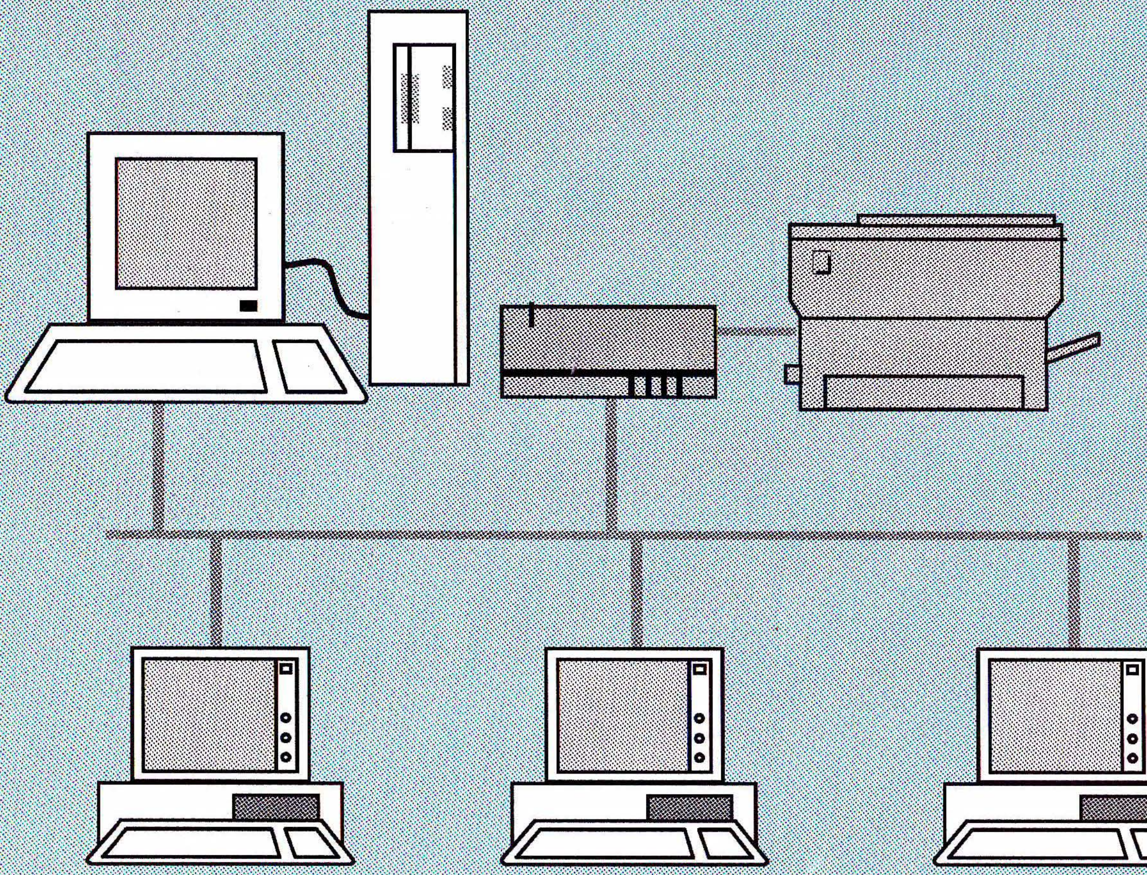
Information System For Transportation Planning



DELAWARE VALLEY
REGIONAL PLANNING COMMISSION
MAY 1995

Information System For Transportation Planning

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REGIONAL PLANNING COMMISSION
APRIL 1995

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Created in 1965, the Delaware Valley Regional Planning Commission (DVRPC) is an interstate, intercounty and intercity agency which provides continuing, comprehensive and coordinated planning for the orderly growth and development of the Delaware Valley region. The region includes Bucks, Chester, Delaware, and Montgomery counties, as well as the City of Philadelphia, in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer counties in New Jersey. The Commission is an advisory agency which divides its planning and service functions between the Office of the Executive Director, the Office of Public Affairs, and four line Divisions: Transportation Planning; Regional Planning; Regional Information Services Center which includes the office of Regional Planning; and Finance and Administration. DVRPC's mission for the 1990s is to emphasize technical assistance and services, and to conduct high priority studies for member state and local governments, while determining and meeting the needs of the private sector.

The DVRPC logo is adapted from the official seal of the Commission and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole while the diagonal bar signifies the Delaware River flowing through it. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey. The logo combines these elements to depict the areas served by DVRPC.

DELAWARE VALLEY REGIONAL PLANNING COMMISSION

Publication Abstract

TITLE: **INFORMATION SYSTEM FOR TRANSPORTATION PLANNING**	**Date Published:** MAY 1995 **Publication No.** 95007

Geographic Area Covered:

DVRPC REGION: Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties in Pennsylvania; Burlington, Camden, Gloucester, and Mercer Counties in New Jersey; City of Camden, City of Trenton, City of Philadelphia, and City of Chester

Key Words:

Geographic Information System, Geographic Information Layers, Relational Database Management, Geographic Layers, Database Dictionary.

ABSTRACT

This report describes the Delaware Valley Regional Planning Commission Geographic Information System for Transportation Planning activities (GIS-T) and types of databases and data items. It also illustrates some of the transportation planning activities that have utilized this system at Delaware Valley Regional Planning Commission.

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EXECUTIVE SUMMARY

To date, the vast majority of Geographic Information Systems (GIS) for transportation applications have used GIS as a platform for integrating and displaying data on fixed transportation infrastructure like roads and bridges. While facility management is clearly important, it only represents a small fraction of those transportation problems to which GIS could successfully be applied. transportation planners, policy makers, and managers are just beginning to comprehend how GIS can help them in their work. Promising applications include: travel demand forecasting, market analysis, transit route planning, vehicle monitoring, real-time operational control, congestion management, and transportation/land use planning.

In accordance with the mandated 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) and with years of valuable transportation planning information collected, the Delaware Valley Regional Planning Commission (DVRPC) is committed to developing a personal computer (PC) based Geographic Information System for Transportation (GIS-T) Planning activities. To develop an effective and efficient GIS-T, several steps had to be taken.

First, a general framework of the system was developed to define its goals and objectives. Second, several PC based GIS programs were researched and evaluated. As a result, it was found that TransCAD software best suited the goals and objectives of this project. Among many features, TransCAD is able to share information directly with the Intergraph's Modular GIS Environment (MGE) software under the UNIX operating system. It is also able to share travel simulation networks, trip tables, and outputs directly using TranPlan software. Third, several types of computer hardware were evaluated, and it was concluded that a Pentium™ micro computer processor with a clock speed of 90 MHZ has generally sufficient capacity to operate TransCAD. Fourth, due to the fact that the Census Bureau's 1990 TIGER/Line ™ files are currently available on CD-ROMs and contain various geography levels and features, it was decided to use these files as base maps. Fifth, various transportation planning activities were evaluated in order to find out how these activities could utilize the GIS-T. As a part of this evaluation, a database dictionary framework was developed for each transportation activity. Based on the findings, several GIS-T databases were developed, and the 1990 Census Journey-To-Work, STF1A, and STF3A files loaded onto these databases.

I. Introduction

State Transportation Departments and Metropolitan Planning Organizations (MPOs) are currently faced with ever-increasing demands for information. This data is needed to support more effective decision making processes which vary significantly, from engineering at the individual project level analysis to region wide planning and management. The broad environmental and economic development problems that confront these agencies today require data sharing and cooperation between multiple agencies. These demands for improved information often manifest themselves as mandates, such as the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 that requires management systems for traffic monitoring and for management of pavement, bridges, safety, congestion, public transportation, and intermodal facilities and equipment. Data required by the ISTEA management and monitoring systems coupled with nearly all of the data managed by transportation agencies in general, can be geographically referenced through the use of a Geographic Information System (GIS).

Over the years, DVRPC has collected and produced transportation planning information which was not easily accessible or integrated with other data. The purpose of this report is to describe the activities which organize data from DVRPC's traffic counting program, Congestion Management Systems (CMS), 1990 Census Journey-To-Work information, travel simulations for region and corridor studies, Transportation Improvement Program (TIP), and other sources. into an accessible GIS database. This system is designed to incorporate data from other sources such as PADOT and NJDOT, and produce transportation planning information useful to member governments.

