Methodology for Calculating LEVII Program Benefits in Pennsylvania

Technical Support Document

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Table of Contents

List of Tables

Summary of Appendices

Appendix 1: Mobile Source Highway Emissions Inventory – An Explanation of Methodology

Appendix 2: MOBILE6.2 Input Parameter Summary

Appendix 3: MOBILE6.2 LEVII Technical Data Input Files

Appendix 4: Sample MOBILE6.2 Input File

Appendix 5: Ozone Modeling Results and LEVII Benefits

INTRODUCTION

In 1998, Pennsylvania promulgated the New Motor Vehicle Emissions Control Program (25 Pa. Code Chapter 126, Subchapter D). This program created the Pennsylvania Clean Vehicles (PCV) Program that beginning in model year (MY) 2006 required new light-duty highway motor vehicles offered for sale within Pennsylvania to be certified by the California Air Resources Board (CARB) under that Board's Low Emitting Vehicle (LEV) program. The Pennsylvania Clean Vehicles Program does not require the California Zero Emitting Vehicle (ZEV) requirement. In December 2006, Pennsylvania promulgated amendments to the PCV program that:

- Postponed the compliance date from MY 2006 to MY 2008,
- Updated program definitions in 25 Pa. Code Chapter 121, § 121.1 (relating to definitions),
- Makes program regulatory clarifications, and
- Provides a transition mechanism for compliance with the program.

This document provides estimates of the potential LEVII program benefits within the state and summarizes the methodology used to calculate emissions. The document provides future year projections of mobile (highway) vehicle miles of travel (VMT) and emissions (ozone precursors VOC and NOx) for the years 2010, 2015, 2020, and 2025.

Emission Calculation Methodology

Technical guidance documents from EPA were used in the development of base and future year emissions inventories to support the analyses of potential LEVII program benefits in Pennsylvania. They include:

- *Policy Guidance on the Use of MOBILE6 for SIP Development ad Transportation Conformity*, US EPA Office of Air and Radiation, dated January 18, 2002.
- *Technical Guidance on the Use of MOBILE6 for Emission Inventory Preparation*, US EPA Office of Air and Radiation, and Office of Transportation and Air Quality, dated January 2002, revised February 2, 2005.
- *User's Guide to MOBILE 6.1 and MOBILE6.2, Mobile Source Emission Factor Model*, EPA420-R-02-028, dated October 2002.

Mobile source emission factors were calculated using EPA's MOBILE6.2 emission model. The methodologies used to produce the emission results conform to the recommendations provided in EPA's Technical Guidance. A mix of local data and national default (internal to MOBILE6.2) data has been used for this submission. Local data has been used for the primary data items that have a significant impact on emissions. These include:

- VMT and speeds
- Vehicle type mixes
- Vehicle age distributions
- Hourly distributions
- Temperatures/humidity
- Inspection/Maintenance parameters
- Fuel program characteristics.

For this analysis, local data inputs reflect the latest planning assumptions at the time of the analysis (based on 2002 data). These include current assumptions on control strategies (e.g. Inspection-Maintenance programs) and fuel characteristics. The analysis methodology is consistent with the 2002 National Emissions Inventory (NEI) submission. A detailed methodology is provided in **Appendix 1**.

Methodology for Estimating LEVII Program Credits

The emission benefits of the Pennsylvania Clean Vehicles Program have been calculated using the assumptions and data files documented in EPA's June 5, 2002 guidance entitled, "*Modeling Alternative NLEV Implementation and Adoption of California Standards in MOBILE6"* and the '*Technical Guidance on the Use of MOBILE6 for Emissions Inventory Preparation"*. Several key revisions to the EPA guidance assumptions were needed to reflect the program to be implemented in Pennsylvania. The revisions include the removal of the zero-emitting exhaust vehicle (ZEV) component of the program and a revised phase-in start date of 2008 (EPA guidance assumptions are based on a 2004 start date).

Inventory Submission Materials

To complement this document, attachments have been provided with additional detail regarding the analysis methodology, the MOBILE6.2 input parameters, and the output emission results for the counties in Pennsylvania. These include:

Table 1: Summary of Appendices

Appendix	Title	Description
1	Mobile Source Highway Emissions Inventory – An Explanation of Methodology	Provides summary of methodology used to calculate the VMT and emissions.
2	MOBILE6.2 Input Parameter Summary	Provides summary of input parameters related to traffic data sources, fuel, weather, I/M, and other MOBILE6.2 related parameters.
3	MOBILE6.2 LEVII Input Files	Provides phase-in percentages and exhaust certification bin standards used to reflect LEVII program
4	MOBILE6.2 Sample Input File	Provides example of MOBILE6.2 input files.
5	Pennsylvania ozone (VOC, NOx) Emission Results (By County, Year)	Provides county emissions for a *summer weekday* in 2010, 2015, 2020, 2025 (Results included for 2004, 2006, 2009 LEVII start date) (2008 start date results interpolated)

EMISSION DATA SOURCES AND ANALYSIS TOOLS

This section provides a summary of the input data and analysis tools used to evaluate the potential emission benefits of the Pennsylvania Clean Vehicles Program. The key elements to the modeling protocol are described in the sections below. A more detailed description of the analysis process and tools is provided in the methodology report in **Appendix 1**.

Analysis Tools

The statewide emissions analysis utilizes several key software/programs for producing the county emissions totals. These tools are outlined in **Table 2**.

Table 2: Summary of Inventory Analysis Tools

Tool	Purpose
MOBILE6.2	Produces emission factors for each pollutant in grams/mile for VOC and NOx
PPSUITE	Processes the highway data, Calculates hourly congested speeds for each state roadway segment, Prepares MOBILE6.2 input files, Processes MOBILE6.2 output files

The statewide inventory reflects the highway mobile source emission estimations using EPA's MOBILE6.2 emission model. PPSUITE represents an enhanced version of the Post Processor for Air Quality (PPAQ) software system that has been used for previous inventory and conformity submissions in Pennsylvania. The software has undergone significant revisions to ensure consistency with the MOBILE6.2 emissions model. PPSUITE plays a key role in the development of hourly roadway speed estimates, which are supplied as input to the MOBILE6.2 model. The software is also used to prepare the MOBILE6.2 input shell and to process the MOBILE6.2 outputs.

Traffic Data Source/Fleet Data Inputs

The 2002 PENNDOT Roadway Management System (RMS) data serves as the primary highway data source for the county and functional class VMT estimates. The data source provides a "snapshot" of the regional roadway system and volumes in 2002. The data includes the 2002 average annual daily traffic volumes for all state roadways in Pennsylvania. To account for additional local roadway VMT and to ensure consistency with reported HPMS totals, the 2002 VMT totals are adjusted to match the 2002 HPMS VMT totals reported to FHWA.

Based on the requirements for ozone inventories, traffic volumes on each RMS roadway segment must be adjusted to a summer weekday. The daily and monthly seasonal factors are developed from data contained in the document, *2002 Pennsylvania Traffic Data*, as prepared by PennDOT's Bureau of Planning and Research. The seasonal and daily factors provided in this document are based on statistical analyses of 2002 traffic counts taken at permanent and in-pavement ATR (automatic traffic recorder) locations throughout the state. Based on these seasonal traffic volumes, the PPSUITE software calculates unique congested speeds for each roadway segment during an ozone summer weekday scenario.

PPSUITE calculates congested speeds by hour of the day for each roadway segment and provides the information as input to the MOBILE6.2 software. To disaggregate the daily RMS volumes to hourly volumes, auto and truck hourly pattern data from PennDOT's *2002 Pennsylvania Traffic Data* report are used to determine the temporal variations in traffic volumes.

Vehicle mix patterns are calculated for each county and functional class grouping utilizing a combination of 2002 RMS truck percentages and MOBILE6.2 default vehicle mix distributions. The development of vehicle type pattern data input to the MOBILE6.2 software is described in more detail in **Appendix 1**. The distribution of vehicles to fuel type (diesel, gas) is determined from the MOBILE6.2 default diesel sales fractions.

Vehicle age distributions are input to MOBILE6.2 for each county based on registered vehicles that reflect July 1 summer conditions. These distributions reflect the percentage of vehicles in the fleet up to 25 years old and are listed by the 16 composite MOBILE6 vehicle types. 2002 vehicle age distributions have been used for this inventory from the PennDOT Bureau of Motor Vehicles Registration Database. Due to insufficient data, only data for light-duty vehicles are used as local inputs. The heavy-duty vehicles use the internal MOBILE6.2 defaults.

Traffic Growth Assumptions

Traffic growth forecasting plays a pivotal role in estimating future year emissions for the region. This inventory utilizes county-specific growth rates, as used for past conformity and inventory submissions, based on an extrapolation of historic HPMS VMT growth trends. The growth rates were originally shared between PennDOT, PaDEP, and other Interagency Consultation Group members, including the PA Conformity Work Group (which includes EPA, FHWA, and representatives from larger MPOs within the state).

