

Conversion and Use of 1990 Census Transportation Planning Package in the Delaware Valley Region

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An analysis of the 1990 Census Transportation Planning Package (CTPP) for the Delaware Valley Region is given, with special emphasis on journey-to-work trips, employment, mode of transportation to work, travel time, vehicle ownership, employed persons, and other socioeconomic data essential to transportation planning and travel forecasting. A review of the CTPP computer tapes and data showed some problems with programming, sampling, and bias, which were resolved before the data were used as a base for trend analysis, travel simulation, highway and transit project studies, strategic planning, and economic development. The CTPP information should be adjusted before it is used for transportation planning. The errors in the 1990 CTPP data are generally small, but the package shows no improvement over the presentation of the 1980 data. Most of the 1990 CTPP problems can be avoided in the future if the recommendations made in this paper are considered in Census 2000.

Information on work trips, employed persons, employment, and many other socioeconomic variables gathered during the 1990 census is available in the 1990 Census Transportation Planning Package (CTPP). The CTPP is a special tabulation of census data used in transportation planning at the state and regional levels. Funding for the development and production of the CTPP was provided by the states through the American Association of State Highway and Transportation Officials (AASHTO).

On June 22, 1993, the Delaware Valley Regional Planning Commission (DVRPC) received the first three parts

of the CTPP Statewide Element, but the first three parts of the Urban Element were not received until April 21, 1994, more than 4 years after Census Day in 1990. Work was initiated to process and print CTPP data for various levels of geographic units to be used in transportation system planning analysis and evaluation and for project studies. Because the contents of the CTPP are extensive, work on the processing and use of data continued into 1996.

The purpose of this paper is to discuss briefly the experience of DVRPC with the CTPP data, with special emphasis on the journey-to-work information and other socioeconomic information required for transportation planning and forecasting, such as population, households, employed persons, vehicle availability, and employment. The data are evaluated and some figures are presented to illustrate the magnitude of the errors and discrepancies in the data selected. The use of CTPP data in several DVRPC planning projects, both transportation-related and non-transportation-related, is described. This paper is essentially an update of a similar one by the author on the 1990 CTPP published in 1995 (1).

The DVRPC region includes four suburban counties in Pennsylvania (Bucks, Chester, Delaware, and Montgomery), four suburban counties in New Jersey (Burlington, Camden, Gloucester, and Mercer), and the city of Philadelphia. The Delaware Valley includes an area of 9886 km² (3,817 mi²) and a population of about 5.2 million. There are 352 municipalities, including such major cities as Trenton and Camden in New Jersey and Philadelphia and Chester in Pennsylvania (Figure 1).