This report describes briefly the GIS and database types, relational database management systems, hardware and software, DVRPC's transportation planning database data dictionary descriptions, GIS applications in transportation planning, and some transportation planning activities at DVRPC that have utilized the GIS.

II. Geographic Information System and Database

1. Geographic Information System

Geographic Information System (GIS) is defined by Dueker and Kjerne (NCHRP Report 359, p10, 1993):

> *As a system of hardware, software, data, people, organizations, and institutional arrangements for collecting, storing, analyzing, and disseminating information about areas of the earth.*

According to this definition, a GIS includes not only computing capability and data, but also managers and users, the organizations within which they function, and the institutional relationships that govern their management and use of information. This broad view establishes a basic fundamental premise that the technology of GIS cannot be planned, evaluated, projected, and in isolation from the institutional setting, management framework, and staffing resources upon which its success will depend. GIS system design and implementation planning are not processes that can be separated. They must occur in conjunction with one another.

A GIS for Transportation (GIS-T) is the union of an enhanced Transportation Information System (TIS) and an enhanced GIS. The necessary enhancements to existing Transportation Information Systems is the structuring of the attribute databases to provide consistent location reference data in a form compatible with the GIS, which in turn has been enhanced to represent and process geographic data in the forms required for transportation applications. This report describes the necessary tasks which have been undertaken by DVRPC to develop this system ,as well as other tasks that are proposed for developing a GIS-T for the DVRPC region.

2. Database Types

There are five types of database structures that are used in any GIS: point, line, area, tabular, and raster. The point, line, area, and table databases are vector databases, which means that the geographic information is stored as a series of points and lines. However, raster data is stored as bit-mapped images.

a. Point Database

A point database contains information about points (e.g., traffic count locations) such as coordinates. It has only one layer. For example, the point database structure could be used for bridges, cities, populated places, and ZIP Code centroids. Other uses would be large trip generators, accidents, roadside features, and traffic counting stations.

b. Line Database

A line database is made up of a link layer and a node layer. The geometry of a line is defined by the starting and ending nodes and by a series of coordinates which describe the shape of the line. These intermediate coordinates, called shape points, are not considered to be nodes and do not possess attributes other than geographic coordinates (longitude and latitude). The links and nodes have attributes that describe their characteristics. The line database structure was used for the various representations of the highways, transit routes, rail, water, pipelines, and other linear features.

c. Area Database

An area database is made up of areas or regions that are surrounded by boundaries. The geometry of an area is defined by a series of boundary edges which completely enclose the area. The area database structure is used to define census geographical units such as census blocks, tracts, counties, and MCDs. When these layers are aggregates of a base layer (e.g., block groups, tracts, and counties are aggregates of census blocks), they are represented as multiple layers in the same database. As a result, common boundary lines are stored in the database only once.

d. Tables

Table databases are used to store and manipulate data, such as travel times and flows between zone centroids in vector and matrix format. For example, GIS can display DVRPC model simulation trip tables in the map window as straight lines connecting origin and destination points. The lines can be drawn with width proportional to the value in the table cell.

e. Raster Files

Two types of raster data are popular: aerial photographs and United States Geographic Survey maps. These images can be used to test the geographic accuracy and completeness of the various vector databases. While these lack any topological intelligence, they can provide considerable background and reference information. They are most useful in areas that have experienced rapid growth not yet reflected in any of the existing vector databases.

III. Database Management Systems

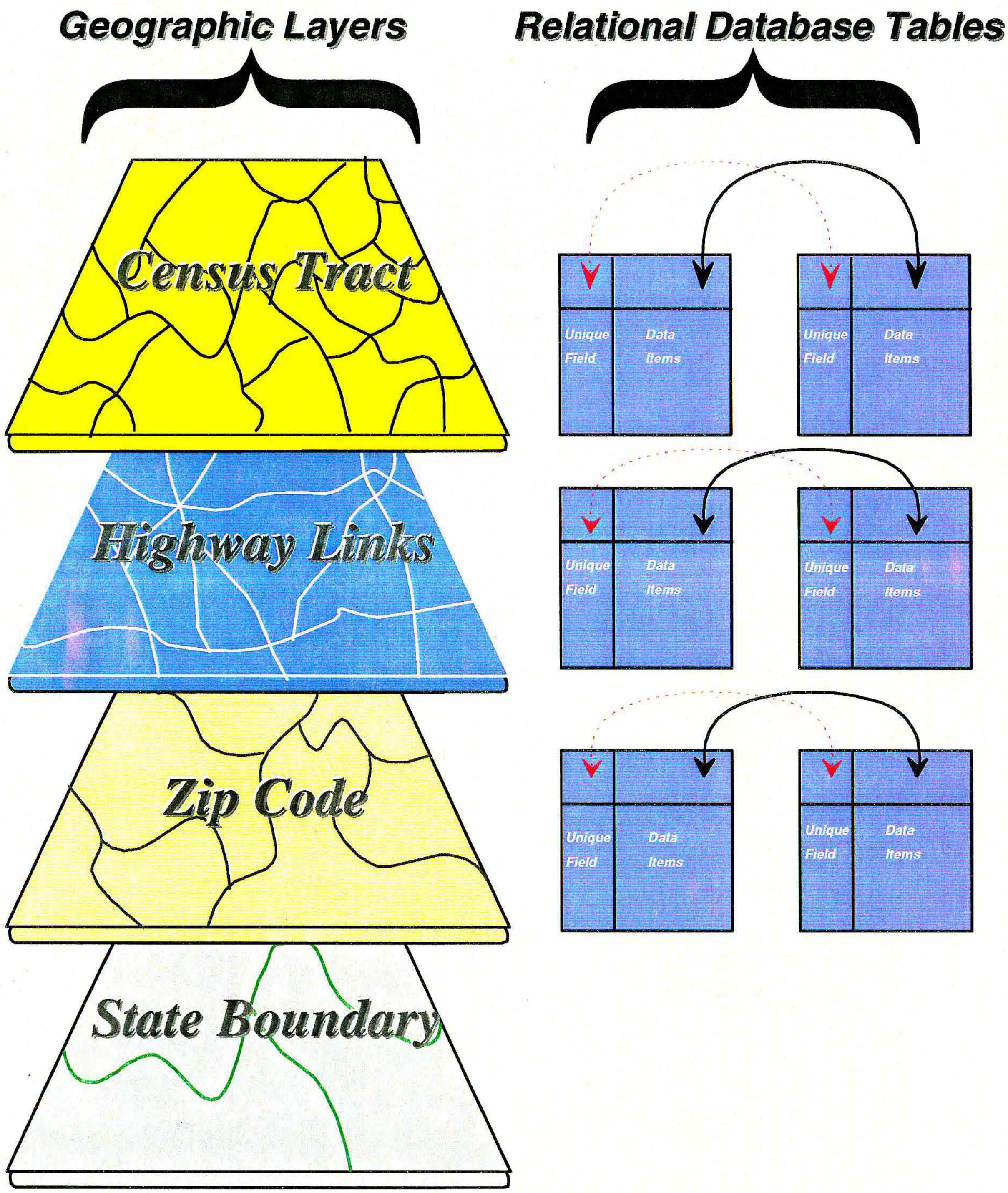
The database management system (DBMS) is composed of a file management system and a user interface to the filing system. A relational database is like a file management system. Database tables are made up of records which consist of individual data fields. A table is considered a two dimensional array: rows and columns. The rows consist of individual records, and columns are made of individual fields. The key feature of a relational database manager is the fact that individual data tables can be joined or "related" to one another on the basis of unique fields.

In the GIS environment, these relational databases are used in two ways. First, some GISs have relational database managers embedded within the software tools. For example, TransCAD software has a relational database manager embedded and makes use of this software tool to manage and query both graphic and non-graphic data elements. Second, some GISs offer interfaces to relational database management systems.