I/M and Fuel Parameters

The Inspection Maintenance (I/M) program inputs to the MOBILE6.2 model are based on current programs within the county. The Pennsylvania inspection and maintenance (I/M) program was upgraded and expanded throughout the state with a phase-in period starting in December 2003 and fully implemented by June 2004. The program test requirements vary by region and include on-board diagnostics (OBD) technology that uses the vehicle's computer for model years 1996 and newer to download potential engine problems that could effect emissions. The program, named PAOBDII, is implemented in the Philadelphia, Pittsburgh, and South Central / Lehigh Valley Regions. The Northern Region receives gas cap and visual inspections and the other 42 counties in the Commonwealth receive a visual inspection. Vehicles subject to the program include 1975 and newer model year gasoline cars and light duty trucks up to 9,000 pounds GVW. New model years are exempt for the first year. The county of registration determines which inspections are required.

The summer weekday RVP values are consistent with values used for past inventory efforts. These assumptions, as well as the I/M program and fuel parameters, are summarized in **Appendix 2 and 4**.

Weather Data

Weather information is based on information obtained from the National Climatic Data Center to calculate the minimum and maximum temperatures and absolute humidity data inputs to the MOBILE6.2 model. These assumptions are consistent with the 2002 NEI inventory submission.

Other weather data required by MOBILE6.2 are assumed as the program defaults. These include the cloud cover, peak sun, and sunrise/sunset options.

Other Inputs

Federal vehicle emissions control and fuel programs are incorporated into the MOBILE6.2 software. The programs include:

- The Federal Motor Vehicle Control Program (FMVCP) including the National Low Emission Vehicle Program (NLEV) and federal Tier II / Low Sulfur Fuel Program;
- Emissions standards for medium and heavy duty vehicles in 2002, 2004 and 2007;
- Stage II and Onboard Refueling Vapor Recovery (ORVR).
  Note: Pennsylvania considers emissions from refueling operations an area source category. While MOBILE6.2 is employed to calculate emissions factors for that source category, refueling emissions are not included in highway vehicle emissions estimations.

For analyses used to determine benefits related to the Pennsylvania Clean Vehicles Program, modifications were made to the federal vehicle control assumptions in MOBILE6.2. The input parameters were revised according to EPA guidance as discussed in the following sections.

ESTIMATING LEVII PROGRAM CREDITS

The emission benefits of the Pennsylvania Clean Vehicles Program have been calculated using the assumptions and data files documented in EPA's June 5, 2002 guidance entitled, "*Modeling Alternative NLEV Implementation and Adoption of California Standards in MOBILE6"*.

EPA's guidance provides key assumptions used to model the LEVII program impacts including:

- CARB LEVII phase-in schedules
- LEVII exhaust emission certification bin standards
- Methods for treatment of PZEV, AT-PZEV evaporative emissions

The calculations of LEVII benefits are determined by comparisons to a base-case, which is considered the Tier2 federal program. MOBILE6.2 assumes the default Tier2 phase-in schedule as estimated and prepared by EPA. This phase-in schedule is automatically applied within MOBILE6.2 applications. Assumptions must also be made for the sales of future vehicles under California's LEVII program. The analysis uses the CARB LEVII phase-in percentages for passenger cars and light-duty trucks as presented in EPA's June 2002 guidance (Tables A-1 to A-3). The phase-in percentages are based on a 2004 program start date. Since the Pennsylvania Clean Vehicles Program will start in 2008, alternative LEVII phase-in percentages have been developed for these analyses. Note that Pennsylvania's program will not include California's ZEV mandate, thus those phase-in assumptions are not used for the analysis.

The LEVII program may include significant sales of PZEV and AT-PZEV type vehicles. Under the ZEV mandate, such vehicles must produce "near-zero" evaporative emissions. As indicated in EPA's June 2002 Guidance, the MOBILE6 model can only produce evaporative emissions for the following conditions:

- Zero evaporative emissions consistent with Pure ZEV vehicles
- Evaporative emissions equivalent to LEVII/Tier2 vehicles

In reality, the PZEV and AT-PZEV evaporative emissions fall somewhere between these two options. The EPA June 2002 Guidance recommends an approach that assumes that such vehicles produce evaporative emissions consistent with LEVII vehicles.

Summary of Technical Data Files

EPA's June 2002 guidance provides the key input data needed to reflect the impacts of the California LEVII program. **Table 3** summarizes the files used for Pennsylvania's analyses, including the revisions and modifications made to each EPA file. **Appendix 3** provides a printout of the technical data files used in the analyses.

Technical data files were developed and applied for alternative LEVII program start dates including 2004, 2006, and 2009. The files provided by EPA were used directly for the 2004 program start date calculations; however, EPA's LEVII94.D file was not used since the Pennsylvania Clean Vehicles Program does not include California's ZEV mandate.

Table 3: LEVII Technical Data Input Files

MOBILE6 Command	EPA Guidance Input Data File	Description	Modifications for Pennsylvania Analysis
T2 EXH PHASE-IN	LEVIIPH.D	CARB LEVII Phase-in percentages by exhaust certification bin for model years 2004-2015	Files created for alternative program start dates: 2004 start date: Use EPA file directly – No Modification 2006 start date: Create pal2exh.06* Combination of M6 Tier2 defaults from T2EXH.D file for years 2004, 2005 and LEVII standards from LEVIIPH.D for years 2006 and above 2009 start date: Create pal2exh.09* Combination of M6 Tier2 defaults from T2EXH.D file for years 2004-2008 and LEVII standards from LEVIIPH.D for years 2009 and above
T2 CERT	LEVIIST.D	CARB LEVII exhaust certification bins	Use EPA file directly – No Modification
T2 EVAP PHASE-IN	LEVIIEVP.D	CARB LEVII phase-in percentages for evaporative standards for model years 2004 and up	Files created for alternative program start dates: 2004 start date: Use EPA file directly – No Modification 2006 start date: Create pal2evp.06* Combination of M6 Tier2 defaults from T2EVAP.D file for years 2004, 2005 and LEVII standards from LEVIIEVP.D for years 2006 and above 2009 start date: Create pal2exh.09* Combination of M6 Tier2 defaults from T2EVAP.D file for years 2004-2008 and LEVII standards from LEVIIEVP.D for years 2009 and above
94+ LDG IMP	LEVII94.D	For model years 2004-2025 used only to establish fraction of zero-emitting exhaust vehicles (ZEVs)	Use NLEVNE.D for all scenarios since Pennsylvania program does not have ZEV mandate

** Due to difference in Tier2 and LEVII bin definitions and the need to combine into one file, phase-in percentages were moved to different bin numbers to ensure correct vehicle standard representation*

Calculation of LEVII Program Benefits

Analyses were conducted to identify the potential emission impacts of adopting the California LEVII program in Pennsylvania. The analyses provided in this memo focus on the ozone precursors VOC and NOx. The analyses were conducted before Pennsylvania agreed upon the 2008 program start date and were completed for 2004, 2006 and 2009 alternative program start dates. For this submission, 2008 LEVII emissions and benefits are determined by simple straight line interpolation between the 2006 and 2009 start date alternative runs.

Appendix 5 provides the emission tables for each alternative start date as well as the emission impacts for 2010, 2015, 2020, and 2025. **Table 4** provides the benefits of the Pennsylvania Clean Vehicles Program (with 2008 start date and no ZEV mandate) as compared to the existing federal Tier2 program. The table illustrates emission benefits in tons/day.

Table 4: Impact of the Pennsylvania Clean Vehicles Program vs Federal Tier2 Program

Statewide Results	2010		2015		2020		2025	
	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx
Emission Benefits (tons/day)	-0.93	-0.97	-2.74	-3.52	-5.63	-6.79	-7.81	-9.13

** Negative values indicate emission benefits over Tier2 Program*

RESOURCES

Draft Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations, EPA, June, 2003

Consolidated Emissions Reporting, Federal Register, June 10, 2002

2002 Pennsylvania Traffic Data, PENNDOT Bureau of Planning and Research, 2002.

User's Guide to MOBILE6.1 and MOBILE6.2, Mobile Source Emission Factor Model, EPA420-R-02-028, dated October 2002.

Technical Guidance on the Use of MOBILE6 for Emission Inventory Preparation, US EPA Office of Transportation and Air Quality, January 2002.

Policy Guidance on the Use of MOBILE6 for Emission Inventory Preparation, US EPA Office of Air and Radiation, January 18, 2002.

Modeling Alternative NLEV Implementation and Adoption of California Standards in MOBILE6, EPA, June 5, 2002, revised February 2, 2005.

APPENDIX 1

Mobile Source Highway Emissions Inventory

An Explanation of Methodology

March 2007

Explanation of Methodology
March 2007

TABLE OF CONTENTS

List of Exhibits

INTRODUCTION

The purpose of this document is to explain how Pennsylvania estimates emissions from highway vehicles for inclusion in its emission inventories and State Implementation Plans.

