% of Ave. Wkdy	% @ Work	% of Ave. Wkdy	% @ Work	% of Ave. Wkdy	% @ Work	% of Ave. Wkdy	% @ Work	% of Ave. Wkdy
Not Urbanized	SUNDAY	22%		#		#		#		#	
	MONDAY	80%	96%	#	#	#	#	#	#	#	#
	TUESDAY	83%	99%	#	#	#	#	#	#	#	#
	WEDNESDAY	88%	105%	#	#	#	#	#	#	#	#
	THURSDAY	86%	102%	#	#	#	#	#	#	#	#
	FRIDAY	81%	97%	#	#	#	#	#	#	#	#
	SATURDAY	37%		#		#		#		#	
	Av. Weekday	83%		82%		76%		59%		100%	
All	SUNDAY	22%		17%		24%		30%		#	
	MONDAY	80%	96%	79%	98%	82%	98%	71%	84%	#	#
	TUESDAY	84%	101%	75%	94%	77%	92%	86%	101%	#	#
	WEDNESDAY	85%	102%	86%	108%	94%	113%	77%	90%	#	#
	THURSDAY	86%	103%	78%	98%	89%	106%	92%	108%	#	#
	FRIDAY	82%	98%	84%	105%	80%	95%	97%	114%	#	#
	SATURDAY	36%		22%		28%		21%		#	
	Av. Weekday	84%		80%		84%		85%		83%	

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Table B.2
(Continued)

Absenteeism by Day of Week and Metropolitan Area Size
(Percent at Work)

Size of urbanized area (1,000's)		Motocycle % @ Work	Motocycle % of Ave. Wkdy	Bicycle % @ Work	Bicycle % of Ave. Wkdy	Walk % @ Work	Walk % of Ave. Wkdy	ALL % @ Work	ALL % of Ave. Wkdy
50-200	SUNDAY	#		#		#		23%	
	MONDAY	#	#	#	#	#	#	78%	98%
	TUESDAY	#	#	#	#	#	#	80%	101%
	WEDNESDAY	#	#	#	#	#	#	79%	100%
	THURSDAY	#	#	#	#	#	#	82%	103%
	FRIDAY	#	#	#	#	#	#	77%	97%
	SATURDAY	#		#		#		29%	
	Av. Weekday	97%		67%		61%		80%	
200-500	SUNDAY	#		#		#		19%	
	MONDAY	#	#	#	#	#	#	81%	102%
	TUESDAY	#	#	#	#	#	#	81%	101%
	WEDNESDAY	#	#	#	#	#	#	80%	101%
	THURSDAY	#	#	#	#	#	#	85%	107%
	FRIDAY	#	#	#	#	#	#	71%	89%
	SATURDAY	#		#		#		35%	
	Av. Weekday	100%		100%		51%		80%	
500-1,000	SUNDAY	#		#		#		19%	
	MONDAY	#	#	#	#	#	#	77%	96%
	TUESDAY	#	#	#	#	#	#	74%	93%
	WEDNESDAY	#	#	#	#	#	#	84%	104%
	THURSDAY	#	#	#	#	#	#	83%	103%
	FRIDAY	#	#	#	#	#	#	85%	105%
	SATURDAY	#		#		#		36%	
	Av. Weekday	71%		45%		71%		80%	
>1,000 W/O Subway	SUNDAY	#		#		#		25%	
	MONDAY	#	#	#	#	#	#	78%	95%
	TUESDAY	#	#	#	#	#	#	85%	103%
	WEDNESDAY	#	#	#	#	#	#	82%	99%
	THURSDAY	#	#	#	#	#	#	85%	103%
	FRIDAY	#	#	#	#	#	#	83%	100%
	SATURDAY	#		#		#		33%	
	Av. Weekday	60%		93%		67%		83%	
>1,000 W/ Subway	SUNDAY	#		#		#		20%	
	MONDAY	#	#	#	#	61%	72%	77%	94%
	TUESDAY	#	#	#	#	86%	102%	84%	102%
	WEDNESDAY	#	#	#	#	89%	106%	85%	103%
	THURSDAY	#	#	#	#	85%	101%	83%	100%
	FRIDAY	#	#	#	#	98%	117%	83%	101%
	SATURDAY	#		#		40%		33%	
	Av. Weekday	100%		82%		84%		82%	

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Table B.2
(Continued)

Absenteeism by Day of Week and Metropolitan Area Size
(Percent at Work)