These relational databases, however, should be designed so that they all have one unique data field across the entire system in order to be able to manage and query both graphic and non-graphic data elements. However, since NJDOT and PennDOT have different roadway network identifier systems (NJDOT uses mile post as a record identifier while PennDOT uses state route identifier), each database will be designed so that there will be at least one unique primary and secondary field per database. For example, to query both graphic and non-graphic data elements of a desired section of HPMS in NJ, the graphic data layer and HPMS relational database will be linked to each other via state highway mile post field (i.e., primary unique field). Further, to accomplish the same thing in PA, there must be a primary unique database field key and at least two secondary fields. This is due to the fact that in PA, state route section numbers are unique within the county boundary, but they are not unique within the state boundary. Therefore, the unique primary field would be the designated county code, and unique secondary fields would be state route and state route section number.

Figure 1 illustrates the linkage between relational database tables and related geographic layers via designated primary and/or secondary database unique fields. It should also be noted that any other highway networks that are not included in NJDOT and/or PennDOT highway networks (e.g. local roads, some county roads, etc.) will be imported from sources such as the 1990 Tiger/Line Census raw data files.

Figure 1. Geographic Layers and Relational Database Tables Illustration



IV. Software, Hardware, GIS Framework, and Future GIS Activities at DVRPC:

Currently, there are two types of GIS hardware and software in operations at DVRPC. This section briefly describes these and also describes the basic framework for the development of GIS-T and future GIS-T activities at DVRPC. Furthermore, the GIS-T system is designed for transportation planning activities at DVRPC.

1. Software

Intergraph - DVRPC is utilizing the Intergraph's Modular GIS Environment (MGE) software under the UNIX operating system. The MGE software is a comprehensive suite of modules designed for GIS and mapping applications. The MGE consists of modules for project and data management, data collection and integration, and spatial query and analysis. The system uses ORACLE database software. The MGE software also includes an option to share information among other GIS packages . This software, however, lacks some features specially needed for the transportation planning process. For example, in addition to polygon processing to support environmental and land use information capabilities, transportation applications of GIS require additional functionality for treatment of linear feature databases and corresponding travel simulation networks. Among these requirements are representation of trip generation, trip distributions, turn prohibitions and penalties, and highway and transit assignments . The software configuration is under review and will likely convert from UNIX to Windows NT.

TransCAD- After an extensive literature review search and evaluations of the several GIS commercial software programs, it was found that only one vendor at the time of the evaluation process had designed its GIS system with spatial data structuring and other resources especially optimized for efficient support of the transportation modeling process. This software is called TransCAD and constitutes a revolutionary system for transportation data management and analysis. It makes it possible to store, retrieve, analyze, and visualize all types of transportation and related geographic data in new and useful ways. Furthermore, TransCAD comes with many transportation analysis procedures similar in nature to the transportation planning packages currently available (TRANPLAN, MINUTP, etc.). TransCAD also has a utility procedure that enables users to share information to most popular GIS packages including to and from MGE. TransCAD is designed to operate on any IBM compatible personal computers. This software runs under Microsoft Disk Operating System (MS-DOS) and MS Windows.

GisPlus - The GisPlus contains the same basic GIS capabilities as TransCAD software. However, unlike TransCAD, GisPlus does not have highway and transit analysis capabilities. This software is very useful for a speedy thematic mapping presentation and/or sketch planning analysis using Census demographics and TIGER/Line™ data files. Similar to TransCAD, GisPlus software is also designed for the PC and runs under MS-DOS or the MS Windows operating system.

2. Hardware

Intergraph - The MGE software currently runs on a network system which utilizes four Intergraph Workstations. The three workstations are networked through a 10-base T network hub. The system is managed by a central file server. The file server is connected to a tape input/output device, through a plot server to a Versatech color electrostatic plotter. There is also a TD2 personal workstation that is windows NT based. The hardware configuration is currently being evaluated and is expected to undergo a substantial change in the next three months.

TransCAD - TransCAD is high performance software and it requires the most powerful PC available. At the time of purchasing TransCAD, the most powerful PC available was the Intel 66 MHz, 486DX2 processor. Today, however, due to the large computer files size coupled with the complexity of the census demographic and geographical databases, it requires at least an Intel 90 MHz, Pentium micro computer processor.

GisPlus - GisPlus requires a minimum of an Intel 33 MHZ, 386 processor. However, for the best performance and speed, it requires at least an Intel 66MHZ, 486DX2 processor.

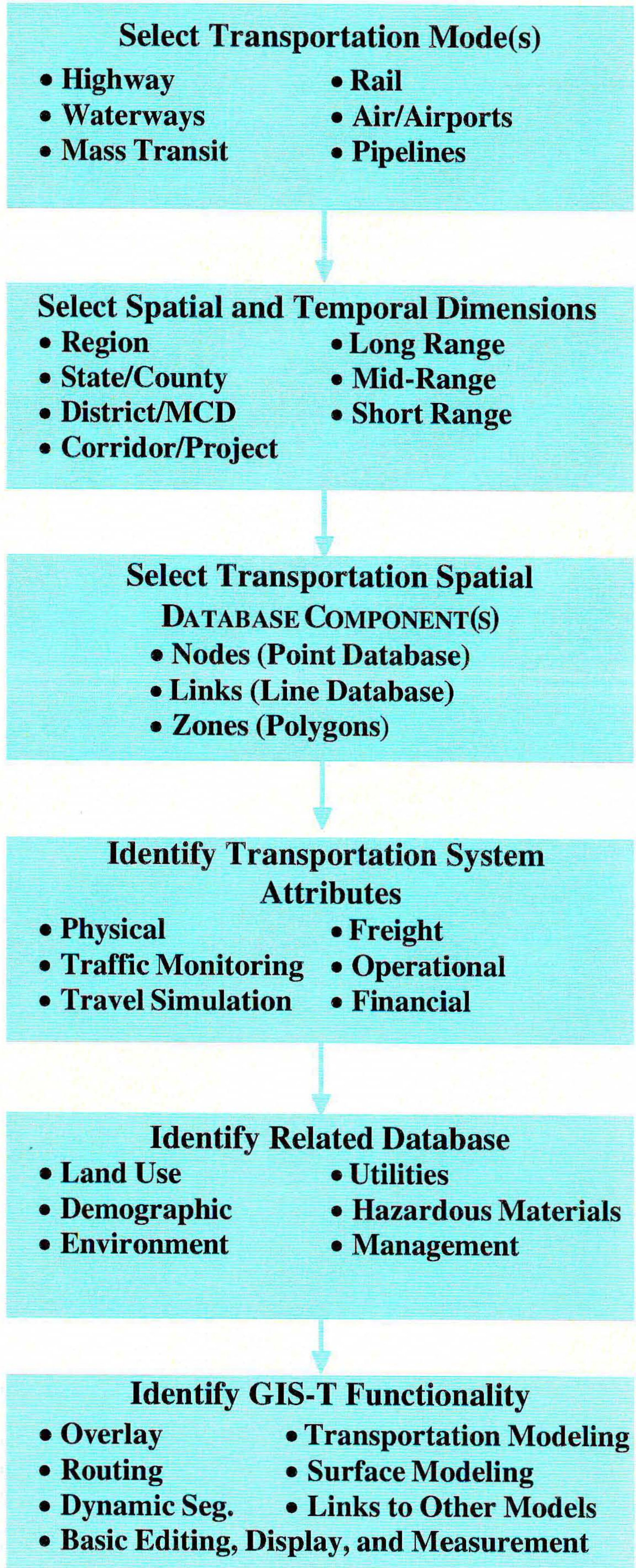
3. Framework Development

Because almost all information used by DVRPC and its member governments can be linked to location, a wide variety of applications of GIS-T are possible. In order to identify applications that will be most useful to DVRPC and its member governments, a framework for application was developed. This framework, as shown in Figure 2, has six steps:

a) Select transportation mode(s)
b) Select spatial and temporal dimensions
c) Select spatial database component(s)
d) Identify transportation system attributes
e) Identify related databases
f) Identify GIS-T functionality

The framework covers applications relevant to any of the basic functional areas covered by DVRPC. However, due to the time constraints and needs of the other related projects to utilize this system, the development of the project has mainly focused on highway and transit modes and any GIS databases related to these modes. The other tasks of the framework will be developed and implemented in the future.