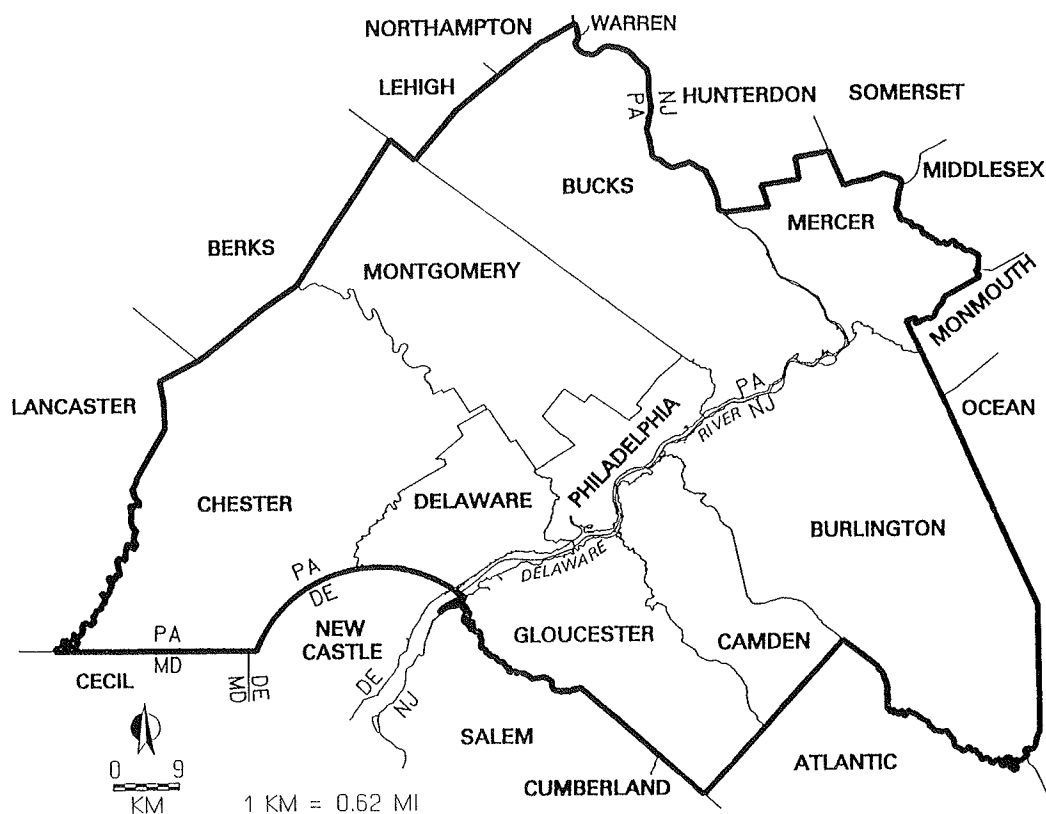


FIGURE 1 Map of the Delaware Valley Region.

CONTENTS OF 1990 CTPP

The CTPP information was selected from the responses to the 1990 long-form census questionnaire distributed to about 17 percent (1 in 6) of all households. The Bureau of the Census prepared two 1990 CTPP packages: the Statewide and Urban elements. The Statewide Element consists of six parts containing information at the municipal level. These parts are labeled A through F.

The Urban Element provides data at the level of traffic analysis zone (TAZ), which for the most part is equivalent to a census tract. There are 1,395 TAZs in the DVRPC region. Census block groups are used in densely developed areas such as the Philadelphia central business district (CBD) where census tracts are too large for traffic simulation and analysis. There are eight parts in the CTPP Urban Element, labeled 1 through 8. Part 5, however, has been eliminated.

The 1990 data were collected using the following census areal units: block, block group, tract, place, minor civil division (MCD), county, and Metropolitan Statistical Area (MSA). In 1975 the DVRPC zonal system, used for the collection of data in 1960 origin and destination surveys, was converted to the census areal system in order to easily use census data in land use and transportation planning. This conversion has made it

much easier to provide an equivalency table of all tracts, blocks, block groups, and TAZs. The preparation of such a tabulation proved to be tedious, costly, and time consuming because the Delaware Valley region includes more than 74,000 blocks, 1,317 tracts, and 1,395 TAZs. The TAZs are used for travel simulation at the regional level.

In March 1992 DVRPC prepared a correspondence table for use in the tabulation of the Urban Element information. This table includes the following:

- Traffic analysis zone,
- Census block group number,
- Superdistrict,
- Minor Civil Division,
- Census state code,
- County, and
- Census tract number.

In addition to this information, DVRPC specified all external counties with a significant commuting flow from and to the DVRPC region. Because of programming difficulties, this file was not used by the Census Bureau. Instead, DVRPC was asked in 1994 to prepare a revised table (equivalency file), which inserted the TAZs in each census block record.

REVIEW AND EVALUATION OF 1990 CTPP DATA

A review of the 1990 CTPP data from Parts 1, 2, and 3 for the Delaware Valley region indicated some programming, definitional, and statistical problems. Unlike the 1980 Urban Transportation Planning Package (UTPP), the 1990 CTPP contains data on work-trip destinations not identified by block or tract. The Census Bureau could not allocate all 1990 trips to TAZs because the Topologically Integrated Geographic Encoding and Referencing (TIGER) File does not contain address ranges for some suburban and rural areas in the region. The Census Bureau provided a list of places that failed the census allocation process. Specifically, any place that has less than 70 percent address range coverage and less than 70 percent of the persons working in the place coded to tract and block failed the test. In such places, the Census Bureau allocated the work places to default zones and asked DVRPC to review the list and allocate the default data to the affected TAZs, including water tracts (Figure 2).