Size of urbanized area (1,000's)		Motocycle		Bicycle		Walk		ALL	
		% @ Work	% of Ave. Wkdy	% @ Work	% of Ave. Wkdy	% @ Work	% of Ave. Wkdy	% @ Work	% of Ave. Wkdy
Not Urbanized	SUNDAY	#		#		#		22%	
	MONDAY	#	#	#	#	52%	94%	77%	96%
	TUESDAY	#	#	#	#	58%	105%	80%	99%
	WEDNESDAY	#	#	#	#	63%	113%	84%	105%
	THURSDAY	#	#	#	#	63%	114%	83%	103%
	FRIDAY	#	#	#	#	40%	73%	77%	96%
	SATURDAY	#		#		42%		36%	
	Av. Weekday	79%		77%		55%		80%	
All	SUNDAY	#		#		27%		22%	
	MONDAY	#	#	#	#	57%	88%	78%	96%
	TUESDAY	#	#	82%	103%	71%	108%	82%	101%
	WEDNESDAY	#	#	#	#	75%	114%	83%	103%
	THURSDAY	#	#	#	#	60%	91%	83%	103%
	FRIDAY	#	#	#	#	65%	99%	80%	98%
	SATURDAY	#		#		34%		34%	
	Av. Weekday	80%		80%		66%		81%	

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Table B.3

Work Trips
"Normal Mode" to Mode on Travel Day Adjustment
(Annual Trips in Millions)

Metro Area Size (1,000's)		Mode on Survey Day: Auto	Bus	Subway	Railroad	Taxi	Mcycle/ Moped	Bicycle	Walk	Normal Total	Survey Day Total	Adjustment Factor to Survey Day
	Normal Mode											
50-200	Auto	1,469	#	#	#	#	#	#	#	1,479	1,481	1.00
	Bus	#	36	#	#	#	#	#	#	43	36	0.83
	Subway	#	#	#	#	#	#	#	#	#	#	#
	Railroad	#	#	#	#	#	#	#	#	#	#	#
	Taxi	#	#	#	#	#	#	#	#	#	#	#
	Motorcycle	#	#	#	#	#	#	#	#	#	#	#
	Bicycle	#	#	#	#	#	#	#	#	#	#	#
	Walk	#	#	#	#	#	#	#	30	39	47	1.21
	Total	1,481	36	#	#	#	#	#	47	1,584	1,584	1.00
	Normal Mode											
200-500	Auto	1,238	#	#	#	#	#	#	#	1,243	1,248	1.00
	Bus	#	24	#	#	#	#	#	#	33	25	0.77
	Subway	#	#	#	#	#	#	#	#	#	#	#
	Railroad	#	#	#	#	#	#	#	#	#	#	#
	Taxi	#	#	#	#	#	#	#	#	#	#	#
	Motorcycle	#	#	#	#	#	#	#	#	#	#	#
	Bicycle	#	#	#	#	#	#	#	#	#	#	#
	Walk	#	#	#	#	#	#	#	#	#	15	#
	Total	1,248	25	#	#	#	#	#	15	1,297	1,297	1.00
	Normal Mode											
500-1,000	Auto	1,195	#	#	#	#	#	#	#	1,198	1,202	1.00
	Bus	#	42	#	#	#	#	#	#	51	44	0.87
	Subway	#	#	#	#	#	#	#	#	#	#	#
	Railroad	#	#	#	#	#	#	#	#	#	#	#
	Taxi	#	#	#	#	#	#	#	#	#	#	#
	Motorcycle	#	#	#	#	#	#	#	#	#	#	#
	Bicycle	#	#	#	#	#	#	#	#	#	#	#
	Walk	#	#	#	#	#	#	#	22	26	27	1.04
	Total	1,202	44	#	#	#	#	#	27	1,284	1,284	1.00
	Normal Mode											
>1,000	Auto	3,641	#	#	#	#	#	#	#	3,686	3,688	1.05
W/O	Bus	30	114	#	#	#	#	#	#	157	129	0.85
Subway	Subway	#	#	#	#	#	#	#	#	#	#	#
	Railroad	#	#	#	#	#	#	#	#	#	#	#
	Taxi	#	#	#	#	#	#	#	#	#	#	#
	Motorcycle	#	#	#	#	#	#	#	#	#	#	#
	Bicycle	#	#	#	#	#	#	#	#	#	18	#
	Walk	#	#	#	#	#	#	#	66	84	95	1.15
	Total	3,688	129	#	#	#	#	18	95	3,954	3,954	1.00