Figure 2. DVRPC's GIS-T Framework Process



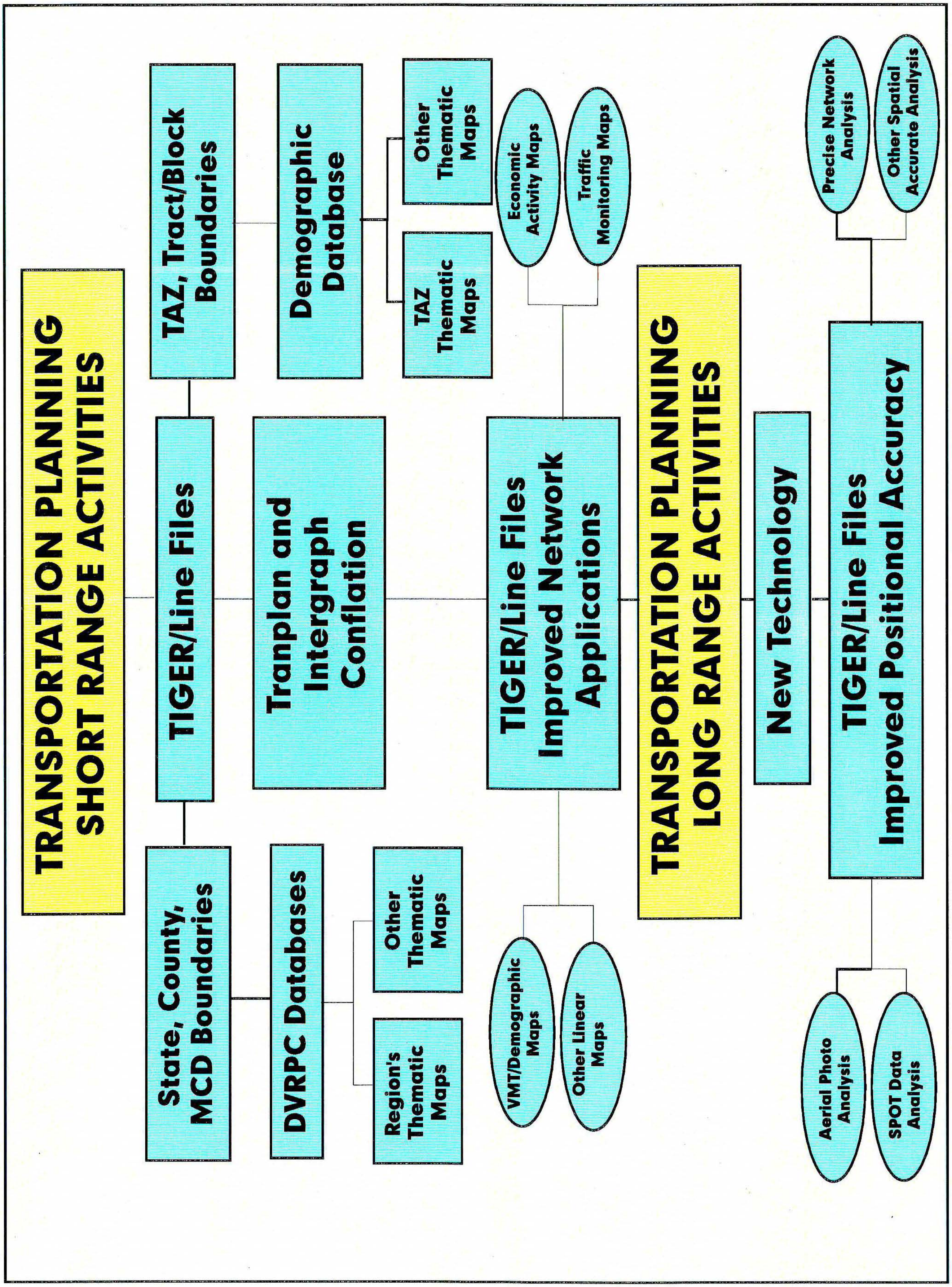
4. Future GIS Activities

Presently, DVRPC is working towards implementing greater enhancements and accuracy into its spatial data sets, and will, resources permitting, pursue technologies such as aerial photography and video logging. The aim is to produce a precise, spatially accurate database of networks and associated transportation features which can be used for a variety of planning purposes, including detailed design and engineering projects.

GIS-T products are useful in assisting regional as well as local projects. This system is also very useful for unique transportation planning projects such as the required ISTEA management systems and the Delaware Valley Freight Intermodal Study. For example, the Freight Intermodal Study requires a database to include several data items regarding intermodal facilities including rail, port, and airport. The GIS-T products, of a visual or quantitative nature, would support the study goals and objectives, and be extremely valuable.

An outline of the current and future GIS-T projects at DVRPC is shown in Figure 3 .

Figure 3.


TRANSPORTATION PLANNING
SHORT RANGE ACTIVITIES
State, County, MCD Boundaries
TIGER/Line Files
TAZ, Tract/Block Boundaries
DVRPC Databases
Tranplan and Intergraph Conflation
Demographic Database
Region's Thematic Maps
Other Thematic Maps
TAZ Thematic Maps
Other Thematic Maps
VMT/Demographic Maps
Other Linear Maps
TIGER/Line Files Improved Network Applications
Economic Activity Maps
Traffic Monitoring Maps
TRANSPORTATION PLANNING
LONG RANGE ACTIVITIES
New Technology
TIGER/Line Files Improved Positional Accuracy
Aerial Photo Analysis
SPOT Data Analysis
Precise Network Analysis
Other Spatial Accurate Analysis

V. Implementation Process

1. Base Maps

DVRPC uses the Census Bureau's 1990 TIGER/Line ™ Files which are now available on CD-ROMs, as the base for its GIS-T program. The TIGER/Line ™ Files contain various geography levels for the 9-county DVRPC region (i.e., Minor Civil Division, Census Tracts, Census Block Groups, and Census Blocks), and a database with attributes useful for various applications. The files include roads, address ranges, railroad, water features, and various political and statistical boundaries used by the Census Bureau to collect and tabulate data from the decennial census. TransCAD software uses the TIGER/Line™ files to create geographical databases which then could be utilized for creating and presenting thematic maps using Census Bureau demographic and economic data and other data sets. TransCAD also uses TIGER/Line ™ files to provide the basis for geocoding applications.

TIGER/Line file attributes were used to create files for County boundaries, Minor Civil Division (MCD) boundaries, Street Database boundaries, 1990 Census Tracts, and Transportation Analysis Zones. The creation of these various boundary files provides a basis for future projects within DVRPC, such as spatial analysis and thematic mapping. It should also be mentioned that DVRPC recently received the 1992 TIGER/Line ™ Files, which are the updated versions of the 1990 TIGER/Line ™ Files. This update includes address ranges for the rural areas within the DVRPC region and any additional line segments since the 1990 release. Currently, there is an ongoing activity to update various maps using the 1992 TIGER/Line ™ Files.

2. Database Dictionary

DVRPC has many data items that describe the region's transportation system attributes. These transportation system attributes can be grouped into at least nine transportation planning activities which require a GIS-T. The following is a detailed description of the data dictionary for these activities:

a. Traffic Counts

Traffic counts are collected for a variety of objectives (e.g., model simulation validation, intersection design, etc.). Furthermore, traffic counts are collected in many different forms depending upon the objective of the project. Currently, five traffic count techniques are performed by DVRPC:

a)Automated Traffic Recorder (ATR) by hour, 24 hours
b)Classification counts (ATR) by hour, 24 hours, 13 FHWA classes

c)Manual counts by hour of the day
d)Turning movements by hour of the day
e)Travel speed by lane, 13 FHWA functional classes, 24 hours

In addition, there are other traffic counting techniques that are performed by NJDOT, PennDOT, counties within the region, and consultants that should be incorporated into the traffic counts GIS database.

To develop a traffic count GIS database, the above items must be aggregated to a single computer file. This is a GIS point database. This database could be used to query and display graphically locations of the counts and related data elements (e.g., AADT, K-factor, Peak Hour Factor, D-Factor, etc.) Some of the data fields that this database will have are: state code, county code, mcd code, route, functional class code, location description, mile post (in NJ), state route section number (in PA), AADT, year, direction, d-factor, k-factor, percent truck, peak hour period, peak hour volume by direction, and peak hour volume.