Programming and Format Problems

After receiving the 1990 CTPP tapes from the Census Bureau, DVRPC immediately started to extract the data needed for various air-quality and transportation planning studies. Data on population, households, vehicle

availability, and employed persons were printed for each TAZ, MCD, and county for review and use in several studies. Also, trip origins and destinations were printed to evaluate trip patterns at the zonal level. The format of the tapes was found to be quite complex and confusing. There was no labeling on the tapes, and the names of the tables were puzzling. No documentation of certain record types was available. The variations in recorded content should have been clearly recorded in both the general documentation and the data dictionary.

For example, review of the tapes of the CTPP Urban Element indicated that they do not have the same computer record size and block size at the tract or zonal levels. Part 3 has a record size of 1,180 and block size of 23,600, but Part 2 has a record size of 10,616 and block size of 21,230. These problems have caused some confusion, delay, and duplication of effort.

Problems of Definition and Statistics

As stated previously, the Census Bureau obtained information on workers and not on trips; the latter information is usually collected in home interview surveys for transportation planning studies. The analysis of workers' trip tables (Part 3) by travel mode indicated that some walk and railroad trips were unrealistic in terms of travel time or distance. It was found, for example, that some workers walked from Philadelphia to places a con-

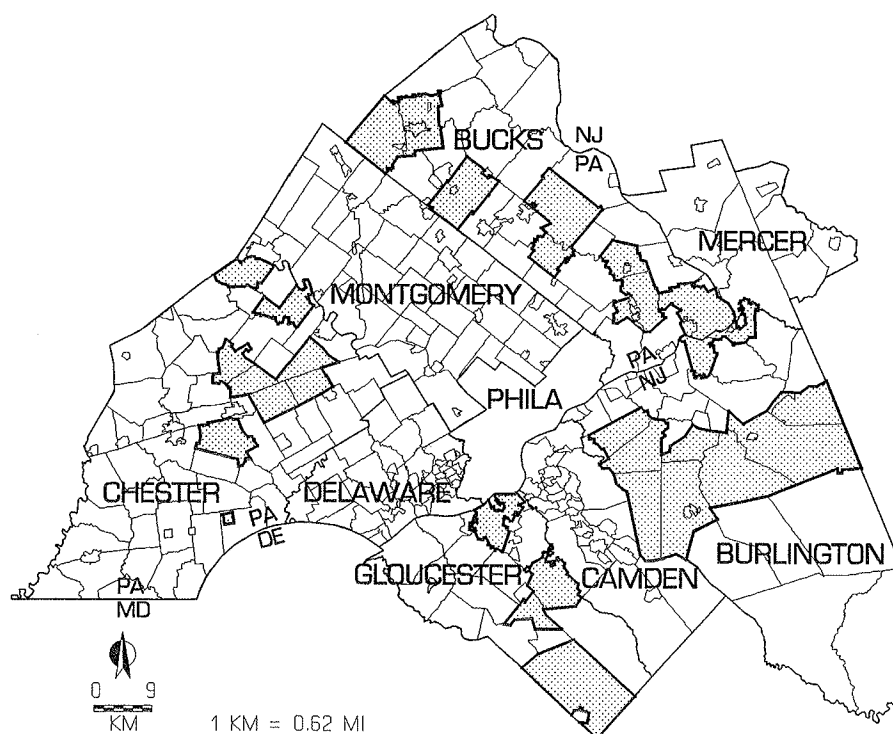


FIGURE 2 Location of default traffic analysis zones.

siderable distance from the city. Similarly, there were railroad trips where no such service existed. These few irrational trips are due to errors in census coding and sampling or to incorrect information returned by respondents who did not understand the census questionnaire. Many respondents confused the access mode with the principal mode of travel.