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Table B.3
(Continued)

Work Trips
"Normal Mode" to Mode on Travel Day Adjustment
(Annual Trips in Millions)

Metro Area Size (1,000's)		Mode on Survey Day: Auto	Bus	Subway	Railroad	Taxi	Mcycle/ Moped	Bicycle	Walk	Normal Total	Survey Day Total	Adjustment Factor to Survey Day
	Normal Mode											
>1,000	Auto	3,319	#	#	#	#	#	#	#	3,364	3,404	1.01
W/Subway	Bus	24	227	#	#	#	#	#	35	294	263	0.89
	Subway	21	#	200	44	#	#	#	29	309	223	0.72
	Railroad	19	#	#	57	#	#	#	#	101	110	1.10
	Taxi	#	#	#	#	15	#	#	#	17	19	1.06
	Motorcycle	#	#	#	#	#	#	#	#	#	#	#
	Bicycle	#	#	#	#	#	#	#	#	#	#	#
	Walk	#	#	#	#	#	#	#	193	200	280	1.40
	Total	3,404	263	223	110	19	#	#	280	4,314	4,314	1.00
	Normal Mode											
Not	Auto	6,556	#	#	#	#	#	#	33	6,611	6,631	1.00
Urbanized	Bus	#	16	#	#	#	#	#	#	31	28	0.90
	Subway	#	#	#	#	#	#	#	#	12	#	#
	Railroad	#	#	#	#	#	#	#	#	#	#	#
	Taxi	#	#	#	#	#	#	#	#	#	#	#
	Motorcycle	#	#	#	#	#	#	#	#	#	#	#
	Bicycle	#	#	#	#	#	#	#	#	26	16	0.60
	Walk	43	#	#	#	#	#	#	186	231	228	0.99
	Total	6,631	28	#	#	#	#	16	228	6,933	6,933	1.00
	Normal Mode											
All Areas	Auto	17,417	31	#	#	#	#	#	78	17,580	17,655	1.00
	Bus	79	459	#	#	#	#	#	59	609	525	0.86
	Subway	32	#	201	44	#	#	#	31	325	231	0.71
	Railroad	19	#	#	57	#	#	#	#	103	111	1.07
	Taxi	#	#	#	#	24	#	#	#	31	32	1.05
	Motorcycle	#	#	#	0	0	33	#	#	47	62	1.31
	Bicycle	#	#	#	0	0	0	55	#	79	60	0.76
	Walk	76	#	#	#	#	#	#	509	592	690	1.17
	Total	17,655	525	231	111	32	62	60	690	19,365	19,365	1.00

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Table B.4

Work Trips
Adjustment for Multiple Trips per Day
(1,000,000s of Annual Trips)