This database coupled with the other databases such as the street database, enables DVRPC staff to produce various traffic count maps graphically showing traffic count locations and the characteristics of the study area such as AADT, percentage truck, k-factor, etc. In addition, this system allows users to transfer traffic count data into various computer file types. This option is very helpful for the DVRPC staff to share information with the member governments. Figure 4 illustrates the location of some traffic counts and the AADT in Center City Philadelphia using the TIGER/Line™ street and traffic count databases.

b. Highway Performance Management Systems (HPMS)

In accordance with the Federal Highway Administration (FHWA) requirements, the state must assess the highway system periodically with respect to extent and physical condition, safety, efficiency, and economy. The HPMS has been implemented to meet these needs. The HPMS data assess the system length, use, condition, performance, and operating characteristics of the highway infrastructure. HPMS has three major types of data: Universe Mileage Data (e.g., functional class code, NHS code, AADT, number of through lanes, etc.), Sample Data (e.g., lane width, horizontal alignment, K-factor, directional factor, etc.), and Areawide Data (e.g., land area, DVMT, accident data, population, etc.).

The HPMS subsystem consists of point and line databases. The point database consists of traffic information such as AADT, percent truck, k-factor, etc. The line database consists of HPMS section information such as section functional class code, lane width, pavement type, section length, etc. Some of the data fields that this subsystem will include are: state code, county code, mcd code, section type, rural/urban code, nonattainment

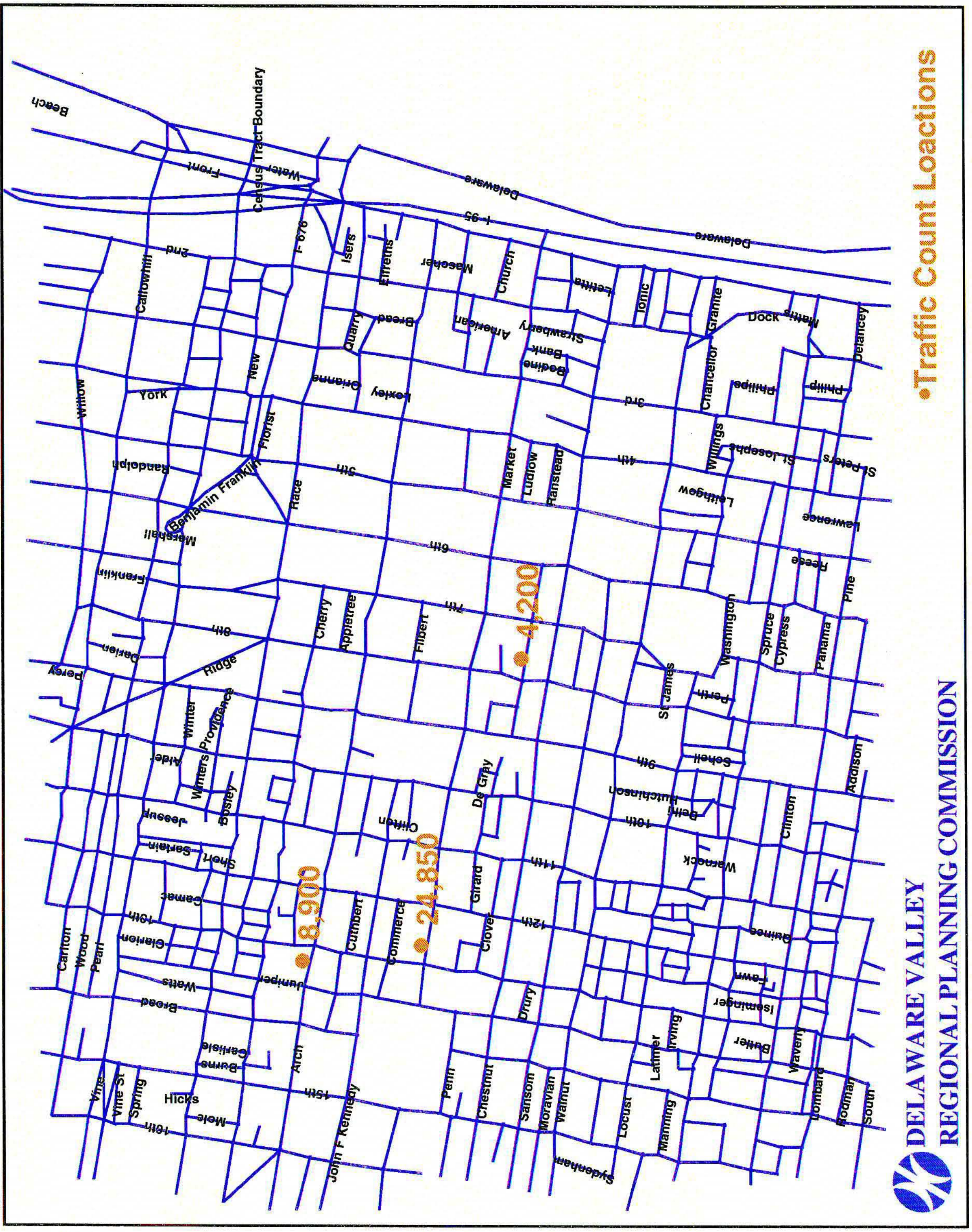


Figure 4. Traffic Count Locations

area code, functional class code, national highway system, route, functional class code, location description, mile post (in NJ), state route section number (in PA), AADT, year, umber of lanes, lane width, speed limit, k-factor, peak hour capacity, v/c ratio, future AADT, and donut area (i.e., the area outside of the FHWA approved adjusted boundary of one or more urbanized areas but within the boundary of a nonattainment area).

By using this database, various presentation and thematic maps could be produced to illustrate the physical condition of the HPMS sections such as number of lanes, VMT, etc. Furthermore, a series of tables and charts could be produced by simply transferring data fields into other computer programs such as Lotus 123© and Word Perfect©.

c. Congestion Management Systems (CMS)

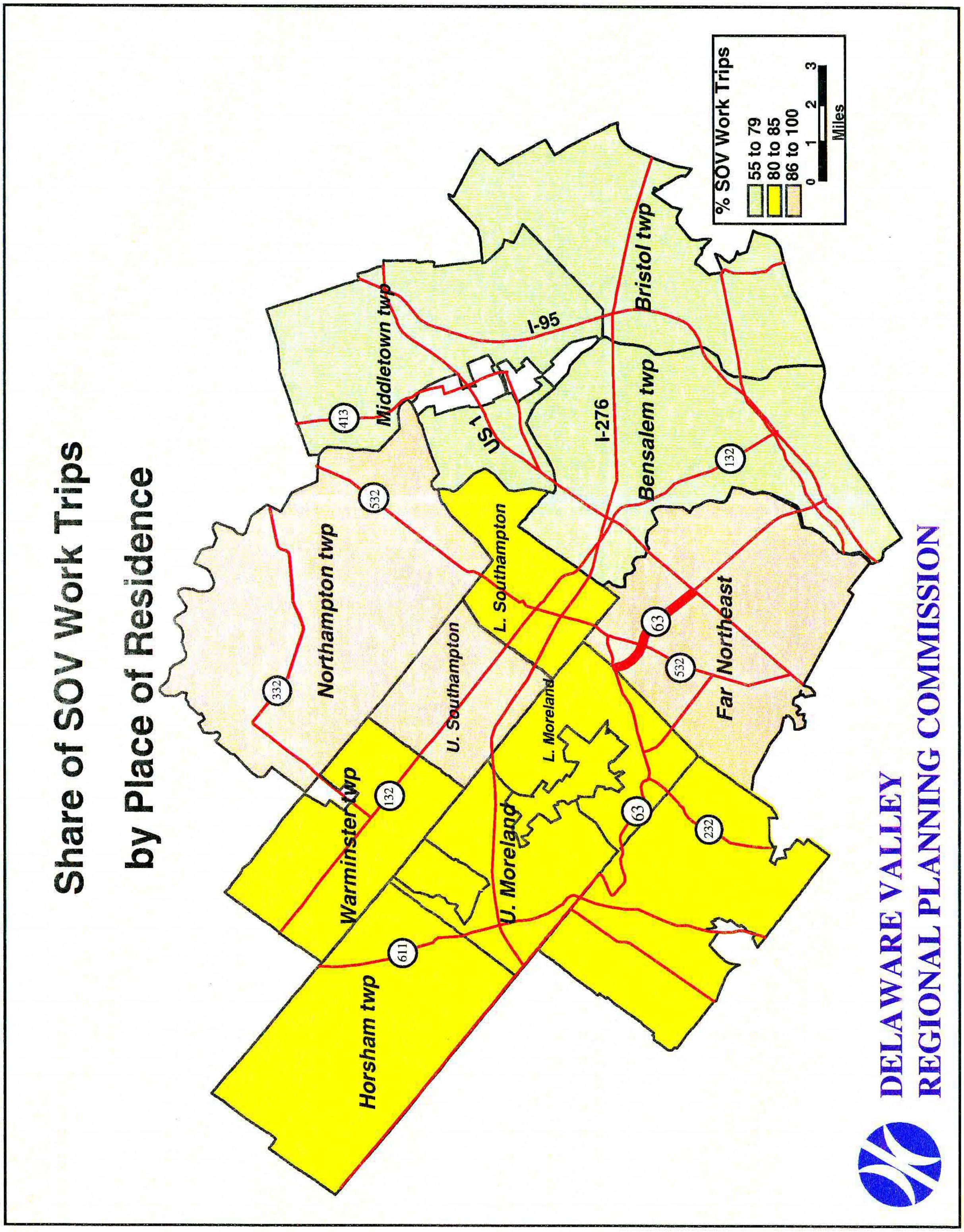
This database enables the DVRPC staff to create thematic maps coupled with supporting tables and charts of the congested corridors within the DVRPC region. Furthermore, this system is designed to show and map the mode and commuting patterns of resident workers using the 1990 Census Journey-To-Work data files. For example , Figure 5 shows a thematic map to illustrate the percent SOV for the Woodhaven road project. The purpose of this project is to complete the last section of the Woodhaven Road/PA 63 Expressway. Completing the expressway will alleviate traffic congestion on many local roads within the study area.

