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Air Quality Case Studies Report

August 1995
Final Report

SEEING CLEARLY...A Series of Reports on Transportation and Air Quality

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Office of Environment and Planning
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Prepared by

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13. ABSTRACT (Maximum 200 words)

The Federal Highway Administration (FHWA) recognizes that many metropolitan areas are struggling with how to respond adequately to the 1990 Clean Air Act Amendments (CAAA) and the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA), particularly the process for establishing the conformity of the transportation improvement programs (TIPs) and long-range transportation plans. Political representatives and technical staff from state, regional, and local governments have asked the Federal Government to provide more information on the air quality conformity processes that have been adopted by different metropolitan areas. These case studies document the processes in the Denver, Raleigh-Durham, Philadelphia, and Washington, D.C. nonattainment areas, focusing on travel demand and air quality modeling. Also included is information on regional demographic and economic forecasting, jurisdictional and institutional issues, technical issues and concerns, and the estimated cost of determining conformity.

The conformity processes in each of the case studies were conducted under the United States Department of Transportation (US DOT)/United States Environmental Protection Agency (EPA) Interim Conformity Guidance. Even with the issuance of the Final Conformity Guidance in November 1993, the case studies contain relevant information that could prove useful to different metropolitan areas in preparing the next round of conformity analyses.

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METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)
1 foot (ft) = 30 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2 = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2 = 0.09 square meter (m_2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectares (he) = 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gr)
1 pound (lb) = .45 kilogram (kg)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)
1 tablespoon (tbsp) = 15 milliliters (ml)
1 fluid ounce (fl oz) = 30 milliliters (ml)
1 cup (c) = 0.24 liter (l)
1 pint (pt) = 0.47 liter (l)
1 quart (qt) = 0.96 liter (l)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)
1 centimeter (cm) = 0.4 inch (in)
1 meter (m) = 3.3 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square meter (m^2) = 1.2 square yeards (sq yd, yd^2)
1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
1 hectare (he) = 10,000 square meters (m^2) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gr) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

VOLUME (APPROXIMATE)

1 milliliters (ml) = 0.03 fluid ounce (fl oz)
1 liter (l) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] °C = x °F

QUICK INCH CENTIMETER LENGTH CONVERSION

INCHES: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

CENTIMETERS: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 25.40

QUICK FAHRENHEIT-CELSIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NBS Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SD Catalog No. C13 10286.

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LIST OF ABBREVIATIONS

APCD	Air Pollution Control Division
AQCC	Colorado Air Quality Control Commission
BEA	United States Bureau of Economic Analysis
CAAA	Clean Air Act Amendments of 1990
CMSA	Consolidated Metropolitan Statistical Area
CMAQ	Congestion Management and Air Quality Funds
CO	carbon monoxide
Del DOT	Delaware Department of Transportation
DRCOG	Denver Regional Council of Governments
DVRPC	Delaware Valley Regional Planning Commission
EPA	United States Environmental Protection Agency
ETRP	Employee Trip Reduction Program
FHWA	Federal Highway Administration, US Department of Transportation
FIP	Air Quality Federal Implementation Plan
FTA	Federal Transit Administration, US Department of Transportation
GIS	Geographical Information Software
HC	hydrocarbons
HOV	high occupancy vehicle
HPMS	Highway Performance Monitoring System
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
IVHS	Intelligent Vehicle Highway System
LAN	local area network
LOV	low occupancy vehicle
LRT	light rail transit
MARC	Maryland Commuter Rail
Maryland DOT	Maryland Department of Transportation
MINUTP	A Travel Demand Simulation Package
MPO	Metropolitan Planning Organization
MSA	Metropolitan Statistical Area
MWAQC	Metropolitan Washington Air Quality Committee
MOBILE	US Environmental Protection Agency's Mobile Emissions Model
NAAQS	National Ambient Air Quality Standards
NJ DEPE	New Jersey Department of Environmental Protection and Energy
NJ DOT	New Jersey Department of Transportation
NMHC	nonmethane hydrocarbons
NO_x	nitrous oxide
NCDOT	North Carolina Department of Transportation
PM_{10}	small particulate matter
PennDOT	Pennsylvania Department of Transportation
PennDER	Pennsylvania Department of Environmental Resources
RAQC	Regional Air Quality Council

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RDS	Delaware Valley Regional Planning Commission's 2010 Regional Development Strategy
RTD	Regional Transportation District (Denver)
RVP	Reid Vapor Pressure
SJTPO	South Jersey Transportation Planning Organization
SIC	standard industrial classification
SIP	state implementation plan
3-C	Continuing, Cooperative, and Comprehensive Planning Process
TAZ	traffic analysis zone
TCM	Transportation Control Measure
TDM	Transportation Demand Management
TIP	Transportation Improvement Program
TPB	National Capital Regional Transportation Planning Board
TRANPLAN	A Travel Demand Simulation Package
TSM	Transportation Systems Management
US DOT	United States Department of Transportation
UPWP	Unified Planning Work Program
UTPP	urban transportation planning process
UTPS	urban transportation planning software
VMT	vehicles miles traveled
VOC	volatile organic compound
Volpe Center	John A. Volpe National Transportation Systems Center, Research and Special Projects Administration, US Department of Transportation
WashCOG	Washington Council of Governments
WILMAPCO	Wilmington Metropolitan Area Planning Coordinating Council
WMATA	Washington Metropolitan Area Transit Authority

1. INTRODUCTION

The Federal Highway Administration (FHWA) recognizes that many metropolitan areas are struggling with how to respond adequately to the 1990 Clean Air Act Amendments (CAAA) and the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). Of particular concern is the process for establishing the conformity of the transportation improvement programs (TIPs) and long-range transportation plans. Political representatives and technical staff from state, regional, and local governments have expressed interest in the Federal Government providing more information on the air quality conformity processes that have been adopted by different metropolitan areas. In response to this interest, case studies have been prepared to document the processes in the Denver, Raleigh-Durham, Philadelphia, and Washington, D.C. nonattainment areas. These case studies focus on travel demand and air quality modeling; however, they also include information on regional demographic and economic forecasting, jurisdictional and institutional issues, technical issues and concerns, and the estimated cost of determining conformity.

The conformity processes described in each of the case studies were conducted under the United States Department of Transportation (US DOT)/United States Environmental Protection Agency (EPA) Interim Conformity Guidance. Even with the issuance of the Final Conformity Guidance in November 1993, the case studies contain relevant information that could prove useful to different metropolitan areas in their preparation of the next round of conformity analyses.

Recognizing that each metropolitan area is distinct in its approach to resolving issues, these case studies are not intended to be paradigms. Nonetheless, similarities among metropolitan areas exist, and each of their experiences establishes benchmarks for other metropolitan areas to assess their approaches or progress toward meeting the Federal requirements.

The case studies focus on metropolitan level planning within the ozone nonattainment area. As a result, the case studies include information on the ongoing air quality conformity processes for each metropolitan area (and their urban transportation planning processes (UTPP) within any of these ozone nonattainment areas (table 1). The carbon monoxide (CO) or small particulate matter (PM_{10}) nonattainment areas are also of interest and are covered; however, they typically cover smaller geographical areas than the ozone nonattainment areas.

Three of the case studies - Philadelphia, Washington, D.C., and Raleigh-Durham - discuss how inconsistencies exist between the geographical designation for the nonattainment areas and the planning boundaries for metropolitan transportation planning. The Philadelphia nonattainment area covers four states and includes four metropolitan planning organizations (MPOs). The Washington, D.C. nonattainment area also covers more than one state (Maryland, Delaware, and Washington, D.C.), but has only one MPO. Unlike the Philadelphia nonattainment area, the Washington, D.C. nonattainment area also includes non-urbanized areas outside of the MPO's planning boundaries. Despite the geographical proximity of Raleigh and Durham (25 miles), they have separate MPOs and air quality conformity processes.

Table 1. Overview of Metropolitan Planning Organizations within ozone nonattainment areas.

Ozone Non-attainment Area	Urbanized Areas	Metropolitan Planning Organizations	U.S. Census MSA 1990 Populations[1]
Philadelphia	Philadelphia	Delaware Valley Regional Planning Commission	4,856,887
	Wilmington	Wilmington Area Planning Coordinating Council	578,587
	Dover	Dover Metropolitan Planning Organization	
	Vineland	South Jersey Transportation Planning Organization	138,053
Washington, D.C.	Washington, D.C.	National Capital Region Transportation Planning Board/Washington Council of Governments	3,923,574
Raleigh-Durham	Raleigh	Greater Raleigh Metropolitan Planning Organization	735,480
	Durham	Durham - Chapel Hill - Carrboro Metropolitan Planning Organization	
Denver	Denver	Denver Regional Council of Governments	1,848,319
	Boulder		
	Longmont		

[1]For consistency purposes, U.S. Census Metropolitan Statistical Area (MSA) estimates are presented in this table; however, the text of this report also includes MPOs' population estimates. The U.S. Census and MPO estimates do not necessarily agree. The MSA and the MPO's planning boundaries do not always coincide and each of the MPOs use different estimation procedures.

The four nonattainment areas that were selected - Denver, Raleigh-Durham, Philadelphia, and Washington, D.C. - represent a cross section of metropolitan areas with varying air quality, transportation, economic, geopolitical, and planning issues. They also vary in population size from small to very large (tables 2 and 3). To a great extent, they represent the mix of metropolitan areas in the United States that must meet the requirements of the CAAA.

Table 2. Air quality designations for nonattainment and urbanized areas.

Nonattainment and Urbanized Areas	Air Quality Designations		
	Ozone	**Carbon Monoxide**	**Small Particulate Matter**
Philadelphia	Severe	Moderate	
Wilmington	Severe	Attainment	
Dover	Severe	Attainment	
Vineland	Severe	Attainment	
Washington, D.C.	Serious	Moderate	
Raleigh	Moderate	Moderate	
Durham	Moderate	Moderate	
Denver	Transitional	Moderate	Moderate

For example, Raleigh and Durham, which have been designated moderate for ozone and CO, are smaller metropolitan areas that have experienced high rates of population and travel growth over the last ten years. Even though bus service is available in both cities, their respective transit mode shares are very low. Consideration is being given to adopting policies that will encourage denser land development; however, highway construction is the focus of Raleigh and Durham's transportation investment programs. Since the respective MPOs have limited staff, the required technical analyses, such as travel demand and air quality modeling, are conducted by the North Carolina Department of Transportation (NCDOT).

In contrast, the Philadelphia metropolitan area, which has been designated in severe nonattainment for ozone and moderate for CO, has experienced an average annual population growth rate of only about 0.4 percent. The region has an old and complex transportation infrastructure, which includes the following transit modes: bus; heavy and light rail; trolley; and commuter rail. Thus, the focus of its transportation plan and program is the reconstruction of the existing infrastructure. The MPO for the Philadelphia area has in-house staff capable of completing the required transportation and air quality technical analyses, all of which are conducted with the close cooperation of the Pennsylvania and New Jersey Departments of Transportation and environment (or natural resources).

Table 3. An overview of urbanized areas' demographic, transportation, institutional, and planning features.

Urbanized Areas	Compound Annual Growth Rate 1980-1990 (%)	Transportation Infrastructure (includes limited comments about highway networks)	Institutional and Planning Issues
Philadelphia (PMSA)	.4	Extensive, but aging highway and transit networks. Transit includes rail, trolley and bus service. Also, have extensive commuter rail.	Due to its geopolitical coverage, the MPO must coordinate closely with state agencies in Pennsylvania and New Jersey. This requires completing emission runs that reflect the policies and conditions of the two states.
Wilmington (PMSA)	1	Bus service	The MPO, which also includes Cecil County, Maryland, has limited staff. Consequently, it relies on the Delaware and Maryland Departments of Transportation for technical support. One of its member counties, Salem County, New Jersey, recently left to join a newly created MPO made up of southern New Jersey counties.
Dover (Kent County)	1 (1980-1986)	Limited bus service	The MPO was recently formed and only has one part-time staff person. It relies on the Delaware DOT for completing its conformity analyses.
Vineland (PMSA)	.6		The MPO is a member of the Southern Jersey Transportation Planning Organization, which was recently formed to serve Cumberland, Salem, and Cape May counties. It relies on New Jersey DOT for completing its conformity analyses.

Table 3. An overview of urbanized areas' demographic, transportation, institutional, and planning features (continued).

Urbanized Areas	Compound Annual Growth Rate 1980-1990 (%)	Transportation Infrastructure (includes limited comments about highway networks)	Institutional and Planning Issues
Washington, D.C. (MSA)	2	Bus and heavy rail service	The multistate area is served by one MPO. The conformity technical analyses for donut areas located in southern Maryland are being conducted by the MPO's technical staff. A separate independent regional committee has been formed to focus on the development of the regional air quality strategy and implementation plan.
Raleigh	3 (for Raleigh-Durham MSA)	Bus service	The MPO has limited technical staff. The North Carolina DOT has a strong statewide planning staff that prepares the urbanized area's long-range plan and conformity analysis. The area has experienced strong growth. New highway construction is the focus of its capital investment program.
Durham		Bus service	The MPO has limited technical staff. The North Carolina DOT has a strong statewide planning staff that prepares the urbanized area's long-range plan and conformity analysis. The area has experienced strong growth. New highway construction is the focus of its capital investment program.
Denver (CMSA)	1	Bus service. Have begun constructing one leg of a proposed light rail system through downtown.	The MPO, which has the responsibility for making the air quality conformity determination, shares responsibility for the technical analyses with the Air Pollution Control Division of the Colorado Department of Health. The MPO does the travel demand modeling and the state generates the emissions estimates.

2. FINDINGS

This section presents an overview of the case studies focusing on what has been learned in each of the four areas. The discussions of procedures are purely descriptive; no attempt has been made to analyze or critique the approaches that have been adopted.

The findings are based on reviews of metropolitan air quality conformity analyses and telephone conversations with Federal, State, regional, and local planners and engineers who have been involved in the processes. (The names of each case study's participants are listed in the appendix.)

The discussion highlights similarities and differences in the approaches adopted by these metropolitan areas, and identifies problems that might be addressed by future Federal Government action (either by providing additional technical and informational support or determining future policy changes).

2.1 DETERMINING CONFORMITY - TRANSPORTATION IMPROVEMENT PROGRAM AND TRANSPORTATION PLAN

Under the CAAA, all transportation plans and programs that include Federally funded projects must conform to a state implementation plan (SIP). As interpreted in regulations issued to implement the conformity provision of the CAAA, this means that the expected emissions from transportation plans and TIPs must be found to be consistent with the implementation plan's required schedule of motor vehicle emissions reductions.

2.1.1 TIP Evaluation

The conformity analyses conducted by the metropolitan areas were overwhelmingly based on projects included in the TIPs. The project listings in the TIPs were used to establish baseline and action ("build" and "no-build") scenarios for evaluating emission levels in the milestone and attainment years.

2.1.2 Plan Evaluation

The focus of the evaluations was not on the long-range plans and whether or not they conformed to the SIPs. Recognizing the traditional relationship between plan and program in the UTPP, this is a reasonable approach. It assumes that the projects in the TIPs are based on or derived from the policies, goals, and strategies expressed in the long-range transportation plan. Unfortunately, long-range plans have not always been developed at a level of specificity that identifies what transportation projects will be in place at different time frames within the planning period.

The requirements of the final rules for conformity and metropolitan transportation planning under the CAAA and ISTEA will strengthen the relationship between plans and programs. Long-range plans will have to become more than policy statements; they will have to include a level of project specificity which will enable MPOs to establish whether or not the plans are financially constrained. As a result, future conformity determinations will shift from the present emphasis of evaluating projects listed in the TIPs to a more comprehensive assessment of those projects identified in the long-range plans.

2.2 INCONSISTENCY BETWEEN NONATTAINMENT AND MPO PLANNING AREAS

The nonattainment areas (particularly for ozone) and the geopolitical boundaries of the entities responsible for completing the conformity analyses rarely coincide. This situation arises because the boundaries of designated nonattainment areas relate more to the measurement of emission levels than the metropolitan boundaries that form the basis for planning areas. This inconsistency creates a level of complexity. (For example, more than one MPO or state may make up a nonattainment area; a part of a nonattainment area may lie outside an MPO; and more than one nonattainment area may lie within the planning area.). This complexity also makes it very difficult to ascertain the **total** nonattainment area's progress toward reducing emissions.

The Interim and Final Conformity guidelines permit one determination of conformity for nonattainment areas with more than one metropolitan area. Since the focus of urban transportation planning (from the Federal perspective) has been at the metropolitan planning level, this has resulted in each MPO in the nonattainment area completing a conformity determination.

There are also areas (sometimes referred to as "donut" areas) that have not joined an MPO, but must still meet the conformity requirements. The completion of conformity analyses in these "donut" areas has in some instances required special agreements with an organization capable of conducting the technical analyses.

Some of the jurisdictional and institutional issues that were identified in the case studies are described below.

2.2.1 <u>Multiple MPOs</u>

The Philadelphia Ozone nonattainment area covers four states and includes four different MPOs. The Delaware Valley Regional Planning Commission (DVRPC), which serves as the MPO for the Philadelphia area (and covers eight out of the fourteen counties that make up the ozone nonattainment area), has in-house staff capable of completing the required transportation and air quality technical analyses. The other MPOs located in the nonattainment area have limited staff, and must therefore rely on their respective state Departments of Transportation to complete the technical analyses.

The Raleigh and Durham areas were newly designated as a single moderate nonattainment area for CO and ozone in 1991, even though the two urban areas maintain separate UTPPs. To comply with the requirements of the CAAA, the Greater Raleigh MPO and the Durham-Chapel Hill-Carrboro MPO made conformity determinations based on their respective TIPs and long-range transportation plans.

2.2.2 "Donut" Areas

The Washington, D.C. ozone nonattainment area boundary extends beyond the MPO's planning boundaries to include Charles and Calvert counties in southern Maryland. By agreement, the Washington Council of Governments (WashCOG), which conducts the technical analyses for determining conformity on behalf of the region's MPO (the National Capital Region Transportation Planning Board), has incorporated Charles County into its travel demand and air quality modeling efforts. Over the coming year it will also incorporate Calvert County. Incorporating these two counties makes good sense because considerable suburban development has occurred in southern Maryland as a result of high rates of growth and steep increases in housing values in those counties adjacent to Washington, D.C.

The Raleigh-Durham ozone nonattainment area does not coincide with the combined boundaries of the two MPOs. A rural, unincorporated portion of the nonattainment area currently lies outside Durham's MPO planning area. Even though EPA has indicated in writing that it would like this area included in the conformity analysis, the MPO and the state have chosen not to do so since the area is rural and these agencies consider it to have little or no impact on the region's ambient air quality.

In response to the 1990 Census and ISTEA requirements, the Greater Raleigh MPO has recently expanded its boundaries so that they now approximate those of their portion of the ozone nonattainment area. Even so, due to a lack of travel data, no adjustments have been made to the region's travel model to incorporate the expanded land area.

2.2.3 Multiple Nonattainment Areas within a Planning Area

The city of Longmont, which is a member of the Denver MPO (the Denver Regional Council of Governments), is part of a separate nonattainment area for CO. Since it is part of Denver Regional Council of Government's (DRCOG) regional transportation modeling effort, DRCOG generates socioeconomic and transportation demand estimates for the Longmont urbanized area to use in its air quality planning.

2.3 CONSULTATION AND COORDINATION

To meet the requirements of the CAAA, MPOs, and state agencies (Departments of Transportation, natural resources, environment or public health) have had to form close working relationships. Through the Ozone Transport Commission, a group of northeastern states has forged a working relationship for coordinating policy; however, limited consultation or coordination appears to exist among organizations with conformity responsibility within individual ozone nonattainment areas or in adjacent nonattainment areas. Even though it is possible to track the anticipated progress by urbanized area, this would be difficult to accomplish for nonattainment areas with more than one MPO.

2.4 INSTITUTIONAL ARRANGEMENTS FOR COMPLETING TECHNICAL ANALYSES

In urbanized areas, MPOs are required by the CAAA to make the air quality conformity determination. Only the country's larger MPOs appear to have the staff and technical expertise to complete the analysis that is necessary to support this determination. This means that many MPOs have had to seek technical support from state agencies or consultants. Also, in certain urban areas, political considerations appear to influence the choice of which agencies complete the technical work.

2.4.1 State Support

The research that has been conducted for these four case studies indicates that MPOs covering urbanized areas with populations less than one million do not usually have very large staffs or individuals with the technical expertise to conduct the analyses that are necessary for determining conformity. The MPOs contacted in Delaware, New Jersey, and North Carolina that fall into this category rely on their State Departments of Transportation to conduct travel and air quality modeling. Without these centralized statewide functions, many MPOs would have had difficulty completing the air quality conformity analyses mandated by the CAAA.

The relationship between NCDOT and the state's MPOs illustrates this point best. NCDOT's Statewide Planning Branch supports, develops and operates regional transportation models, and prepares long-range plans, known as thoroughfare plans, for the state's urbanized areas (except Charlotte). It also conducts air quality conformity analyses (i.e., running EPA's MOBILE model) for the state's seven nonattainment areas.

2.4.2 Consultant Support

Among the agencies that were contacted, the use of consultants for the purpose of determining conformity has been limited. The Delaware Department of Transportation (Del DOT), which conducts the conformity analyses for the Wilmington and Dover areas, has contracted with a consultant to assist with its MOBILE runs. Also, Del DOT recognized that it needed consultant support to ensure continued progress toward meeting the mandated deadlines. Over time, it plans to augment its in-house expertise and rely less on consultant services. Similarly, WashCOG has contracted with a consultant to assist in the development of inputs for the MOBILE model and to run the model.

Consultants are also being used by some MPOs and state transportation agencies to identify, evaluate, and quantify the impacts of transportation control measures (TCMs). Conformity and SIP requirements necessitate the quantification of the potential impact of TCMs; however, little is known about the effect different categories of TCMs will have on emissions.

2.4.3 Shared Responsibilities

In Denver, the technical analyses that support the conformity determination are a shared responsibility between DRCOG and the Air Pollution Control Division (APCD) of the Colorado Department of Health. DRCOG, which has the responsibility for making the air quality conformity determination, conducts the travel demand modeling while the APCD generates emissions estimates using EPA's MOBILE model.

Due to DVRPC's geopolitical coverage, the Pennsylvania and New Jersey State Departments of Transportation are actively involved in the air quality conformity process. This involvement consists primarily of reviewing or providing input data necessary to complete MOBILE model runs.

2.5 FORMATION OF ADDITIONAL INSTITUTIONAL ARRANGEMENTS

In the Washington, D.C. and Denver metropolitan areas, additional policy-making bodies or organizations have been formed to ensure the regions' compliance with the CAAA. The focus of these organizations is primarily on meeting SIP requirements rather than on making conformity determinations.