		Total First Home to Work			Total All Home to Work			Total All Home to Work		
		Weekend	Weekday	All	Weekend	Weekday	All	Weekend	Weekday	All
50-200	Auto	369	3,094	3,463	382	3,228	3,610	1.03	1.04	1.04
	Bus	#	70	70	#	70	70	#	1.00	1.00
	Subway	#	#	#	#	#	#	#	#	#
	Railroad	#	#	#	#	#	#	#	#	#
	Taxi	#	#	10	#	#	10	#	#	1.00
	Motorcycle	#	14	15	#	14	15	#	1.00	1.00
	Bicycle	#	24	24	#	24	24	#	1.00	1.00
	Walk	10	90	99	10	94	104	#	1.05	1.04
	ALL	385	3,298	3,682	397	3,437	3,834	1.03	1.04	1.04
200-500	Auto	330	2,575	2,905	339	2,732	3,071	1.03	1.06	1.06
	Bus	#	50	50	#	50	50	#	1.00	1.00
	Subway	#	#	#	#	#	#	#	#	#
	Railroad	#	#	#	#	#	#	#	#	#
	Taxi	#	#	#	#	#	#	#	#	#
	Motorcycle	#	#	10	#	#	10	#	#	1.00
	Bicycle	#	11	11	#	11	11	#	1.00	1.00
	Walk	21	47	68	21	51	72	#	1.08	1.06
	ALL	355	2,697	3,052	364	2,858	3,222	1.03	1.06	1.06
500-1,000	Auto	280	2,536	2,816	297	2,623	2,921	1.06	1.03	1.04
	Bus	#	78	78	#	78	78	#	1.00	1.00
	Subway	#	#	#	#	#	#	#	#	#
	Railroad	#	#	#	#	#	#	#	#	#
	Taxi	#	#	#	#	#	#	#	#	#
	Motorcycle	#	15	21	#	15	21	#	1.00	1.00
	Bicycle	#	#	#	#	#	#	#	#	#
	Walk	6	56	61	6	59	65	1.00	1.06	1.06
	ALL	292	2,692	2,983	309	2,782	3,091	1.06	1.03	1.04
>1,000	Auto	1,011	7,701	8,712	1,052	7,962	9,014	1.04	1.03	1.03
W/O Subway	Bus	#	257	270	#	262	275	#	1.02	1.02
	Subway	#	#	#	#	#	#	#	#	#
	Railroad	#	#	#	#	#	#	#	#	#
	Taxi	#	#	#	#	#	#	#	#	#
	Motorcycle	15	29	44	15	33	48	1.00	1.14	1.09
	Bicycle	#	38	44	#	47	52	#	1.22	1.19
	Walk	40	191	231	40	206	246	1.00	1.08	1.07
	ALL	1,085	8,234	9,320	1,126	8,509	9,636	1.04	1.03	1.03
>1,000	Auto	906	7,158	8,064	934	7,383	8,317	1.03	1.03	1.03
W/ Subway	Bus	25	540	566	25	548	573	1.00	1.01	1.01
	Subway	57	420	477	61	421	482	1.06	1.00	1.01
	Railroad	#	236	242	#	236	244	#	1.00	1.01
	Taxi	12	40	52	14	41	55	1.12	1.03	1.05
	Motorcycle	#	#	#	#	#	#	#	#	#
	Bicycle	#	20	20	#	26	26	#	1.32	1.32
	Walk	69	610	678	69	631	700	1.00	1.04	1.03
	ALL	1,080	9,033	10,112	1,115	9,295	10,410	1.03	1.03	1.03
Not Urbanized	Auto	1,641	13,643	15,284	1,727	14,420	16,147	1.05	1.06	1.06
	Bus	#	47	56	#	47	56	#	1.00	1.00
	Subway	#	14	14	#	16	16	#	1.16	1.16
	Railroad	#	#	#	#	#	#	#	#	#
	Taxi	#	15	15	#	18	18	#	1.20	1.20
	Motorcycle	#	37	39	#	37	39	#	1.00	1.00
	Bicycle	#	38	43	#	38	43	#	1.00	1.00
	Walk	77	437	513	83	462	544	1.08	1.06	1.06
	ALL	1,737	14,236	15,973	1,828	15,043	16,872	1.05	1.06	1.06

Table B.4
(Continued)

Work Trips
Adjustment for Multiple Trips per Day
(1,000,000s of Annual Trips)

		Total First Home Based Work			Total All Home Based Work			Total All Home Based Work		
ALL	Auto	4,537	36,708	41,249	4,735	38,348	43,083	1.04	1.04	1.04
	Bus	47	1,025	1,072	47	1,056	1,103	1.00	1.03	1.03
	Subway	57	434	491	61	437	498	1.06	1.01	1.01
	Railroad	#	242	250	#	242	253	#	1.00	1.01
	Taxi	16	63	79	18	67	85	1.09	1.07	1.08
	Motorcycle	29	109	138	29	113	142	1.00	1.03	1.03
	Bicycle	#	138	149	#	152	164	#	1.11	1.10
	Walk	222	1,429	1,651	228	1,502	1,731	1.03	1.05	1.05
	Other	#	154	159	#	171	179	#	1.11	1.12
	ALL	4,933	40,165	45,098	5,140	41,918	47,059	1.04	1.04	1.04

- designates insufficient data.

Table B.5

Work Trips
Adjustment for Trip Chaining
(1,000,000s of Annual Trips)

Direct Home to Work Trips

Metro Area Size (1,000's)	Auto	Bus/ Trolley Bus	Subway/ Elevated	Commuter Train	Taxi	Motorcycle/ Moped	Bicycle	Walk	ALL
50 -200	1,559	38	#	#	#	#	#	51	1,671
200-500	1,313	25	#	#	#	#	#	#	1,365
500-1,000	1,244	42	#	#	#	#	#	29	1,326
>1,000 W/OSubway	3,842	135	#	#	#	#	20	97	4,124
>1,000 W/Subway	3,538	271	229	125	20	#	#	293	4,487
Not Urbanized	6,964	28	#	#	#	#	23	239	7,290
ALL	18,461	539	237	127	37	62	72	725	20,259