The GIS-T TransCAD system is used to identify significant travel patterns and the mode used for travel between the originating and ending points of these patterns. The state-of-the-art Overlay and Buffer Zone procedures of the TransCAD software were used to graphically display, and map the travel patterns and modes used for travel within the study area.

d. 1990 Census Data & Demographic and Employment Forecasts

The Census data, and forecasted demographic and employment data, are the foundations for most of the transportation planning process. Therefore, a comprehensive subsystem has been developed which includes all related transportation planning information using the 1990 Census data and demographic and employment forecasts. This subsystem consists of line and area databases. The GIS line database is based on the TIGER/Line ™ data files. The GIS area database consists of both the 1990 Census demographic and employment data, as well as forecasted demographic and employment data elements for different levels of geography (i.e., block groups, tracts, etc.). Some of the data fields are: census tract number, census block group number, street name, total population, total households, sex by employment status, household size by number of workers, number of workers in household by household income, mean household income by number of workers, vehicle available, vehicles available by household income, sex by occupation, sex by means of transportation, means of transportation to work, time leaving to go to work,

Figure 5. Percent Single Occupancy Vehicle for Woodhaven Road Project



earnings per worker by means of transportation, means of transportation to work by travel time to work, workers per vehicle, workers per carpool, total housing units, and occupancy/vacancy status.

This database enables DVRPC staff, member governments, and other users, such as consultants, to effectively and efficiently develop transportation planning strategies and make decisions. This database includes the latest Bureau of the Census demographic data files such as STF3A, STF3B, Journey-To-Work , etc. In addition, this database includes the DVRPC's forecasted demographic data bank files, such as year 2020 population and employment forecasts at the zonal and municipal level (Figure 6 illustrates the forecasted change in occupied housing units by county in the DVRPC region.) The geographical base of this database is at the Transportation Analysis Zone (TAZ) level. This database is especially designed to aggregate data items to any geographical level higher than the TAZ base geographic level (i.e., census tract, mcd, county, state, and DVRPC region). This database has been used by DVRPC staff , member governments, and many consultants for various transportation and land use planning projects which will be discussed later in this chapter. For example, the travel patterns of workers who reside in Voorhees Township, NJ is shown in Table 1. This table is designed and broken into three segments. The first segment shows the 12 highest municipalities to which resident workers from Voorhees Township commute to work. The second segment shows the travel patterns of the resident workers who work in the nine counties of the DVRPC region. The last segment shows the Voorhees resident workers who commute to work outside of the DVRPC region.