The evaluation of employment data by industry showed that some respondents misunderstood the census question that used the Standard Industrial Classification (SIC) system (Question 28). Some were not able to identify their industry correctly because some SIC categories are not easily defined and understood. The public administration sector is especially complicated. An employee of a municipal utility authority, for example, may consider himself either a member of the public administration sector or a member of the public utilities sector.

ACCURACY OF CTPP DATA

Place-of-Residence Data

Generally, the 1990 CTPP data are very good for transportation planning purposes. The data on population, household, car ownership, employed persons, and other socioeconomic characteristics obtained from Part 1 are quite accurate and do not require any major adjustment because of sampling or nonsampling errors. Part 1 data compare favorably with the 100 percent census counts, Standard Tape File 1 (STF1). Table 1 illustrates the magnitude of difference between the population produced from Part 1 and from the 100 percent counts for a few TAZs, MCDs, and counties selected at random. As can

be seen, the differences in population and resident workers are small and are acceptable for all planning purposes. However, the number of households in the CTPP is slightly lower than that in the total count. Most of the difference, 2,319 out of a total of 2,667, is found in the city of Philadelphia. All household zonal data were adjusted to be consistent with the 100 percent census counts, which are equal to those extracted from the tabulations of the STF3.

Place-of-Work Data and Development of Employment File

As described previously, Parts 2 and 3 contain worker trip data at the place of work for various geographic units such as TAZs, MCDs, and counties. If trip destinations by resident workers living and working in the region and nonresident workers working in the region are added together, the sum should be approximately equal to the number of regional jobs, or employment. A certain percentage of these work-trip destinations (employment) should be added to account for workers who were absent during the census week because of illness, vacation, or other personal reasons and workers who had more than one job.

Using data from the Bureau of Economic Analysis, Bureau of Labor Statistics, previous DVRPC employment files, and local wage records, the 1990 CTPP work trips (number of workers at the place of destination) were adjusted four times in order to develop the employment file at the zonal level. The first adjustment was made to account for absentee rates reported by the census for each county (2.16 percent for the region) from responses to

TABLE 1 Comparison of 1990 CTPP Population, Households, and Resident Workers with Total Census Counts

Areal Unit	Population			Households			Resident Workers		
	CTPP	Total Count	Diff.	CTPP	Total Count	Diff.	CTPP	Total Count	Diff.
TAZ									
100	1,204	1,205	-1	476	515	-39	557	558	-1
400	9,030	9,030	0	4,279	4,319	-40	3,678	3,678	0
700	3,750	3,750	0	1,459	1,434	25	2,118	2,118	0
990	6,169	6,169	0	1,880	1,881	-1	2,780	2,780	0
Municipality									
New Hope, PA	1,400	1,400	0	811	810	1	964	964	0
Media, PA	5,957	5,957	0	2,876	2,867	9	3,243	3,243	0
Glassboro, NJ	15,614	15,614	0	5,069	5,019	50	7,422	7,422	0
County									
Philadelphia, PA	1,585,577	1,585,577	0	600,740	603,059	-2319	657,389	657,387	2
Mercer, NJ	325,824	325,824	0	116,777	116,941	-164	166,680	166,680	0
Total Region	5,182,705	5,182,705	0	1,891,614	1,894,281	-2667	2,496,292	2,496,215	77

Question 21a on the long-form questionnaire used in 1990. It should be noted, however, that other DVRPC data files indicate that the average rate of employee absenteeism for some companies ranges between 3 and 6 percent.

Second, all employment data were adjusted upward to reflect multiple jobholding based on the results of a survey conducted for the Bureau of Labor Statistics using a national sample of about 60,000 households (2). It was found that the national rate for multiple jobholding was 6.2 percent and varies by employment sector, ranging from 4.7 percent for construction workers to 9.3 percent for those working in government.

Third, employment estimates at many MCDs were examined, and some were adjusted upward or downward to account for coding discrepancies and respondent errors. Such adjustments were necessary at the municipal level to bring the estimates into agreement with data from the Bureau of Labor Statistics, DVRPC files, and municipal tax records. Finally, employment estimates at the TAZ level were examined to allocate the trips coded to default zones and water tracts by the Census Bureau.