2.5.1 Regionwide Air Quality Committee - Washington, D.C. Region

The Metropolitan Washington Air Quality Committee (MWAQC), which includes all of the jurisdictions that make up the ozone nonattainment area, is charged with developing and adopting strategies for reducing emissions from mobile and stationary sources to be included in the nonattainment area's 15 percent volatile organic compound (VOC) reduction plan. Its membership includes a number of jurisdictions that are not participants in the MPO, as well as representatives from the Maryland, Virginia, and Washington, D.C. Departments of Transportation. All individuals representing participating jurisdictions are elected officials.

2.5.2 State Involvement in Establishing Regionwide Air Quality Policy - Denver Region

Air quality planning in the Denver region is a cooperative effort conducted by DRCOG, APCD of the Colorado Department of Health, and the Regional Air Quality Council (RAQC). The RACQ, which was created in 1989 by the Governor, is designated as the lead agency for air quality planning in the Denver nonattainment area, and is responsible for preparing the Denver portions of the state implementation plans (SIPs). (As already stated, DRCOG and the APCD share responsibility for conducting the analyses necessary to support a conformity determination.)

The RACQ was formed after consultation by the Governor with local units of government in the Denver area. It has a 35-member board, 17 of whom are local elected officials appointed by cities and counties throughout the Denver region. As part of the SIP process, the RACQ identifies, analyzes, and recommends control measures to include in the SIP document relating to control of CO and ozone precursor emissions. This is accomplished by working with implementing organizations, including the state legislature and local governments.

2.6 TRANSPORTATION CONTROL MEASURES

Despite their agencies' efforts to evaluate and select TCMs, several of the participants expressed concern about the focus in the CAAA on the use of TCMs to achieve air quality standards. The general sentiment they expressed is that TCMs are unlikely to be very effective, and that too much time is being spent on implementing measures that will not bring air quality results rapidly. Even though TCMs are not perceived to be an effective strategy for achieving air quality goals, they are perceived positively as a means to influence people's travel choices.

2.6.1 TCM Evaluation

A number of individuals who were contacted said that they would like the Federal Government to provide standardized methods or travel demand modeling tools for evaluating the marginal impact of different TCMs. To quantify the marginal impact of a range of TCMs on future levels of emissions, different MPOs and State Departments of Transportation have sought outside assistance from consultants.

2.6.2 Identification of Effective TCMs for Large Urbanized Areas with an Aging Infrastructure

The Philadelphia metropolitan area has been struggling to identify TCMs that (1) are compatible with its older, multimodal transportation infrastructure, (2) will have a measurable impact on air quality, and (3) will be acceptable to an active and demanding environmental community. The region is not committed to the construction of high occupancy vehicle (HOV) lanes on areawide expressways since many of the region's expressways are only four lanes and limited room exists to accommodate the addition of high occupancy lanes. Also, the addition of HOV lanes is difficult to justify in corridors that are already served by rail transit and commuter rail.

2.6.3 Appropriateness of TCMs in Smaller Urbanized Areas with High Growth Rates

NCDOT's long-range planning for Raleigh and Durham focuses on reducing system-wide congestion and emissions by building missing highway links (including freeways), widening roads, and improving intersections and signalizations. TCMs are not included in the thoroughfare plans for the different metropolitan areas. They have not been seriously considered as a means to reduce vehicle miles traveled (VMTs) and improve air quality since they are perceived to be possibly expensive solutions with no guarantees of effectively reducing VMTs and auto emissions. Given the nonattainment area's moderate designation for ozone and CO, committing to these potentially costly and disruptive actions could be difficult for planners and local officials to justify.

2.6.4 Quantification of the Effect of TCMs on Statewide Emissions Levels

Recently, the New Jersey Department of Transportation (NJ DOT) (with the assistance of a consultant) conducted an analysis to determine the extent to which TCMs, proposed by local governments and MPOs throughout the state, and employee trip reduction programs would impact statewide air quality. The analysis, which included 500 to 600 TCMs, concluded that these measures would result in an aggregate statewide reduction of 8.39 tons per day of VOC. This represents only 4 percent of the total VOC reduction that New Jersey must achieve.

2.7 REGIONAL LAND USE AND AIR QUALITY PLANNING

ISTEA encourages governmental units to consider the interaction between land use and transportation. In addition, environmentalists have advocated the adoption of policies that would encourage greater residential densities and other changes in land use patterns as a means of reducing vehicle miles of travel.

The MPOs that were contacted have no regulatory power to affect land use or land development. Through the continuing, cooperative and comprehensive (3-C) planning process MPOs along with state and regional transportation organizations have the mechanism for programming transportation capital investments with potential long-term impacts on land development.

Different agencies are also initiating planning activities that could affect land development and transportation supply. Specific activities that are ongoing in North Carolina and Delaware at the regional level are described below.

2.7.1 North Carolina

In response to the growing economic interaction among Raleigh, Durham, and Chapel Hill, the Triangle Transit Authority was recently formed to provide inter-urban transit service. It is currently providing bus service to the cities within the Triangle, and studying the feasibility of constructing a regional fixed-guideway system. As part of this research, the Authority is considering alternative land use scenarios which assume the development of transit-dependent communities and much denser inter-urban corridors.

Also, a neotraditional neighborhood was recently proposed for the Chapel Hill area. Its developers claimed that this land development concept would produce 60 percent fewer trips than a traditional single family housing development.

Despite these planning activities, staff members of NCDOT's Statewide Planning Branch generally do not anticipate any significant changes in land use patterns over the long term. The Raleigh-Durham region continues to experience high growth and local jurisdictions have not yet adopted land use policies or regulations that would encourage denser development patterns.

2.7.2 Delaware

Del DOT, which has responsibility for almost all roads within the state (including many minor collectors), has developed extensive computerized representations of the highway networks serving three of its most urban counties. These networks are being used for travel demand modeling purposes (Del DOT uses TRANPLAN to complete the travel analyses). It has linked TRANPLAN to a geographical information software (GIS) program (MapInfo), which also allows access to extensive demographic, land use, and employment location data. This enables Del DOT to conduct interactive analyses. Analysts can produce highway simulations for the base year and any horizon year, and analyze the impact of new development proposals on the transportation network. For example, Del DOT used the system to analyze the potential impact of a proposed Mercedes-Benz assembly plant. It also facilitated analyzing travel and emissions under "build" and "no-build" scenarios as part of the air quality conformity analysis process for different milestone years.

2.8 TRAVEL DEMAND MODELING

Generally, the travel demand models that are being used by planning agencies interviewed for this study represent the state-of-the-practice. For the most part, a 4-step travel demand estimation process is being used. Travel demand forecasting packages, such as TRANPLAN and MINUTP, operated on high performance microcomputers, are the typical means for conducting the analysis. Two different MPOs, DRCOG, and DVRPC, are continuing to use their mainframes for all or parts of their analyses.

2.8.1 Availability of Current Travel Data and Model Updates

Many of the travel demand models that are in use were calibrated using travel behavior inventories or surveys that were conducted in the 1960s and 1970s. For example, Del DOT's models are based on a travel behavior survey that was conducted in the 1960s.

The Triangle Transit Authority, which serves Raleigh, Durham, and Chapel Hill, will be conducting a multimodal travel survey as part of its inter-city rail study. The survey, which will be used to estimate a new regional travel demand model, will be the first comprehensive travel survey to be conducted in North Carolina in 20 years.

Even though many regions' technical analysts have been interested in undertaking new travel behavior surveys, they have been unable to secure sufficient funds or support from local policymakers. The Denver region has repeatedly included travel demand surveys in its Unified Planning Work Program (UPWP); however, it has not been able to proceed with extensive survey work due to funding constraints.

Nevertheless, travel behavior surveys that are limited in scope have been conducted in different regions so that their transportation planning models can be updated or enhanced. For example, WashCOG adjusted its trip generation, distribution, and car occupancy submodels in 1992 to conform to data that were obtained from a 1987/88 home interview survey and traffic counts conducted in 1990. Similarly, DVRPC has recalibrated its model using cordon counts, together with a home survey that was conducted in the late 1980s.

During 1994, WashCOG is planning to update and recalibrate its mode choice model, and to review the entire model chain as U.S. Census data become available. This will consist of comparing estimated and observed trips and then adjusting the model's constant and coefficients to correspond more closely to observed behavior.

For the Philadelphia region, the 1960 Penn-Jersey Study was the original source for the trip generation data. Since then, these trip rate data have been validated in 1970 and 1980 using screenline counts. A home survey completed from 1988 to 1989 indicates that the basic relationships have remained stable, although the number of trips per household has increased. In response to this, DVRPC intends to increase the trip rates in its cross-classification matrix.

2.8.2 <u>Truck Trip Estimation</u>

Only two of the areas that were contacted, Denver and Washington, D.C., are generating internal truck trip estimates.

2.8.3 <u>Mode Split Estimation</u>

The travel demand models that are used in Raleigh, Durham, and southern New Jersey exclude the mode split step. Since transit represents less than 1 percent of total person trips in both Raleigh and Durham, NCDOT subjectively estimates transit shares based on actual route patronage and expected extensions of the bus system.

2.8.4 Model Enhancements

Three of the MPOs, WashCOG, DVRPC, and DRCOG, are beginning to consider enhancements (e.g., feedback loops) to their travel demand models, which would enable them to estimate peak hour travel and assess policy and land use changes. In some regions, consideration is also being given to enhancing the models so that they would be able to estimate bicycle travel.

Even though strong interest exists in making many of these improvements, limited progress has been made. The staffs are hampered by funding constraints and approval from policy makers.

WashCOG has programmed a number of these enhancements in its fiscal year 1994 UPWP. It plans on improving trip generation by developing a model to estimate car ownership. The model would be based on income, transit service availability, area type (e.g., inner city, urban, or suburban), and land-use density. It is also planning on differentiating between peak and nonpeak hour travel during the trip distribution and trip assignment stages by creating a feedback loop that cycles back congested travel times by time of day.

2.8.5 Interface Between Travel Demand and Air Quality Models

The conversion of the travel assignment output into an estimation of emissions using EPA's MOBILE model is somewhat cumbersome. To improve the interface between the two modeling processes, three of the organizations that were contacted have developed a post-processor program. These programs are being used to convert the daily travel into hourly estimates, and compute vehicle miles of travel and associated speeds.

2.9 AIR QUALITY MODELING

Different individuals expressed concerns about the accuracy of EPA's MOBILE model and the current practice of air quality planning. According to planners with NCDOT, MOBILE produces higher emissions results for high speed facilities than it produces for arterials which have acceleration and deceleration cycles of greater amplitude and frequency. In addition, planners stated that the conformity analysis process attempts to produce results at a level of precision and accuracy far greater than the inputs. The inputs are based on techniques or methods with considerable variability or error. That is, surveys and travel demand models do not produce exact results.

2.10 FUTURE TECHNICAL AND INFORMATIONAL NEEDS

The technical and informational needs expressed by the case studies' participants were very comparable. Overwhelming interest exists for the Federal Government to provide more information and technical support. The following topics were identified by participants:

- Different modeling procedures that have been adopted by metropolitan areas and states;
- Roles and responsibilities different organizations are assuming in SIP development;
- How TCMs are being modeled;
- Employee Commute Option programs that have been developed;
- Strategies for reducing the hydrocarbon baseline emissions as well as nitrous oxides (NO_x) emissions;
- Different uses for applications of Congestion Management and Air Quality funds; and
- New transportation model packages, and corridor-specific air quality models.

Many of the participants expressed interest in the Federal Government conducting more regional or multiregional meetings with representatives from different state or regional transportation agencies. In this way, representatives of different organizations would have an opportunity to share their experiences or approaches to meeting the requirements of the CAAA.

Other suggestions included: (1) issuing a bulletin on a regular basis that reports how different metropolitan areas and states are proceeding with their air quality planning; and (2) conducting a survey of metropolitan areas followed by a summary report that highlights successes and problems encountered in attempting to meet CAAA milestones.

3. CONCLUSIONS

The case studies indicate that the metropolitan areas are moving forward with implementing the required air quality conformity and transportation planning processes; however, continued guidance and technical support is needed from the Federal Government. A number of conclusions can be reached regarding the progress made by metropolitan areas in conducting air quality conformity analyses and the support or guidance that they will need to improve the process.

- Completing the air quality conformity process and demonstrating a region's progress in attaining the National Ambient Air Quality Standards is frequently hampered by: (1) the inconsistencies between the geographical designation for the nonattainment areas and the planning boundaries for metropolitan transportation planning areas; (2) the differences among the air quality and transportation policies adopted by states that must work together to reduce emissions in a nonattainment area; (3) the lack of consultation among MPOs located within a nonattainment area who are each conducting conformity determinations; and (4) the limited staff size and technical capabilities among many MPOs, particularly in areas with populations of less than one million.

- In many metropolitan areas, particularly those with populations of less than one million, the demonstration of air quality conformity is dependent upon the technical capabilities of the in-house technical staffs of the State Departments of Transportation.

- Due to differences among the metropolitan areas stemming from economic and demographic growth patterns and existing transportation infrastructure, the approaches to meeting the regions' travel demands and emissions reduction requirements vary. In fast growing areas, the construction of missing links in the highway network is considered necessary to improve traffic flow and alleviate congestion. In contrast, the focus of the TIP in areas with complex and older transportation systems is on highway and transit reconstruction rather than the implementation of TCMs and management systems.

- A considerable amount of concern exists among planners and policy makers about the focus in the CAAA on the use of TCMs to achieve air quality standards. The concern is that TCMs are unlikely to be effective in contributing to the rapid reduction in emissions that is mandated.

- Due to inconsistencies between the state-of-the-practice urban transportation models that are used and the MOBILE model, serious questions remain regarding the accuracy of the emissions calculations (by link and speed) that are being produced. This requires the development of additional transportation and air quality modeling enhancements.

- Not all metropolitan areas are estimating truck trips and considering their impact on regional air quality.
- More technical information and guidelines are needed so that regions can improve their air quality analysis and planning for NO_x and small PM_{10}.

4. RALEIGH AND DURHAM METROPOLITAN AREAS

4.1 OVERVIEW

Raleigh and Durham have been historically treated as separate metropolitan planning areas. They are relatively small metropolitan areas that have experienced high growth rates. The combined population of the metropolitan areas grew from 561,222 in 1980 to approximately 738,431 in 1990, or by 32 percent.

The air quality nonattainment areas that have been designated for ozone and CO include the Raleigh and Durham metropolitan planning areas. Separate MPOs exist for each of these metropolitan areas, and they each have air quality conformity determination responsibilities.

A centralized planning function in North Carolina's Department of Transportation guides short- and long-range regional transportation planning in the state's urbanized areas (except Charlotte). This consists of developing and maintaining regional travel demand models, and preparing long-range transportation plans known as Thoroughfare Plans. As part of this planning function, NCDOT conducts air quality conformity analyses for the state's MPOs.

Due to an increase in population, the economic interaction between the cities has grown. This has been recognized by state and regional planners and they have begun to make plans for the development of a combined regional transportation model over the next three years.

Long-range planning in these metropolitan areas focuses on reducing systemwide congestion and emissions by building missing highway links (including freeways), widening roads, and improving intersections and signalizations. The metropolitan areas have not committed to TCMs to achieve reductions in emissions.

Even though the ozone and CO nonattainment areas were designated moderate in 1991, the state will request the areas to be redesignated in attainment by the end of 1993.

4.2 BACKGROUND INFORMATION

4.2.1 Jurisdictional and Institutional Issues and Responsibilities

The combined Raleigh and Durham metropolitan areas were newly designated as moderate nonattainment areas for CO and ozone in 1991. For each pollutant, the two metropolitan areas were designated as one nonattainment area even though they have separate 3-C planning processes managed by the Greater Raleigh MPO and the Durham-Chapel Hill-Carrboro MPO. To conform to the requirements of the CAAA, separate conformity analyses were completed for the two "regions" based on their respective TIPs and long-range transportation plans. To date, two rounds of conformity analyses have been completed for each of the metropolitan areas.

NCDOT's Statewide Planning Branch supports transportation planning in metropolitan areas by providing technical planning expertise. This includes the development and operation of regional transportation models and the preparation of regional long-range plans known as thoroughfare plans. The Statewide Planning Branch has also assumed responsibility for conducting air quality conformity analyses for the state's seven nonattainment areas. In doing this, NCDOT works closely with North Carolina's Department of Environment, Management, and Natural Resources' Division of Environmental Management, which has responsibility for preparing the state implementation plan (SIP).

The MPO in Charlotte is the only one in the state with the in-house modeling expertise necessary to support plan development and air quality conformity analysis. Since many of the MPOs in the state are not large enough to develop or maintain a modeling capability, the development of a centralized statewide function has proven to be advantageous. Without the state's modeling capability, many of the state's MPOs would have had difficulty completing the air quality conformity analyses mandated by the CAAA.

The technical planning performed by the Statewide Planning Branch is performed in close cooperation with the MPOs and local planning staff. Local jurisdictions are responsible for preparing population and employment estimates that are necessary to run the models. The MPOs provide policy direction and prepare annual TIPs. Statewide Planning staff and local staff cooperatively develop thoroughfare plans that address system deficiencies and alternative transportation solutions. A thoroughfare plan will become a region's official plan when adopted by the MPO, the State Board of Transportation, and the affected municipal governments.

The Statewide Planning staff has expanded its in-house expertise to support the air quality conformity process. Two of the urban coordinators have assumed greater responsibility for managing the data development and the execution of the travel demand and air quality modeling.

The Durham-Chapel Hill-Carrboro Thoroughfare Plan, which was officially approved by the MPO in October 1991, was developed more than five years ago. Even though the thoroughfare plan has been adopted by the MPO, only the city of Durham has approved its portion. Since the state is in disagreement with the Chapel Hill portion of the MPO plan, this portion has never been officially adopted. Due to this impasse and no MPO endorsement for the number of lanes for new facilities identified in the plan, a qualitative rather than a quantitative conformity determination of the thoroughfare plan was made by the Statewide Planning Branch.

NCDOT is required to develop a state TIP. In the fall of each year, the MPOs present NCDOT with a prioritized list of projects for the upcoming state TIP. During the winter, NCDOT staff, in consultation with the Board of Transportation (who are members of the MPOs' transportation advisory committees), develop a draft state TIP. The draft state TIP is then used by the MPOs as the core of their local TIPs.

The state has historically insisted that the MPOs prepare financially constrained TIPs. As a result, the state and the metropolitan areas have had more than a 90 percent track record in their implementation of programmed projects.

The nonattainment area does not coincide with the combined boundaries of the two MPOs (figures 1 and 2). Between the first and second rounds of conformity analyses, the Greater Raleigh MPO's boundaries were expanded based on the results of the 1990 census and ISTEA requirements. Due to a lack of travel data, no adjustments were made to the region's travel model to incorporate the expanded land area.

Dutchville Township is the only portion of the nonattainment area outside Durham's MPO planning area. Since this township is not incorporated and is only a small portion of Granville County, the MPO and the state have recommended against including the area within the MPO boundary. EPA has indicated in writing that it does not agree with the decision.

4.2.2 Regional and Local Planning Activities

The interaction between Raleigh and Durham has grown substantially during the last ten years. To a great extent, this can be attributed to an economic boom that has resulted in an influx of people from all over the country. Due to a greater awareness of the economic interaction of the communities in the Triangle, plans are currently being made to develop a combined Raleigh-Durham-Chapel Hill regional transportation model. Planners predict that a model will be developed in about three years.

In response to the growing economic interaction, the Triangle Transit Authority was recently formed to provide inter-urban transit service. It is currently providing bus service to the cities within the Triangle, and studying the feasibility of constructing a regional fixed guideway system. As part of this research, the Authority is considering alternative land use scenarios that assume the development of transit-dependent communities and much denser inter-urban corridors. In addition, the study will produce socioeconomic forecasts, and the first comprehensive, multimodal travel survey to be conducted in North Carolina in 20 years. Local, regional, and state planners are currently strategizing on how to use this research to develop the combined Raleigh-Durham travel demand model.

Municipally operated bus service is available in Raleigh and Durham. Transportation planners estimate transit's mode share to be less than 1 percent in Raleigh and Durham. Raleigh and Durham's daily ridership is estimated to be 12,000 and 8,500, respectively. The city of Durham recently took over control of the transit system which had been operated by the local electric utility, Duke Power.

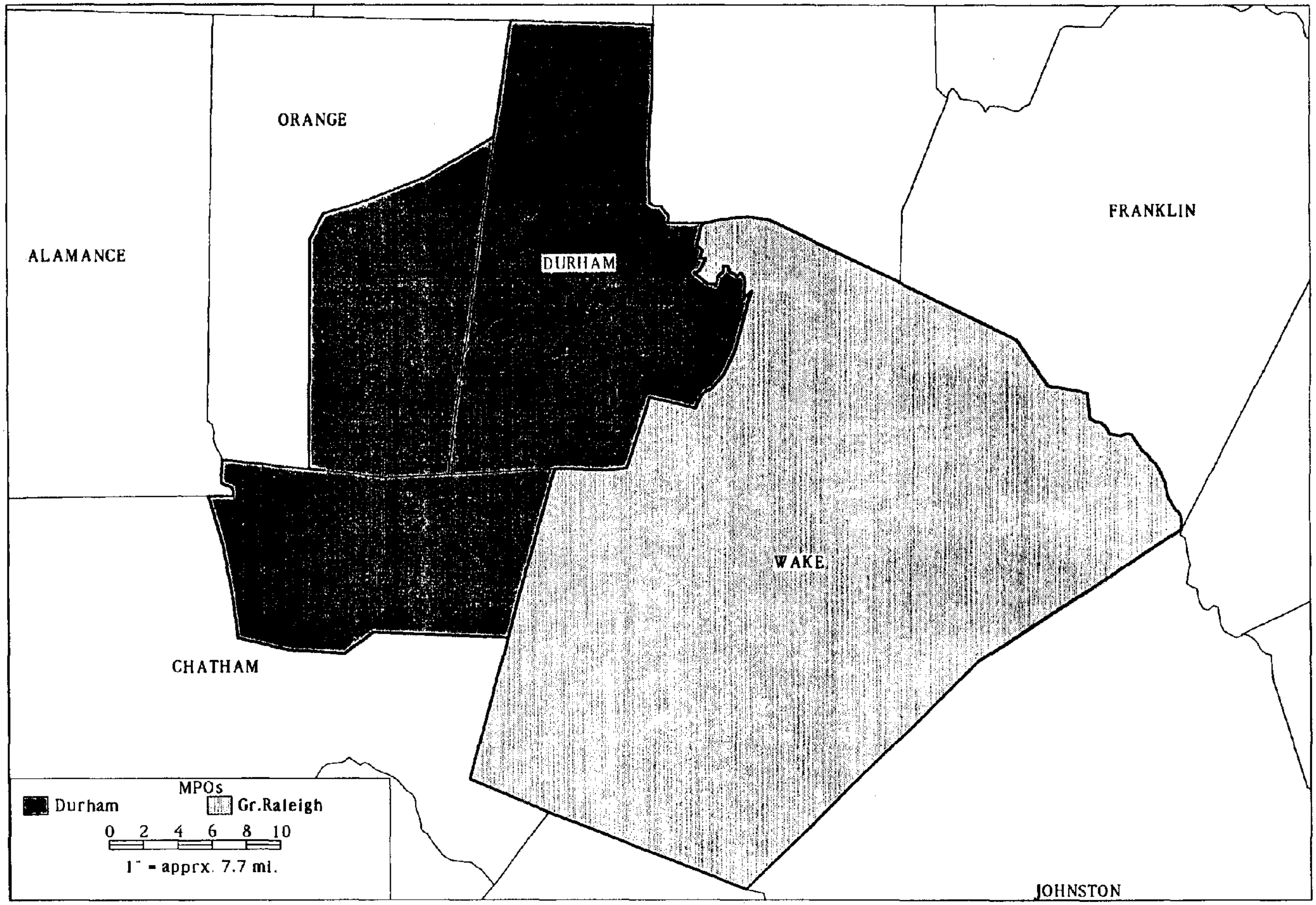

Figure 1. Greater Raleigh and Durham-Chapel Hill-Carrboro MPO areas.