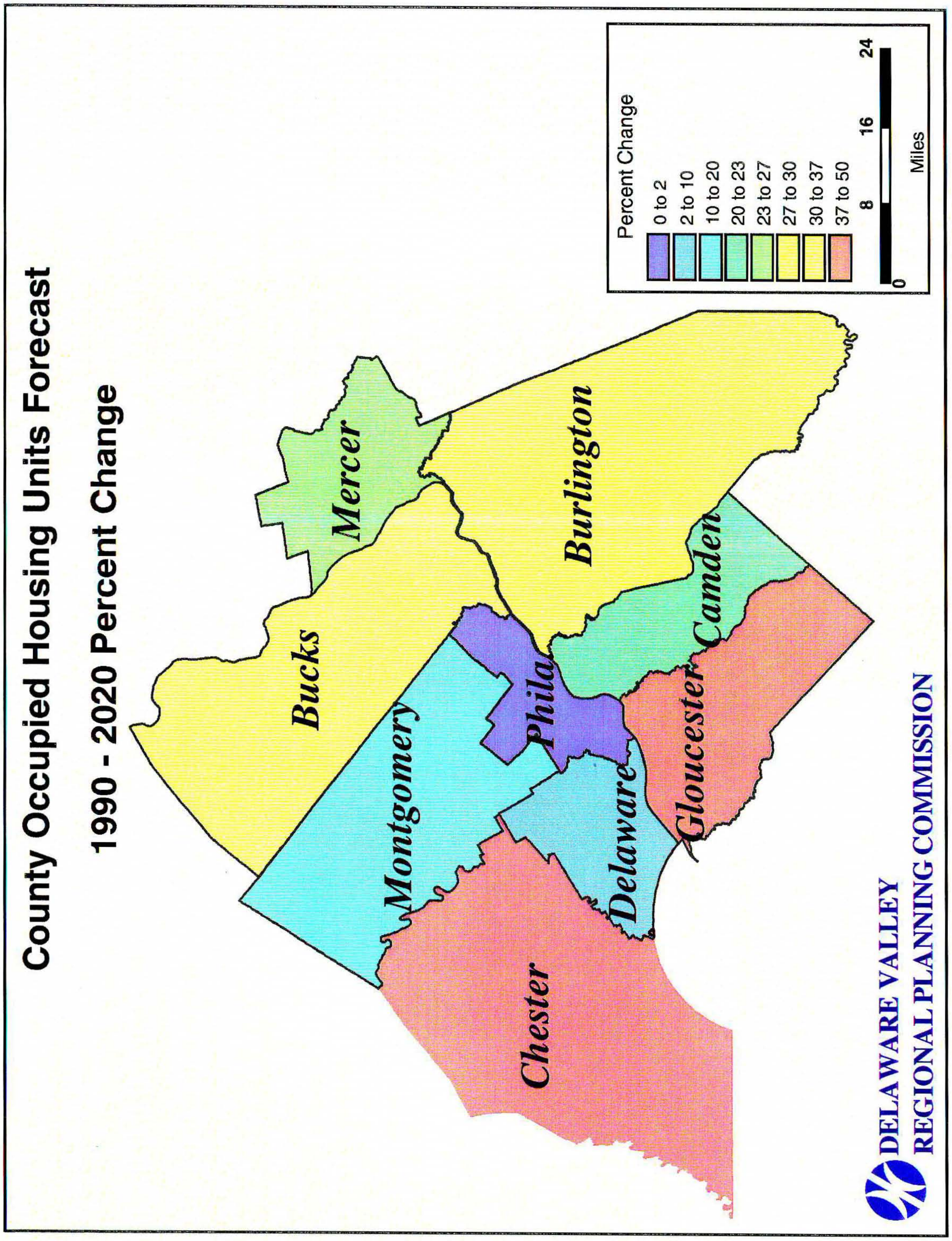


Figure 6. Occupied Housing Units Forecast

Table 1. Travel Patterns of Residence Workers in Voorhees Township, NJ

Place of Employment	Number of Workers	Percent of Total	Means of Transportation								
			Drive Alone	Carpool/ Vanpool	Bus/ Trolley	Subway/ Elevated	Railroad	Transit Share	Bicycle	Walked	Other Means
Philadelphia	3,182	24.4%	1,567	322	0	561	669	38.7%	0	24	39
Voorhees Township	1,788	13.7%	1,493	113	0	0	10	0.6%	0	161	11
Cherry Hill Township	1,397	10.7%	1,319	70	0	0	8	0.6%	0	0	0
Camden City	775	6.0%	641	78	0	40	6	5.9%	0	0	10
Evesham Township	507	3.9%	448	59	0	0	0	0.0%	0	0	0
Mount Laurel Township	422	3.2%	396	17	0	0	0	0.0%	9	0	0
Pennsauken Township	297	2.3%	246	51	0	0	0	0.0%	0	0	0
Moorestown Township	265	2.0%	236	9	0	0	0	0.0%	0	0	20
Maple Shade Township	187	1.4%	139	48	0	0	0	0.0%	0	0	0
Gibbsboro Borough	151	1.2%	151	0	0	0	0	0.0%	0	0	0
Deptford Township	145	1.1%	135	10	0	0	0	0.0%	0	0	0
Berlin Borough	143	1.0%	115	0	0	0	0	0.0%	0	0	18
Total Burlington County	1,903	14.6%	1,676	184	14	0	0	0.7%	9	0	20
Total Camden County	5,723	44.0%	4,995	409	0	58	61	2.1%	0	161	39
Total Gloucester County	525	4.0%	465	60	0	0	0	0.0%	0	0	0
Total Mercer County	153	1.2%	127	26	0	0	0	0.0%	0	0	0
Total Bucks County	185	1.4%	147	9	0	0	29	15.7%	0	0	0
Total Chester County	51	0.4%	35	8	0	0	8	15.7%	0	0	0
Total Delaware County	260	2.0%	198	36	0	19	0	7.3%	0	7	0
Total Montgomery County	241	1.9%	200	41	0	0	0	0.0%	0	0	0
Total Philadelphia County	3,182	24.4%	1,567	322	0	561	669	38.7%	0	24	39
Regional Total	**12,223**	**93.9%**	**9,410**	**1,095**	**14**	**638**	**767**	**11.6%**	**9**	**192**	**98**
Rest of New Jersey	522	4.0%	370	106	0	0	22	4.2%	0	6	18
Rest of Pennsylvania	34	0.3%	34	0	0	0	0	0.0%	0	0	0
Delaware	86	0.7%	86	0	0	0	0	0.0%	0	0	0
Elsewhere	152	1.2%	113	17	22	0	0	14.5%	0	0	0
Total	**13,017**	**100.0%**	**10,013**	**1,218**	**36**	**638**	**789**	**11.2%**	**9**	**198**	**125**

e. Travel Surveys

This subsystem consists of GIS point and table databases. The point database shows the site of the survey, and includes several survey data fields such as: state, city, mcd, zip code, survey id number, location, period, bus route code, subway code, truck route, origin, and destination.

The product from this database includes thematic maps and computer files, which then can be imported to popular database computer programs such as dBase© for further processing and analysis. Applications include Origin-Destination Travel Surveys and market research projects.

f. Travel Simulation Data

This subsystem includes GIS point, line, table, and area databases. The point database includes data elements such as node numbers, traffic count locations; the line database includes information related to characteristics of the model network such as traffic volumes, number of lanes, link distance, v/c ratio; the table database includes data items such as trip tables. The area database includes the information relating to the zonal structure of the model. The data fields that could be included in this subsystem are: node number, link distance, link travel time, uncongested link speed, congested link speed, link capacity, traffic counts and the year, zonal demographic and employment data, assigned volumes and the year, v/c ratios, link area type, link facility type, link geocode, number of lanes, link distance, and link direction code.

This database could produce many useful products for transportation planners, including thematic maps showing different traffic flow, v/c ratios, travel simulation network characteristics, etc.

g. Transit Data

This subsystem consists of line and point databases. A line database consists of transit routes, and a point database could include transit station locations. Some of the fields that can be incorporated into this subsystem are: state code, county code, mcd code, transit operator code (NJ TRANSIT, SEPTA, PATCO, etc.) route number/code, station name, fare zone, number of inbound peak period boarding, number of peak period outbound alighting, travel time from Center City, total number of parking spaces, number of monthly spaces, and parking fees.

h. Transportation Improvement Program (TIP)

This subsystem consists of GIS point and line databases. Some of the data fields that can be included in this subsystem: location of projects which have an impact on air quality, MOBILE computer program input parameters, 1990 highway source emissions, and Transportation Control Measures.

This database produces various maps and databases to show the location of the TIP projects.

i. Journey-To-Work and other Demographic Data

The DVRPC has already imported the 1990 Census CTPP package (also known as "Journey-To-Work "), 1990 Census STF3A, and 1990 Census STF3C data items into a GIS-T database. This database contains several tables which holds many data items. This database contains all modes of transportation to and from work at the TAZ level for the entire DVRPC region . This database has been used extensively for various transportation planning projects which will be described in the next chapter. In addition, this database is very useful to produce statistical tables, charts, and maps for any highway, transit, and land use analysis projects within the region.

Table 2 summarizes the above mentioned transportation planning activities by database types and database dictionary.

Table 2. Summary of Transportation Planning Activities by Database Types

Transportation Activity	Type of Database	Database Dictionary
A. Traffic Counts	Point	State code, county code, MCD code, routes, functional class code, mile post (in NJ) and route section number (in PA), AADT, year, direction, D-factor, K-factor, percent truck, peak hour period and factor, and peak hour volume.
B. Highway Performance Management Systems	Point, Line	State code, county code, MCD code, section type, rural/urban code, nonattainment area code, functional class code, mile post (in NJ) and route section number (in PA), AADT, year, lane width, speed limit, D-factor, K-factor, percent truck, peak hour period and factor, and peak hour volume
C. Congestion Management Systems (CMS)	Point, Line, Area	State code, county code, MCD code, section type, rural/urban code, nonattainment area code, functional class code, mile post (in NJ) and route section number (in PA), AADT, year, lane width, speed limit, observed speed limit, D-factor, K-factor, percent truck, peak hour period and factor, and peak hour volume, control access, capacity, performance level
D. Census data and Demographic & Employment Forecasts	Line, Area	Census Block, Block Group, and Tract Number, street names, population, employment, household characteristics, income, means of transportation to work, travel time to work, and housing characteristics
E. Travel Surveys	Point, Table	State code, county code, zip code, location, period, modes of transportation to work, origin, and destination
F. Travel simulation	Point, Line, Area, Table	Nodes and links characteristics, travel time, V/C ratio, assigned volume, forecasted travel time and speed
G. Transit	Point, Line, Table	State code, count code, MCD code, transit operator code, transit line characteristics, transit station characteristics
H. Transportation Improvement Program (TIP)	Point. Line, Area	Project location, air quality mobile computer program inputs and impacts, Transportation control measures (TCM) parameters
I. Journey-to-work	Point, Line, Table, Area	1990 census journey-to-work data files at the TAZ, census tract, MCD, county planning area, county, state, and region levels

3. Conflation

The DVRPC's regional travel simulation process uses TRANPLAN software for modeling applications, which provides data concerning traffic counts and distance and time attributes for links in the region's road network. There has been an ongoing activity to combine the commission's various road networks into a GIS-T. This will allow a wide range of analysis applications, including combinations of TRANPLAN, Census CTPP and demographic data, and geocoding applications. At the present time, however, the TRANPLAN model outputs have been imported into a GIS-T database for more advanced analysis such as displaying and mapping the desire line of travel.

4. Review and Documentation

If this system is to produce accurate, reliable results, controls must be applied at every stage of system operation-including input, processing, output, and file storage. All procedures and data files associated with this system have or will be documented and reviewed by key staff at DVRPC who use and/or are knowledgeable regarding the GIS-T fundamentals. In addition, a data dictionary document will be developed to include all types of data items and types, data locations, and data sources. Any data and/or process enhancements or modifications to this system requires the review and approval of key staff at DVRPC before incorpation.