All zonal data were factored to county and municipal control totals by employment sector, and a new computer file was prepared for users of these data. DVRPC uses the following 11 SIC sectors to generate trip production and attraction: agriculture, forestry, and fisheries; mining; construction; manufacturing; transportation; wholesale trade; retail trade; finance, insurance, and real estate; service; government; and military.

Table 2 shows a comparison of CTPP employment before and after adjustments for selected TAZs, MCDs, counties, and the total region. It also shows the percent difference between the unadjusted CTPP employment

estimates and those adopted by DVRPC. As the data in Table 2 show, the differences between the two sets of employment estimates are small (about 10 percent). In general, the percent difference between the two sets of employment estimates increases as the size of a geographic unit decreases because of the sampling error and coding problems.

Means of Transportation

Most parts of the CTPP include information on the worker's mode of transportation to work. Respondents were asked to choose one of 11 travel modes that they usually took to work for most of the distance between the place of residence and work. The travel mode proportions appear to be reasonable because they compare favorably with DVRPC highway traffic counts and transit surveys for large areas and the region. Table 3 shows that the difference between the CTPP data and DVRPC estimates for total public transportation work trips is 1.9 percent. However, such a difference becomes large for travel submodes within smaller areas. In the Philadelphia CBD, the difference between the CTPP and estimated subway-elevated and bus trips is about 35 percent. Such large differences are mainly due to incorrect responses to the questionnaire. It appears that many respondents confused the access mode to a station with the principal mode of travel to work. The Philadelphia CBD highway trips computed by the DVRPC model are underestimated by about 5 percent. This problem will be resolved when the model is recalibrated with the 1990 census data at the subarea level.

TABLE 2 Comparison of 1990 CTPP and DVRPC Adopted Employment Estimates

Areal Unit	1990 Employment Estimates			% Diff.
	CTPP Unadjusted	CTPP Adjusted	DVRPC Adopted	Adopted vs. CTPP Unadj.
<u>TAZ</u>				
100	119	119	—	—
400	1,711	1,719	—	—
700	2,259	2,349	—	—
990	492	493	—	—
<u>Municipality</u>				
New Hope, PA	2,351	2,579	2,351	0.0
Media, PA	10,110	10,993	11,210	10.9
Glassboro, NJ	7,287	7,924	7,924	8.7
<u>County</u>				
Philadelphia, PA	761,244	834,335	836,874	9.9
Mercer, NJ	204,826	224,356	220,592	7.7
Total Region	2,433,682	2,697,229	2,693,879	10.7

TABLE 3 Comparison of 1990 CTPP and DVRPC Work Trip Estimates by Mode

Areal Unit	Mode	CTPP Data	DVRPC Estimates	Percent Diff.
Philadelphia CBD	Regional Rail	27.7	25.2	-9.0
	Subway-elevated and Bus	81.5	110.3	35.3
	Highway	117.9	111.5	-5.4
Total Region	Public Transportation	273.2	278.5	1.9
	Highway	1,954.0	1,969.2	0.8

Note: Values are in thousands of trips per day.

Table 4 shows the 1980 and 1990 average travel time of commuters in selected counties and the total region. The regional average travel time has changed slightly since 1980. Despite increasing traffic congestion in the region, regional travel time of work trips declined by 2.8 percent in the 1980s because of the decline of urban areas and the growth of suburbs, where the private automobile is the predominant mode of travel. According to the CTPP data, it takes much longer to commute by public transportation than by automobile. The decline in the share of public transportation in the region contributes to the decrease in commuting time because driving alone takes less time than traveling by public transportation. Commuters in the region have shifted from slower to faster modes of transportation. The 1990 CTPP average regional travel time compares very well with DVRPC average commuting time, which is based on an actual travel survey (24.6 versus 23.8 min).

These problems are similar to those experienced with the 1980 UTPP. For this reason, the CTPP trip information should be adjusted before it is used for transportation planning and travel forecasting. The adjusted CTPP employment and traffic data for the Delaware Valley region are quite reasonable.