Direct Work to Home Trips

Metro Area Size (1,000's)	Auto	Bus/ Trolley Bus	Subway/ Elevated	Commuter Train	Taxi	Motorcycle/ Moped	Bicycle	Walk	ALL
50 -200	1,209	28	#	#	#	#	#	41	1,301
200-500	991	#	#	#	#	#	#	33	1,054
500-1,000	986	32	#	#	#	#	#	29	1,055
>1,000 W/OSubway	3,008	116	#	#	#	#	23	80	3,238
>1,000 W/Subway	2,801	248	170	89	14	#	#	230	3,565
Not Urbanized	5,500	18	#	#	#	#	#	205	5,767
ALL	14,495	464	176	91	24	38	67	618	15,972

Total Home Based Work Trips

Metro Area Size (1,000's)	Auto	Bus/ Trolley Bus	Subway/ Elevated	Commuter Train	Taxi	Motorcycle/ Moped	Bicycle	Walk	ALL
50 -200	2,768	66	#	#	#	#	21	91	2,973
200-500	2,303	47	#	#	#	#	#	51	2,421
500-1,000	2,230	75	#	#	#	#	#	58	2,382
>1,000 W/OSubway	6,850	250	#	#	#	#	43	176	7,361
>1,000 W/Subway	6,339	518	399	213	34	#	21	523	8,051
Not Urbanized	12,464	46	#	#	#	46	34	444	13,057
ALL	32,956	1,003	413	218	60	99	138	1,343	36,231

- designates insufficient data.

Table B.5
(Continued)

Work Trips
Adjustment for Trip Chaining
(1,000,000s of Annual Trips)

Total All Home to Work Trips

Metro Area Size (1,000's)	Auto	Bus/ Trolley Bus	Subway/ Elevated	Commuter Train	Taxi	Motorcycle/ Moped	Bicycle	Walk	ALL
50 -200	1,753	38	#	#	#	#	#	61	1,877
200-500	1,455	27	#	#	#	#	#	33	1,528
500-1,000	1,395	45	#	#	#	#	#	36	1,489
>1,000 W/OSubway	4,284	139	#	#	#	#	20	103	4,570
>1,000 W/Subway	3,911	283	242	131	20	#	16	329	4,938
Not Urbanized	7,848	28	#	#	#	#	23	254	8,190
ALL	20,647	560	250	133	38	64	83	815	22,590

Total All Work to Home Trips

Metro Area Size (1,000's)	Auto	Bus/ Trolley Bus	Subway/ Elevated	Commuter Train	Taxi	Motorcycle/ Moped	Bicycle	Walk	ALL
50 -200	1,749	35	#	#	#	#	#	53	1,861
200-500	1,453	26	#	#	#	#	#	37	1,527
500-1,000	1,405	34	#	#	#	#	#	29	1,480
>1,000 W/OSubway	4,283	130	#	#	#	#	23	105	4,551
>1,000 W/Subway	3,993	279	197	113	21	#	#	330	4,953
Not Urbanized	7,821	19	#	#	#	21	#	240	8,138
ALL	20,706	523	206	115	31	533	77	794	22,504

Total all Trips Between Work & Home

Metro Area Size (1,000's)	Auto	Bus/ Trolley Bus	Subway/ Elevated	Commuter Train	Taxi	Motorcycle/ Moped	Bicycle	Walk	ALL
50 -200	3,502	73	#	#	#	#	25	113	3,738
200-500	2,908	54	#	#	#	#	#	69	3,056
500-1,000	2,801	79	#	#	#	#	#	65	2,967
>1,000 W/OSubway	8,567	269	#	#	#	#	43	208	9,120
>1,000 W/Subway	7,905	562	439	243	41	#	29	659	9,890
Not Urbanized	15,670	47	16	#	20	37	40	494	16,328
ALL	41,353	1,083	456	248	69	597	160	1,609	45,095

- designates insufficient data.