Overview of Emissions Inventories

Pennsylvania's inventories generally categorize emissions into four categories:

- highway vehicles
- stationary sources (major industrial, commercial and utility sources)
- area sources (smaller industrial/commercial sources, consumer products)
- nonroad mobile sources (including construction and agricultural equipment, lawn and garden equipment)

An evaluation of emissions from point, area, and mobile sources is needed to develop a complete inventory needed for a maintenance demonstration plan. This inventory provides the mobile source activity and emissions for base and future years that can be used to support such a demonstration.

Of all of the sources of air pollution, only the emissions of some stationary sources are measured directly and continuously through instrumentation. Emissions from all other sources must be estimated in some fashion, including those from highway vehicles. In their very simplest form, estimates of emissions follow the following pattern:

Emission rate x activity level = emissions per time period (usually day or year)

Most emission rates have been developed by EPA, in cooperation with industry and states, over many years and are compiled and documented in a reference volume, Compilation of Air Pollution Emission Factors (AP-42). For example, the annual VOC emissions from residential fuel oil heating could be estimated by:

AP-42 emission rate	*X*	*activity level* =	*emissions*
0.713 pounds/gallon	*X*	# dwelling units *x* % using oil *x* # gallons per unit	# pounds of VOC per year

Adding up the products of the emission rates and activity levels for all sources of a given pollutant constitutes the emission inventory for that pollutant.

Highway Vehicle Emission Inventories

Highway vehicles contribute significantly to air pollution, particularly to ground-level ozone, which is the most persistent air pollutant in Pennsylvania. Ozone is not created directly but formed in sunlight from VOCs and NOx. Both VOCs and NOx are emitted from highway vehicles. Pennsylvania's ozone-related emission inventory efforts have been focused on these pollutants.

Obviously, direct measurement of emission levels from all vehicles in use is impossible. In comparison to highway vehicles, estimating residential heating emissions is a fairly simple calculation because there is a constant emission rate and a fairly simple measure of activity. For highway vehicles, however,

estimating the emission rate and activity levels of all vehicles on the road during a typical summer day is a complicated endeavor.

If every vehicle emitted the same amount of pollution all the time, one could simply multiply those emission standards (emission rate in grams of pollution per mile) times the number of miles driven (activity level) to estimate total emissions. But, the fact is that emission rates from all vehicles vary over the entire range of conditions under which they operate. These variables include air temperature, speed, traffic conditions, operating mode (started cold? started warm? running already warmed up?) and fuel. The inventory must also account for non-exhaust or evaporative emissions. In addition, the fleet is composed of several generations, types of vehicles and their emission control technologies, each of which performs differently. This requires that the composition of the fleet (vehicle ages and types) must also be included in the estimation algorithm.

In order to estimate both the rate at which emissions are being generated and to calculate vehicle miles traveled (activity level), Pennsylvania examines its road network and fleet to estimate vehicle activity. For ozone-related inventories, this is done for a typical summer weekday. For CO and PM emission inventories, this may be done for a typical winter weekday or annual conditions. Not only must this be done for a baseline year, but it must also be projected into the future. This process involves a large quantity of data and is extremely complex.

Computer models have been developed to perform these calculations by simulating the travel of vehicles on the Commonwealth's roadway system. These models then generate emission rates (also called emission factors) for different vehicle types for area-specific conditions and then combine them in summary form. The "area-specific conditions" include vehicle and highway data, plus control measure characteristics and future year projections of all variables.

MOBILE. The heart of the highway vehicle emission calculation procedure is EPA's highway vehicle emission factor model, MOBILE. This is a FORTRAN program that calculates **average** in-use fleet emission factors for ozone precursors for each of twenty-eight categories of vehicles under various conditions affecting in-use emission levels (e.g., ambient temperatures, average traffic speeds, gasoline volatility) as specified by the model user. MOBILE produces the "emission rates" referred to in the previous section.

The model was first developed as MOBILE1 in the late 1970s, and has been periodically updated to reflect the collection and analysis of additional emission factor data over the years, as well as changes in vehicle, engine and emission control system technologies, changes in applicable regulations, emission standards and test procedures, and improved understanding of in-use emission levels and the factors that influence them. For this inventory effort, Pennsylvania utilizes MOBILE6.2 as approved by EPA. In addition to VOC, CO, and NOx, MOBILE6.2 produces emission factors for PM related emission categories as needed for other inventory efforts.

PPSUITE. Pennsylvania also uses a post processor named PPSUITE (formerly named PPAQ - Post Processor for Air Quality), which consists of a set of programs that perform the following functions:

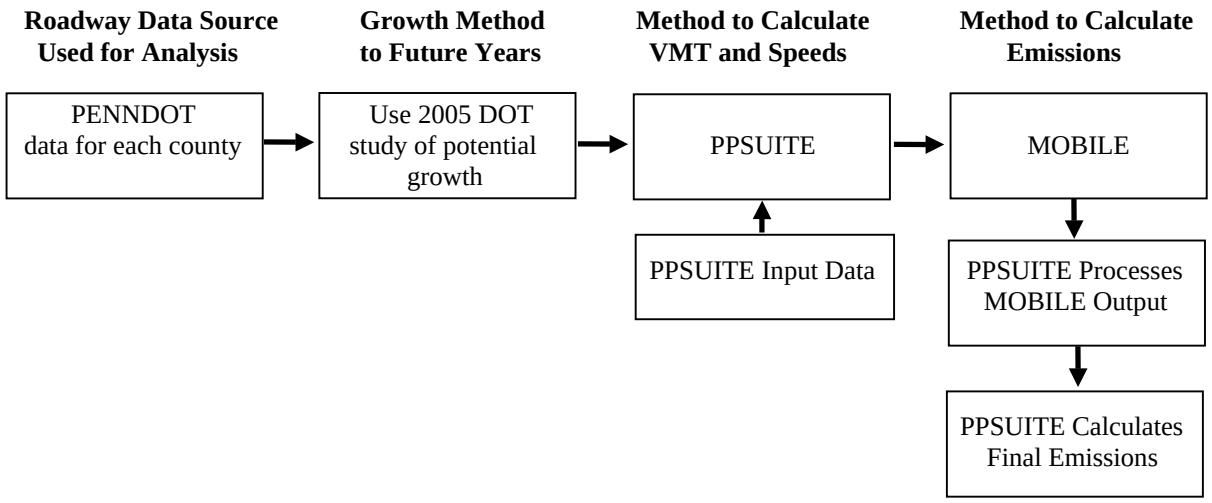
- Analyzes highway operating conditions
- Calculates highway speeds
- Compiles vehicle miles of travel (VMT) and vehicle type mix data
- Prepares MOBILE6 runs
- Calculates emission quantities from output MOBILE6 emission rates and accumulated highway VMT.

PPSUITE has become a widely used and accepted tool for estimating speeds and processing MOBILE emission rates. It is currently being used for the New York City region, for the north and south New Jersey regions, and in other states including Louisiana, Virginia, and Indiana. The software is based upon accepted transportation engineering methodologies. For example, PPSUITE utilizes speed and delay estimation procedures based on planning methods provided in the 2000 Highway Capacity Manual, a report prepared by the Transportation Research Board (TRB) summarizing current knowledge and analysis techniques for capacity and level-of-service analyses of the transportation system.

These two computer programs interact as shown in Exhibit 1.

Exhibit 1

Emission Calculation Process for Pennsylvania



WHERE DOES PENNSYLVANIA OBTAIN ITS DATA?

Data Used in MOBILE

Two major types of information are written into the MOBILE model by EPA: basic emission rates and travel weighting rates. EPA's Office of Mobile Sources obtains this information from a number of sources, including its new vehicle certification program, in-use vehicle random sample studies and special studies (including information from some state I/M programs). For more information on MOBILE, a users guide and various documents (as well as the model itself) are available through EPA's website (http://www.epa.gov/OMSWWW/models.htm).

Basic emission rates are those which are produced under very standardized conditions. The model then modifies (corrects and/or weights) these rates based on other model or input parameters. Rates are incorporated for model year and vehicle type. MOBILE also calculates an assumed amount of increase in emissions as vehicles accumulate mileage.

In addition to exhaust emissions, evaporative VOC emission sources from gasoline-powered vehicles are also included[1]:

- diurnal emissions (evaporated gasoline emissions generated by the rise in temperature over the course of a day when the vehicle is not being driven),
- hot soak emissions (evaporated gasoline emissions occurring after the end of a vehicle trip, due to the heating of the fuel, fuel lines, fuel vapors),
- running loss emissions (evaporated gasoline emissions occurring while a vehicle is driven, due to the heating of the fuel and fuel lines),
- resting loss emissions (small but continuous seepage and minor leakage of gasoline vapor through faulty connections, permeable hoses and other materials in the fuel system).

Evaporative emissions are very dependent on temperature and fuel volatility as well as vehicle model year.

Travel Weighting Fractions. Research has found that newer cars tend to be driven more. The model reflects this, using state-specific vehicle age distributions from registration data. The model also contains assumptions about trips per day and miles per day by age of the vehicle. This is important for exhaust emissions because these emissions are greater when the vehicle is not warmed up (cold start). Also, this information helps characterize evaporative emissions.