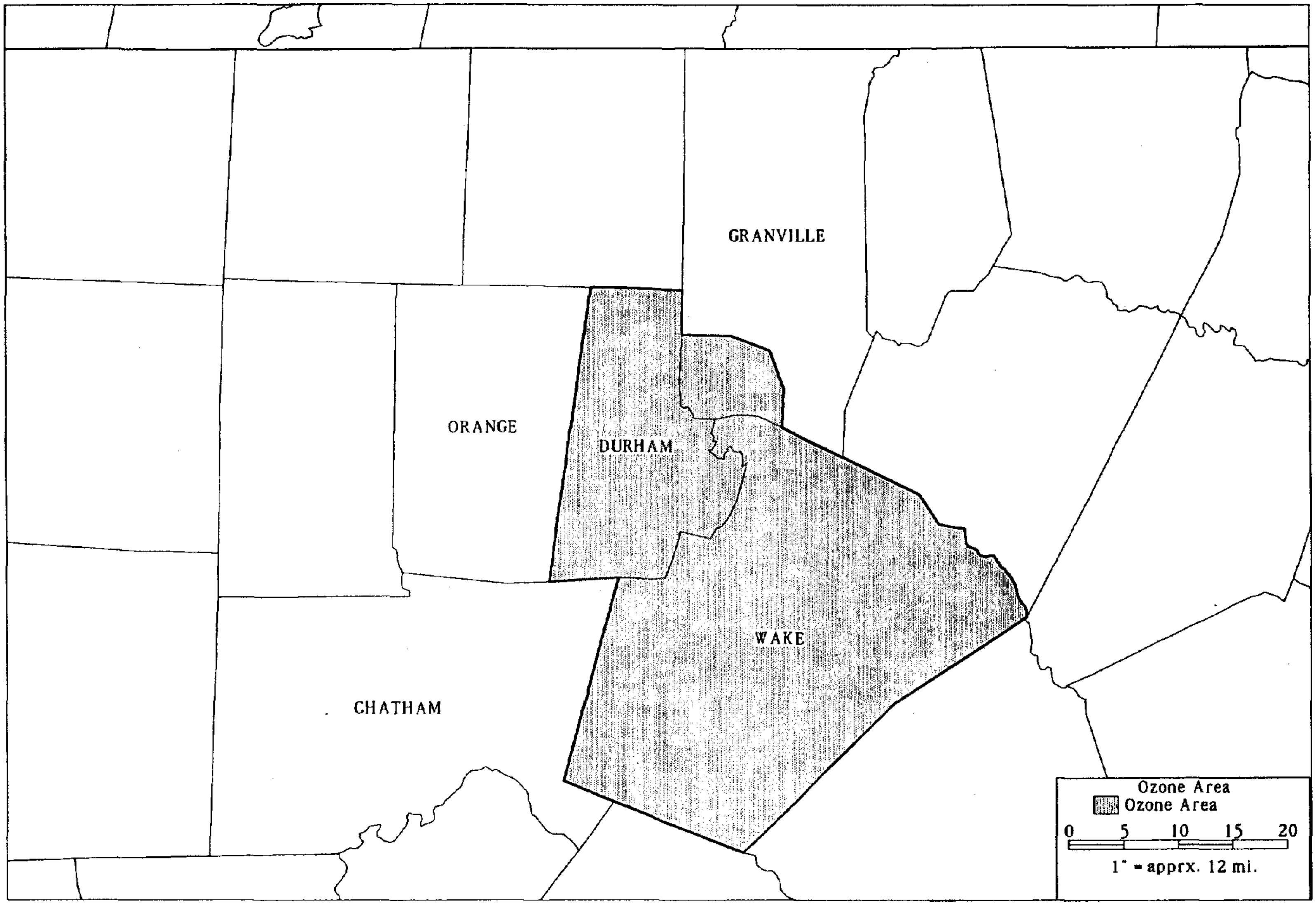

Figure 2. Raleigh-Durham ozone nonattainment area.

4.2.3 Air Quality Nonattainment Status

The state will be seeking to have the Raleigh and Durham metro areas declared in attainment for ozone and CO by the end of 1993. (They will also seek redesignations for all of the state's nonattainment areas, including Charlotte.) The Raleigh and Durham metro areas have been within EPA standards for the last three to four years. Even with the redesignation, the state will continue to conduct conformity analyses as part of the federally required air quality maintenance program.

The state and metro areas' planners, engineers, and air quality specialists attribute the non-attainment designation to extremely hot and humid weather during the summer of 1988 that caused pollutants from the Ohio Valley to stall out over the southeast portion of the United States. (A comparison of weather conditions over a period of time indicates that this was an atypical year.) The areas' air quality specialists also attribute the improvement to the turnover in the automotive fleet (there have been five new model years) along with the mandated tailpipe improvements that have been made by the auto manufacturers, and to the initiation of an inspection and maintenance program about a year ago.

4.3 SOCIOECONOMIC/LAND USE PROJECTIONS

The Greater Raleigh and the Durham-Chapel Hill-Carrboro MPOs do not generate socioeconomic and land-use projections. For its transportation modeling efforts, the Statewide Planning Branch relies on projections developed by local jurisdictions. The projections are prepared by each of the jurisdictions at the Traffic Analysis Zone (TAZ) level. Even though the projections are independently developed, the efforts are coordinated to a certain extent with the Statewide Planning Branch to establish TAZ boundaries and to ensure that the TAZs are consistently sized. The MPOs are also involved in the process.

Historically, the State of North Carolina has not played a major part in shaping land use. At the local level, some interest exists in affecting the interaction between land use and transportation by adopting policies that will encourage greater densities. The Triangle Transit Authority's fixed guideway study will be assessing scenarios that assume denser land uses. Also, a neo-traditional neighborhood was recently proposed for the Chapel Hill area; its developers originally estimated a 60 percent reduction in trips. Despite this, the Statewide Planning Branch staff do not anticipate any significant changes in land use patterns over the long term even with the continuation of high growth rates. No significant changes are foreseen because local jurisdictions have not yet adopted land use policies or regulations which would encourage denser development patterns.

4.3.1 The Durham Area

The most recent population and employment forecasts for the city and county of Durham were prepared in 1985. Forecasts are available for the years 2000 and 2010. The population and employment forecasts are an outgrowth of the area's comprehensive land use and small area planning efforts, and are based on local knowledge of existing land uses, densities, and land availability. Educated guesses were made to determine how much land would be developed during the first 15 years of the planning period (by 2000) and the succeeding 10 years (2010). As part of this effort, surveys are conducted by TAZ to identify every household and employer. The Durham planning area is divided into 650 TAZs. In preparing the household inventory, residences are rated on a scale of 1 to 5 to stratify the planning area's population by income and trip-making potential. The inventories also provide another indication of where the region's growth will occur, and indirectly, what the rate of growth will be for the different TAZs.

The Durham area's population and employment forecasts are supposed to be updated every seven years. It has now been eight years since the last update, and it remains unclear whether or not an update will occur in the near future. The MPO would like the Durham City and County Planning Department to undertake an update in 1994.

In developing the Durham forecasts, local planners reviewed state-prepared forecasts, and guessed at migration rates. No historical population or employment data were available at the TAZ level, and the impact of existing and proposed transportation facilities was subjectively considered.

Local planners concluded that the state-prepared forecasts were low. Instead of a future annual population growth rate of about 1 to 1.75 percent, they forecasted average annual growth rates for population and employment of approximately 4 percent and 4.5 percent for 1990 to 2015, respectively. During the 1980s, actual average annual growth rates for population and employment were approximately 2 percent and 4 percent. The city and county planner that was contacted said that the 1990 U.S. Census population estimate was much lower than what they had projected. The current annual population growth rate is estimated to be approximately 2 percent.

4.3.2 <u>The Raleigh Area</u>

Raleigh's most recent population and employment forecasts were prepared in 1988 by the Research Triangle Institute. The Institute estimated econometric models and produced forecasts for 1995 and 2010 by TAZ. These forecasts now appear to be overly optimistic. At the time the forecasts were prepared, Raleigh was experiencing a 4 percent average annual growth rate. The annual growth rate peaked at 8.6 percent in 1986; however, starting in 1989, annual growth rates slowed to 1 percent to 3 percent. Local planners expect future growth to be approximately 2 percent per year.

Raleigh's Planning Department recognizes the deficiencies inherent in the forecasts prepared by the Research Triangle Institute. It anticipates that the Triangle Transit Authority fixed guideway study will produce more "realistic" forecasts based on a range of transportation and land-use scenarios. These forecasts are being prepared by Hammer, Siler and George in conjunction with the Research Triangle Institute. In addition, Raleigh is attempting to estimate employment by location and SIC code by using data available from the state's Employment Security Office and a limited mail-back survey.

4.4 TRANSPORTATION PLAN AND NETWORKS

4.4.1 Transportation Plan

As stated earlier, NCDOT's Statewide Planning Branch, in close cooperation with the MPOs, prepares the long-range transportation plans for the state's urbanized areas. Based on systemwide deficiencies, these plans, known as thoroughfare plans, examine alternative solutions. Since transit use in the Raleigh and Durham areas is negligible, the alternative solutions focus mostly on highway improvements.

The thoroughfare plans are updated approximately every five years. The Greater Raleigh MPO adopted its thoroughfare plan in 1987; and the Durham-Chapel Hill-Carrboro MPO adopted its plan in 1991.

To a great extent, congestion improvement has been the focus of the thoroughfare plans. Proposed improvements have included completing missing freeway and highway links, constructing and widening roads, and improving intersections and signalization. The added systemwide capacity reduces congestion and the stop-and-go vehicular movements that have a major impact on air quality. Typical projects include:

- The completion of links in the Interstate-40 beltway around Raleigh.
- The extension of State Highway 147 to connect I-40 with 85 on the east side of Durham. Completion is scheduled for December 1996.
- The construction of an eastern extension of the Durham Freeway, known locally as the East End Connector, to complete a circumferential freeway link around the city of Durham. Construction is scheduled to begin in 1998; completion is anticipated after 2000.
- The construction of a new road on the north side of Durham, known as Eno Drive. The project, which will be built to Federal specifications, will be exclusively financed with funds from the North Carolina Highway Trust Fund. A fixed guideway alternative was considered during the corridor study; however, the diversion to transit was so insignificant that the alternative was dropped from consideration. The project is currently in the environmental impact stage, and construction is anticipated to occur after 2000.

TCMs are not included in the thoroughfare plans and have not been seriously considered as a means to reduce VMTs and improve air quality. Concern was expressed that they are frequently expensive solutions with no guarantees of effectively reducing VMTs and auto emissions. Given the nonattainment moderate designation for ozone and CO, committing to these actions could be difficult to justify.

4.4.2 Transportation Networks

For both Raleigh and Durham, two traffic networks were developed for 1995 and 1996 based on their respective TIPs. In addition, a thoroughfare plan network was developed for each of the planning areas. Then, 1990, 1995, 1996, and 2010 trip tables were developed for each network based on the productions and attractions used to produce the latest thoroughfare plan updates.

For Raleigh, sixteen highway network/trip table combinations for 1990, 1995, 1996, and 2010 were modeled based on the current TIP and most recently updated thoroughfare plan. Similarly, seven highway network/trip table combinations for Durham were prepared. The 1990 highway network includes all freeways, expressways, and arterials, and many of the collectors in and around Raleigh and Durham. Several factors were considered in determining facility type: (1) number of lanes, (2) number of signals per mile, and (3) free flow speed. All significant projects, even if not Federally funded, were included in future year networks. Since the transit mode share in the nonattainment area is estimated to be less than 1 percent, no base or future year transit networks were developed for either the Raleigh or Durham models.

4.5 TRANSPORTATION/TRAFFIC FORECASTS

The Raleigh and Durham travel demand models represent the state-of-the-practice. For the most part, a four-step travel demand estimation process is used by NCDOT; however, no mode split model is estimated (table 4). Instead, transit ridership is estimated using an ad hoc procedure that consists of applying diversion factors to the zonal trip estimates. Also, neither the Raleigh nor the Durham models produce estimates of truck trips.

4.5.1 Trip Generation and Peak Period Definition

For trip generation, the Raleigh model incorporates a series of cross-classification submodels that include activity descriptive variables such as household income and auto ownership. For the Durham model, trip generation is based on a drive-by survey that stratifies households into five different household categories based on perceived housing values. Different trip generation rates are then assigned to each of the household categories. In both the Raleigh and Durham models, average weekday trip ends are generated for each forecast year for work and nonwork purposes. Each model stratifies the work and nonwork trip purposes further; however, the stratification is more extensive in the Raleigh model.

Table 4. Overview of the travel demand models for Raleigh and Durham.

Model Steps	Raleigh	Durham
Trip Generation		
Internal	Cross classification submodels.	Trip generation rates by household category.
External	Adjusted cordon surveys.	Adjusted cordon surveys distributed by a gravity model.
Trip Distribution		
Internal	Gravity model.	Gravity model.
External	Several iterations of a Fratar model.	Gravity model.
Modal Split	Subjective estimation based on actual route patronage and expected extensions of the bus system. To account for the transit estimate, the "total trip" estimate is adjusted.	Subjective estimation based on actual route patronage and expected extensions of the bus system. To account for the transit estimate, the "total trip" estimate is adjusted.
Trip Assignment	Incremental assignment.	Incremental assignment.

The trip rate data used is based on origin-destination studies that were conducted in the early 1970s. Concerned about the age of these trip rates, NCDOT has adjusted them using recent ground counts. External and through trip estimates are based on old origin and destination cordon surveys that have also been adjusted using the results from facility and corridor studies. A gravity model is used to distribute through trips for the Durham planning area. For Raleigh, several iterations of a Fratar Model are then made to distribute the through trips and to ensure a certain degree of reasonableness. External-internal trips for Raleigh are distributed using a gravity model. For those trips originating outside of the planning area, a somewhat subjective estimate of secondary nonhome-based trips is made using a base estimate and growth factors.

No differentiation between peak and nonpeak hour travel is made in the Raleigh and Durham models. NCDOT personnel would like to improve the modeling effort to differentiate between peak and nonpeak hour travel.

4.5.2 Trip Distribution

For both planning areas, a gravity model is used, with the impedance function only reflecting travel time. Travel cost is not used as a variable. The consensus is that people (particularly white collar employees, who constitute a high growth segment of the Raleigh-Durham market) value time, and do not particularly consider any of the "hard" travel costs. For most people living in the Raleigh-Durham area, parking is free or relatively inexpensive.

Staff in the Statewide Planning Branch believe that these gravity models underestimate the distribution of trips to certain attractors, such as the Research Triangle Park and the three major universities, which tend to employ a high proportion of white collar professionals. They have thought about using models that would stratify the trips by income to improve trip distribution.

4.5.3 Modal Split

Since transit represents less than 1 percent of total person trips in the two planning areas, no mode split models have been calibrated for the Raleigh and Durham regional travel demand models. (Raleigh has approximately 12,000 transit riders per day.) For estimating future transit trips, the Statewide Planning Branch and the city of Raleigh identified existing and future zones to be served by transit. Using actual transit patronage route data for benchmarking purposes, a subjective estimate of transit trips by zone was made. To account for these transit trips, the total zonal trips estimated during the trip generation step were adjusted downward.

4.5.4 Trip Assignment

An incremental assignment with four capacity restraints is used. The Statewide Planning Branch has experimented with equilibrium and stochastic traffic assignments but have found the results to be comparable. This is attributed to the fact that the Raleigh and Durham planning areas do not have severe congestion. In doing the assignments, the Statewide Planning Branch has found that it must lower the speeds (the program default) on the freeways to avoid overloading these facilities.

The staff believed that the speeds embedded in the transportation modeling software that they had been using worked well in assigning trips to reasonable paths; however, they were concerned that the speeds were not representational for any given facility or volume. The consensus was that arterial speeds were the least consistent and accurate. Since local arterials carry a substantial proportion of total traffic, and their speeds are very sensitive to changes in volume and improvements, the staff considered this a potentially serious shortcoming for conducting air quality analyses. This concern prompted the Statewide Planning Branch staff to develop a post-processor program to calculate more accurate speeds for each link. The program uses algorithms and values derived from the *1985 Highway*

Capacity Manual, NCHRP 187, Florida Department of Transportation's 1988 Level of Service Tables, and NCDOT traffic data.

No intrazonal trips were estimated or assigned to the networks for Raleigh and Durham. TRANPLAN does generate intrazonal trips, but the Statewide Planning Branch has not had much confidence in them. For the third round of conformity, the Statewide Planning Branch is considering tackling this issue.

4.5.5 General

Travel demand analyses are being done using the TRANPLAN package on 386 and 486 microcomputers.

The Statewide Planning Branch is not actively using any GIS packages to assist in its analyses even though it has access to GIS Plus and ARCINFO. These packages will be incorporated into their work to a greater extent, particularly the development of the combined Raleigh-Durham regional travel demand model that is currently being discussed. The Statewide Planning Branch recognizes the extent to which these packages can be used, and their need to develop in-house expertise. The Raleigh Planning Department is currently using a GIS system to conduct transportation analyses and to support policy decisions at the MPO level.

4.6 EMISSIONS ESTIMATES

Emissions estimates are made by the NCDOT's Statewide Planning Branch. Over the last few years, different versions of the MOBILE model have been used to complete the conformity analyses. The 1991 and 1992 conformity analyses were completed using MOBILE4.0 and 4.1, respectively. MOBILE5A is currently being used by the Statewide Planning Branch staff.

Statewide Planning used traffic assignment results from each regional model to make the emissions estimates. The MOBILE model's defaults are used for the most part to produce emissions factors; however, some "locally" developed inputs were used (for example, temperature, and fuel volatility). Locally developed vehicle mixes were not available during the first two rounds of conformity. Estimated emissions of CO and hydrocarbons (HC), for 1990 and two future milestone years, for the Raleigh planning area are listed in tables 5 and 6. (Since a qualitative determination was made for the Durham planning area, no data are available.)

The Statewide Planning Branch staff and other planners had a number of concerns or reservations regarding the use of the MOBILE model and the current practice of air quality planning. These concerns or reservations are summarized below.

- The conversion of the travel assignment output into an estimation of emissions is somewhat cumbersome. For both the Raleigh and Durham planning areas, the Statewide Planning Branch estimates and presents emissions inventories based on estimates of VMTs grouped by driving speed ranges. To do this, speeds are aggregated across the model's domain of facilities.

- The Statewide Planning Branch is not convinced that MOBILE 4.1 produces accurate air pollution estimates in the 55 to 65 mph driving speed range. They indicate that the MOBILE model produces higher emissions results for high speed facilities than it produces for arterials that have acceleration and deceleration cycles of greater amplitude and frequency. Since many of the proposed road improvements in the Raleigh and Durham areas are for higher speed facilities, this model characteristic is of concern.

- The EPA requested that the lowest speed range (< =20 mph) be divided into four separate 5-mph ranges. Although this change gives the appearance of greater precision, it actually undermines the reliability of the analysis. Standard travel forecast models are incapable of making accurate speed estimates for highly congested, low speed conditions. The problem is compounded by the steep increase in emissions factors at low speed.

Table 5. VMT and emissions estimates for carbon monoxide - 1990, 1995, and 2000 - Raleigh MPO planning area (kg).

	Vehicle Miles of Travel		Carbon Monoxide	
Year	No-Build	Build	No-Build	Build
1990	12,443,399		617,964	
1995	14,929,286	14,929,286	616,478	616,478
2000	14,637,954	14,637,556	446,421	445,625

Table 6. VMT and emissions estimates for hydrocarbons - 1990, 1996, and 2000 - Raleigh MPO planning area (kg).

	Vehicle Miles of Travel		Hydrocarbons	
Year	No-Build	Build	No-Build	Build
1990	12,443,399		72,547	
1996	13,878,403	13,878,403	44,440	44,440
2000	14,637,954	14,637,556	40,099	40,032

- The conformity analysis process attempts to produce results at a level of precision and accuracy far greater than the inputs. The inputs are based on techniques or methods with considerable variability or error. That is, surveys and travel demand models do not produce exact results.

- Frequently, the air quality conformity determination can be affected by the inclusion or exclusion of a project. For example, the exclusion of an intersection of an interchange upgrade (which is a controversial project) in the Durham planning area could possibly affect progress toward meeting the 1996 attainment deadline. Also, if the implementation of different TIP projects slip, then actual results could be far worse than what is being forecasted.

- The MOBILE model and the transportation planning software packages developed by the private sector are inadequate for conducting the quality of analysis that is expected. The MOBILE model is based on out-of-date and generalized data. In lieu of the MOBILE model, EPA needs to consider offering mode specific emissions models that could also be used for corridor-level studies. These models would require corridor-specific information regarding delays, grades, intersections, and fleets.

4.7 FUTURE TECHNICAL AND INFORMATIONAL NEEDS

The Statewide Planning Branch staff indicated an interest in the Federal Government providing more technical training regarding the operation of the MOBILE model (including seminars and workshops), developing a more even state in the art of air quality modeling, and defining to a great extent what is conformity. Interviewees indicated that a need exists for further education at all levels of government regarding what needs to be done to meet the CAAA requirements. Specifically, further awareness among politicians and policy makers is needed, particularly at the MPO level, regarding the importance and severity of the CAAA.

4.8 ESTIMATED COST OF DETERMINING CONFORMITY

The Statewide Planning Branch was unable to provide a detailed breakdown of the costs that they incur. Interviewees estimated that the travel demand and air quality modeling requires about two person-weeks per city. For Raleigh and Durham, these portions of the conformity costs are approximately $10,000.

4.9 NEXT ROUND OF CONFORMITY

For the next round of conformity analyses, the Statewide Planning Branch is considering the following improvements to the travel demand and air quality modeling process:

- Reconsideration of the methodology for estimating intrazonal trips;
- Reassessment of the impedance factor (i.e., time) in the trip distribution and assignment steps;
- Development of a procedure to estimate peak hour trips; and
- Reconsideration of cold start proportions in the MOBILE model.