Table B.5
(Continued)

Work Trips
Adjustment for Trip Chaining
(1,000,000s of Annual Trips)

Adjustment for Trip Chaining - Home to Work

Metro Area Size (1,000's)	Auto	Bus/ Trolley Bus	Subway/ Elevated	Commuter Train	Taxi	Motorcycle/ Moped	Bicycle	Walk	OTHER	ALL
50 -200	0.89	1.00	#	#	#	#	#	0.83	#	0.89
200-500	0.90	0.93	#	#	#	#	#	#	#	0.89
500-1,000	0.89	0.94	#	#	#	#	#	0.80	#	0.89
>1,000 W/OSubway	0.90	0.97	#	#	#	#	1.00	0.94	#	0.90
>1,000 W/Subway	0.90	0.96	0.94	0.95	1.00	#	#	0.89	0.86	0.91
Not Urbanized	0.89	1.00	#	#	#	#	1.00	0.94	0.89	0.89
ALL	0.89	0.96	0.95	0.95	0.96	0.96	0.87	0.89	0.88	0.90

Adjustment for Trip Chaining - Work to Home

Metro Area Size (1,000's)	Auto	Bus/ Trolley Bus	Subway/ Elevated	Commuter Train	Taxi	Motorcycle/ Moped	Bicycle	Walk	OTHER	ALL
50 -200	0.69	0.81	#	#	#	#	#	0.78	#	0.70
200-500	0.68	#	#	#	#	#	#	0.89	#	0.69
500-1,000	0.70	0.94	#	#	#	#	#	1.00	#	0.71
>1,000 W/OSubway	0.70	0.89	#	#	#	#	1.00	0.76	#	0.71
>1,000 W/Subway	0.70	0.89	0.86	0.79	0.66	#	#	0.70	0.89	0.72
Not Urbanized	0.70	0.96	#	#	#	#	#	0.85	0.87	0.71
ALL	0.70	0.89	0.86	0.79	0.77	0.07	0.87	0.78	0.87	0.71

Total Adjustment for Trip Chaining

Metro Area Size (1,000's)	Auto	Bus/ Trolley Bus	Subway/ Elevated	Commuter Train	Taxi	Motorcycle/ Moped	Bicycle	Walk	OTHER	ALL
50 -200	**1.58**	**1.81**	**#**	**#**	**#**	**#**	**#**	**1.61**	**#**	**1.59**
200-500	**1.58**	**#**	**#**	**#**	**#**	**#**	**#**	**#**	**#**	**1.58**
500-1,000	**1.59**	**1.89**	**#**	**#**	**#**	**#**	**#**	**1.80**	**#**	**1.60**
>1,000 W/OSubway	**1.60**	**1.86**	**#**	**#**	**#**	**#**	**2.00**	**1.70**	**#**	**1.61**
>1,000 W/Subway	**1.61**	**1.84**	**1.81**	**1.74**	**1.66**	**#**	**#**	**1.59**	**1.75**	**1.63**
Not Urbanized	**1.59**	**1.96**	**#**	**#**	**#**	**#**	**#**	**1.80**	**1.76**	**1.60**
ALL	**1.59**	**1.85**	**1.80**	**1.75**	**1.73**	**1.03**	**1.73**	**1.67**	**1.74**	**1.61**

- designates insufficient data.

APPENDIX C
METROPOLITAN AREA SURVEYS AND SURVEY CYCLES

To develop the conversion factors, a review of surveying habits of major metropolitan areas was undertaken. Supplemented by lists previously compiled by a study completed by the Metropolitan Transportation Commission in Oakland, California, a list of available data is given below stratified by area size. Surveys that were conducted at repeated points in time were designated as "revealed preference" surveys and are distinguished from stated preference surveys with an "RP" or "SP", respectively.

Surveys that have been conducted by various agencies include:

Household Survey - A survey diary is completed by each person in the household for the previous travel day providing information on time of travel, mode, purpose, origin/destination, and auto occupancy.

Cross-sectional/Longitudinal - For the cross-sectional/longitudinal survey, a select group of individuals in an area are interviewed or complete a travel diary several times over a period of many years to determine the change in travel patterns over time. These surveys determine revealed preference. Other surveys called conjoint (also called "direct utility" or "stated preference") surveys have appeared in the last five to ten years as a tool to help determine modal preferences and calibrate mode choice models, and are collected in this fashion. The survey typically asks a group of people what it would take to change their current mode of travel depending upon other options that may be available. Variables such as mode, cost, in-vehicle time, and out-of-vehicle time are changed and the participant's response to the changes on some type of scale determines the related changes of modal use.

On-Board Survey - Similar to the household survey, this survey asks for the travel characteristics of transit riders. Typically done in person on the transit mode or through a mail-back postcard, the survey obtains information on time of travel, purpose, origin/destination, mode of access, and cost.