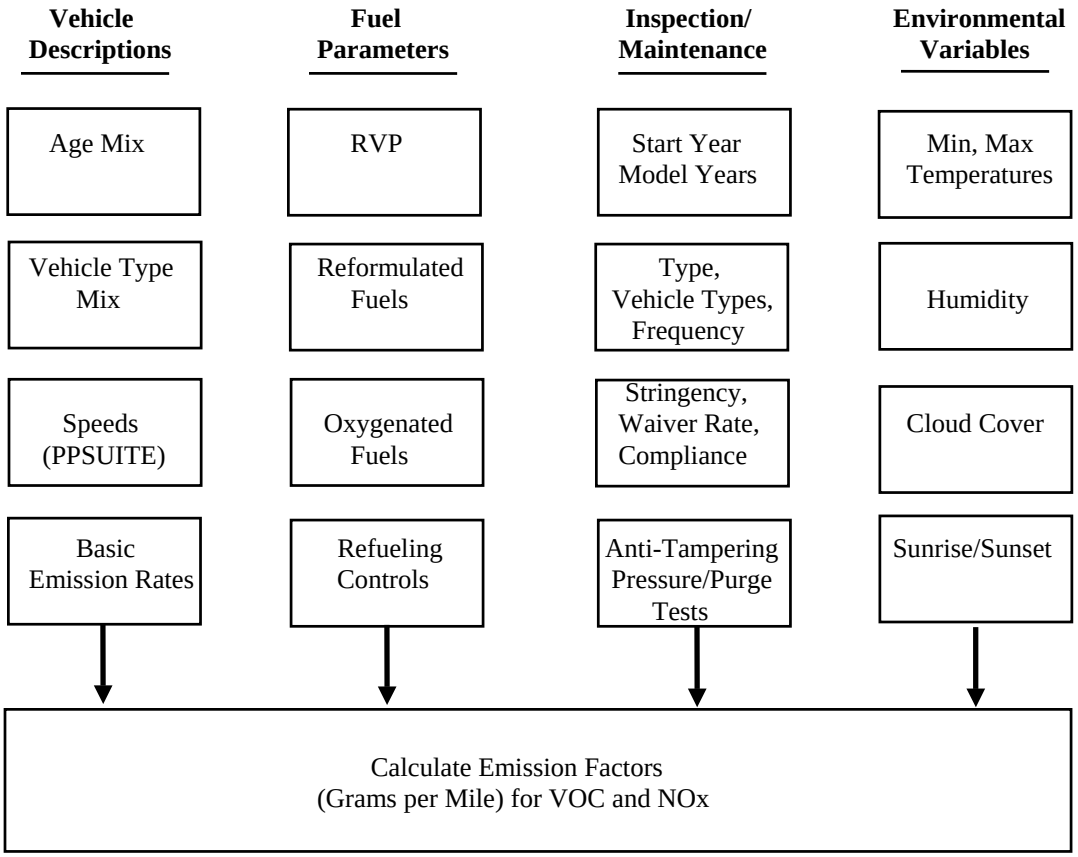
[1] Some states use MOBILE to estimate refueling emissions (gasoline vapor emissions generated by the refueling of vehicles, where in the absence of controls the vapor in the vehicle fuel tank is displaced by the incoming liquid fuel and released to the atmosphere). Pennsylvania handles these emissions in the area source inventory.

What Are The Necessary Data Inputs to MOBILE?

A large number of inputs to MOBILE are needed to fully account for the numerous vehicle and environmental parameters that affect emissions including traffic flow characteristics (as determined from the PPSUITE software), vehicle descriptions, fuel parameters, inspection/maintenance program parameters, and environmental variables as shown in Exhibit 2. With some input parameters, MOBILE allows the user to choose default values, while others require area-specific inputs.

Exhibit 2

MOBILE Inputs



For an emissions inventory, area specific inputs are used for all of the items shown in Exhibit 2 except for the basic emission rates, which are MOBILE defaults. In addition, Pennsylvania uses the MOBILE6.2 default starts-per-day data and soak distributions that are used to calculate the number of starts in cold and hot start modes. EPA requires that the number of starts occurring per vehicle be determined from instrumented vehicle counts. Since such local data is not available, the MOBILE6.2 national defaults are used for the Pennsylvania analyses. A vehicle will generate more emissions when it is first operated (cold start). It generates emissions at a different rate when it is stopped and then started again within a short period of time (hot start). Soak distributions are used to determine the time between when an engine is turned off to the next time it is restarted.

Vehicle Descriptions. Vehicle age distributions are input to MOBILE for each county based on registered vehicles reflecting July 1 summer conditions. These distributions are obtained from PENNDOT's Bureau of Motor Vehicle Registration Database. Vehicle Type Mix is calculated from algorithms using a combination of MOBILE6.2 default percentages and PENNDOT truck percentages from roadway data. (See also the discussion of Vehicle Type Pattern Data in the next section.) Speeds are discussed extensively in the next section.

Significant changes have occurred in the MOBILE6.2 model as compared to previous releases. Some of the information previously applied by the post processor after running MOBILE can now be input directly to the MOBILE6.2 model run. This includes information on the hourly distribution of VMT and the hourly speeds that occur during the day. Another important change in MOBILE6.2 is the influence of facility type on output emission factors. For example, MOBILE6.2 assumes that an average speed on a freeway results in a different emission factor than the same speed on an arterial roadway. Thus MOBILE6.2 is indirectly accounting for the accelerations and decelerations that typically occur on such roadways. MOBILE6.2 has four distinct facility types: Freeway, Arterial, Local, and Ramp. For any emission run, the input functional classes analyzed must be mapped to the above facility types. The following mapping scheme is used for the Pennsylvania runs:

PENNDOT Functional Classes	***MOBILE6.2 Facility Type***
1,11,12	Freeway
2,6,7,8,14,16,17	Arterial
9,19	Local

Since ramps are not directly represented within the RMS database information, it is assumed that 8% of the Freeway VMT is Ramp VMT. This is consistent with the recommendations provided in EPA's Technical Guidance on the Use of MOBILE6.2 for Emissions Inventory Preparation.

Fuel Parameters. The same vehicle will produce different emissions using a different type of gasoline. Fuel control strategies can be powerful emission reduction mechanisms. An important variable in fuels for VOC emissions is its evaporability, measured by Reid Vapor Pressure.

MOBILE allows the user to choose among conventional (used in most of Pennsylvania), federal reformulated (now used in the Philadelphia area), oxygenated (not used in Pennsylvania) and low Reid Vapor Pressure (RVP) gasoline (used in the Pittsburgh area starting in 1998). Pennsylvania chooses the MOBILE inputs appropriate to the year, season, and control strategy for the area being modeled.

MOBILE also allows users to calculate refueling emissions, the emissions created when vehicles are refueled at service stations. Pennsylvania includes refueling emissions in its area source inventory and not in its highway vehicle inventory. However, that calculation uses a grams per gallon emission rate generated by MOBILE.

Vehicle Emission Inspection/Maintenance (I/M) Parameters. MOBILE allows users to vary inputs depending on the I/M program in place for the area or, of course, choose "no I/M program." The inputs include:

- program start year
- stringency level
- first and last model years subject to the program
- waiver rates
- compliance rates

- program type (test-only, test-and-repair, etc.) and effectiveness
- frequency of inspection (annual, biennial)
- vehicle type coverage
- test type (idle, loaded, etc.)
- pass/fail standards or "cutpoints"
- technician training program

Some cutpoints (the emissions at which vehicles are failed) are contained in MOBILE, while others must be put in by the model user. Pennsylvania uses the parameters specific for the geographic area and year for which the modeling is being performed.

Environmental Variables. Evaporative emissions are influenced significantly by the temperatures of the surrounding air. Minimum and Maximum temperatures have been compiled for each county based on information from EPA's CHIEF bulletin board reflecting airport temperatures on emission violation days. For annual and winter weekday analysis, average monthly temperatures are compiled for each county.