DVRPC USES OF 1990 CTPP

The uses of the 1990 CTPP in the Delaware Valley region are somewhat similar to applications in other metropolitan areas (3-5). DVRPC has already used census data in

various transportation planning studies and will continue to use the CTPP in the future. As mentioned earlier, the CTPP includes many socioeconomic data items and trip information that are invaluable to local and state governments, transit operators, and private corporations for making a variety of transportation and locational decisions, including the locations of shopping centers, industrial parks, banks, and service industries and the estimation of highway and transit travel, parking requirements, transit fleet sizes, and service schedules.

Six major uses of the 1990 CTPP in the Delaware Valley region are described in the following subsections.

Data Base for Transportation Planning

DVRPC has completed a project to prepare a data bank for transportation planning at the TAZ, superdistrict, municipal, and county levels. This information includes population, vehicle availability, employment, work trips by mode, travel time, household income, and other socioeconomic variables required for traffic simulation and transportation planning and travel forecasting. Such data have been extracted from Parts 1, 2, and 3 of the CTPP. All data items have been edited for reasonableness and adjusted if necessary on the basis of other census data and DVRPC surveys, traffic counts, and data sources as described earlier. These data have been used in most transportation system and project planning studies in the last 3 years.

Data Summaries and Trend Evaluations

DVRPC has completed three reports on the journey-to-work trends in the Delaware Valley region (6-8). These reports compare the 1970, 1980, and 1990 journey-to-work information, means of transportation for commuting to work, employed persons, and employment at the county and regional levels. They also analyze the commuting flow between the counties of the Delaware Valley region and surrounding counties and cities. The reports were well received by planners and decision makers because they provide factual information about trends in land use development and travel patterns in the region.

TABLE 4 Average Travel Time of Commuters

County of Residence	Travel Time (minutes)		
	1980	1990	% Diff
Bucks, PA	24.0	24.2	0.8
Montgomery, PA	21.9	22.5	2.7
Burlington, NJ	24.0	24.1	0.4
Mercer, NJ	21.7	22.1	1.8
Total Region	25.3	24.6	-2.8

For example, Table 5, taken from the regional report (6), gives the 1970–1990 trends in the distribution of Montgomery County resident workers by place of work. Other tables show the trends in employment and mode of travel for all DVRPC counties, cities, and selected municipalities.

Short data bulletins were also published. Each includes one or two information items obtained from Parts 1, 2, or 3 of the CTPP. For example, a bulletin was prepared on vehicle ownership growth between 1970 and 1990 for the counties in the Delaware Valley region. It also includes households stratified by the number of vehicles owned (zero, one, two, or three or more vehicles).

Update of DVRPC Traffic Simulation Models

DVRPC's staff has used the 1990 census data to update and validate its travel forecasting models. Ten years ago the 1980 UTPP was used to check and validate the DVRPC traffic simulation models (Figure 3). These models follow the traditional steps of trip generation, trip distribution, modal split, and travel assignment, and use the computer programs included previously in the Urban Transportation Planning System (UTPS). In addition to this system, DVRPC is now using the TRANPLAN and TRANSCAD systems for travel forecasting and air-quality analysis.

Generally, the models are similar to those used in other large urban areas that depend on census data for system analysis and project studies. Figure 3 shows the steps followed to update the DVRPC traffic simulation process. A careful review and evaluation of the results of each model were conducted, and necessary adjustments were made to achieve the most accurate calibration. The simulated traffic volumes were compared with actual highway traffic counts and public transportation ridership to ensure that acceptable accuracy of the simulated results is obtained from these models. Specifically, DVRPC used the CTPP data in the following activities:

- Development of accurate inputs on population, households, vehicle availability, resident workers, and employment at the TAZ level;
- Comparison and analysis of DVRPC trip rates for work with the CTPP;
- Comparison and analysis of DVRPC trip length and travel time distribution for work with the CTPP;
- Comparison and evaluation of work trips estimated by the DVRPC model with the CTPP;
- Comparison and analysis of DVRPC automobile occupancy model with the CTPP; and
- Analysis and evaluation of DVRPC external work trips with the CTPP.