Intercept Survey - This survey, also known as a "roadside" or "origin-destination" survey, is typically completed at the periphery (cordon) of the study area to better estimate trips that have one origin or one destination trip end outside of the study region. The data are invaluable for determining trips that have both origin and destination end of the trip outside of the region. The survey is conducted through on-site interview or mail-back and contains origin/destination of trip, vehicle type (including truck), vehicle occupancy, and purpose. Supplementing this type of survey, truck surveys typically focus on this vehicle type by conducting surveys at weighing stations or designated truck routes.

Population figures for the different size urban areas were obtained from the State and Metropolitan Area Data Book 1991. Definition of urban area size can be categorized into a number of different levels. The metropolitan statistical area (MSA) has other derivations that aggregate and define different regions around the country. Tables in this appendix use the following designations as indicated in the tables:

MSA	Metropolitan Statistical Area
NECMA	New England County Metropolitan Area
CMSA	Consolidated Metropolitan Statistical Area
PMSA	Primary Metropolitan Statistical Area
CITY	Central City as defined by city boundary
CDP	Census Designated Place (smaller than an MSA designation)

Urbanized Area Surveys
Population Over 750,000

Urbanized Area	Area Type	1990 Population	% Population Change 80-90	H.H. Surveys on Census Cycle	Stated (S) or Revealed (R) Survey	On-Board Transit	O-D Roadside Truck	Data Source
Albany-Schenectady-Troy, NY	MSA	874,000	+5%	1983				FHWA
Atlanta, GA	MSA	2,833,000	+33%	1980/1991	1994SP	1990	1992	
Baltimore, MD	MSA	2,382,000	+8%	1988/1992		1984	1985	BRCOG
Boston, MA-NH	NECMA	3,784,000	+3%	1963/1991				TPS
Buffalo-Niagara Falls, NY	CMSA	1,189,000	-4%	1973/1991				NFTC
Chicago, IL	PMSA	6,069,000	0%	1979/1988-92				CATS
Cleveland-Akron-Lorain, OH	CMSA	2,760,000	-3%	1978/1991-92		1976/1986		NOACA/GCRTA
Columbus, OH	MSA	1,377,000	+11%	1988-89				MORPC
Dallas/ Ft.Worth,TX	CMSA	2,553,000	+33%	1984/1989-92	1984RP	1989-92	1989-92	NCTCOG
Denver, CO	PMSA	1,623,000	+14%	1985				DRCOG
Detroit, MI	PMSA	4,382,000	-2%	1980/1990				SEMCOG
Hampton Roads, VA	MSA	1396,000	+20%	1994	1995SP	1990	1994	HRPDC/VDOT
Houston, TX	PMSA	3,302,000	+21%	1984/1990	1988RP		1990	HGAC
Kansas City, MO-KS	MSA	1,566,000	+9%	1991?				MARC
Los Angeles-Long Beach, CA	PMSA	8,863,000	+18%	1976/1990			1990	SCAG

Source: Of population data U.S. Bureau of the Census, 1990 Census of Population and Housing, Supplementary Reports, Metropolitan Areas as Defined by the Office of Management and Budget, June 30, 1993, (1990 CPH-S-1-1); and unpublished data.

Urbanized Area	Area Type	1990 Population	% Population Change 80-90	H.H. Surveys on Census Cycle	Stated (S) or Revealed (R) Survey	On-Board Transit	O-D Roadside Truck	Data Source
Miami-Hialeah, FL	PMSA	1,937,000	+19%	1986		1978		METRO DADE
Milwaukee, WI	PMSA	1,432,000	+3%	1985/1992		1985/1991	1985/1991	SWRPC
Minneapolis/St. Paul, MN-WI	MSA	2,464,000	+15%	1985/1990		1990	1990	MET COUNCIL
New York, NY	PMSA	8,547,000	+3%	1964/1989-90		1989	Yearly (HUB)	NYMTC
Philadelphia, PA	PMSA	4,856,000	+3%	1986/1988			1990	DVRPC
Phoenix, AZ	MSA	2,122,000	+41%	1988				MAG
Pittsburgh, PA	PMSA	2,056,000	-7%	1978-80/1990				SPRPC
Portland, OR	PMSA	1,240,000	+12%	1983-85/1990	1988RP	1983-85	1989	METRO
Raleigh-Durham, NC	MSA	735,000	+31%	1992				NCDOT
Salt Lake City-Ogden, UT	MSA	1,072,000	+18%	??				
San Antonio, TX	MSA	1,302,000	+22%	1990		1990	1990	BEXAR MPO
San Diego, CA	MSA	2,498,000	+34%	1986				SANDAG
San Francisco, CA	PMSA	1,604,000	+8%	1981/1990	1990RP	1990	1990	MTC
Seattle, WA	PMSA	1,973,000	+23%	1985-88	1989RP			PSCOG
St. Louis, MO	MSA	2,444,000	+3%	1966/1990				EW GATEWAY
Washington, DC	MSA	3,924,000	+21%	1980,1988/1990		1987	1990	MWCOG