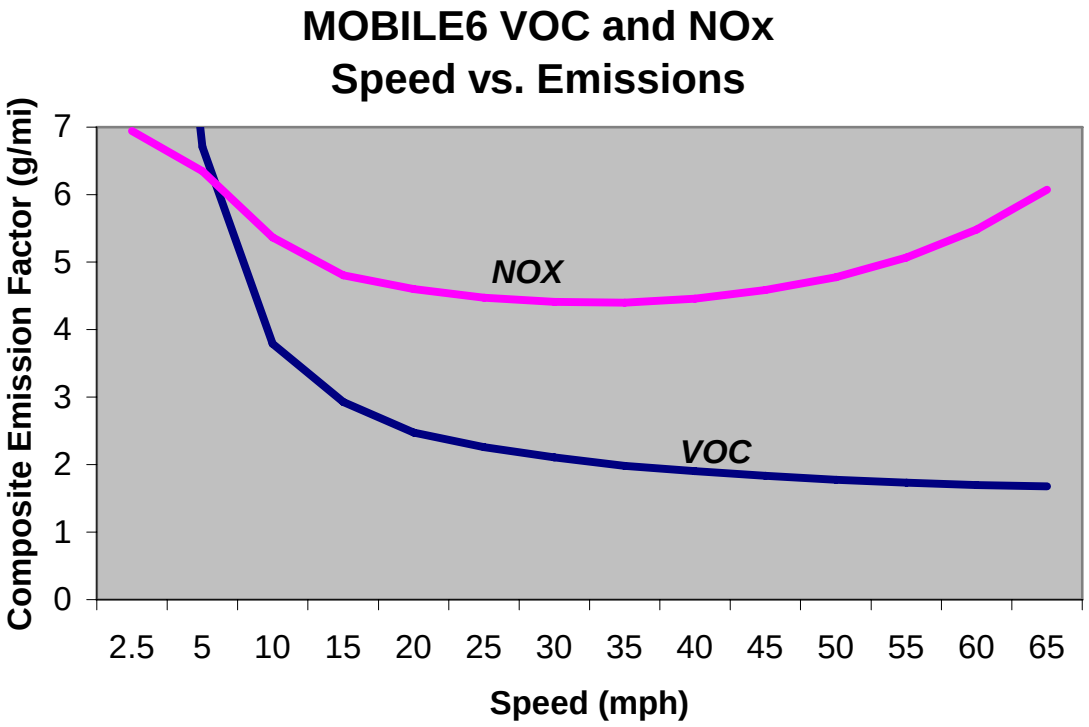
A summary of the MOBILE related inputs used for the inventory and future year estimates are attached with the submission.

Emission and Speed Relationships

Of all the user-supplied input parameters, perhaps the most important is vehicle speed. Emissions of both VOC and NOx vary significantly with speed, but the relationships are not linear, as shown in Exhibit 3. While VOCs generally decrease as speed increases, NOx decreases only at the low speed range and increases steeply at higher speeds.

To obtain the best estimate of vehicle speeds, Pennsylvania uses the PPSUITE set of programs, whose primary function is to calculate speeds and to organize and simplify the handling of large amounts of data needed for calculating speeds and for preparing MOBILE input files.

Exhibit 3



Roadway Data

The roadway data input to emissions calculations for Pennsylvania uses information from the Roadway Management System (RMS) maintained by PENNDOT's Bureau of Planning and Research. PENNDOT obtains this information from periodic visual and electronic traffic counts. RMS data is dynamic since it is continually reviewed and updated from new traffic counts and field visits conducted by PENNDOT. Information on roadways included in the National Highway System is reviewed at least annually, while information on other roadways is reviewed at least biennially.

On a triennial basis, a current "snapshot" of the RMS database is taken and downloaded to provide an up-to-date record of the Commonwealth's highway system for estimating emissions. The current "snapshot", in this case 2002, is used for the 2002 statewide inventory analysis.

The RMS database contains all state highways, including the Pennsylvania Turnpike, divided into segments approximately 0.5 miles in length. These segments are usually divided at important intersections or locations where there is a change in the physical characteristics of the roadway (e.g. the number of lane changes). There are approximately 99,000 state highway segments for the 67 Pennsylvania counties contained in the RMS. Each of these segments contains an abundance of descriptive data, but only the following information is extracted for emission calculations:

- Lanes

- Distances
- Volumes in Average Annual Daily Traffic (AADT)
- Truck percentages
- PENNDOT urban/rural classifications
- PENNDOT functional class codes

RMS volumes and distances are used in calculating highway VMT totals for each county. As discussed in the next section, adjustments are needed to convert the volumes to an average summer weekday, winter weekday, and monthly day. Lane values are an important input for determining the congestion and speeds for individual highway segments. Truck percentages are used in the speed determination process and are used to split volumes to individual vehicle types used by the MOBILE software.

Pennsylvania classifies its road segments by function, as well as whether it is located in an urban, small urban or rural area, as indicated below in Exhibit 4. The PENNDOT urban/rural (UR) and functional classes (FC) are important indicators of the type and function of each roadway segment. The variables provide insights into other characteristics not contained in the RMS data that are used for speed and emission calculations. In addition, VMT and emission quantities are aggregated and reported using both UR and FC codes.

Exhibit 4

PENNDOT Classification Scheme: Urban/Rural Codes and Functional Class Codes

Urban/Rural Code	1=Rural 2=Small Urban 3=Urban	
Functional Class	Rural Functional Classes Used For Rural Areas	Urban Functional Classes Used For Small Urban and Urban Areas
	1=Rural Freeway	11=Urban Freeway
	2=Rural Other Principal Arterial	12=Urban Expressway
	6=Rural Minor Arterial	14=Urban Principal Arterial
	7=Rural Major Collector	16=Urban Minor Arterial
	8=Rural Minor Collector	17=Urban Collector
	9=Rural Local	19=Urban Local

Note: Functional Classes 3,4,5,10,13,15,18 are not currently used in PENNDOT's RMS database

Additions and Adjustments to Roadway Data

Before the RMS data can be used by PPSUITE for speed and emission calculations, several adjustments and additions must be made to the roadway data.

HPMS Adjustments: According to EPA guidance, baseline inventory VMT computed from the RMS highway segment volumes must be adjusted to be consistent with Highway Performance Monitoring System (HPMS) VMT totals. The HPMS VMT reported for Pennsylvania is a subsystem of the RMS established to meet the data reporting requirements of the Federal Highway Administration (FHWA) and

to serve as PENNDOT's official source of highway information. Although it has some limitations, the HPMS system is currently in use in all 50 states and is being improved under FHWA direction.

The HPMS VMT totals are developed from the data contained in the RMS database at the time of reporting and serves as a "snapshot" of the RMS data for a particular year. Since the RMS database does not contain many local roads, a separate procedure is used by PENNDOT to estimate total local VMT for the HPMS system. HPMS VMT summaries are prepared each year and reported by PENNDOT urban/rural and functional class codes. The VMT contained in the HPMS reports are considered to represent average annual daily traffic (AADT).

Although the HPMS VMT and the roadway data used for an inventory emissions analysis are both based on data from the RMS system, differences do exist between them and include the following. First, the HPMS and inventory roadway data are "snapshots" of the RMS data taken at different times. Since the RMS is dynamic, changing constantly due to new data, differences will result between the data used for calculating HPMS VMT totals and the inventory data used for an emissions analysis. Second, local estimates of HPMS VMT are obtained through alternative procedures developed by PENNDOT. However, the emissions inventory makes use of those few local roads contained in the RMS system. To account for such differences, adjustment factors are calculated and used to adjust the inventory roadway data to the reported HPMS VMT totals submitted to FHWA.

Adjustment factors are calculated which adjust the base year RMS download (in this case 2002) VMT to the reported HPMS totals for that year. These factors are developed for each county, urban/rural code, and functional class combination and are also applied to all future year runs. Adjustments for the "higher" functional classes (e.g. Freeway, Arterials - major routes) were very close to 1.000 since HPMS VMT is derived from RMS information, and the only difference in the data is that the "snapshot" for the emission calculations is taken at a different time than for the HPMS. "Lower" classes (e.g. local roads) require greater adjustment since a large part of the local system is not under state jurisdiction and is not in the RMS database. There is, of course, a significant amount of local road mileage in the state. It is assumed that those local streets that are in RMS are representative of all local streets in their area with respect to volume and speed, so that roadway mileage adjustment is appropriate.

Seasonal Adjustments to Volumes: The RMS contains AADT volumes that are an average of all days in the year including weekends and holidays. An ozone emission analysis, however, is based on a typical summer weekday. PM and CO analyses require volumes representing a typical winter weekday and monthly average conditions (needed for producing annual totals). Therefore, the RMS volumes must be seasonally adjusted. Seasonal factors were developed for each functional class and urban/rural code based on yearly count information prepared by PENNDOT's Bureau of Planning and Research. These factors are applied to the existing RMS AADT volumes to produce the July volumes.

Additional Network Information: The PPSUITE software system allows for many additional variables other than those available in the RMS database. Using these variables improves the ability of Pennsylvania to incorporate real roadway conditions into its estimates. The variables include information regarding signal characteristics and other physical roadway features that can affect a roadway's calculated congested speed. PPSUITE's ability to estimate congested speeds by road segment improves Pennsylvania's emissions inventories because of the overwhelming role speed plays in emission rates. If specific information regarding these variables is known or obtained for areas, this information can be appended to the RMS database. Otherwise, default values are assumed based on information provided by the PPSUITE input speed/capacity lookup data as described below.

Speed/capacity lookup data provides PPSUITE with initial (free-flow with no congestion) speeds and capacities for different urban/rural code and functional class groupings. The initial speeds and capacities are used by PPSUITE in determining the final congested speed for each roadway segment. Speeds can also be greatly impacted by signals and other roadway features. As a result, this data provides default signal densities (average number of signals per mile for different functional classes) as well as default values for variables that determine the decay of speed with varying levels of congestion. As discussed above, values from the speed/capacity data can be overridden for specific links by directly coding values to the roadway database segments. The speed capacity data was developed from a combination of sources including the following:

- Information contained in the 2000 Highway Capacity Manual
- PENNDOT information on speeds and signal densities
- Engineering judgment

24-hour Pattern Data: Speeds and emissions vary considerably depending on the time of day (because of temperature) and congestion. Therefore, it is important to estimate the pattern by which roadway volume varies by hour of the day. The 24-hour pattern data provides PPSUITE with information used to split the daily roadway segment volumes to each of the 24 hours in a day. Pattern data is in the form of a percentage of the daily volumes for each hour. Distributions are provided for each county and functional class grouping. This data was developed from 24-hour count data compiled by PENNDOT's Bureau of Planning and Research, according to the process in Procedures for Adjusting Traffic Count Data, 2002.