5. THE DENVER REGION

5.1 OVERVIEW

The Denver Region experienced substantial growth between the late 1970s and the mid-1980s; however, since then, growth rates have slowed. Due to the economic downturn that the region experienced during the mid-to-late 1980s, DRCOG has recently revised its socioeconomic forecasts downward. The population of the Denver metropolitan area grew by 16 percent, from 1.6 million in 1980 to 1.9 million in 1991. The population and employment growth occurred primarily in the suburbs.

The Denver nonattainment area has been classified moderate for CO. The ozone non-attainment area meets the CAAA's qualifications for classification as a transitional area. The Denver/Boulder area has also been classified a moderate nonattainment area for PM_{10}. The region's transportation and air quality planners are concerned about how to estimate a PM_{10} inventory budget and identifying effective PM_{10} reduction strategies.

The technical analysis that supports the conformity determination is a shared responsibility between DRCOG, which is the MPO for the region, and the APCD of the Colorado Department of Health. DRCOG is responsible for the travel demand modeling and the APCD is responsible for generating emissions estimates using EPA's MOBILE model. Even though the technical analysis is shared, the air quality determination is the responsibility of DRCOG.

Long-range planning focuses on reducing systemwide congestion and emissions by building missing highway links, widening roads, improving intersections and signalization, and implementing a range of TCMs. The metropolitan areas has completed many of the TCMs identified in the 1979 and 1982 SIPs. These measures have included mass transit/demand management strategies such as the construction of HOV lanes and a light rail segment to serve the central business district (currently under construction), experimentation with free bus fare, and the introduction of an unlimited-use transit pass.

5.2 BACKGROUND INFORMATION

5.2.1 Jurisdictional and Institutional Issues and Responsibilities

Air quality planning in the Denver region is a cooperative effort conducted by the APCD, the Colorado Air Quality Control Commission (AQCC), the RAQC, and DRCOG.

The RACQ, which was created in 1989 by the governor, is the lead agency for air quality planning in the Denver nonattainment area. It is responsible for preparing SIPs. The organization was formed after consultation with local units of government in the Denver area. It has a 35-member board, 17 of whom are local elected officials appointed by cities and counties throughout the Denver region. DRCOG is a member of the board.

As part of the SIP process the RACQ identifies, analyzes, and recommends control measures to include in the plan. This is accomplished by working with implementing organizations, including the state legislature and local governments.

APCD is responsible for performing the technical analysis that serves as the basis for strategy development and attainment demonstration. It prepares emissions inventories, conducts air quality modeling, analyzes air quality data, and provides technical advice and assistance. In addition, it assists the RACQ with identifying and analyzing the effectiveness of control measures. Similarly, the RACQ staff assist APCD with portions of the technical analysis.

The AQCC is a nine-member citizen panel appointed by the governor to perform a variety of regulatory duties outlined in state statute. The AQCC adopts rules and regulations to implement state law, and is also responsible for adopting a comprehensive SIP meeting all requirements of the CAAA. The AQCC also adopts rules and regulations to implement the plan.

As the region's MPO, DRCOG is responsible for developing the long-range transportation plan and TIP for the region. For the purposes of regional air quality planning, DRCOG is the authoritative source for the population, employment, traffic demand, and congestion estimates that are necessary to produce air pollution inventories.

As required by the CAAA, DRCOG is responsible for conducting the air quality determination on the transportation plan and the TIP. In doing this, DRCOG produces the travel demand estimates for the long-range plan and TIP using its regional travel demand model. APCD then generates emissions inventories using EPA's MOBILE model. In 1992-93, DRCOG's Transportation Services Division aided the preparation of the CO and PM_{10} SIPs through a study of TCMs and the preparation of transportation data sets.

The MPO planning process has been organized to ensure communication and coordination among all of the air quality agencies. The AQCC and APCD have representatives on all of DRCOG's transportation committees. The AQCC and the RAQC are nonvoting members of DRCOG's Transportation Committee, which is the body responsible for the management of the UTPP. APCD staff are full participants in the air quality technical work of the MPO's planning program through its participation on two of the MPO's committees known as the Regional Review Team and Transportation Advisory Committee. RAQC staff representatives are also invited to attend all Regional Review Team meetings. In addition, DRCOG is a member of the RACQ board.

DRCOG also sponsors two programs that are intended to reduce emissions. They are: (1) a regional rideshare office that produces carpool matchlists, organizes vanpools, and sponsors, with Regional Transportation District (RTD), the Ecopass (an annual bus pass with a guaranteed ride home program); and (2) a traffic signal coordination program that coordinates traffic signals between communities and along major travel corridors.

The MPO serves essentially six counties - Denver, Boulder, Adams, Arapahoe, Jefferson, and Douglas - and three urbanized areas - Denver, Boulder, and Longmont (figure 3). The planning area excludes eastern portions of Adams and Arapahoe counties, and Rocky Mountain National Park in the northwest corner of Boulder County. In 1992, Longmont was designated by the U.S. Census Bureau as an urbanized area, and DRCOG became the MPO for the area.

The nonattainment areas for ozone and PM_{10} for the most part coincide with the MPO's planning boundaries. The Denver CO nonattainment area excludes the southern portion of Jefferson County, the western portion of Douglas County, and the Longmont urbanized portion of Boulder County (figure 4). The Longmont urban area has been designated a separate CO nonattainment area. Since it is part of DRCOG's regional transportation modeling effort, DRCOG generates socioeconomic and transportation demand estimates for the urbanized area to use in its air quality planning.

5.2.2 Regional and Local Planning Activities

In 1985, DRCOG adopted the Regional Development Framework (RDF), which identifies urban development goals for the metropolitan area and establishes a basis for generating socioeconomic forecasts by TAZs. According to DRCOG staff, the RDF is essentially a trend plan since local governments control land use planning and development. Development is largely market-based and reflects competition among jurisdictions for commercial development.

Over the last couple of years, DRCOG has begun to rethink its RDF. It has established a task force to identify a preferred long-range vision for regional growth and development. The task force began by identifying ten guiding principals, and it is now evaluating a range of scenarios that include different transportation improvements. One of the objectives of this analysis is to consider the impact of transportation improvements on urban form.

TCMs, adopted through the SIP process, must be included in both the Regional Transportation Plan and the TIP. When developing demand estimates for the long-range plan and the short-range TIP, the effect of TCMs is taken into account through reductions in travel demand or increases in speeds on various facilities. Since the late 1970s, the region has adopted a range of TCMs that include employer-based programs, vanpooling, a carpool location service, HOV lanes, parking management, episodic restrictions on auto use, ramp metering, traffic signalization improvements, and implementation of a regional bicycle plan. TCMs that are planned or are being implemented include the construction of a 5.3-mile light rail line, expansion of the parking management program, continued construction of HOV lanes, and display signs instructing motorists to turn off engines while idling for prolonged periods of time (table 7).

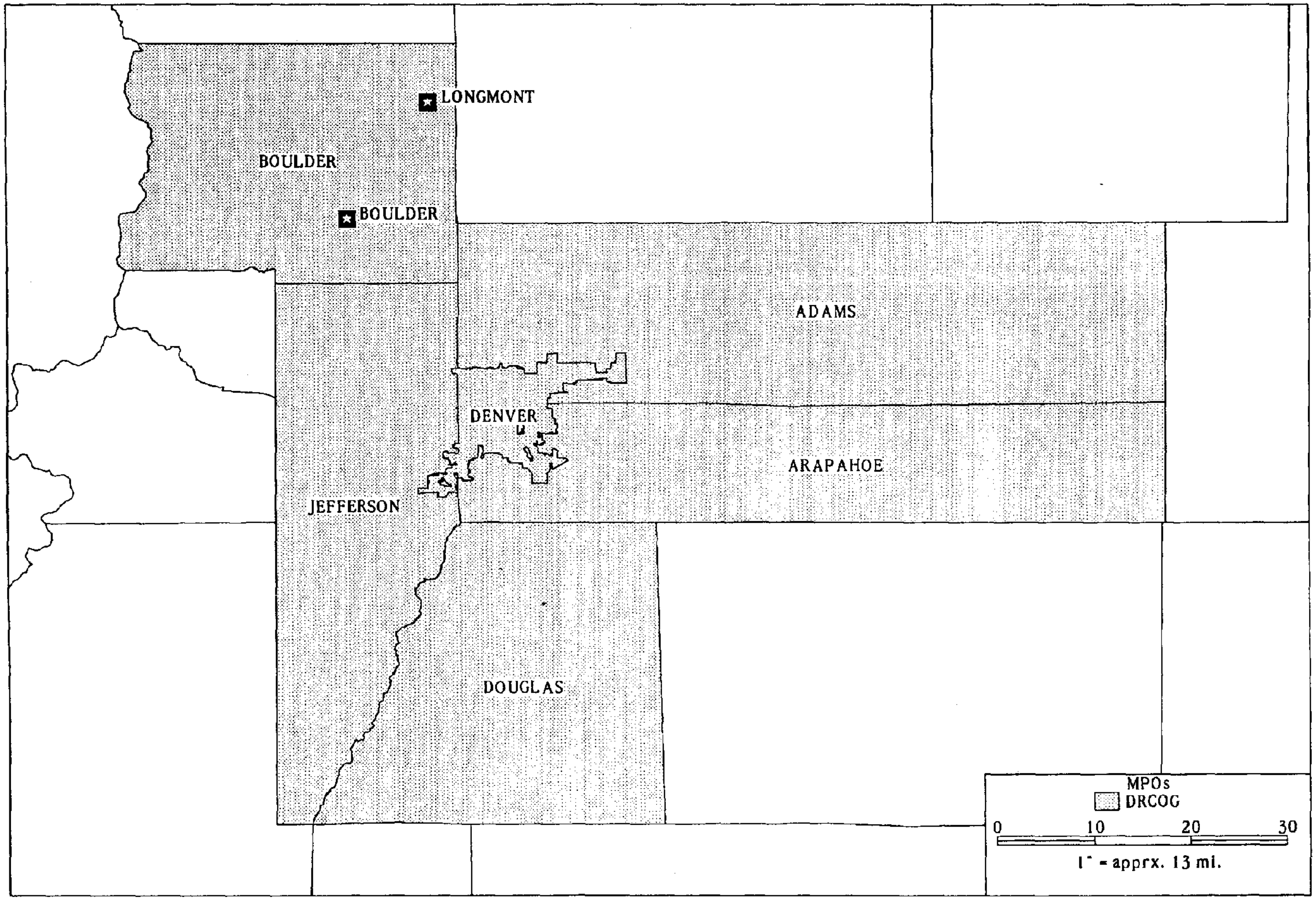

Figure 3. Denver Regional Council of Governments planning area.

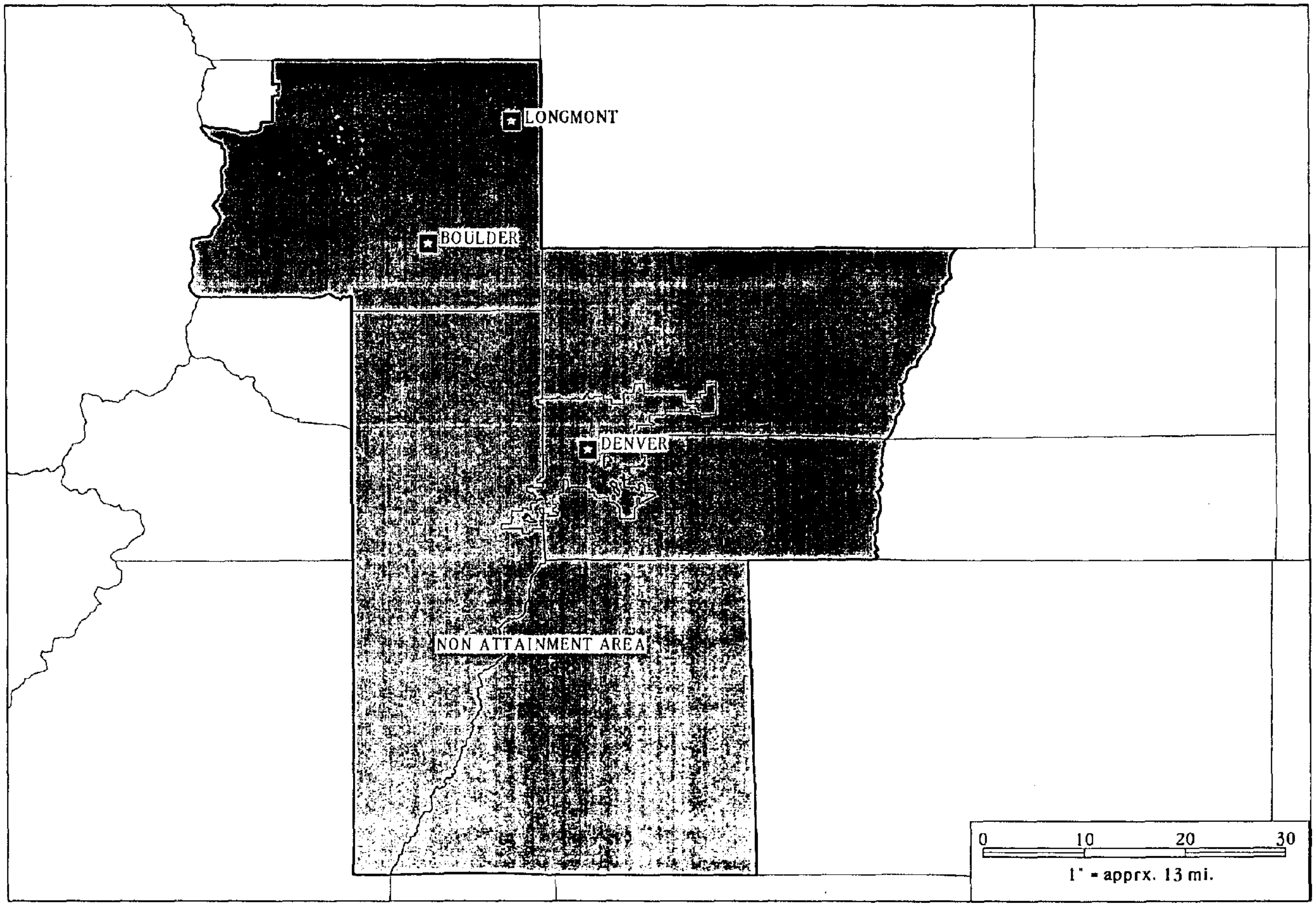

Figure 4. Denver ozone nonattainment area.

Table 7. Overview of Denver region TCMs.

TCMs	Actions
Transit Improvements	Experimented with free bus fare in 1978.
	Construction of 16th Street Mall. Initiated free 16th Street Mall shuttle.
	Initiated EcoPass program.
	Will continue to construct transit centers.
	Constructed 6 bus entrances/meter bypasses; also, 5 bus-only access ramps onto freeway.
	Initiated construction of light rail segment to serve as CBD segment of southeast corridor.
	Initiated guaranteed ride program.
	Expanded park-and-ride lots to 49; 9,359 spaces provided by 1992.
High Occupancy Vehicle Lanes	Initiated construction of Santa Fe HOV lane. Initiated construction of a bus-only lane on I-25 and U.S. 36.
Carpool and Vanpool Services	Initiated rideshare/carpool locator service in 1974. Conducted a vanpool demonstration project.
Variable Work Hours	Completed a study in 1980; regularly provide information to employers.
Regional Traffic Control	Completed the Regional Traffic Signal Study in 1982; implementing signalization program.
Parking Management	Prepared parking management plans in 1978 and 1981. Identified the relationships between parking policies and vehicle miles of travel reduction and transit use. Also, identified prototypical activity centers and recommended strategies.
Regional Bike Plan	Prepared a bike plan; constructed 484 miles of bike lanes by 1986.

Table 7. Overview of Denver region TCMs (continued).

Episodic Restrictions	Provide information on bad air days and encourage the use of alternative modes.
Display Signs	Instituted an idling ordinance in Denver requiring drivers to turn off engines if idling more than 10 minutes.
Inspection and Maintenance	Inspect all 1968 and newer automobiles. 1989 legislation changed annual inspection requirement to every 2 years for 1986 and newer vehicles.
Freeway Ramp Metering	Provided 28 ramp meters.

5.3 SOCIOECONOMIC/LAND USE PROJECTIONS

Population in the eight county Denver region grew by 16 percent from approximately 1.6 million persons in 1980 to 1.9 million in 1991. Employment increased 23 percent to 984,000 in 1991. Although the region experienced an economic downturn in the mid-1980s, the economy has begun to rebound. The annual employment growth rate since 1988 has been approximately 2.9 percent. Most of the region's population and employment growth has occurred in the suburbs. Between 1980 and 1990, Denver's regional population share fell from 30 percent to 25 percent, and its employment share dropped from 49 percent to 41 percent.

Demand estimation begins with development of regional level estimates of demographic and economic growth. The regional level estimates are allocated to 54 regional statistical areas using a multivariate regression model that has been recalibrated using 1990 U.S. Census data. The estimates are then disaggregated to 1,400 TAZs using locally prepared development plans. New population and employment forecasts are currently being prepared. Due to the economic downturn in the mid-1980s, the DRCOG staff anticipate that the revised forecasts will be about seven years behind the forecasts prepared in 1986.

5.3.1 Regional Population and Employment Forecasts

Forecasts have been made to the years 2000, 2010, and 2020. The employment forecasts were prepared first, based on national economic projections prepared by the Bureau of Economic Analysis. Regional demographic forecasts were then prepared using a cohort-survival model, with careful attention to factors affecting in- and out-migration.

The national forecasts show a decline in the labor force for the years at the end of the planning period. After the forecasts were reviewed by a committee of local economists and demographers, DRCOG modified its forecasts upward slightly. The revised forecasts show modest growth that is slower than the high growth rates of the 1960s and 1970s. The growth rates reflect a turnaround (as experienced over the past few years) from the recession that occurred in the mid-to-late 1980s.

5.3.2 Allocation to Regional Statistical Areas (RSA)

An activity allocation model developed by DRCOG was used for this allocation. The model includes about 15 independent variables, such as vacant land, water availability, and existing transportation infrastructure (e.g., lane-miles of highways and numbers of interchanges). These types of transportation measures reflect intra-RSA rather than inter-RSA accessibility. DRCOG's staff intends to add another variable to the demographic distribution model to model the effect of the existence of rapid transit.

The results of the allocation model are reviewed by local governments. Adjustments are made where necessary to reflect more detailed knowledge of local development policies and trends.

5.3.3 Allocation to Traffic Analysis Zones (TAZ)

This is a manual process carried out mostly by the localities based on their site-specific knowledge.

5.4 TRANSPORTATION PLAN

The current long-range plan was adopted in 1987, and includes construction of a circumferential freeway plus supporting roads and other roadway projects. It also includes construction of a rapid transit system, and an HOV lane system. The plan is detailed, showing freeway, transit, and HOV access points, interchanges, and number of lanes. Currently, DRCOG is preparing an interim long-range plan for the year 2015 in response to ISTEA requirements. Following its preparation, a 2020 plan will be produced.

Busway and HOV facilities have already been built, and construction is starting on a 5-mile light rail line that is being exclusively financed with local funds. An alternatives analysis is underway to examine the extension of the light rail system.

The region has some dedicated funding for transit, including a 0.6 percent sales tax ($.006), and a "user tax" on corporations making out-of-state purchases, which raises about $10 to $15 million per year. Insufficient funding exists to finance the transit and highway projects in the long-range plan. Currently, the MPO is considering more financially constrained alternatives.

To date, Denver has used mostly "softer" TCMs such as ride-sharing programs, bikeways, and park-and-ride lots (table 7). Despite these efforts, the percent of trips by alternative/public modes in recent years has declined significantly. Analyses undertaken last year indicated that the present course would reduce VMT growth only by about 1 or 2 percent per year. Since congestion is generally much lower than in major eastern cities, the region's populace does not have a strong incentive to rideshare.

Increased consideration is now being given, at least at the technical planning level, to other potential TCMs, including vanpool subsidies, higher parking fees, and gas tax hikes. A committee called the Transportation/Air Quality Working Group was organized by the local planning air quality agency, the RAQC, to develop a more "innovative" set of strategies. Since this effort was unable to produce a consensus set of recommendations, a consultant is being hired to advise the region.

5.5 TRANSPORTATION/TRAFFIC FORECASTS

5.5.1 Basic Assumptions

The travel demand modeling attempts to capture individuals' responses to changes in traveling costs. The model differentiates between automobile operating costs, transit fares, and parking costs, and it incorporates individuals' sensitivity to the changes in these costs. For example, it is assumed that the long-term effect of changes in gasoline prices (a component of automobile operating costs) is relatively inelastic. Gasoline prices are assumed to rise in real terms and return to early 1980s levels, and then stay constant for the remainder of the forecast period.

Transit fares are assumed to remain constant in real terms, even though fare increases historically have not kept pace with inflation. (Depending on how calculated, fare revenues return about 18 to 35 percent of operating and maintenance costs.)

Future automobile fleets reflect a continuation of past trends plus Federally mandated changes (regarding, for example, alternative fuels). Truck usage is assumed to increase in proportion to the increase in jobs and households over the next ten years.

Parking costs are estimated with a model that utilizes such factors as employment density, CBD/non-CBD location, and nature of adjacent zones. There is concern that future parking costs are difficult to estimate, and that the model may not deal with supply and demand adequately. The model is now being reviewed by COMSIS, a transportation consulting firm.

The impacts of many transportation demand management programs (TDMs), such as employer-based programs, cannot be measured directly by the travel demand model. There are two other methods for determining TDM/transportation systems management (TSM) effectiveness. Their Short Range Policy Analysis model (developed by Cambridge Systematics, a transportation consulting firm) estimates the effects of such programs as vanpool and carpool. For other TDM/TSMs, information is gathered and analyzed from similar projects which have already been implemented. For example, to estimate the effectiveness of alternative programs for work at home, companies that have tried this were studied. The results, such as the percentage of people participating, were used to estimate the potential success of a larger program.

5.5.2 Trip Generation and Peak Period Definition

Average weekday trip ends are generated for each forecast year using cross-classification models for the following trip purposes: (1) home-based work; (2) home-based nonwork; (3) nonhome based; (4) truck trips; (5) internal/external trips; and (6) external/external trips. The trip ends are then factored into half-hour segments using data from a 1971 origin-destination survey and a 1985 small sample household survey (which yield similar time-of-day distributions). For each half-hour, total trips are then compared with an aggregate measure of system capacity derived from total lane-miles by type of facility. This permits the identification of periods of the day with significant levels of congestion. It also facilitates the identification of the times of day when the A.M. and P.M. peak periods begin and end. A current one-hour A.M. peak period is expected to stretch to a two-hour peak period by 2010. (No runs as yet have been made for the more distant forecast years.)

Table 8. An overview of the Denver travel demand model.

Model Steps	Descriptions
Trip Generation	Cross-classification models to generate trip ends for six trip purposes, including truck trips.
Trip Distribution	
Internal	Gravity model with highway travel time as its impedance.
External	Fratar model.
Modal Split	Multinomial model that splits trips into drive alone, 2-person carpool, 3+ person carpool, transit with walk access, and transit with auto access.
Trip Assignment	
Peak Period	Incremental assignment.
Off-Peak Period	Two iterations.