TABLE 5 Montgomery County Resident Workers: Distribution by Place of Work (6)

Place of Work	1970	1980	1990	Percent Change	
				'70–'80	'80–'90
Bucks	8,488	14,325	20,986	68.8	46.5
Chester	5,900	10,525	17,920	78.4	70.3
Delaware	5,897	7,773	10,933	31.8	40.7
Montgomery	158,986	204,673	229,923	28.7	12.3
Philadelphia	<u>54,489</u>	<u>55,598</u>	<u>55,956</u>	2.0	0.6
Total PA portion	233,760	292,894	335,718	25.3	14.6
Burlington	1,632	532	1,484	–67.4	178.9
Camden	3,089	1,643	2,808	–46.8	70.9
Gloucester	883	225	474	–74.5	110.7
Mercer	<u>1,877</u>	<u>354</u>	<u>1,024</u>	–81.1	189.3
Total NJ portion	<u>7,481</u>	<u>2,754</u>	<u>5,790</u>	–63.2	110.2
Total Region	241,241	295,648	341,508	22.6	15.5
Berks	2,499	3,070	3,670	22.8	19.5
Lancaster	82	172	162	109.8	–5.8
Lehigh	633	773	1,390	22.1	79.8
New Castle	513	282	580	–45.0	105.7
Northampton	665	196	326	–70.5	66.3
Other	<u>5,504</u>	<u>4,185</u>	<u>5,324</u>	–24.0	27.2
Total External	9,896	8,678	11,452	–12.3	32.0
Total Trips	251,137	304,326	352,960	21.2	16.0

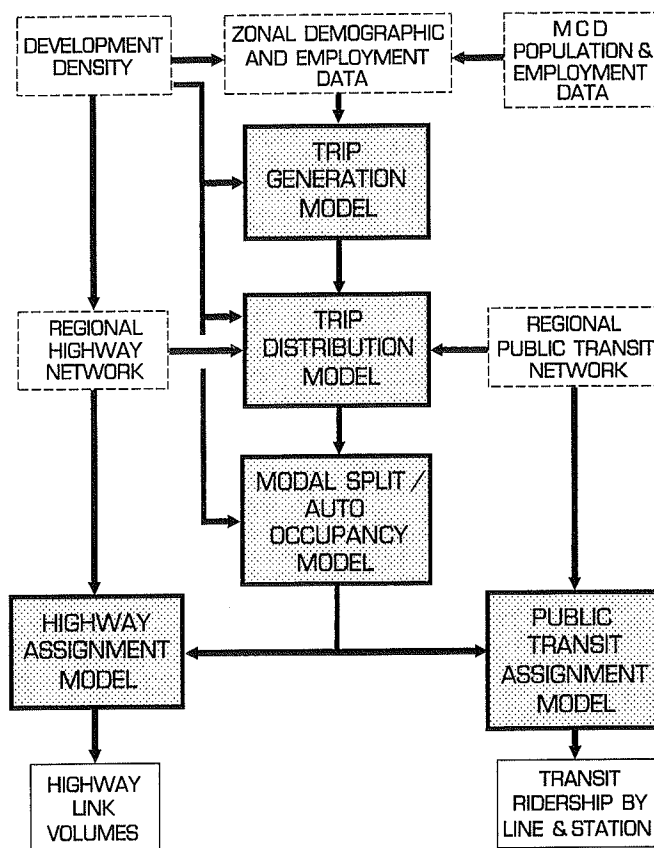


FIGURE 3 DVRPC regional travel simulation process.

In order to convert the CTPP trip data to home-based-work (HBW) productions and attractions internal to the DVRPC region (both trips end within the region), the census trip matrix was multiplied by 1.74 (2×0.87). This factor, which accounts for trip chaining, second jobs, absenteeism, and the corresponding work-to-home trips, was needed to convert the census home-to-work data to the average weekday production-attraction format tabulated from traditional home interview surveys for travel simulation. No explicit mode shift factors were used. A factor of 1.76 was used to convert the 1980 census UTPP data.