Vehicle Type Pattern Data: Basic emission rates may differ by vehicle type. These types are listed below in Exhibit 5.

Exhibit 5

MOBILE6.2 Input Composite Vehicle Classes

1.	LDV	- Light-Duty Vehicles (Passenger Cars)
2.	LDT1	- Light-Duty Trucks 1 (<6,000 lbs)
3.	LDT2	- Light-Duty Trucks 2 (<6,000 lbs, LVW=3,751-5,750)
4.	LDT3	- Light-Duty Trucks 3 (6,001-8,500 lbs)
5.	LDT4	- Light-Duty Trucks 4 (6,001-8,500 lbs, LVW>5,751)
6.	HDV2B	- Class 2b Heavy Duty Vehicles
7.	HDV3	- Class 3 Heavy Duty Vehicles
8.	HDV4	- Class 4 Heavy Duty Vehicles
9.	HDV5	- Class 5 Heavy Duty Vehicles
10.	HDV6	- Class 6 Heavy Duty Vehicles
11.	HDV7	- Class 7 Heavy Duty Vehicles
12.	HDV8A	- Class 8a Heavy Duty Vehicles
13.	HDV8B	- Class 8b Heavy Duty Vehicles
14.	HDBS	- School Buses
15.	HDBT	- Transit and Urban Buses
16.	MC	- Motorcycles

MOBILE summary reports by vehicle type are also useful in knowing what kinds of vehicles generate emissions. The vehicle type pattern data is used by PPSUITE to divide the hourly roadway segment volumes to the sixteen MOBILE6.2 (MOBILE5 had eight) vehicle types. Similar to the 24-hour pattern

data, this data contains percentage splits to each vehicle type for every hour of the day. The vehicle type pattern data was developed from several sources of information:

- Hourly distributions for trucks and total traffic compiled by PENNDOT's Bureau of Planning and Research, according to Procedures for Adjusting Traffic Counts, 2002
- PENNDOT truck percentages from the RMS database
- MOBILE6.2 default vehicle type breakdowns for the analysis year

The vehicle type pattern data is developed for each county and functional class combination. First, RMS truck percentages are averaged for all roadways within a county, functional class grouping. Using this percentage data, the total roadway volume for any segment could be divided to both auto and truck vehicle type categories. However, these percentages do not yet enable volumes to be divided to each of the sixteen MOBILE6.2 vehicle types. As a result, MOBILE6.2 default vehicle type breakdowns are then used to divide the auto and truck percentages, calculated above, to each specific MOBILE6.2 vehicle type. Note that the defaults used vary by analysis year; as a result, each forecast year will utilize a unique vehicle mix distribution. PENNDOT hourly distributions for trucks and total traffic are then used to create vehicle type percentage breakdowns for each hour of the day.

Vehicle Type Capacity Analysis Factors: Vehicle type percentages are provided to the capacity analysis section of PPSUITE to adjust the speeds in response to trucks. That is, a given number of larger trucks take up more roadway space than a given number of cars, and this must be accounted for in the model. Capacity is adjusted based on the factors provided in this data. Values are developed from information in the 2000 Highway Capacity Manual and are specific to the various facility types.

Producing Future Year Volumes

Growth factors are used to project future highway volumes from the volumes provided in the RMS database. In the past, separate factors were derived for each county and highway functional class from an analysis of historic global update factors provided by PENNDOT's Bureau of Planning and Research, coupled with estimates of population and employment growth from the U.S. Department of Commerce's Bureau of Economic Analysis (BEA). The factors were then applied to base year traffic volumes (in this case 2002) on each highway segment in the RMS network database.

For this submission, county-specific growth rates from a PENNDOT study completed in 2005 have been used to forecast volumes. As part of that study, a statewide traffic growth forecasting system was developed that incorporates traffic data from PENNDOT's Traffic Information System and socioeconomic forecasts. The forecasting system was developed to support Department research endeavors related to transportation conformity and air quality planning.

The study, as documented in the report "*Statistical Evaluation of Projected Traffic Growth, Traffic Growth Forecasting System: Final Report, March 14, 2005*", included the development of VMT forecasts and growth rates for four functional classifications in each Pennsylvania county: urban interstate, urban non-interstate, rural interstate, and rural non-interstate. The forecasts used statistical relationships based on historic HPMS VMT trends and future county socioeconomic projections from Woods and Poole.

SPEED/EMISSION ESTIMATION PROCEDURE

The previous sections have summarized the input data used for computing speeds and emission rates for Pennsylvania. This section explains how PPSUITE and MOBILE use that input data to produce emission estimates. Exhibit 6 on the following page summarizes PPSUITE's analysis procedure used for each of the 99,000 highway segments in the state.

Producing an emissions inventory with PPSUITE requires a process of disaggregation and aggregation. Data is available and used on a very small scale -- individual ½ mile roadway segments 24 hours of the day. This data needs to first be aggregated into categories so that a reasonable number of MOBILE scenarios can be run, and then further aggregated and/or re-sorted into summary information that is useful for emission inventory reporting.

One of the major enhancements of MOBILE6.2 is the increased detail of traffic that can be input to the emissions model. The PPSUITE post processor calculates hourly speeds for each roadway segment. Since previous versions of MOBILE only allowed one average speed as input for each scenario, the post-processed speeds had to be aggregated and run through MOBILE with scenarios representing four separate time periods. MOBILE6.2 allows for direct input of the 24 hourly speeds as well as options to account for each link's speed separately. These added features utilize the full extent of the information output from the speed processing programs and provide for more accurate emission estimates of the available traffic data.

Volume/VMT Development

Before speeds can be calculated and MOBILE run, volumes acquired from RMS must be adjusted and disaggregated. Such adjustments include factoring to future years (not needed for 2002 base year), seasonal adjustments, and disaggregating daily volumes to each hour of the day and to each of the sixteen MOBILE6.2 vehicle types.

Future Year Volumes: The RMS database contains up-to-date current year volumes. However, to conduct a future year analysis, these volumes must be factored to the year being analyzed. Growth factors have been prepared for each county and functional class grouping. These growth factors are applied to the base year 2002 RMS volumes to obtain future year estimates that can be utilized by PPSUITE.

Example:

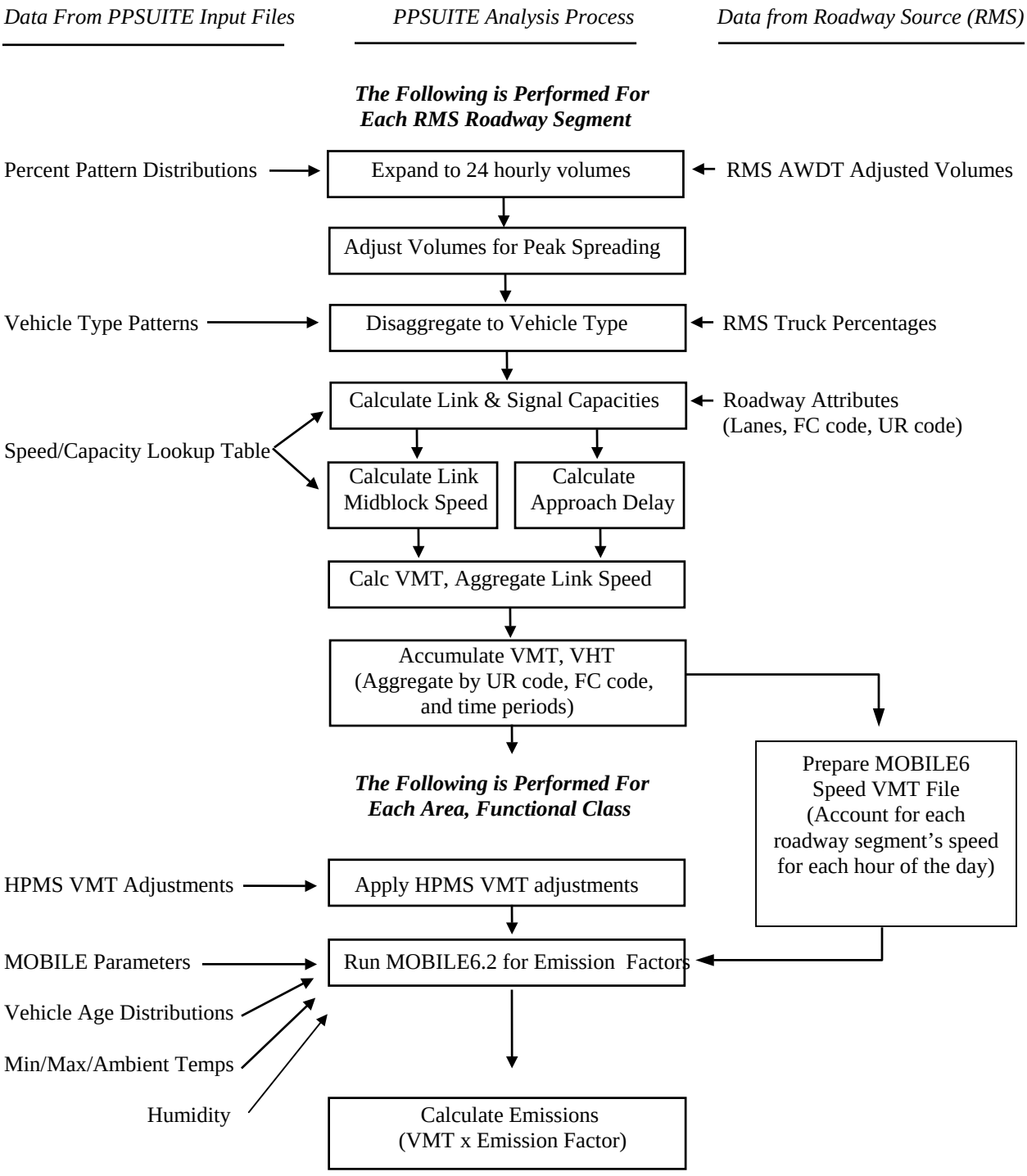
A typical freeway link in the RMS database is I-80 segment 2500 in Luzerne County, Pennsylvania. This link has an urban/rural code=1 which indicates the link is in a rural area, and a functional class=1 indicating a rural freeway. The average annual daily traffic (AADT) from the RMS database for this link in 2002 is 12,077 vehicles/day.