5.5.3 Trip Distribution

Work and nonwork trips are distributed for the peak and off-peak periods, respectively. A gravity model with the impedance function reflecting only highway travel times is used for all trip purposes except external-external trips. For the external-external trips, a simple Fratar model is used. (A more complex model previously was used which took costs, carpooling, and transit use into account. The model was difficult to explain to decision-makers, and FTA would not allow different trip tables to be developed for various alternatives.) Special K-factors are applied for the Boulder urbanized area to account for the fact that this area's trip making tends to be more self-contained than estimated by the original gravity model.

5.5.4 Modal Split

A multinomial logit model is used to split mode trips among five modes: drive alone; carpool (2 persons); carpool (3 or more persons); walk to transit; and drive to transit (park-ride plus kiss-ride). Independent variables in the model include typical measures of travel times (in-vehicle, walk, first wait, transfer, etc.) and costs (transit fares, auto operating costs, and parking costs), plus a CBD indicator. Results obtained to date have seemed reasonable in light of available empirical data, and the Independence from Irrelevant Alternatives property has not been a significant problem in estimating modal shares.

5.5.5 Trip Assignment

An incremental assignment process is used for the peak period, with trucks being assigned first, then general purpose traffic, then two-person carpools, and finally 3-or-more-person carpools. An all-or-nothing assignment process previously was used for the off-peak period, but two iterations are now being performed to obtain more realistic link speeds. Estimated link loads have been checked against available traffic counts.

Estimates of truck trips are derived in large part from old survey data (from the 1970s). DRCOG staff would like to survey trucking firms again, but this is relatively expensive. Some classification counts have been done, and the estimates of truck movements have been compared with these counts and found to be reasonable.

Estimated speeds resulting from the assignment process have been checked against data collected with speed guns and from some speed-and-delay runs. Estimated and measured speeds have compared very closely on freeways. For arterials, estimated speeds have been about 10 to 15 percent lower than the comparable measured speeds (which is generally conservative for purposes of estimating emissions).

5.5.6 General

Travel demand analyses are being done using the Urban Transportation Planning Software (UTPS) package on a mainframe, plus the microcomputer-based MINUTP. Currently, MINUTP is used only for sketch planning purposes; however, it is expected that the regional travel demand effort will gradually shift entirely to the micros. DRCOG has two GIS packages -- ARCINFO and TransCAD -- but are making limited use of these at present because of the costs (time) required to use them. It is not clear just how much of this problem is inherent to the software, or the need to climb higher on the learning curve.

5.6 EMISSIONS ESTIMATES

Emissions estimates of the regional transportation plan and TIP are made by APCD using the most recent MOBILE model (table 9). (MOBILE4.1 was used for the second round of conformity analyses.) Inputs to the model are derived from the traffic assignment results and from other local sources. In general, they use few of the MOBILE defaults. Fleet mix is estimated using available classification counts by area type as well as automobile registration data. Hot and cold starts were estimated for two different vehicle types based on sample zones and assigned trips. From these estimates, appropriate look-up tables were developed.

Intrazonal traffic is of significant concern for emissions purposes. This traffic is estimated separately (i.e., it is not produced by the four-step modeling process), and represents about 5 to 10 percent of overall VMT.

Table 9. Comparison of build and no-build VMT and emissions estimates.

VMT and Emissions Estimates	1990 Base	1995 TIP No-Build Committed Network	1995 TIP Build
VMT/day	36,028,500	42,830,900	42,594,400
Carbon monoxide (tons/day)	1,199	820	806
Hydrocarbons (tons/day)	117	98	97

(The analysis of build and no-build scenarios is a requirement of the Interim Conformity Guidelines.)

5.7 FUTURE TECHNICAL AND INFORMATIONAL NEEDS

The Denver air quality planners would like informational and technical guidance on how to establish an emissions budget for PM_{10}. They have sought guidance from EPA but have not received any yet.

APCD staff has indicated an interest in receiving guidance on different market-based strategies that the region could consider and test when running the regional travel demand model.

5.8 ESTIMATED COSTS OF DETERMINING CONFORMITY

DRCOG's estimated costs for completing a conformity analysis are itemized in table 10. The costs include all direct labor and overhead incurred by DRCOG. They do not include the cost of running the MOBILE emissions model, which is the responsibility of APCD.

Table 10. Costs of determining conformity.

Steps	Person Hours	Costs
Methodology development	96	$ 4,381
Model runs	560	24,964
TCM status analysis	160	11,006
Conformity finding	104	6,590
Presentations	80	6,207
Total	1,000	$53,148

5.9 NEXT ROUND OF CONFORMITY

For the next round of conformity, the region would like to test alternative market-based strategies, and re-examine fleet composition and oxygenated fuels.

PM_{10} will be estimated using quantitative analysis (instead of qualitative analysis). The analysis will compare the levels of VMT estimated in the PM_{10} SIP development process to the levels of VMT generated in the TIP analysis.

6. WASHINGTON, D.C.

6.1 OVERVIEW

The metropolitan area has over 3.9 million people and has experienced high growth rates over the last ten years. In addition, the U.S. Census has recently combined the Washington, D.C. and Baltimore metropolitan areas to create a Consolidated Metropolitan Statistical Area (CMSA). The combined population of the Baltimore and Washington, D.C. metropolitan area is approximately 6.3 million people.

The economic interaction between two of the counties in the Baltimore metropolitan area and the Washington, D.C. area has grown substantially in the last fifteen to twenty years. This interaction has been recognized, and Howard and Anne Arundel counties (which are located in the Baltimore-Washington, D.C. corridor) have been included in Washington, D.C.'s regional travel demand modeling process.

The nonattainment area covers a multistate area and does not coincide with the planning area for the region's MPO. The National Capital Region Transportation Planning Board (TPB), which is the MPO for the region, is responsible for conducting the air quality conformity determination. The technical support for the process is provided by the Metropolitan Washington Council of Governments.

The region has created an organization known as the MWAQC with participants from all of the jurisdictions that make up the ozone nonattainment area. The members representing the different jurisdictions are elected officials. This includes a number of jurisdictions that are not participants in the MPO. Membership is also extended to top officials from the Maryland, Virginia, and Washington, D.C. Departments of Transportation and air quality agencies. The Committee is charged with developing the regional air quality strategy and plan. Technical support for the Committee is provided by the transportation and environmental planning staff of the WashCOG, as well as the Maryland, Virginia, and Washington, D.C. Departments of Transportation and air quality agencies.

The nonattainment area is designated serious for ozone and moderate for CO. The region has drafted a plan for reducing its hydrocarbon baseline emissions by 15 percent, which has been presented to the public for review and comment. In developing a strategy for reducing emissions, the region has been wrestling with the following strategies in the draft contingency portion of the SIP: allowing more right turns on red lights; increasing the number of flashing yellow lights in the early morning hours to improve traffic flow; instituting a "Cash-for-Clunkers" program; and building additional park-and-ride lots. The most controversial strategy that the region is wrestling with is whether or not to adopt an employee commute options program that would require employers to reduce the number of single-occupancy vehicles arriving at their work sites.

Long-range planning focuses on reducing systemwide congestion and emissions by building missing highway links (including freeways), widening roads, extending metrorail, constructing high-occupancy-vehicle lanes, and improving commuter rail service.

6.2 BACKGROUND INFORMATION

6.2.1 Jurisdictional and Institutional Issues and Responsibilities

The management of air quality planning in the Washington, D.C. region rests with the TPB and MWAQC. These are policy bodies composed primarily of elected officials representing the region's jurisdictions. Many of the same jurisdictions are represented on both of these committees; however, membership varies according to the committees' designated missions. In addition to elected officials, membership on these committees includes representatives from the Departments of Transportation and air quality boards of Maryland, Virginia, and Washington, D.C. Membership on the TPB includes the Washington Metropolitan Area Transit Authority (WMATA) and ex-officio representatives from different Federal agencies.

The TPB is the MPO for the Washington D.C. region. As the MPO, the committee manages the regional transportation planning process and establishes the overall policy direction for transportation. Its specific responsibilities include the preparation of the region's TIP and long-range transportation plan. As a result, it has overall approval for the region's capital expenditures for transportation projects, including TCMs, and responsibility for determining the conformity of the region's TIP and long-range plan.

Its membership includes representatives from the 18 cities and counties that are members of the WashCOG as well as Stafford County and the City of Manassas (figure 5). Additional members include the transportation agencies of Washington, Maryland, and Virginia, the Washington Metropolitan Area Transit Authority (WMATA), the Metropolitan Washington Airports Authority, five Federal agencies, the general assemblies of Maryland and Virginia, and private transportation providers.

The TPB also serves as the transportation planning policy committee of WashCOG. This relationship serves to insure that transportation planning is integrated with comprehensive metropolitan planning and development, and is responsive to the needs of the local governments who are members of WashCOG. The technical analysis that is necessary to support the TPB is conducted by WashCOG's transportation, land use, and environmental planning staff.

For air quality conformity analysis, COG staff use their approved socioeconomic and land-use forecasts, prepare highway and transit networks, and run the regional travel demand model to estimate base and future daily trips and vehicle miles of travel. WashCOG's Department of Environmental Programs is responsible for estimating levels of emissions

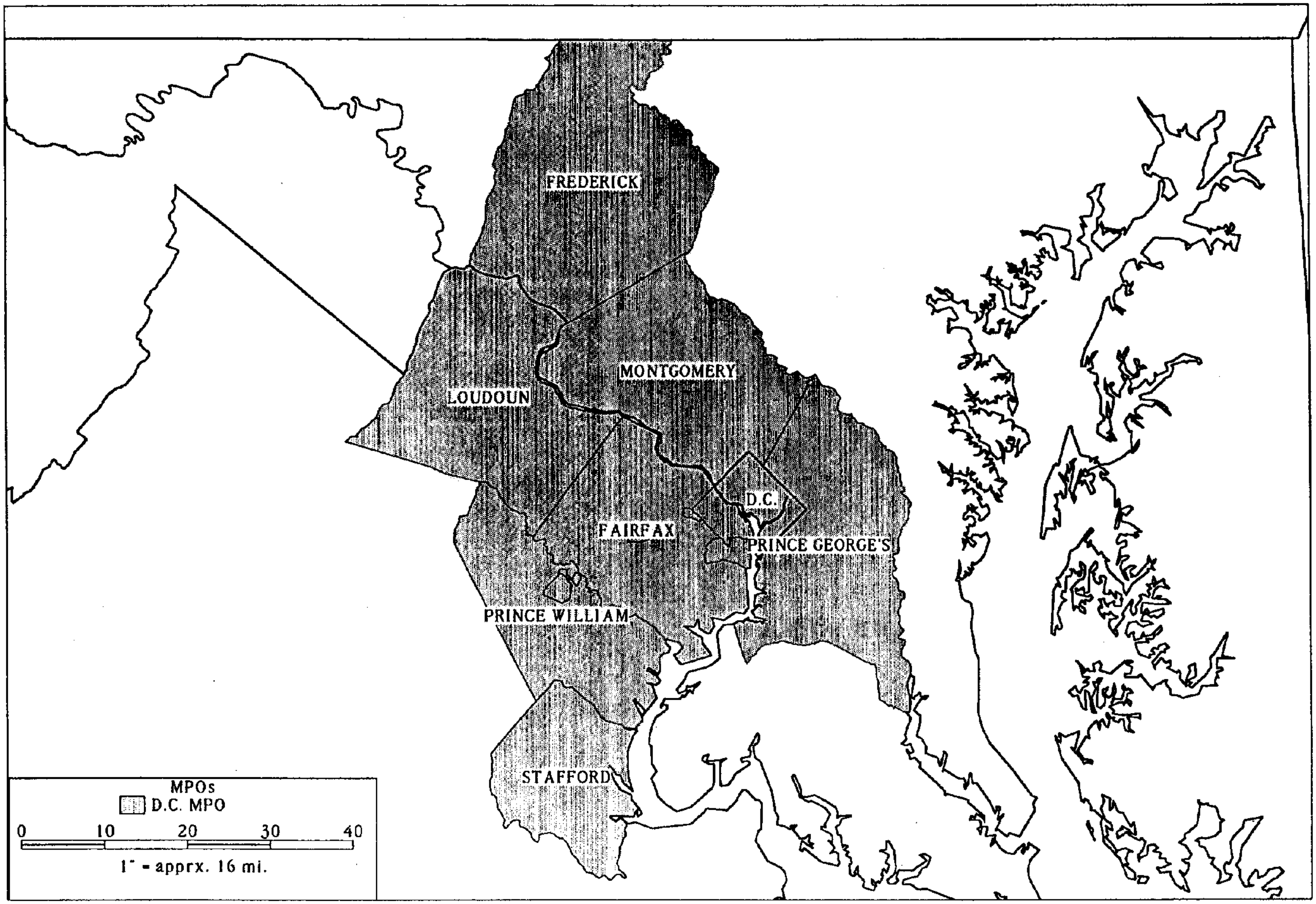

Figure 5. Washington, D.C. MPO planning area.

(i.e., the rates of hydrocarbon, CO, and nitrogen oxide produced by cars and trucks on the highway system) using EPA's MOBILE model. In recent years, WashCOG has contracted an environmental consulting firm to assist in the development of MOBILE model inputs (other than transportation) and to run the MOBILE model.

The focus of the MWAQC is on SIP requirements. It is charged with developing and adopting strategies for reducing emissions from mobile and stationary sources to be included in the nonattainment area's 15 percent reduction plan. This is the ultimate attainment demonstration for the area. Its members represent the jurisdictions within the boundaries of the designated nonattainment areas, including Maryland, Virginia, Washington, D.C., and Alexandria. Membership also includes Frederick, Montgomery, Prince George's, Charles, and Calvert counties in Maryland, and Arlington, Fairfax, Loudoun, Prince William, and Stafford counties in Virginia (figure 6). Technical support for the committee is also provided by WashCOG as well as the Departments of Transportation and air quality agencies of Maryland, Virginia, and Washington, D.C.

6.2.2 Regional and Local Planning Activities

The MPO's planning area covers Prince George's, Montgomery, and Frederick counties in Maryland, and Arlington, Fairfax, Loudoun, Prince William, and Stafford counties and the cities of Alexandria, Virginia and Washington, D.C. The ozone nonattainment area's boundaries extend beyond the TPB's planning boundaries and include Charles and Calvert counties in southern Maryland. Charles and Calvert are not members of the MPO or COG; instead, they belong (along with St. Mary's County) to a regional planning organization known as the Tri-County Council. Even though the Tri-County Council is not an MPO, it has a regional travel demand model. It, however, has not elected to conduct the conformity analysis for the transportation improvements programmed for Charles and Calvert counties. Stafford County, which is also a member of MWAQC, does not belong to WashCOG; however, it has selected to be a member of the TPB.

WashCOG has incorporated Charles County into its travel demand and air quality modeling efforts. To a great extent, this makes good sense. Considerable suburban development has occurred in Charles County. The region's high rates of growth, and Montgomery and Prince George's steep increases in housing values, have spurred the development. WashCOG is also moving toward incorporating Calvert County into its regional travel demand model. Since the transportation projects programmed for Calvert County have been air quality neutral, no quantitative analysis based on travel demand and MOBILE model runs have been necessary.

For the CO nonattainment area, no boundary or organizational issues exist regarding the completion of the transportation and air quality modeling effort. This is because the nonattainment area's boundaries fall within the MPOs planning area. The nonattainment area includes the cities of Washington, D.C. and Alexandria, and Arlington and Fairfax counties in Virginia, and portions of Montgomery and Prince George's counties in Maryland.

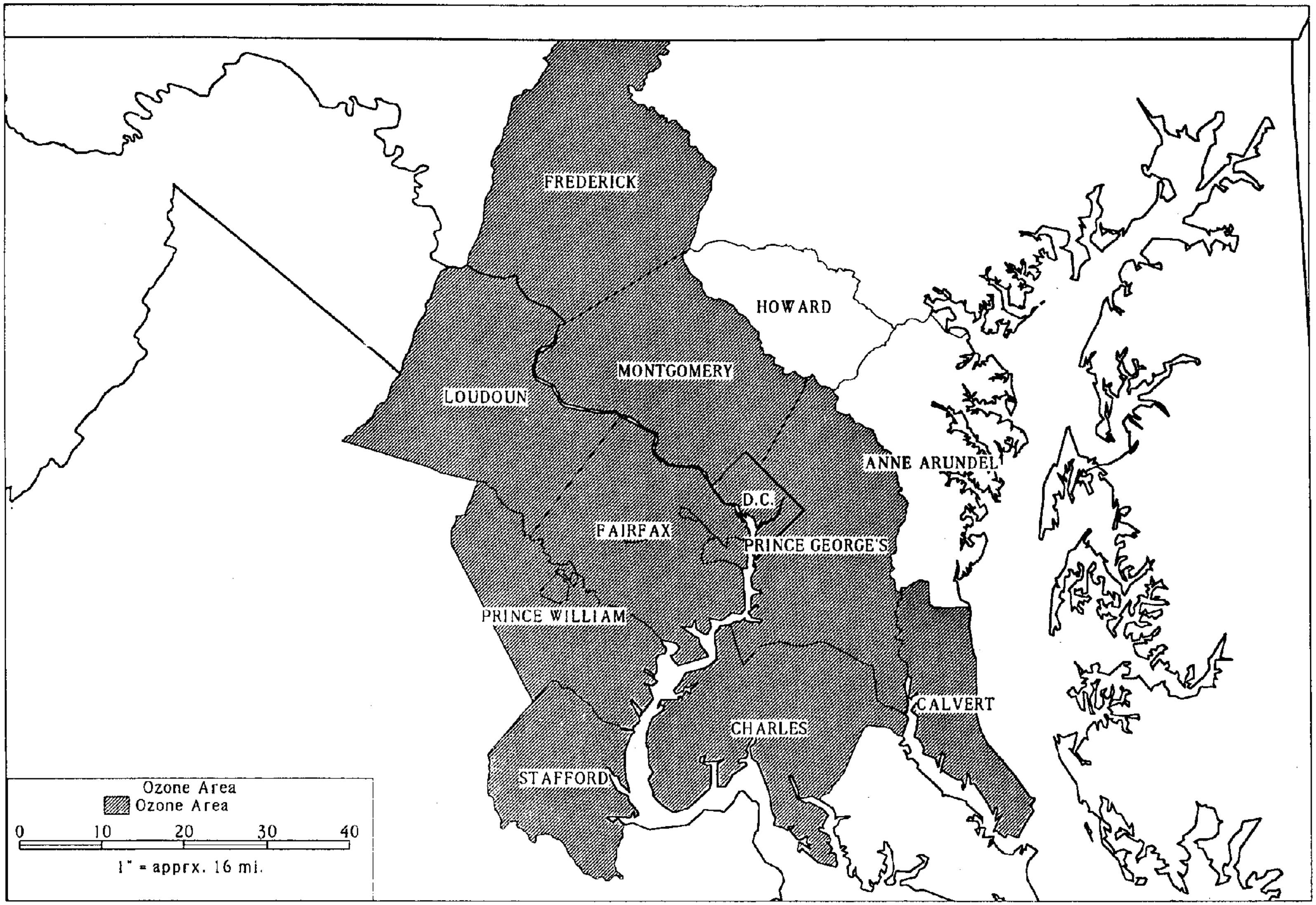

Figure 6. Washington, D.C. ozone nonattainment area.

As part of its travel demand and air quality analysis, WashCOG also models Howard and Anne Arundel counties, which are centrally located in Maryland between Baltimore and Washington, D.C. These counties are members of the Baltimore MPO, known as the Baltimore Metropolitan Council (BMC), which has its own regional travel demand model and air quality conformity program. Over the last 15 to 20 years, the economic interaction between these two counties, particularly Howard, and the Washington, D.C. area has grown tremendously. Due to this, WashCOG contends that the inclusion of these two counties improve the simulation of travel demand that it generates for Montgomery and Prince George's counties. In doing this, WashCOG estimates the traffic flows to and from Anne Arundel and Howard counties to the Washington D.C. metropolitan area using BMC's TAZs and highway networks. The networks include freeways, expressway, major and minor arterials, and some collectors. WashCOG has proceeded with its incorporation of Anne Arundel and Howard counties into its analysis with the cooperation of Maryland Department of Transportation (Maryland DOT) and BMC. Maryland DOT and BMC provide WashCOG with highway network information, a listing of highway improvements, and socio-economic data.

The U.S. Census has recently designated the Baltimore and Washington, D.C. regions as one CMSA. WashCOG and BMC have responded by agreeing to coordinate the preparation of their socioeconomic forecasts, and to meet on a quarterly basis. Prior to this redesignation of the statistical area, the planners responsible for socioeconomic forecasting in Howard and Anne Arundel counties had been active, but "nonofficial" participants, on the WashCOG committee overseeing its cooperative forecasting process.

6.3 SOCIOECONOMIC/LAND USE PROJECTIONS

Population in the Washington, D.C. region grew by about 22 percent from approximately 3.2 million persons in 1980 to 3.9 million in 1990. The region also added approximately 660,000 new jobs, representing a 43 percent increase in employment.

WashCOG is responsible for managing what it refers to as the region's cooperative forecasting process. The process, which began in the mid-1970s, relies on the generation of regional forecasts of population, households, and employment by WashCOG using a set of econometric models and the production of bottoms-up forecasts by member jurisdictions. The process is structured so that the regional and local forecasts are subject to review by a committee of peers. This requires each of the jurisdictions to be able to justify whatever forecasts they submit with information regarding recent as well as proposed residential, or commercial developments.

So far, WashCOG has completed four cooperative forecasting rounds. For the purpose of developing its 2020 transportation plan, it is beginning its fifth round. The first steps will involve a thorough review of the econometric model's demographic and economic assumptions. The current base year is 1990; future year estimates are available by five-year increments through the year 2020.

The forecasts generated by the econometric model establish a benchmark for the cooperative forecasting process. For any forecasting round, the sum of the local jurisdictions' forecasts cannot exceed the regional forecasts by more than 3 percent. In practice, the sum of the local forecasts are usually within 1 percent of the regional forecasts.

No one methodology or technique has been established for the local jurisdictions to follow to generate their sets of forecasts. Some of the counties, such as Montgomery, Prince George's and Fairfax, have developed more sophisticated techniques, whereas other jurisdictions are simply extrapolating historical trends. Nevertheless, the local forecasts are developed based on the planners' land use patterns, development proposals, new residential and commercial construction, and existing and proposed transportation facilities. Each jurisdiction is responsible for producing TAZ level forecasts. Since the region is divided into more than 1500 TAZs, the preparation of the local level forecasts is very time consuming and typically requires an 18-month commitment.

The cooperative forecasting process has been very successful at estimating the overall growth in the region for extended periods of time, such as 10-year increments. For example, the region's population, employment, and household forecasts were within .8 percent, 2.5 percent, and 1.2 percent of the 1990 census estimates. The process involves the preparation of three different sets of forecasts representative of three possible economic scenarios. The intent is to select the scenario that will be the most likely.