In 1988 DVRPC conducted a small-sample home interview survey to be used in conjunction with the 1990 CTPP data. Comparison of census-based HBW trips with the 1988 home interview survey indicated that the factor of 1.74 provides reasonable results at the regional level for driving alone and transit travel. The work trip automobile occupancy from the census data (1.09 persons per vehicle) is somewhat lower than the survey result (1.13 persons per vehicle). For Philadelphia CBD attractions, the census data tend to underestimate subway-elevated and bus trips and overestimate drive-alone automobile trips. Commuter rail trip attractions are slightly underestimated by the census data.

Highway and Transit Corridor Studies

The 1990 CTPP data, especially the journey-to-work information contained in Part 3, have been used in several transit corridor studies to check travel demand or ridership for each transit submode, including high-speed rail, express bus and park-and-ride service, and local bus service in the suburbs.

The 1990 CTPP data are also being used in many proposed highway and transit corridor studies because it is the only information available for transportation planning at the regional level.

Strategic Planning and Economic Development

DVRPC used the 1990 CTPP information on employment to evaluate the significant changes in the type and location of industries and commercial establishments. This evaluation resulted in recommendations and strategies aimed at attracting new industries and high-technology firms to the Delaware Valley. Also, employment information was useful in the redevelopment of declining urban centers and provision of the required physical improvements for their rehabilitation.

Existing access patterns were examined in terms of origins and destinations and modal split. Access problems for particular labor populations, such as low-wage workers, were identified. Access opportunities were also identified on the basis of data analyses, site analyses, and consultations. Solutions related to both transportation and land use have been proposed to improve access to employment centers, as dictated by findings.

Provision of 1990 CTPP Data to Public Agencies and Private Corporations

Finally, DVRPC has been providing the 1990 CTPP information to any public or private agency involved in planning or urban studies, including studies for housing, finance, real estate, health facilities, social services, economic base, and economic development. Many planning agencies and private companies in the Delaware Valley region are very much interested in obtaining the CTPP information for their various studies.

CONCLUSIONS

Generally, the 1990 CTPP for the Delaware Valley region contains good quality data for air-quality and transportation planning, travel forecasting, economic base and employment location studies, urban development analysis, and planning and evaluation of transit services. The use of the CTPP minimizes the need for large-scale data collection in the Delaware Valley and decreases the rising costs of surveys required for transportation planning at the system and project levels. Without census data it would be almost impossible to conduct many transportation studies in the region, and most of the DVRPC applications could not have been accomplished without these data. Under current budget conditions, it is almost impossible to conduct a home interview survey that would provide results similar to those included in the CTPP.

The analysis of CTPP data indicates a few programming, statistical, and bias problems. Most of these problems were resolved before DVRPC used the CTPP as a data base for trend analysis, traffic simulation, highway and transit project studies, strategic planning, and economic development. As with the 1980 data, the 1990 employment estimates must be adjusted before they are used in transportation planning studies because they do not include all jobs.

Most of the 1990 CTPP problems and errors can be avoided in the 2000 census by quality control edits and a careful review of the census questionnaire as well as the computer formats and programs required for processing the information. Specifically, the journey-to-work questions (21, 22, 23, and 28) should be simplified to prevent any confusion on the part of respon-

dents to questions on mode of travel, destination, and industry classification. Many confused the access mode to subway-elevated or railroad lines with the principal mode of travel. The questionnaire should be redesigned to capture multimodal trip information from the place of residence to the place of work and to avoid any error or misunderstanding in the employment sectors.

The format of the 1990 CTPP tapes is rather complex and must be simplified and checked for consistency. The funding and development of two packages in 1990—Statewide and Urban elements—was an excellent idea since they include better coverage of commutershed areas and could be used for checking accuracy and consistency of the census information. AASHTO should again provide the funding for the CTPP 2000. Finally, DVRPC has not as yet received all parts of the CTPP; a more timely release of data is obviously important to all census data users.

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