Growth factors have been developed to factor the 2002 volume to future years. For example, to factor the 2002 volume to the year 2014, a growth factor of 1.282 would yield:

2014 volume = 12,077 vehicles/day x 1.282 = 15,483 vehicles/day

Exhibit 6

PPSUITE Speed/Emission Estimation Procedure



Seasonal Adjustments: PPSUITE takes the input daily volumes from RMS which represent AADT and seasonally adjusts the volumes to an average weekday in July. This adjustment utilizes factors developed

for each functional class and urban/rural code. VMT can then be calculated for each link using the adjusted weekday volumes.

Example:

Again, assume the rural freeway link: I-80 segment 2500 in Luzerne County, Pennsylvania. The average annual daily traffic (AADT) for this link in 2002 is 12,077 vehicles/day.

Seasonal factors have been developed for urban/rural code and functional class combinations. For an urban/rural code=1 and a functional class=1, the factor to convert from AADT to an average weekday in July is = 1.15

Average Weekday July Volume = 12,077 x 1.15 = 13,889 vehicles/day

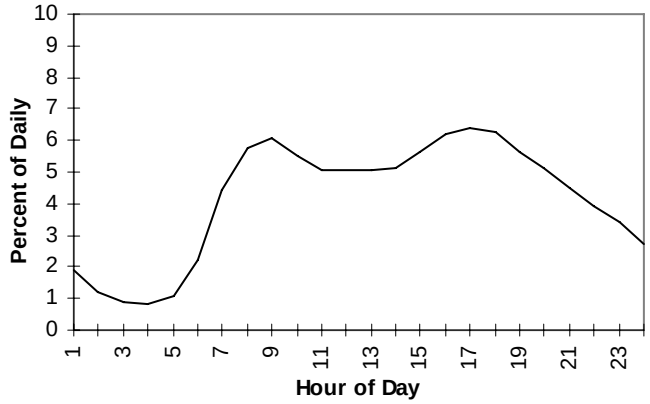
Total VMT (daily) for this link is calculated as volume x distance. The distance of this link as obtained from RMS is 0.286 miles.

2002 VMT = 13,889 vehicles/day x 0.296 miles = 41,111 vehicle-miles / day

Disaggregation to 24 Hours: After seasonally adjusting the link volume, the volume is split to each hour of the day. This allows for more accurate speed calculations (effects of congested hours) and allows PPSUITE to prepare the hourly VMT and speeds for input to the MOBILE6.2 model.

Example:

To support speed calculations and emission estimates by time of day, the July weekday volume is disaggregated to 24 hourly volumes. Temporal patterns were previously developed from PENNDOT count data and input to PPSUITE. For the I-80 rural freeway link with morning peak volumes similar to evening peak hours (neutral), the following temporal pattern is applied:



Using the I-80 segment for 1990, typical hourly volumes which result include:

8-9 a.m.	6.0% x (41,111 vehicle miles/ 0.296mi.) = 833 vehicles/hour (vph)
12-1 p.m.	5.0% x (41,111 vehicle .miles/ 0.296mi.) = 694 vph
5-6 p.m.	6.3% x (41,111 vehicle miles/ 0.296mi.) = 875 vph

After dividing the daily volumes to each hour of the day, PPSUITE identifies hours that are unreasonably congested. For those hours, PPSUITE then spreads a portion of the volume to other hours within the same peak period, thereby approximating the "peak spreading" that normally occurs in such over-capacity conditions.

Disaggregation to Vehicle Type: EPA requires VMT estimates to be prepared by vehicle type, reflecting specific local characteristics. As a result, for Pennsylvania's emission inventory runs, the hourly volumes are disaggregated to the sixteen MOBILE6.2 vehicle types based on count data assembled by PENNDOT in combination with MOBILE6.2 defaults.

Example:

Disaggregation of the total I-80 volume (by hour) to the various vehicle types would include the following:

Total Volume 8-9 am = 833 vph

Vehicle Type Volume 8-9 am:

LDV	40.7%	338 vph
LDT1	7.4%	62 vph
LDT2	24.8%	207 vph
LDT3	7.6%	63 vph
LDT4	3.5%	29 vph
HDV2b	5.0%	42 vph
HDV3	0.5%	4 vph
HDV4	0.4%	3 vph
HDV5	0.3%	3 vph
HDV6	1.1%	9 vph
HDV7	1.3%	11 vph
HDV8a	1.4%	12 vph
HDV8b	5.1%	42 vph
HDBS	0.3%	3 vph
HDBT	0.1%	1 vph
MC	0.5%	4 vph

Speed/Delay Determination

EPA recognizes that the estimation of vehicle speeds is a difficult and complex process. Because emissions are so sensitive to speeds, it recommends special attention be given to developing reasonable and consistent speed estimates; it also recommends that VMT be disaggregated into subsets that have roughly equal speed, with separate emission factors for each subset. At a minimum, speeds should be estimated separately by roadway functional class.

The computational framework used for this analysis meets and exceeds that recommendation. Speeds are individually calculated for each roadway segment and hour and include the delays encountered at signals. Rather than accumulating the roadway segments into area/functional groupings and calculating an average speed (as done in past), each individual link hourly speed is represented in the MOBILE6.2 speed VMT file. This represents a significant enhancement in the MOBILE model since past versions only allowed input of one average speed for each scenario. MOBILE6.2 allows the input of a distribution of hourly speeds. For example, if 5% of a county's arterial VMT operate at 5 mph during the AM peak hour

and the remaining 95% operate at 65mph, this can be represented in the MOBILE6.2 speed input file. For the Pennsylvania runs, distributions of speeds are input to MOBILE6.2 for separate scenarios representing county and functional class groupings; VMT is accumulated by the same groupings for the application of the emission factors to produce resulting emission totals.

To calculate speeds, PPSUITE first obtains initial capacities (how much volume the roadway can serve before heavy congestion) and free-flow speeds (speeds assuming no congestion) from the speed/capacity lookup data. As described in previous sections, this data contains default roadway information indexed by the urban/rural code and functional class. For areas with known characteristics, values can be directly coded to the RMS database and the speed/capacity data can be overridden. However, for most areas where known information is not available, the speed/capacity lookups provide valuable default information regarding speeds, capacities, signal densities and characteristics, and other capacity adjustment information used for calculating congested delays and speeds.

Example:

The speed/capacity lookup table is used to obtain important data used for link speed calculations. For the I-80 link with an urban/rural code = 1 (rural) and a functional class = 1 (freeway), the lookup table provides information including the following:

freeflow speed = 65 mph
capacity = 1800 vph per lane
number of signals = 0

This information is used along with the physical characteristics of the roadway to calculate the delay (including congestion) to travel this link during each hour of the day:

For example: The I-80 link is calculated to have a travel time, including delay of 17.76 seconds for the 8-9am hour

Total travel time, in vehicle hours, for the 8-9am hour is calculated as:

VHT (8-9am) = 17.76 seconds x 833vph / 3600 sec/hr = 4.12 vehicle hours

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The result of this process is an estimated average travel time for each hour of the day for each highway segment. The average time can be multiplied by the volume to produce vehicle hours of travel (VHT).