Despite the success at forecasting overall growth trends, the process has had less success at predicting economic peaks and valleys of two-to-three years duration. Soon after President Reagan's election in the early 1980s, WashCOG produced its third round of cooperative forecasts. WashCOG and its technical committee (consisting of representatives from local jurisdictions) believed that the region's economic growth would be slow. The country was in a recession and the President had pledged to de-emphasize the Federal Government. This led WashCOG to adopt its low growth economic scenario. However, by the mid-1980s it became clear that WashCOG and its member jurisdictions underestimated the regional impact of the administration's policies in stimulating private sector growth. By 1985, the region's employment level had already exceeded WashCOG's 1990 projections.

The econometric models are structured to account for cycles in the national and regional economies. Despite the influence of the Federal Government in the region, WashCOG has found that the regional economy increasingly cycles along with the national economy. The metropolitan area's economy experienced strong growth through most of the 1980s, and then cooled down and entered a recession, as did the nation's economy. As in most of the United States, the region's economic recovery has been soft. WashCOG reports that the region has not experienced the high level of job creation that is typical after a recession, and many of the region's employers remain skittish about future growth. To account for national trends, particularly in employment by industry, Bureau of Labor Statistics data are used in the econometric models.

Even though the forecasting process has remained fairly stable, WashCOG has recognized that the role of the Federal Government and its impact on the regional economy has changed over the last 10 years. President Reagan's economic policies (that is, the de-emphasis of the role of the Federal Government and the defense build-up) spurred a high level of private sector growth in the regional economy. WashCOG previously used Federal employment as an explanatory variable in its econometric models. It has discovered that total Federal procurements are a better predictor of the impact of the Government in stimulating regional economic growth.

To date, the region's transportation supply has been implicitly considered by local planners in the preparation of forecasts. To better respond to ISTEA and CAAA requirements, WashCOG has modified the process so that the availability of transportation facilities is explicitly considered. In other words, the jurisdictions must make qualitative judgements regarding future growth and development in each of the TAZs using empirical information on the availability of transportation facilities. WashCOG is currently considering installing the Direct Residential Allocation Model and Employment Allocation (DRAM/EMPAL), which is a quantitative model, to enhance the region's analysis of how accessibility has affected regional growth. The model's output is not intended to replace the Delphi approach used by WashCOG and the local planners. It is intended to be another source of useful information that can be used to measure the reasonableness of the region's forecasting process.

6.4 TRANSPORTATION PLAN, PROGRAMS, AND NETWORKS

6.4.1 Transportation Plan and Transportation Improvement Program

The TPB is responsible for preparing the long-range transportation plan for the Washington, D.C. metropolitan area. The last update to the long-range plan (with a 2010 target date) was completed in April 1993. To meet ISTEA requirements, the TPB intends to produce and adopt a revised plan with a 2020 horizon by July 1994.

The long-range transportation plan, which includes transit, rail, highway, and HOV projects, provides a framework for selecting what projects are included in the TIP. For the most recent TIP (fiscal years 1994 to 1999), the TPB followed ISTEA requirements and advanced only projects that are listed in the long-range transportation plan to the programming stage. This move brings the region closer to having a financially constrained planning process as required by ISTEA. It also means that the most recent TIP conformity analysis includes only those projects that have a strong likelihood of being in place.

The region has programmed Metrorail extensions, new park-and-ride lots at rail stations, new highways, highway widenings, and HOV projects. A number of HOV lanes already exist on areawide expressways. Programmed HOV projects include the extension of the HOV lane on the Shirley Highway (I-95) in northern Virginia, further south into Stafford County. Other HOV projects include the extension of the I-66 facility, and new HOV lanes on I-270.

Projects, such as transit operating assistance, highway rehabilitation, and bridge reconstructions that are air quality neutral, were not incorporated into the conformity analysis.

The region is committed to implementing transportation projects and a range of TCMs that will have the effect of reducing the rate of growth in VMT and improving areawide congestion levels. More than half of the TIPs' annual element is programmed for transit projects (table 11). The TCMs that the region is committed to include ride-sharing programs, bikeways, traffic management (signalization) systems, flashing yellow lights at intersections, and telecommuter centers (which are being sponsored by the U.S. General Services Administration) (table 12).

Table 11. Funding categories in the annual element of the FY94 TIP.

CATEGORY	TOTAL ANNUAL ELEMENT COST (Thousands of Dollars)
Highway	$876,600
Transit	
Capital	1,004,000
Operating	291,400
Ride-sharing	900
Bikeways	1,200
TOTAL	$2,174,100

Even with these measures, the auto occupancy rate assumed in the travel demand analysis remains fairly stable at about 1.15 passengers from 1990 through the year 2010 for home-based work trips, and the percent of transit users drops by about 1 percent. Despite this, the number of high occupancy automobiles increases by 112 percent from approximately 28,800 to 56,900.

The region is currently debating the adoption of episodic measures and different employee commute options (ECO). The episodic measures include recreational boating and lawnmowing restrictions on projected nonattainment days. In a recent letter to Maryland, the EPA warned that any state implementation plan (SIP) which contains episodic strategies to meet the 15 percent requirement will not be approved. The concern is that episodic measures do not result in real, permanent, quantifiable, and enforceable emissions reductions. In addition, Washington, D.C. and Virginia have expressed concern that the ECOs are overburdensome and should not be included in the SIP.

Table 12. Overview of the Washington, D.C. region's TCMs.

TCMs	Existing and Proposed Actions
Transit improvements	This includes construction of park-and-ride lots, expansion of parking at commuter rail stations, track work and station construction for Maryland Commuter Rail, rail extensions, and development of a public transportation management system.
Metrorail completion	Continued extension of Metro in the Virginia and Maryland suburbs.
Bikeways	Construction or improvement of bikeways in Washington, D.C., Maryland, and Virginia. Also, installation of bike racks/lockers.
Alternative fuels	Conversion of the WMATA fleet from gas to dual fuel capability.
High Occupancy Vehicle lanes	HOV lanes have been constructed on a number of areawide freeways. Extensions are proposed for I-270, the Beltway, and I-95.
Highway signalization	Virginia Department of Transportation will be implementing computerized systems in Fairfax, Prince William's, and Loudon counties, and in the cities of Arlington, Manassas, Alexandria, Fairfax, and Herndon. Will be using flashing yellow lights in intersections, particularly in northern Virginia, to a greater extent.
Ride-sharing	Offer carpool and ride-share programs. Also, sponsoring guaranteed ride program.
Intelligent Vehicle Highway Systems (IVHS)	Development of telecommuter centers; installation of automatic ticket machines on buses.
Cash-for-Clunkers	Considering a program to be implemented in the nonattainment area.
Employee commute options	The region is debating the adoption of employee commute options that would require employers to participate in the reduction of single-occupancy vehicles by promoting such activities as telecommuting, providing shuttle buses to the subways, and subsidizing car pools.
Episodic Measures	The region is debating measures such as mandatory or voluntary no-drive days and restrictions on the use of lawnmowing equipment on nonattainment days for adoption in its contingency plan.

6.4.2 Transportation Networks

Highway networks were developed to enable a comparison of future emissions levels under "build" and "no-build" conditions, and to ultimately demonstrate attainment and maintenance of the ozone standard. As a result, networks exist for the base year, 1990, and the following future years: 1996, 1999, and 2010. The year 1996 is the target date for reducing the area's baseline for hydrocarbon emissions by 15 percent. It is also the implementation date for the current TIP. The year 1999 is the area's target date for demonstrating attainment for ozone, and 2010 is the horizon year for WashCOG's land activity forecasts. The 2010 network can also be used to demonstrate the area's maintenance of the ozone standard. Highway networks include link speeds, distances, and capacities associated with each major facility in the metropolitan area. The HOV highway network is the same as the low occupancy vehicle (LOV) network with the exception of revised link speeds coded on preferential HOV facilities.

Due to difficulties in obtaining and coding detailed inputs, WashCOG was not able to develop transit (for metrorail and bus) networks specific to each scenario (build and no-build) and year (1996 and 1999) for the latest conformity analysis. Instead, an alternative approach was adopted. It involved matrix manipulation of transit travel times and access characteristics from pre-existing 1985 and 2010 networks. This was done by merging travel time data for specific corridor improvements from the 2010 network (the 103-mile metrorail system) with a 1985 base year (existing metrorail system) network to represent the additional metrorail service that would be in place in 1990 and by 1996 and 1999. This procedure was first used to update the 1985 network to 1990. It was then repeated for 1996 and 1999. Transit networks include speeds and distances of links traversed by transit operators as well as the headways assumed for each transit route.

By using this approach, not all transit elements of the TIP were analyzed. Transit service elements, such as Virginia Railway Express and Maryland Commuter Rail (MARC), were not included. For next year's conformity analysis, WashCOG staff plan to prepare separate transit networks for each scenario and simulation year. This will enable them to analyze specific service enhancements such as increased headways, and additional rail access mode elements. These include park-and-ride lots, and feeder services.

6.5 TRANSPORTATION/TRAFFIC FORECASTS

The metropolitan Washington, D.C. travel demand models represent the state-of-the-practice. A four-step travel demand estimation process is used (table 13). The trip generation, distribution, and car occupancy submodels were last validated in 1992 using data that were obtained from a 1987/88 home interview survey, and traffic counts conducted in 1990. Over fiscal year 1994, WashCOG is planning on updating and validating the mode choice model, and reviewing the model chain as U.S. Census data become available. This will consist of comparing estimated and observed trips and then adjusting the model's constants and coefficients.

6.5.1 Trip Generation

For trip generation, the metropolitan Washington, D.C. model incorporates a series of cross-classification submodels that produce trip tables for the following different purposes: home-based work trips, nonwork purposes, taxi, visitor/tourist, school, and through trips. The models incorporate land activity descriptive variables such as the number of households and employment by type. The residential trip generation model also classifies trips by auto ownership rate categories and areas of the region. During fiscal year 1994, WashCOG will be developing a model to estimate car ownership based on the following types of variables: (1) income; (2) transit service level availability; (3) the type of area (e.g., inner city, urban, or suburban); and (4) land use density.

Through trips are factored up based on a 1980 travel survey that produced a trip table. For the region's three airports - National, Dulles, and Baltimore-Washington International - individual trip rates were developed which are applied on an ad hoc basis. Truck trips are also generated using a separate model, based on a survey from the 1970s which produced trip rates by truck type and employment category. The survey data were updated in 1989.

Table 13. Overview of Metropolitan Washington, D.C. travel demand models.

Model Steps	Description
Trip generation	
Internal	A series of cross-classification submodels that estimate home-based work person trips and vehicle travel for home-based shop, home-based other, and nonhome-based purposes. Also, use of a model to produce truck trips.
External	Factored up using a trip table based on a 1980 travel survey.
Trip distribution	
Internal	Gravity model.
External	Gravity model. Uses 2 friction curves based on the different types of trip lengths observed on interstates and major arterials.
Modal split	A nested logit model that is used to split home-based work trips into three primary mode groups: transit, drive alone, and group ride. The transit mode is split further by differentiating by the mode of access to the transit stop. The group mode is distributed to 2, 3, and 4+ auto occupants.
Trip assignment	Incremental assignment with four iterations of capacity restraints.

6.5.2 Trip Distribution and Peak Period Definition

A gravity model is used, with the impedance function only reflecting highway travel time. An f-curve is used to smooth out observed travel lengths for different trip purposes. No transit measures are included in the gravity model.

No differentiation between peak and nonpeak hour travel is made. WashCOG personnel would like to improve its modeling effort to differentiate between peak and nonpeak hour travel during trip distribution and trip assignment. Over the next year, WashCOG intends to calibrate the home-based work trip purpose using congested travel times cycled back from the traffic assignment step. The other purposes will be calibrated using off-peak travel times. To do this, WashCOG is researching the use of a feedback loop from the trip assignment step to trip distribution.

6.5.3 Modal Split

A nested logit model is used to split home-based work trips into the following three primary mode groups: transit, drive alone, and group ride. The transit mode is split further. This is done by differentiating between what mode of access, either walk or auto, is chosen to the transit stop. The group mode is also split further. This is done by distributing the mode into three groups corresponding to 2, 3, and 4+ auto occupants.

The model includes zonal and interchange variables. Zonal variables related to trip origin include automobile ownership levels, highway access time, and the zonal area percent that is within walking distance to transit. At the destination end, zonal variables considered are daily parking costs, highway egress time, and the zonal area percent that is within walking distance from transit service. The zonal parking costs are calculated in a submodel as a function of zonal employment density. Trip interchange variables include transit fares as well as several level-of-service variables estimated for A.M. peak-hour conditions. Highway level-of-service variables, time and distance, are based on a capacity constrained assignment. Transit level-of-service variables are developed from networks that reflect both walk access and drive access to transit service. For each access type, network time is calculated by the following transit trip components: (1) access time; (2) initial wait time; (3) transfer wait time; and (4) bus in-vehicle time.

6.5.4 Trip Assignment

An incremental assignment (for total vehicle trips) with four iterations of capacity restraints is used. Link speeds are looped back into the modal choice model. WashCOG staff would like to create a feedback loop to recycle speeds into the gravity model for the home-work purpose. To date, some work has been done to accomplish this. The region's UPWP indicates that WashCOG will develop a procedure or model for splitting daily trips into time periods for making peak period or peak hour assignments.

To interface with the emissions modeling, WashCOG has developed a post-processor program to convert daily travel into hourly estimates, and to compute vehicle miles of travel (VMTs) and associated speeds. Traffic distributions for ten discrete periods of the day were calculated based on a regional traffic count survey conducted in 1980. Traffic distributions were summarized on the basis of the link's directional orientation toward the central downtown core of the District of Columbia. Summaries were made for inbound, outbound, and circumferential traffic. The above distributions were applied to the appropriate link volumes enabling the calculation of volume-to-capacity ratios. The ratios were then used to calculate speeds for time period using speed flow curves adapted from the U.S. Bureau of Public Roads curve. (The WashCOG curve assumes a slower rate of speed decay for instances of extreme congestion.) The resulting average speeds were checked against observed speeds from travel time runs conducted in peak and off-peak conditions.

The VMTs that were generated using this process were checked against Average Daily Traffic (ADT) and Average Weekday Traffic (AWDT) counts supplied by local jurisdictions and the Virginia and Maryland Departments of Transportation. WashCOG has also compared the region's AWDTs with travel results derived from the Highway Performance

Monitoring System (HPMS). WashCOG's aggregate AWDT estimates are about 4 percent higher than its HPMS estimates.

WashCOG staff indicated that intrazonal trips are estimated but are not assigned to the network. For the most part, the number of trips is not significant and the zones are typically very small.

6.5.5 General

Travel demand analyses are being done using the MINUTP package on 386 and 486 microcomputers. Prior to this, the modeling was performed on an IBM mainframe which is still maintained for some applications.

WashCOG is not actively using any GIS packages to assist in its transportation modeling; however, it has ARCINFO and plans on utilizing it to store, manage, and analyze its transportation and land activity data over the next year. A 1990 base year network will be included. Future efforts will include building future year networks and possibly historic networks utilizing the region's 1968 and 1987/88 home interview survey data and the census journey-to-work data from 1980 and 1990. It will also include traffic and transit counts and other transportation performance data.

6.6 EMISSIONS ESTIMATES

WashCOG's Environmental Programs Department is responsible for the emissions estimation process. MOBILE5a was used to estimate emissions rates for the last conformity round. For fiscal year 1994, WashCOG's MOBILE runs were completed by a consultant. Table 14 compares the total trip cycle emissions by milestone year and scenario for the 1994 air quality conformity analysis. Implementation of the build scenario results in a reduction of HC and CO emissions in each of the milestone years as required by the CAAA; however, no reduction in NO_x emissions is predicted.

WashCOG utilizes what is referred to as a "hybrid" method to estimate mobile source emissions, where trip-end emissions are calculated separately from over-the-highway emissions. The estimation of mobile source emissions involves the following three fundamental travel components: (1) running emissions; (2) trip-end emissions; and (3) diurnal emissions. Running emissions refer to those produced after the vehicle has achieved a hot stable running mode and are calculated as a function of VMT. Trip-end emissions refer to those produced at the beginning of vehicle operation, before the engine is fully warmed, and to evaporative emissions produced subsequent to the engine shutdown. Trip origin emissions are divided into two types: cold starts and hot transient starts. Respective

Table 14. Comparison of total trip cycle emissions by year and scenario (tons/day).

Emissions	1990	1996			1999			2010		
	Base	Base	Build	Change	Base	Build	Change	Base	Build	Change
HC	266.1	148.9	148.2	-0.7132	139.6	138.7	-0.8664	120.6	119.4	-1.2
CO	2,169.2	1,169.7	1,163.9	-5.8448	1,144.0	1,136.3	-7.6688	1,204.0	1,186.0	-18.0
NO_x	275.3	241.2	242.0	0.8401	226.4	227.9	1.4149	221.3	222.7	1.4301

pollutant rates per trip are applied to cold starts and hot transient starts to calculate trip origin emissions. Trip destination emissions, also known as hot soaks, are similarly calculated on a per trip emissions rate basis. Diurnal emissions refer to the evaporative loss of HC due to changes in ambient temperature during the day, irrespective of vehicle usage. Hydrocarbon emissions are associated with all travel components mentioned above. CO and NO_x, however, are associated only with trip origin and running phases of the trip cycle.

Running emissions factors are based on vehicle type, the county where vehicles are registered, and average running speed, from 5 to 65 mph in increments of 5 mph. The county where the vehicle is registered is important to determining emissions rates since inspection and maintenance standards vary by state. For HC, an inverse relationship exists between emissions rates and speeds up to 50 mph. Beyond 50 mph, emissions rates begin to rise, but very gradually. NO_x emissions rates tend to increase with speed increases (above 27 mph).

Trip-end emissions are computed by applying emissions factors to zonal trip productions and trip attractions. The computation is therefore performed on centroid connector volumes, and intrazonal trips associated with each traffic zone. Trip origin emissions are calculated by applying cold start and hot transient factors to centroid link volumes (using assumptions of 25 mph, and a 505-second warm-up period) produced from zones and intrazonal volumes. Trip destination volumes are computed by applying hot soak factors to centroid link volumes arriving into zones and, again, to intrazonal trips.

6.7 FUTURE TECHNICAL AND INFORMATIONAL NEEDS

Maryland DOT staff expressed interest in the Federal Government conducting more regional or multi-regional meetings with representatives from different state or regional transportation agencies. This would be an opportunity for representatives of different organizations to share their experiences or approaches to meeting the requirements of the CAAA. Maryland DOT suggested that these workshops could focus on the following:

- Different modeling procedures that have been adopted by metropolitan areas and states;
- Roles and responsibilities different organizations are assuming in SIP development;
- How TCMs are being modeled;
- ECO programs that have been developed;
- Strategies for reducing the hydrocarbon baseline emissions as well as NO_x emissions;
- Different uses for applications of Congestion Mitigation and Air Quality (CMAQ) funds.

WashCOG staff would like the Federal Government to schedule workshops or seminars on how to respond to the new conformity guidelines, and in this way, head off the confusion that is likely to occur at the regional and state levels.

Other suggestions included: (1) issuing a bulletin on a regular basis that reports how different metropolitan areas and states are proceeding with their air quality planning; and

(2) conducting a survey of metropolitan areas followed by a summary report of air quality successes, problems, and ability to meet the required CAAA milestones.

6.8 ESTIMATED COST OF DETERMINING CONFORMITY

WashCOG estimates that the conformity analysis for fiscal year 1994 will cost approximately $220,000. The cost breakdown that was obtained from the region's UPWP is listed in table 15.

The annual air quality conformity process is integrated into WashCOG's year-long transportation planning process, which includes the preparation of the TIP, responding to transportation system changes, and modifying networks. WashCOG is involved in air quality planning throughout the year; the conformity analysis, however, takes WashCOG approximately six months to complete. Approximately 1.5 persons are committed to air quality planning on a full-time basis. A number of different people rotate in and out of the conformity process to complete specific tasks (e.g., coding networks and running models). At any one time as many as five people can be involved.

Table 15. Air quality conformity cost breakdown for FY 1994.

Component	Cost
COG staff salaries including benefits	$146,174
Data processing	13,698
Indirect costs	54,085
Other direct costs	6,043
Total	**$220,000**

6.9 NEXT ROUND OF CONFORMITY

For the next round of conformity analyses, WashCOG is considering the following improvements to the travel demand and air quality modeling process:

- Development of a 1999 transit network and fare matrix;
- Development of a travel time feedback feature in its regional travel demand model from traffic assignment to trip distribution;
- Integration of the COMSIS TDM model into its travel demand modeling to enhance its evaluation of TCMs;
- Further development of the citizen involvement program; and
- Distribution of trips by peak and nonpeak periods.

7. PHILADELPHIA

7.1 OVERVIEW

This nonattainment area, which covers a four-state area with 5.6 million people, is designated severe for ozone and moderate for CO. It is dominated by the Philadelphia metropolitan area; however, it also includes Wilmington and Dover (located in Delaware), and the greater Vineland area located in southern New Jersey (each with their own MPO).[1] EPA has been petitioned to redesignate southern New Jersey as a separate nonattainment area. Ozone monitor readings taken in southern New Jersey in 1993 measured ozone levels that are virtually in compliance with the National Ambient Air Quality Standards (NAAQS).

The MPO for the Philadelphia area has in-house staff capable of completing the required transportation and air quality technical analyses. The other MPOs have limited staff and rely on their respective State Departments of Transportation to complete the technical analyses. Very little coordination exists among the MPOs regarding transportation and air quality planning.

The nonattainment area has two new MPOs. Salem County, located in southern New Jersey, selected to join with three other New Jersey counties to form an MPO. It had previously been a member of the Wilmington MPO. The other newly formed MPO, which only has one staff member, represents Dover and Kent County. The staff support, which is provided by the Dover City Planning Department and the Del DOT, is responsible for the transportation and air quality technical analyses.

The Philadelphia metropolitan area's highway, transit, and rail networks are old and require extensive renovation. Many of the projects in the region's TIP are committed to renovating its infrastructure. The Philadelphia metropolitan area is also attempting to identify TCMs that (1) are compatible with its older, multimodal transportation infrastructure, (2) will have a measurable impact on air quality, and (3) will be acceptable to an active and demanding environmental community.

7.2 BACKGROUND INFORMATION

7.2.1 <u>Jurisdictional and Institutional Issues and Responsibilities</u>

The nonattainment area comprises 14 counties located in Pennsylvania, New Jersey, Delaware, and Maryland. It is officially classified as a severe ozone nonattainment area. Portions of the multistate area are also classified as moderate for CO.

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[1] All of New Jersey is in nonattainment. The counties in the northern portion of the state are part of the New York ozone nonattainment area, which is designated severe-17. All of the counties located in the southern portion of the state, except for Atlantic and Cape May counties, are part of the Philadelphia nonattainment area, which is designated severe-15. Atlantic and Cape May counties have been designated moderate for ozone.