Source: Of population data U.S. Bureau of the Census, 1990 Census of Population and Housing, Supplementary Reports, Metropolitan Areas as Defined by the Office of Management and Budget, June 30, 1993, (1990 CPH-S-1-1); and unpublished data.

Urbanized Area Surveys
Population 250,000 - 750,000

Urbanized Area	Area Type	1990 Population	% Population 80-90	H.H. Surveys	Stated (S) or Revealed (R) Survey	On-Board Transit	O-D Roadside Truck	Data Source
Albuquerque, NM	MSA	481,000	+14%	1962/1990				MRGCOG
Atlantic City, NJ	MSA	319,000	+16%				1972/1982	NJDOT
Austin, TX	MSA	782,000	+46%	1986				TXDOT
Brownsville-Harlingen, TX	MSA	260,000	+24%	1990				TXDOT
Charlotte, NC	City	396,000	+21%	1980				NCDOT
Cincinnati, OH	City	364,000	-6%	1978		1978		ODOT
Honolulu, HI	CDP	365,000	0%	1983				FHWA
Oakland, CA	City	372,000	+10%	1990				MTC
Sacramento, CA	City	369,000	+34%	1990		1990		SACOG
Tampa, FL	City	280,000	+3%	1985				FDOT
Toledo, OH	City	333,000	-6%			1990		TMACOG
Tucson, AZ	City	405,000	+16%	1977/1989				ADOT/PAGTPD

Source: Of population data U.S. Bureau of the Census, 1990 Census of Population and Housing, Supplementary Reports, Metropolitan Areas as Defined by the Office of Management and Budget, June 30, 1993, (1990 CPH-S-1-1); and unpublished data.

Urbanized Area Surveys
Population 100,000 - 250,000

Urbanized Area	Area Type	1990 Population	% Population Change 80-90	H.H. Surveys	Stated (S) or Revealed (R) Survey	On-Board Transit	O-D Roadside Truck	Data Source
Amarillo, TX	MSA	188,000	+8%	1990				TXDOT
Charlottesville, VA	MSA	131,000	+15%	1987			1987	VDOT
Cumberland, MD-WV	MSA	102,000	-6%				1972/1982	NJDOT
Dayton, OH	City	182,000	-6%	1985				ODOT
Winston-Salem, NC	City	143,000	+8%	1975				NCDOT

Source: Of population data U.S. Bureau of the Census, 1990 Census of Population and Housing, Supplementary Reports, Metropolitan Areas as Defined by the Office of Management and Budget, June 30, 1993, (1990 CPH-S-1-1); and unpublished data.

Urbanized Area Surveys
Population Under 100,000

Urbanized Area	1990 Population	% Population Change 80-90	H.H. Surveys	Stated (S) or Revealed (R) Survey	On-Board Transit	O-D Roadside Truck	Data Source
Chowchilla, CA	<100,000		1987				CALTRAN
Clark County, WA	<100,000		1985				FHWA
Goldsboro, NC	<100,000		1983-85/1992				NCDOT
Highpoint, NC	<100,000		1983-1985				NCDOT
Philipsburg, NJ	<100,000					1972/1982	NJDOT
Salem, NJ	<100,000					1972/1982	NJDOT
Sherman/Denison, TX	<100,000		1990				TXDOT
Tri-State, NJ	<100,000					1972/1982	NJDOT
Salem, OR	<100,000		1980				FHWA
Texarkana, TX	<100,000		1990				TXDOT
Tyler, TX	<100,000		1990				TXDOT
Vancouver, WA-BC	<100,000		1985				FHWA

Source: Of population data U.S. Bureau of the Census, 1990 Census of Population and Housing, Supplementary Reports, Metropolitan Areas as Defined by the Office of Management and Budget, June 30, 1993, (1990 CPH-S-1-1); and unpublished data.

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