VI. Typical Applications of GIS-T at DVRPC

DVRPC has utilized the GIS-T in several transportation planning projects. The following are examples of such projects:

1. Congestion Mitigation for Air Quality Projects Evaluation

The Congestion Mitigation for Air Quality (CMAQ) program is designed for transportation projects which contribute to the reduction of air pollution, such as park and ride lots, new transit service, and alternative fuel vehicles. Projects submitted for funding are ranked according to their emissions impacts or benefits. Modeling of CMAQ projects employs a number of methodologies to determine the change in travel characteristics. After the change in travel characteristics is determined, an emissions model calculates the emissions benefits of the proposed project.

The GIS-T has been used to analyze new transit service projects. The CMAQ methodology to analyze transit projects requires the analyst to determine the base daily ridership for each new transit route. To ascertain the base daily ridership, TransCAD was used to determine the population and number of households (and in some instances, employment) within a half-mile band of the new transit route.

The transit route was drawn on the street database of the DVRPC region and the study area. A half-mile buffer zone around the route was then created and the demographic data was extracted from the 1990 Census Tract STF3A database. After obtaining the demographic data from TransCAD, a look-up table was employed to estimate the base daily readership corresponding to the given population and number of households.

2. Year 2020 Transportation Plan

The purpose of this project is to encourage land use patterns that enhance the region and link transportation facilities by providing a comprehensive and coordinated long-range transportation facilities and services plan within a coordinated land use and transportation planning effort.
To develop transportation facilities and site specific land use recommendations, the region was divided into transportation planning corridors. These corridors extended over reasonable widths to capture parallel highway and transit routes. This method established a planning process which was inherently intermodal in nature, and which looked at transportation facilities in the context of their surrounding development. It also was intended to be fully compatible with other ISTEA and CAAA requirements; most notably the establishment of CMS study area boundaries.

Corridors were created by first overlaying a map of the identified DIRECTION 2020 regional, county, growth and revitalized centers with a highway and transit network map. Spine routes were chosen based on travel volume, congestion and facility type. Parallel routes were captured in similar fashion keeping in mind the principal nature of the route as being either radial or circumferential to the Philadelphia/Camden and Trenton CBDs. Emerging radial and circumferential routes were also identified to indicate the growing importance of additional facilities. These may be related to regional growth patterns, the impact of new facilities or the effect of urban areas adjacent to the DVRPC region.

Baseline information collected for each corridor included socio-economic data, Census Journey-to-Work data, land use characteristics, travel patterns, land use patterns, forecasted trends, TIP projects, authority projects where applicable, recommendations of previous planning efforts where available, and mapping. The planning exercise was also framed for each study area in terms of accomplishing the regional goals and objectives through the means best suited for the area in question. Study teams then researched the particular issues affecting each corridor. The corridor boundary file was converted to a form to be used within the TransCAD Geographic Information System. This file was used as a template to determine corridor areas and query census information for the following parameters: population by age cohort, number of households and occupancy rate, persons in institutions, other persons in group quarters, means of travel to work (see Figure 7), length of travel time by cohort, automobile occupancy by cohort, employees with mobility limitations, housing by water/sewer availability and number of vehicle cohorts, employment by sector, employed residents, household and per capita income, and home ownership and rental rates and average values.

3. SEPTA R5 Lansdale/Doylestown Rail Line - Parking Demand Study

The purpose of this project is to determine the number of study area workers, on a municipal basis, whose destination is Center City Philadelphia and, of those, the number and percent using the SEPTA regional rail system as part of their commute to work (i.e., capture ratio).

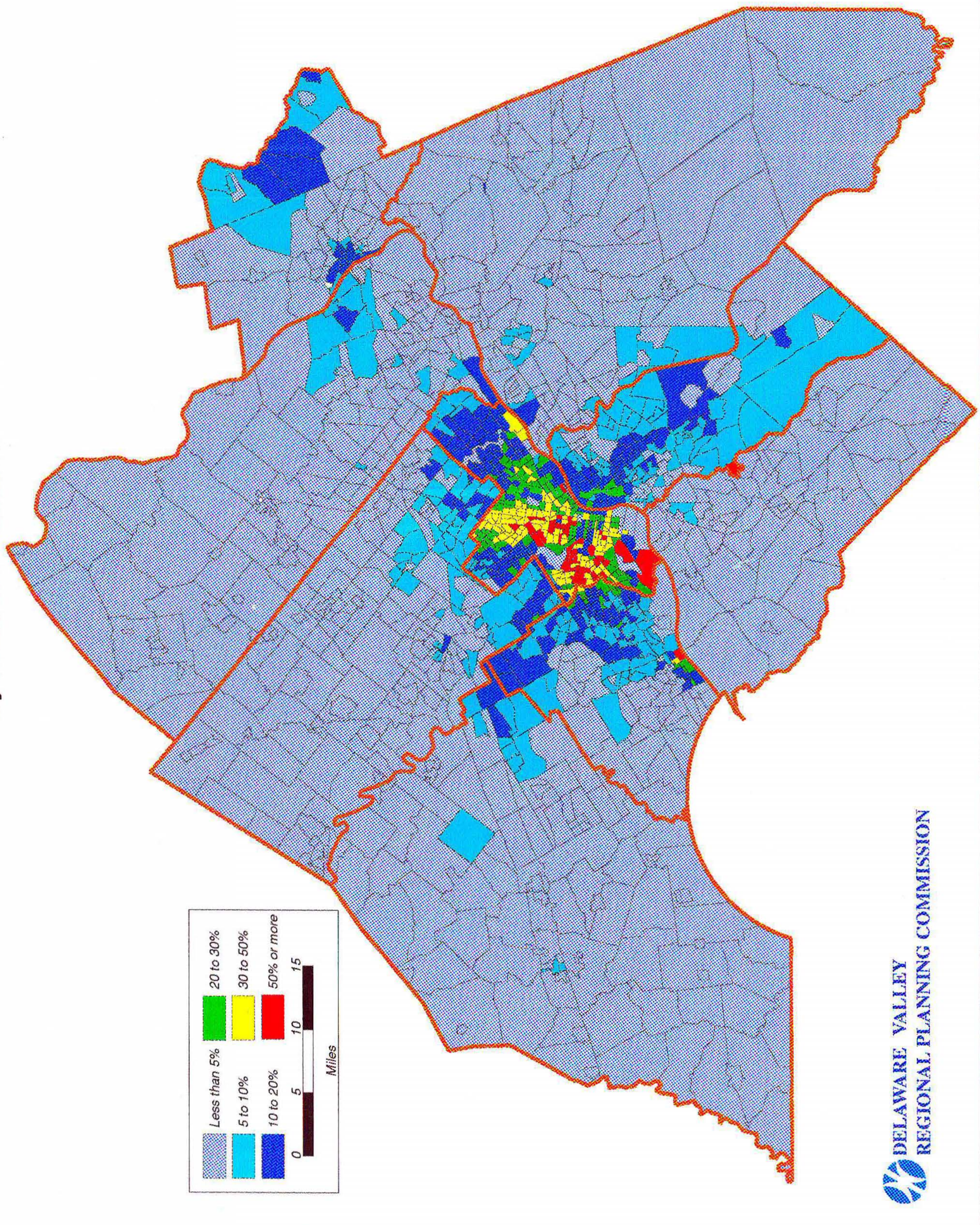
The 1990 Census Journey-To-Work and municipal boundary databases via GIS-T were used to compare the Census numbers with the findings of rail station customer and license surveys for remote portions of the region and areas external to the region. TransCAD software has a special procedure to display on the screen and map graphically the desired travel behavior from origin to destination using the region's transportation network. This procedure was utilized the study.

4. PA Turnpike/I-95 Interchange- CMS and MIS Analysis

The purpose of this project is to study strategies to determine the most effective forms of reducing Vehicle Miles of Travel within the study area, as well as throughout the region.

Figure 7.

Share of Work Trips Taken on Public Transportation by Place of Residence



The GIS-T TransCAD system is used to gather initial demographic information that will be used as input data to the CMAQ modeling analysis. This CMAQ analysis will then be used to determine reductions in VMT for the study area and the DVRPC region.