The management of air quality planning in the greater Philadelphia area involves a range of regional and state institutions. The four-state area contains four different MPOs (figures 7 and 8). Each of these MPOs is conducting separate conformity determinations of its respective TIPs and long-range transportation plans.[2] No mechanism exists at the state or regional level to coordinate or unify these discrete efforts. DVRPC, which is the MPO for the Philadelphia region, has attempted to achieve a certain level of coordination with the two states (Delaware and Maryland) that are outside its planning area. Representatives from the Departments of Transportation of Delaware and Maryland are regularly invited to attend DVRPC's air quality technical advisory committee meetings.

DVRPC is the only MPO that has the in-house staff and expertise to complete the technical aspects of determining conformity. The MPO has a regional travel demand model that it runs in conjunction with EPA's MOBILE model to determine conformity. Two of the MPOs, the South Jersey Transportation Planning Organization (SJTPO) and the Dover Metropolitan Planning Organization (DMPO), have recently been formed, and they rely on their respective Departments of Transportation for regional travel demand and emissions modeling. The Wilmington Metropolitan Area Planning Coordinating Council (WILMAPCO), which is the MPO for New Castle County in Delaware, and Cecil County in Maryland, has been in existence since the 1970s. Since the organization has only one planner, it also relies on the Delaware and Maryland Departments of Transportation for technical support.

DVRPC's membership includes the city of Philadelphia; Delaware; Chester, Bucks, and Montgomery counties in Pennsylvania; and Gloucester, Camden, Burlington, and Mercer counties in New Jersey. Regional transportation and air quality planning is guided by the DVRPC's Board of Directors, Regional Air Quality Committee (RACQ), and the Regional Transportation Committee (RTC). This is done in coordination with the following state agencies: (1) NJ DOT; (2) Pennsylvania Department of Transportation (PennDOT); (3) New Jersey Department of Environmental Protection and Energy (NJ DEPE); and (4) Pennsylvania Department of Environmental Resources (PennDER).

Since 1991, Del DOT and Maryland Department of Transportation (Maryland DOT) have conducted quantitative analyses for New Castle and Cecil counties (which are members ofWILMAPCO), respectively. For the latest round of conformity, Del DOT's Inter-Governmental Coordination Section will complete the technical analyses since it has a travel demand model that covers the city of Wilmington and New Castle County. Even though the Section is capable of operating the MOBILE model, it has had insufficient staff and time to meet the Federal submittal deadline for the 1994 conformity determination. To ensure that the deadline is met, Del DOT has contracted with a consultant to complete the 1994 MOBILE runs.

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2 The CAAA do not require each MPO to conduct separate conformity determinations. Most MPOs have been doing this but the CAAA does not prohibit a single determination for the entire nonattainment area provided it is a coordinated effort by all of the MPOs.

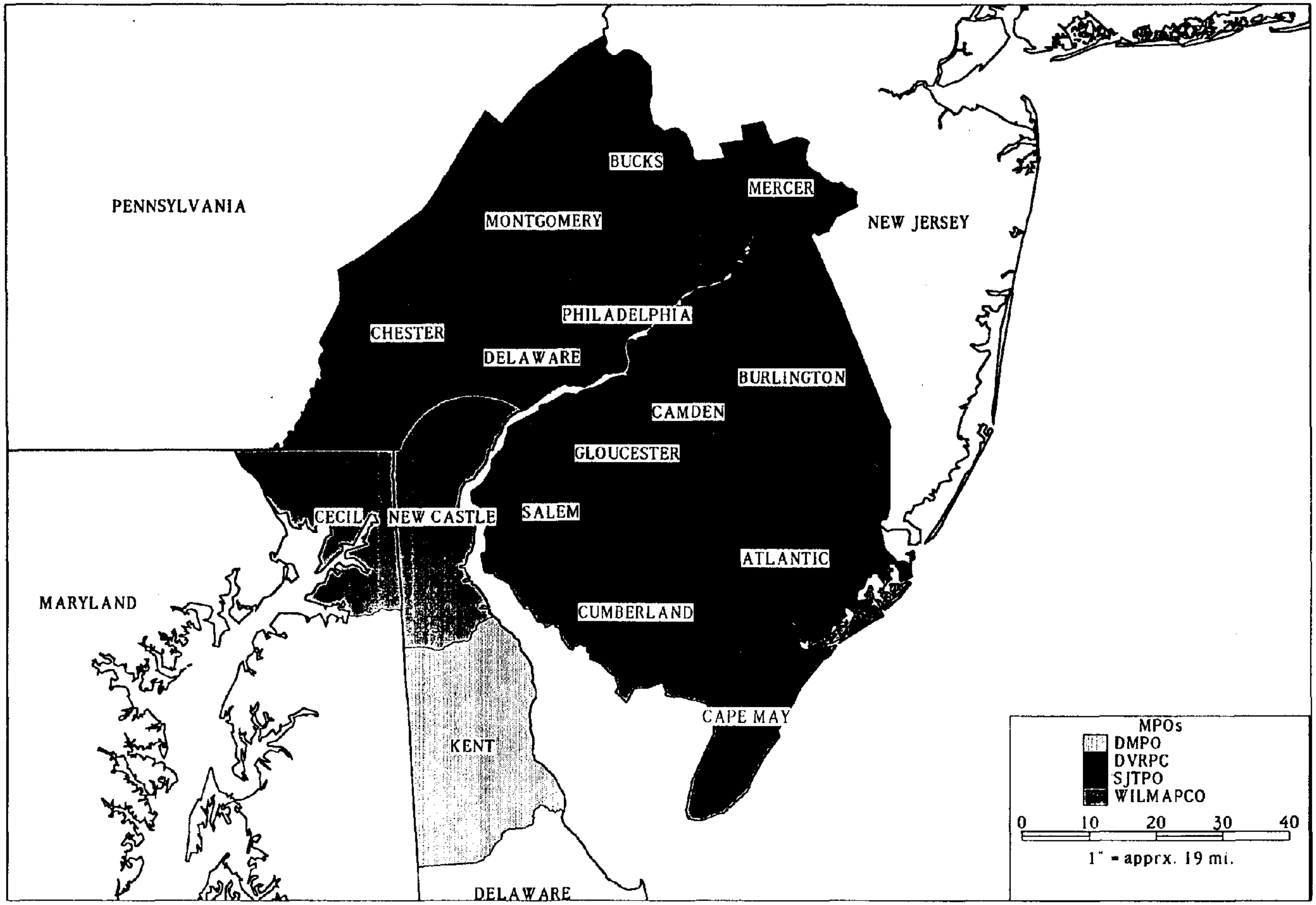

Figure 7. MPOs in the Lower Delaware Valley.

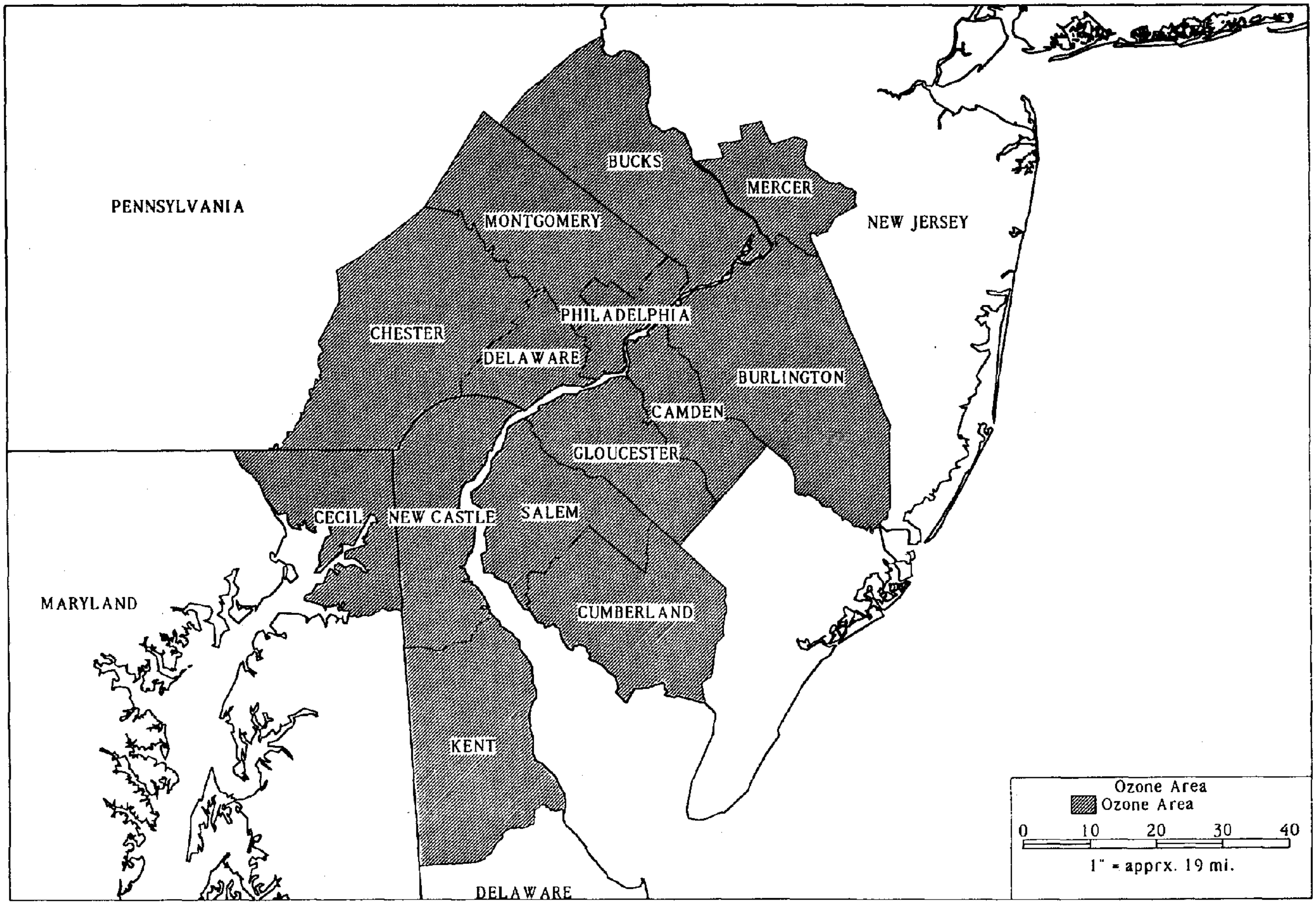

Figure 8. Lower Delaware Valley ozone nonattainment area.

Salem and Cumberland counties in southern New Jersey are also part of the Philadelphia nonattainment area. NJ DOT completed the technical analyses necessary to determine conformity for the SJTPO's fiscal year 1994 TIP. This included running a regional travel demand model, which was developed in the mid-1980s for the four counties, and EPA's MOBILE model.

7.2.2 Regional and Local Planning Activities

The Philadelphia region is the fifth largest in the U.S. Its population is over five million and covers approximately 4,000 square miles in southeastern Pennsylvania and southern New Jersey. Its highway and transit infrastructure is not only extensive but old. As a result, the regional focus is on maintenance and rehabilitation of the system as opposed to new construction. In response to ISTEA regulations, DVRPC is currently preparing a fiscally constrained long-range transportation plan with a 2015 planning horizon.

The development of a regional transportation program and plan that covers nine counties and two different states is a daunting task. The DVRPC Board, which coordinates the regional transportation planning process, provides the forum for the region's elected officials as well as representatives from the states and operating agencies. In addition to Pennsylvania and New Jersey's Departments of Transportation, the following three transit organizations participate in the planning process: (1) the New Jersey Transit Corporation; (2) the Southeastern Pennsylvania Transportation Authority; and (3) the Port Authority Transit Corporation (which is a subsidiary of the Delaware River Port Authority).

WILMAPCO is currently in a state of flux. This is partially due to the loss of one its member jurisdictions. Salem County, located in southern New Jersey, in the summer of 1993 joined with Atlantic, Cape May, and Cumberland counties to form the SJTPO. WILMAPCO, with a consultant's assistance, is now reexamining its strategic direction. In addition to redefining its emissions and identifying policy objectives, WILMAPCO is looking for ways to expand its staff so that it can take on some of the technical responsibilities demanded by the CAAA and ISTEA.

Salem and Cumberland counties (two of the three counties that belong to the SJTPO) have petitioned EPA to be redesignated as a separate nonattainment area. This is based on the contention that monitors were in place in 1988 in the two counties that indicated marginal nonattainment. The decision to include the two counties in the Philadelphia nonattainment area was based on readings taken from a monitor located in Chester, PA, which is located on the west bank of the Delaware River across from Salem County. Even though Chester is nearby, Salem and Cumberland counties assert that Chester is not representative of their transportation and land use patterns. Chester is densely populated and industrial, whereas Salem and Cumberland counties are rural and agricultural. In addition, 1993 readings indicate that ozone levels in Salem and Cumberland counties are virtually in compliance.

Despite being virtually in attainment, Salem and Cumberland counties are subject to New Jersey's employer trip reduction mandates at a potentially enormous cost. The benefits of the counties' participation in the employer trip reduction programs are considered to be infinitesimal when viewed against statewide emissions reductions.

7.3 SOCIOECONOMIC/LAND USE PROJECTIONS

7.3.1 The Philadelphia Metropolitan Area

Population in the Philadelphia region grew 12.4 percent from approximately 4.6 million persons in 1960 to 5.2 million in 1990. DVRPC expects the region's population to reach 5.5 million by 2005 and 5.8 million by 2020. These forecasts represent 7 and 11 percent increases, respectively. Employment is expected to increase at a somewhat faster rate than population, reflecting a continuation of the current trend toward two-earner households. The region's employment is anticipated to increase by 13 percent from 2.7 million in 1990 to about 3.0 million in 2005.

Population and employment growth rates are substantially larger in New Jersey than in Pennsylvania. For example, the Pennsylvania population and employment growth rates for the fifteen-year period from 1990 to 2005 are 4.5 percent and 11.7 percent, respectively. The New Jersey growth rates are 12 percent and 16.8 percent.

In May 1992, DVRPC prepared regional and county population forecasts using a cohort-component method for the following years: 2000, 2010, and 2020. This technique begins with the 1990 U.S. Census disaggregated into five-year age groups of males and females and applies age-specific death and birth rates. In addition to this, age-specific migration rates are calculated by county for each five-year cohort. This was done by examining the 1980 census, the 1985 census estimates, and the 1990 census.

Following this, DVRPC prepares municipal level forecasts using a Density Ceiling Extension Model, which combines historical data projections, ratio trends, and density ceilings for each municipality. This model provides an initial forecast, which reflects past and current trends, but also predicts a realistic future growth curve as density patterns change in a given municipality. They are modified with respect to infrastructure availability, environmental constraints, local planning policy, and development proposals. Following this, DVRPC's transportation division suballocates the municipal level forecasts to minor civil divisions.

To develop its regionwide and county-level employment forecasts, DVRPC began with the countywide employment estimates available from the U.S. Bureau of Economic Analysis (BEA). These forecasts along with state and locally prepared forecasts were then reviewed by a panel of economists from the Delaware Valley region to determine regional forecasts. Following this, a shift-share analysis was used to determine county employment forecasts. This analysis examined each county's historical share of the region's employment and the trends that could cause a shift in their respective shares. Those factors that were considered in the shift-share analysis include land and infrastructure availability, transportation access, and market trends.

These regional and county employment totals were used to develop sectoral distributions by major Standard Industrial Classification (SIC) codes. These regional and county sectoral distributions were prepared based on a review of past trends and patterns both nationally and locally, an assessment of changing forces or conditions which would affect each sector, and a review of national and state sectoral forecasts.

Municipal employment estimates for 1990 were initially based on a disaggregation of the BEA county control totals. Once the data from the Census Transportation Planning Package (also known as the journey-to-work file) became available in 1993, DVRPC decided to use it instead. Unlike the BEA data, it is available by municipality. The MPO also uses the journey-to-work data for its transportation simulation model.

Municipal employment forecasts were then prepared by conducting another shift-share analysis which considered historical data projections, ratio trends, and density ceilings. This analysis was adjusted based on infrastructure availability, environmental constraints, local zoning policy, and development proposals.

7.3.2 The Wilmington and Dover Metropolitan Areas

The State of Delaware has established what is known as the Population Consortium to develop statewide population and employment forecasts. The Consortium includes the state, the counties, and DELMARVA Power and Light, and it was formed to limit political bias. The aggregate level population and employment estimates are available through the year 2020 by five-year increments. The University of Delaware assists in the allocation of the control totals to modified grids or TAZs. These local area forecasts are then reviewed by the counties and Del DOT.

The cohort survival method is used to prepare the population forecasts. Migratory trends in and out of the state, as well as historical growth, are seriously considered in the preparation of these forecasts. The U.S. Census estimated Delaware's population in 1990 to be approximately 666,000 people; the state's estimated total was about 680,000. Approximately 65 percent of the state's population resides in Wilmington and New Castle County.

If the 1990 census population count is an accurate baseline estimate, the state anticipates it will reach its 1990 estimate by the end of 1993. In-migration has slowed from about 9,000 people per year in the 1980s. Since the beginning of the recession, this has dropped to about 3,000 per year.

The employment forecasts are prepared using employee statistics from the Delaware Department of Labor. From these data, the University of Delaware is able to identify approximately 87 percent of the employees in the state by site. These data also allow the University to segment their employment estimates into ten different SIC codes.

7.3.3 Salem and Cumberland Counties, New Jersey

The State of New Jersey adopted a regional development plan in 1992 that was prepared by Rutgers University. The plan included top-down population and employment forecasts that were prepared using econometric models. This initiated a cross-acceptance process with the counties who had developed their own population and employment estimates.

7.4 TRANSPORTATION PLAN AND NETWORKS

7.4.1 The Philadelphia Metropolitan Area

Transportation Plan

The transportation infrastructure of the region reflects its size and diversity. The combined highway and transit system is of varying age and condition. The region has an extensive public transit system, composed of 246 miles of commuter rail lines, 51 miles of rapid rail transit lines, and over 200 trolley and bus routes. Major portions of the system are undergoing reconstruction, yet other portions still suffer from a century of use.

The region has 19,700 miles of roadway and more than 4,100 bridges. The state-owned road system, which accounts for 30 percent of the total road mileage, carries most of the daily traffic volume.

DVRPC is responsible for preparing the long-range transportation plan for the Philadelphia metropolitan area. The Year 2000 Transportation Plan has been the current basis for all long-range transportation planning. To meet ISTEA requirements, DVRPC is pursuing an approach that will produce two plan updates over a relatively short period of time. The first step was recently completed. It resulted in the adoption of a 2015 financially constrained plan by the DVRPC Board. Over the next year, as 1990 census data are received and incorporated into the regional travel simulation and forecasting process, DVRPC staff will develop a 2020 plan. As part of this effort, the regional transportation policy will be reconsidered along with different scenarios for growth and development.

The regional transportation policy embodied in the Year 2000 Transportation Plan encourages residents and employers to locate in and around existing urban and suburban centers, and discourages growth in outlying undeveloped areas. The Plan strives for a balance of highway and transit improvements. This is based on an understanding that scarce resources require the region to dedicate funds to projects that will produce the greatest regional benefit.

The Plan was adopted in 1981 and amended in 1984. As recently as 1991, the Plan was adjusted to respond to changing conditions and current transportation needs. The total capital cost of the amended Plan was approximately $7.0 billion, divided equally between highway projects and public transportation facilities. A considerable allocation was made for smaller and shorter range projects. This was a departure from previous plans that focused mostly on major highway and transit facility improvements.

In 1989, DVRPC adopted the Year 2010 Regional Development Strategy (RDS), which establishes a basic direction for planning regional growth and infrastructure needs for the Delaware Valley. The RDS consists of goals, objectives, and policy statements, the adopted population and employment forecasts, and a future growth scenario. In FY 1992, DVRPC began updating the RDS by adopting revised population and employment forecasts for the nine-county region. These forecasts, which were extended to the year 2020, will serve to guide the development of a new regional development plan for this time period. The Year

2020 Land Use Plan will define a preferred future scenario of growth and development that will be integrated into the Year 2020 Transportation Plan, and the region's air quality planning.

To a great extent, many of the larger highway construction projects included in the Year 2000 Plan have been completed. Since the region's transportation infrastructure is very old, many of the significant projects programmed in the most recently adopted TIP (FY 1994 to FY 1999) focus on the reconstruction of portions of the transit and highway networks. This dedication of resources to reconstruction is necessary to preclude a decline in network capacity. Examples of reconstruction and modernization projects include a 5.2-mile section of the elevated Frankford transit rail line, the Pennsylvania portion of I-95, and US 202.

In addition to this, the TIP includes the purchase of new transit cars and buses, construction of new transit lines, the completion of missing links in the regional highway network, and the construction of intermodal facilities such as park and ride lots and transportation centers. A missing highway link that is programmed is the construction of the Exton Bypass, approximately 5.6 miles in length, between US 30 and US 202.

The region is committed to completing the TCMs identified in the 1982 Pennsylvania SIP. Only two of these TCMs have not been completed. They are the improvement of a suburban rail line to permit restoration of service, and the extension of a trackless trolley. The region is not committed to the construction of HOV lanes on areawide expressways. Many of the region's expressways are only four lanes and limited room exists to accommodate the addition of high occupancy lanes. Also, the addition of HOV lanes is difficult to justify in corridors that are already served by rail transit and commuter rail.

The TIP includes approximately $5 billion in projects. The public transit/transportation portion is close to $2.2 billion. The Pennsylvania highway program will cost $2.3 billion and the New Jersey highway program will be about $490 million (table 16). DVRPC estimates that approximately $4.3 billion in Federal, state, and local funds will be available.

Table 16. Funding categories in the annual element of the FY94 TIP.

CATEGORY	TOTAL ANNUAL ELEMENT COST (Billions of Dollars)
Highway	
Pennsylvania	$2.300
New Jersey	.490
Transit	2.200
TOTAL	$4.990

Transportation Networks

Highway networks were developed to enable a comparison of future emissions levels under "build" and "no-build" conditions, and to demonstrate attainment and maintenance of the ozone standard. As a result, networks exist for the base year, 1990, and the following three forecast years: 1996, 2005, and 2015. The future networks contain the highway improvements contained in the 1994 TIP (for Pennsylvania and New Jersey). The year 1996 is the target date for reducing the area's baseline for hydrocarbon emissions by 15 percent; the year 2005 is the area's target date for demonstrating attainment of the NAAQS for ozone; and the 2015 network corresponds to the long-range transportation plan. The highway networks include link speeds, distances, and capacities associated with each major facility in the metropolitan area. Extensive transit networks which include bus, urban rail, trolley, and commuter rail, have also been developed for the purpose of travel assignment.

The build and no-build highway networks contain all freeways and arterial roadway segments within the nine-county area that are currently open to traffic. The no-build network is very large, covering the 3,850 square mile DVRPC region at an average density of about 12.2 one-way links per square mile. Overall, the network contains over 1400 traffic centroids, 12,500 nodes, 22,500 two-way links and 2,200 one-way links, which generate more than 47,000 network arcs for purposes of minimum path building and highway assignment. This network contains about 6,700 miles of roadway, which constitute virtually all freeways and arterial facilities, and about 11 percent of local roads (tables 17 and 18). These local facilities, which are mostly minor streets within communities, industrial parks, and residential subdivisions, probably only contribute 12 to 13 percent to regional vehicle miles of travel (VMT).

Table 17. Network statistics.

Network Attributes	Statistics
Area Covered	3,846.8 Square Miles
Traffic Centroids (Traffic Analysis Zones)	1,449
Nodes	12,533 (including centroids)
Two-Way Link Cards	22,508 (including centroid connectors)
One-Way Link Cards	2,211
Equivalent One Way Links	47,227

Table 18. Highway route miles.

Functional Class	Computerized Network	Total Open to Traffic	% in Network
Freeway	739	739	100.0
Arterial	4,348	4,348	100.0
Collector/Local	1,580	14,464	10.9
Total	**6,667**	**19,551**	**34.1**

7.4.2 The Wilmington (New Castle County) and Dover (Kent County) Metropolitan Areas

Del DOT, which has responsibility for almost all roads within the state (including many minor collectors), has developed extensive highway networks for three of its most urban counties. These networks are being used for travel demand modeling purposes. Del DOT uses TRANPLAN to complete the travel analyses.

TRANPLAN is linked on a local area network (LAN) to a GIS program (MapInfo) that also has extensive demographic, land use, and employment location data. This enables Del DOT to conduct interactive analyses. They can produce highway simulations for the base year and any horizon year, and analyze the impact of new economic development on the transportation network. This system facilitates analyzing "build" and "no-build" scenarios for the air quality conformity analysis for the different milestone years - 1996, 1999, and 2005.

7.5 TRANSPORTATION/TRAFFIC FORECASTS

7.5.1 The Philadelphia Metropolitan Area

The Delaware Valley's travel demand models represent the state-of-the-practice. A four-step travel demand estimation process is used (table 19). For the Fiscal Year 1994 TIP, DVRPC recalibrated and validated its travel simulation model. Population and employment data from the 1990 census were incorporated and the model outputs were checked against actual counts at transit stations and highway links. Simulations of travel for four future conditions were then made. These simulations project travel to 1996 and 2005 for both the no-build and build scenarios.

7.5.2 Trip Generation

For trip generation, the Delaware Valley model incorporates a series of cross-classification submodels that generate person, truck, and taxi travel from census tract-level estimates of population and employment (for eleven different categories of employment). This is accomplished through the application of trip rates disaggregated by trip purpose (home-based work, home-based nonwork, nonhome based), auto ownership, and area type (CBD, fringe, urban, suburban, rural, and open rural). The 1960 Penn-Jersey Survey was the original source for the trip rate data. Since then, the trip rate data have been validated in 1970 and 1980 using screenline counts. A home survey that was conducted between 1988 and 1989 indicates that the relationships have remained stable but the trips per household have increased. In response to this, DVRPC will be increasing the trip rates in its cross-classification matrix.

External and through trips are estimated using a Fratar model. The number of trips from zone to zone are modified based on cordon station counts and proportional changes in population and employment.

Table 19. Overview of DVRPC's travel demand models.

Model Steps	Description
Trip Generation	
Internal	A series of cross-classification submodels that estimate person, truck, and taxi travel from census tract-level estimates of population and employment. Trips are estimated for the following trip purposes: home-based work, home-based nonwork, and nonhome based.
External and Through	A FRATAR model is used. Relationships are adjusted based on cordon counts and population and employment changes.
Trip Distribution	A gravity model (based on the FHWA model developed by Walter Hansen) is used. This travel impedance is measured by travel time and cost for both highway and transit modes. Intrazonal trips are estimated using the gravity model and a friction factor curve. Truck trips are distributed using a separate gravity model with highway travel times.
Modal Split	A binary probit model is used to divide travel between census tracts into transit and highway components. Besides auto travel, the highway components include the modal share for carpool and vanpool travel.
Trip Assignment	An equilibrium capacity restraining method is used to assign highway volumes. It generally takes about fifteen different iterations. During the different iterations, travel times are recalculated on the basis of the loaded network. Traffic is re-assigned on the basis of the loaded network and minimum time paths.

7.5.3 Trip Distribution and Peak Period Definition

Travel from census tracts within the region is allocated to destinations within the region with a gravity model (based on the FHWA model developed by Walter Hansen). This model assumes that the propensity to travel increases with the attractiveness of the destination (as measured by employment) and decreases as the difficulty of traveling between zones increases. This travel impedance is measured by travel time and cost for both highway and transit modes. Truck trips are distributed using a separate gravity model with highway travel times. In addition to this, intrazonal trips are estimated using the gravity model and a friction factor curve.

No differentiation between peak and nonpeak hour travel is made. Peaking occurs at different times of the day on the region's interstates (e.g., I-95), expressways, and principal arterials. This is attributed to the fact that many of the region's intraregional trips take more than an hour.

7.5.4 Modal Split and Auto Occupancy

A binary probit model is used to divide travel between census tracts into transit and highway components. Besides auto travel, the highway components include the modal share for carpool and vanpool travel.

Generally, the propensity to use public transit increases with the relative transit-to-highway service levels. The relative service levels are estimated through highway and transit out-of-vehicle time and in-vehicle time; highway operating costs and parking charges; and transit fares. The determination of the highway and transit mode shares is also affected by auto ownership, availability of transit submodes, trip purpose, and the consumer price index.

DVRPC also operates an auto occupancy model to determine the average number of persons per automobile. This value is used to convert auto person trips to auto vehicle trips. Auto occupancy is estimated by trip purpose and trip length.

7.5.5 Trip Assignment

The final step in the process is to assign the estimated highway vehicle and transit person trips to specific facilities. This is accomplished by determining the minimum time and cost paths through the highway and transit networks followed by the allocation of the highway and transit volumes. An equilibrium capacity restraining method is used to assign highway volumes. It generally takes about fifteen different iterations. During the different iterations, travel times are recalculated on the basis of the loaded network. Traffic is re-assigned on the basis of the loaded network and minimum time paths. DVRPC averages the results of the different assignments to arrive at a final estimated system loading.

When testing highway alternatives, this procedure automatically reallocates travel to newly constructed or widened highway facilities. For instance, the completion of a missing link in the freeway system will be assigned most of the through travel in the build case because the detour used in the build is longer, and therefore, more time consuming. As a consequence, VMT in the area is reduced in the build alternative because of more direct vehicle routings, and prevailing speeds are also increased because of the congestion relief to parallel facilities provided by the new roadway. Widening an arterial roadway from two to four lanes almost doubles its network capacity. This causes traffic to flow faster, attracting additional trips to the roadway in the assignment process, but probably also reducing emissions because the higher equilibrium speeds on the widened roadway significantly reduce CO and HC emissions factors.

Based on the final assignment, DVRPC calculates vehicle operating speeds by link so that it will be able to calculate emissions factors using the MOBILE model. DVRPC has found that the emissions factors calculated by MOBILE5a vary with vehicle operating speed to a very significant degree. Therefore, DVRPC recognizes that the amount and distribution of the mobile source pollutants (derived from the MOBILE model) will vary according to the method chosen to convert measures of highway congestion into operating speed. Highway travel time studies conducted by DVRPC have shown the FHWA Restraining Curve has a severe tendency to underestimate operating speeds in the Delaware Valley Region by as much as 50 percent. Thus, the use of this function to estimate simulated operating speed would result in severely overestimated emissions.

DVRPC has selected another set of curves to estimate simulated operating speeds. These curves were taken from a report prepared by Creighton, Hamburg, Inc. for the FHWA.[3] A freeway curve was used that relates peak hour link operating speed to the link speed limit, capacity, and peak hour simulated vehicular volume. For arterial highways, curves that relate peak hour link speed to the speed limit, capacity, traffic signal density (per mile), a free flow speed, and the peak hour simulated link volume were used.

Peak hour link volumes were estimated from simulated daily volumes through the use of a peak hour percentage (by functional class and area type) taken from traffic counts. Speed limits, signal densities, and free flow speeds were also used to estimate these volumes. DVRPC travel time surveys have found that daily speeds are on average about 10 percent higher than peak hour speeds.

In addition, DVRPC increased its speeds by up to 5 percent (subject to the minimum speed and speed limit) for the purpose of calculating emissions. Regional travel time surveys indicate that the original Creighton Hamburg curves underestimate actual speeds by about 5 percent. It is believed that drivers have become more acclimated to operating their vehicles under congested conditions. For arterials, a minimum speed of 8 to 10 mph (depending on area type) was added to the Creighton Hamburg formulation to adequately replicate DVRPC's travel time survey data.

7.5.6 General

Travel demand analyses are being done using the TRANPLAN package on a mainframe and 486 microcomputers. DVRPC conducts transit analyses, mode split, and traffic assignment on its mainframe.

DVRPC also has a GIS package (TransCAD) but has not used it extensively. For mapping purposes, it is actively using the Intergraph and Corel Draw software packages.

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[3] Creighton, Hamburg, Inc., *Freeway-Surface Arterial VMT Splitter*, Federal Highway Administration, Washington, D. C., 1971.

7.5.7 Delaware (New Castle and Kent Counties) and Maryland (Cecil County)

The travel demand model was calibrated with the results from an origin-destination survey that was undertaken in the early 1960s. A comprehensive origin-destination survey has been proposed by Del DOT staff; however, it has not been funded. About four years ago, an external station survey was completed for New Castle County.

Del DOT essentially uses a state-of-the-practice four-step travel demand estimation process. As stated earlier, the model is run using TRANPLAN on 486 microcomputers. For trip generation, the New Castle County model incorporates a series of cross-classification submodels that include activity descriptive variables such as population (stratified by age), number of dwelling units, and employment by SIC code. Trips are generated for the following four purposes: home to work; home to shopping; home to school; and other. Del DOT staff recently completed a review of its trip rates, and concluded that its original rates produced the best results. Separate trip rates have been developed for special attractors such as malls and recreational sites. A gravity model with travel time as its impedance measure is used to distribute trips. Toll costs have been converted to a time value and incorporated into the impedance measure. A multinomial logit model is used to estimate mode shares. Del DOT is considering enhancing the mode choice model so that it will be able to separate the demand for specialized transit services. An incremental assignment with four capacity restraints is used to complete the highway assignment.

For Cecil County, Maryland DOT uses the QRS (II and III) travel demand forecasting program.

7.5.8 Salem and Cumberland Counties, New Jersey

The estimation of travel demand for Salem and Cumberland counties is the responsibility of NJ DOT. A travel demand model that was pieced together from pre-existing models by COMSIS in the mid-1980s is used. The model, which is run using MINUTP, is a hybrid of the four step process in that it does not include a mode split submodel. It was calibrated using survey data from the early 1980s.

For trip generation, the attractions and productions are produced using regression and cross-classification models, respectively. The trips are adjusted using a Fratar-type technique to account for population and employment estimates. In addition, the trip tables are factored to account for recreational trip making. A gravity model with travel time as its impedance factor is used to distribute trips, and an iterative traffic assignment process is followed until equilibrium is reached.

7.6 EMISSIONS ESTIMATES

7.6.1 The Philadelphia Metropolitan Area

DVRPC utilizes an emissions processor to calculate mobile source emissions. The necessary inputs are the simulated VMT and speed data by link and emissions factors. For evaluating the FY 1994 TIP, the emissions factors were produced by the MOBILE5a software package. Link level emissions are aggregated to county and state totals.

Table 5 presents the results of these calculations for the FY 1994 TIP build and no-build simulations. CO, NMHC, and NO_x emissions for the region will be reduced in 1996 as a result of implementing the TIP. In 2005, regional reductions range from 1.8 percent for CO, to 1.6 percent for NMHC, to 0.4 percent for NO_x.

Since DVRPC covers two states - Pennsylvania and New Jersey - both of which have adopted different emissions control policies and programs, the MPO must prepare separate sets of MOBILE5a parameters and estimate separate emissions factor tables. For example, the inspection procedures and Stage II recovery systems vary within the region. As a result, DVRPC's staff prepares parameters and generates emissions factors for the city of Philadelphia, suburban Pennsylvania counties, and New Jersey counties. For testing the FY 1994 TIP, separate emissions factor tables were calculated for CO, nonmethane hydrocarbons (NMHC), and nitrogen oxides for 1996 and 2005 and for each of the three subareas (table 20). For each forecast year and pollutant, the mission factor table consisted of 53 speed entries, calculated by whole mile-per-hour increments from 3 to 55 mph.

All emissions factors are based on EPA supplied defaults for vehicle emissions control device tampering rates, exhaust emissions rates and temperature control corrections, and for the VMT mix of highway travel by vehicle age and type (i.e., light duty gas vehicle and various categories of trucks). The following control settings were used: (1) a minimum daily temperature of 75 degrees in Pennsylvania and 72 degrees in New Jersey; (2) a maximum daily temperature of 95 degrees; (3) fuel volatility of 9.0 psi Reid Vapor Pressure (RVP); (4) default operating modes; and (5) low altitude. The states of Pennsylvania and New Jersey provide the information on fleet registrations and age.

Regulations requiring Stage II controls on refueling emissions, through vapor recovery systems on gas pumps, vary by state. In Pennsylvania, only Philadelphia is given credit for Stage II controls (after 1991) in the emissions factors, while all of New Jersey has required these controls since 1989. The details of the vehicle inspection and maintenance programs also differ by state. New Jersey is also given credit for an anti-tampering program in that gas caps, fuel inlet restrictors, and catalytic converters are checked as part of the vehicle inspection procedure. However, Pennsylvania has a slightly higher compliance rate (93 percent versus 91 percent for New Jersey) in that only 7 percent of vehicle owners evade emissions testing.

Table 20. Impacts of the FY 1994 TIP on vehicle emissions (thousands of kilograms/day).

	CO			NMHC			NO_x		
Year/ Area	**Baseline**	**FY 94 TIP**	**Difference**	**Baseline**	**FY 94 TIP**	**Difference**	**Baseline**	**FY 94 TIP**	**Difference**
1990									
PA	1,638.1			241.6			190.9		
NJ	715.7			105.2			99.0		
Region	2,353.8			346.8			289.9		
1996									
PA	1,326.3	1,300.1	-2.0%	211.3	207.6	-1.8%	168.0	167.6	-0.2%
NJ	550.6	540.1	-1.9%	86.1	84.6	-1.7%	87.0	86.6	-0.5%
Region	1,876.9	1,840.2	-2.0%	297.4	292.2	-1.7%	255.0	254.2	-0.3%
2005									
PA	1284.8	1,261.6	-1.8%	179.6	176.8	-1.6%	158.8	158.3	-0.3%
NJ	543.0	532.7	-1.9%	74.6	73.4	-1.6%	79.5	79.1	-0.5%
Region	1827.8	1,794.3	-1.8%	254.2	250.2	-1.6%	238.3	237.4	-0.4%

Table 21 indicates that emissions factors for the year 2005 are smaller than those for 1996, reflecting anticipated improvements in vehicle-based pollution control technologies. As a result of more stringent vehicle inspection procedures and Stage II controls, New Jersey has somewhat smaller emissions factors than Pennsylvania for all pollutants. In 1996, CO factors are smaller in New Jersey by about 5 percent, while NMHC factors in the Pennsylvania suburbs are almost 9 percent higher than New Jersey's because of the absence of the Stage II controls. The planned implementation of Stage II controls in Philadelphia reduces this NMHC difference to about 3 percent. NO_x is relatively unaffected by differences in vehicle inspection measures; the reduction is less than 1 percent.

Table 21. Pennsylvania and New Jersey emissions factors in grams per mile at the regional average speeds (19 mph in 1996 and 18 mph in 2005).

	CO		NMHC			NO_x	
Year	PA	NJ	PA	PHL	NJ	PA	NJ
1996	18.21	17.32	2.80	2.64	2.56	2.23	2.25
2005	16.71	16.40	2.26	2.10	2.08	1.93	1.88

7.6.2 The Wilmington and Dover Metropolitan Areas

Del DOT is responsible for the emissions factors estimation process. MOBILE5a was used to complete the estimation of emissions rates for the last conformity round. This has been completed with the assistance of a consultant. Del DOT conducts a link base analysis for the purpose of calculating emissions rates. In doing this, different travel components are considered. Cold starts, which are estimated to represent 60 percent of the emissions burden, are calculated separately. Running emissions are then calculated by link-based on the final traffic assignment (taking VMT and speed into account).

7.6.3 Salem and Cumberland Counties, New Jersey

NJ DOT's Bureau of Transportation and Corridor Analysis is responsible for estimating emissions factors for Salem and Cumberland counties. MOBILE5a was used for the last conformity round. Local temperature readings from area airports were used in the model, and credit was taken for the adoption of a 240 inspection and maintenance program.

7.7 FUTURE TECHNICAL AND INFORMATIONAL NEEDS AND CONCERNS

The participants in this case study (individuals representing MPOs and state governments) identified technical and informational needs and concerns regarding the air quality conformity process. These are listed below.

- A number of individuals would like the Federal Government to provide standardized methods or travel demand modeling tools for evaluating the marginal impact of different TCMs. Currently, the PennDOT and DVRPC are working with COMSIS in their evaluation and selection of TCMs. In addition, it was stated that the implementation of TCMs in the Philadelphia area is very difficult due to the age of the transportation infrastructure.

  Despite what efforts are underway to evaluate and select TCMs, several of the participants expressed concern about the focus in the CAAA on the use of TCMs to achieve air quality standards. The general sentiment is that TCMs are not very effective, and that "we" are spending a lot of time on implementing measures that will not bring air quality results rapidly. Even though they are not perceived to be an effective strategy for achieving air quality goals, they are perceived positively as a means to influence people's travel choices.

  Recently, NJ DOT, with the assistance of a consultant, conducted an analysis to determine the extent that proposed TCMs from local governments and MPOs throughout the state and employee trip reduction programs (ETRP) would impact statewide air quality. The analysis included 500 to 600 TCMs. All signalization projects that were classified as TCMs were excluded from the analysis. The consultant estimated that TCMs and ETRPs would result in an aggregate statewide reduction of 8.39 tons per day of volatile organic compounds. This represents only 4 percent of the reduction that New Jersey must achieve.

- Some participants expressed an interest in having the Federal Government provide new travel demand modeling tools that would enable MPOs and state agencies to examine the impact of changing land use patterns on air quality.

- Concern was expressed about the dependence on speeds in the MOBILE model in calculating emissions rates. Since emissions reduction benefits for HC and CO are derived from increased speeds, different metropolitan areas could decide to adopt policies or implement projects that would increase trip making, trip lengths and auto ownership. (NO_x, however, increases with speeds above 27 mph.)

- More scientific information is needed on ozone formation in order to develop effective strategies that can be implemented at the regional level.

7.8 ESTIMATED COST OF DETERMINING CONFORMITY

DVRPC estimated its cost for determining conformity for the plan and TIP to be approximately $100,000. Air quality planning is ongoing all year long; however, the technical analysis takes about a month to complete. It requires one to two senior analysts and one assistant.

7.9 NEXT ROUND OF CONFORMITY

For the next round of conformity analyses, DVRPC is considering the following improvements to the travel demand and air quality modeling process:

- Development of a summary of the emissions inventories for the four states located in the nonattainment area;
- Review of the components of the travel demand model;
- Integration of the COMSIS TDM model into its travel demand modeling to enhance its evaluation of TCMs;
- Consider means to enhance the travel demand model to capture the impact of land use changes; and
- Identification of means of incorporating policy directions and new modes, such as bicycles, in the travel demand model.

APPENDIX - CASE STUDY PARTICIPANTS

Raleigh-Durham

1. Larry Anderson, FHWA - Region IV, Air Quality Specialist
2. Don Bryson, North Carolina Department of Transportation, Statewide Planning Branch, Senior Technical Specialist/Urban Coordinator - Greensboro and Winston-Salem
3. Debbie Hutchings, North Carolina Department of Transportation, Statewide Planning Branch, Transportation Engineer/Urban Coordinator - Raleigh
4. David Hyder, North Carolina Department of Transportation, Statewide Planning Branch, Transportation Engineer/Urban Coordinator - Charlotte
5. Ken Ivey, FHWA - North Carolina Division, Raleigh, Program Development Engineer
6. Ed Johnson, City of Raleigh, Department of Transportation
7. Keith Luck, The Durham City and County Planning Department, Principal Planner for Physical and Environmental Planning
8. Keith Painter, Raleigh Department of Planning, Economic Development Planner
9. Wesley Parham, Durham - Chapel Hill - Carrboro Metropolitan Planning Organization, Transportation Engineer
10. Ron Poole, North Carolina Department of Transportation, Statewide Planning Branch, Manager of Statewide Planning
11. Dan Thomas, North Carolina Department of Transportation, Statewide Planning Branch, Transportation Engineer/Urban Coordinator - Durham

Denver

1. Jim DiLeo, Colorado Department of Health - Air Pollution Control Division
2. Ken Lloyd, Regional Air Quality Council, Executive Director
3. Jeff May, Denver Regional Council of Governments, Highway and Transit Coordinator
4. Larry Mugler, Denver Regional Council of Governments, Director of Development Services

Washington, D.C.

1. Charles Baber, Baltimore Metropolitan Council, Transportation Planner
2. Harvey Berlin, Tri-County Council, Charlotte Hall, Maryland, Chief of Transportation
3. Michael Clifford, Metropolitan Washington Council of Governments, Chief, Project Planning and Analysis
4. Robert Griffiths, Metropolitan Washington Council of Governments, Technical Services Director
5. Mario Joquera, FHWA - Region 3, Air Quality Specialist
6. Howard Simons, Maryland Department of Transportation, Office of System Planning, Transportation Planner

Philadelphia

1. Marcia Blank, Pennsylvania Department of Transportation, Director of Air Quality Task Force
2. Tim Chelius, South Jersey Transportation Planning Organization, Executive Director
3. Tony DiGiacomo, Wilmington Metropolitan Area Planning Coordinating Council, Principal Planner
4. Patty Elkis, Delaware Valley Regional Planning Commission, Planning Analyst
5. Wick Havens, Pennsylvania Department of Environmental Resources, Division of Air Resources Management, Acting Chief
6. Mario Joquera, FHWA - Region 3, Air Quality Specialist
7. Bob Miller, New Jersey Department of Transportation, Bureau of Transportation and Corridor Analysis, Section Chief
8. John Moore, New Jersey Department of Transportation, Statewide Planning Bureau, Section Chief
9. Anthony Peer, Delaware Department of Transportation, Manager of Intergovernmental Coordination Section
10. Ed Ratledge, University of Delaware, Center for Applied Demography and Survey Research, Director
11. Ralph Reeb, Delaware Department of Transportation, Transportation Planner
12. Ron Roggenburk, Delaware Valley Regional Planning Commission, Manager of Air Quality Program
13. Howard Simons, Maryland Department of Transportation, Transportation Planner
14. Tom Walker, Delaware Valley Regional Planning Commission, Senior Planning Analyst

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