HPMS and VMT Adjustments

Volumes must also be adjusted to account for differences with the HPMS VMT totals, as described previously. VMT adjustment factors are provided as input to PPSUITE, and are applied to each of the roadway segment volumes. These factors were developed from 2002 data; however, they are also applied to any future year runs. The VMT added or subtracted to the RMS database assumes the speeds calculated using the original volumes for each roadway segment for each hour of the day.

Example:

Using the Luzerne County I-80 rural freeway link example, the daily assigned volume is adjusted to account for reconciliation with the HPMS VMT. RMS VMT (in AADT) for Luzerne County rural freeways totals 962,559 vehicle miles in 2002. HPMS VMT (in AADT) as supplied by PENNDOT and reported to FHWA totals to 990,088 vehicle miles for the rural freeways. A factor is developed by dividing the HPMS VMT by the RMS VMT:

HPMS adjustment factor for Luzerne County rural freeways = 990,088 / 962,559 = 1.029

This factor is held constant in all future years. As an example, this adjustment is made to the I-80 freeway link VMT for the 8-9am hour after speed calculations are made, and produces the final July weekday VMT for this hour used for Ozone runs.

I-80 Link VMT (8-9am) = 833vph x 0.296 miles x 1.029 = 254 vehicle miles

VMT and Speed Aggregation

As discussed in previous sections, MOBILE6.2's ability to handle input distributions of hourly speeds has eliminated the need to aggregate speed data. For Pennsylvania runs, PPSUITE has been set up to automatically accumulate VMT and VHT by geographic areas and highway functional class. The speed files input to MOBILE6.2 for each scenario contain the actual distribution of roadway speeds for that aggregation group. Exhibit 7 illustrates the scenario aggregation scheme used with MOBILE6.2.

Exhibit 7

VMT/VHT Aggregation Scheme

County			67 entries
Urban/Rural Code	1=Rural 2=Small Urban 3=Urban		
Functional Class	1=Rural Freeway	11=Urban Freeway	18 entries
	2=Rural Other Principal Arterial	12=Urban Expressway	
	6=Rural Minor Arterial	14=Urban Principal Arterial	
	7=Rural Major Collector	16=Urban Minor Arterial	
	8=Rural Minor Collector	17=Urban Collector	
	9=Rural Local	19=Urban Local	
			1,206 potential combinations

Geographic aggregation is performed by urban, small urban, and rural areas of each county. Functional class aggregation is according to PENNDOT's eighteen standard functional classes, respecting urban,

small urban and rural definitions. For an individual county, this creates a potential for 18 possible combinations, each of which becomes an input MOBILE6.2 scenario. This allows each MOBILE6.2 scenario to represent the actual VMT mix and speed for that geographic / highway combination. Altogether then, there are potentially 1,206 combinations for which speeds and VMT are computed and emissions are calculated with MOBILE.

MOBILE Emissions Run

After computing speeds and aggregating VMT and VHT, PPSUITE prepares input files to be run in EPA's MOBILE6.2 program which is used to produce VOC and NOx emission factors in grams of pollutant per vehicle mile. The process uses an unmodified version of the MOBILE program that was obtained directly from EPA.

The MOBILE input file prepared by PPSUITE contains the following:

- MOBILE template containing appropriate parameters and program flags
- Temperature data specific to the county and season being run
- Vehicle age and diesel sales fraction data for the county being run
- Scenario data - contains VMT mix, speed distributions specific to scenario as produced by PPSUITE

Example:

A MOBILE input file is created by PPSUITE for Luzerne County. This file contains separate scenarios for each urban/rural code, functional class. A scenario represents a separate MOBILE run with different emission factors calculated and output for each run.

For this example, Luzerne County rural freeways will be run as a scenario with a specific VMT mix file and a speed distribution file accounting for all the roadway speeds within the grouping.

Time of Day and Diurnal Emissions

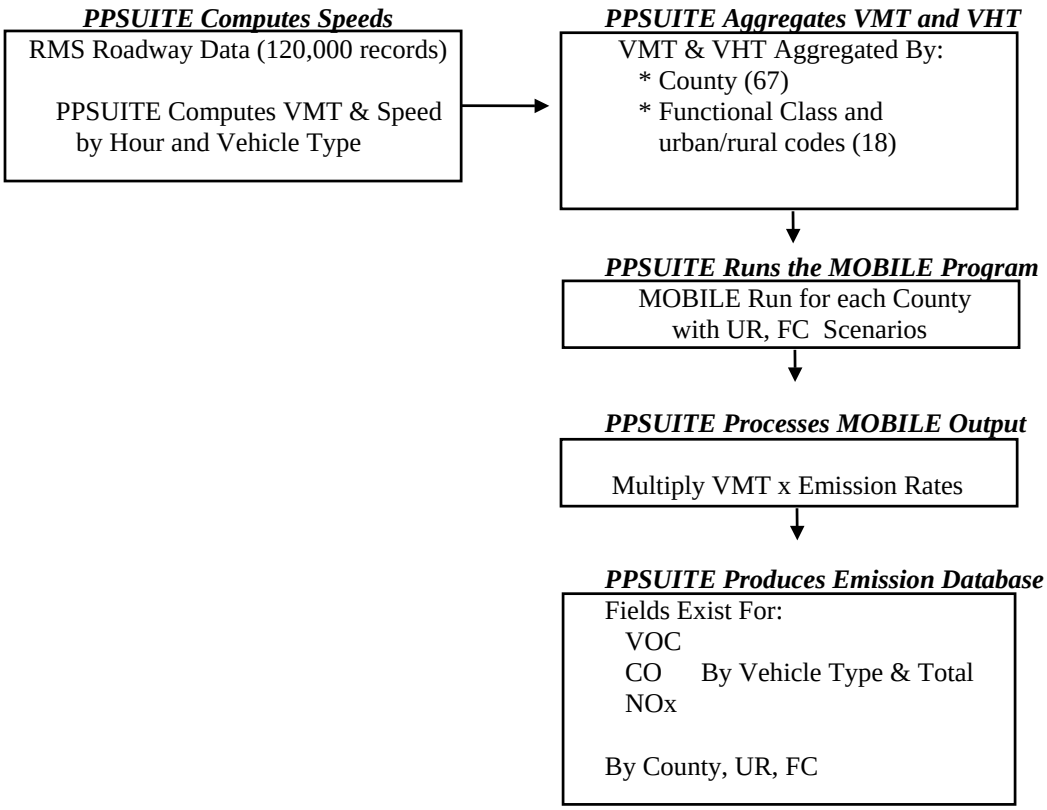
Unlike in the past using MOBILE5, VMT and speeds are no longer aggregated as separate scenarios representing time periods. This was done in the past to account for the unique speeds encountered during each time period in the day. Since MOBILE6.2 allows for hourly roadway speeds to be represented in the speed VMT file, such a process is no longer needed. MOBILE6.2 will internally account for the emissions during each hour in the day and make the necessary diurnal calculations.

Process MOBILE Output

After MOBILE has been run, PPSUITE processes the MOBILE output files and compiles the emission factors for each scenario. Using the above methodology, it allocates daily diurnal emissions to each of the time periods. Using the MOBILE emission factors, PPSUITE calculates emission quantities by multiplying the emission factors by the aggregated VMT totals. PPSUITE then produces an emissions database summarizing VMT, VHT, VOC, and NOx emissions as shown in Exhibit 8.

Exhibit 8

Summary of PPSUITE's Methodology in Producing Emissions Summary



Example:

Luzerne County rural freeways were run as a scenario in MOBILE. Based on the input information, MOBILE6.2 outputs emission factors by vehicle type for this scenario as shown below:

Composite Emission Factors (grams/mile) from MOBIL6 output

Vehicle Type:	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDDV7 ….. For all 28 M6 types
VOC:	1.22	1.86	2.42	3.68	0.36	1.13
NOX:	2.41	3.16	3.66	7.14	1.84	5.84

PPSUITE reads these emission factors from the MOBILE6.2 output file and multiplies them by the Luzerne County rural freeway VMT to obtain emission totals for this scenario. (Note: emissions shown in kg/day which is converted to tons/day in SIP narratives)

PPSUITE computes emissions as follows for this scenario:

			Emission Factors (g/mi)			**Emissions (kg/day)**	
Veh Type	**VMT**		**VOC**	**NOX**		**VOC**	**NOX**
LDGV	84,344	x	1.22	2.41	=	102.9	203.3
LDGT1	30,713	x	1.86	3.16	=	57.1	97.1
LDGT2	21,515	x	2.42	3.66	=	52.1	78.7
LDGT3	4,209	x	3.68	7.14	=	15.5	30.1
LDGT4	3,586	x	0.36	1.84	=	1.3	6.6
HDDV7	7,483	x	1.13	5.84	=	8.5	43.7
….. Repeated for all 28 MOBILE6.2 vehicle types							
Total	155,903					244.6	482.0

The emissions for this scenario are reported and stored in an output database file which contains a record for each scenario with fields containing VMT, VHT, VOC emissions, and NOX emissions. Fields exist for each vehicle type and for the total of all vehicle types as shown below.

Reported by Vehicle Type 1-28 and Total --- Repeated for VHT,HC,NOX

Cnty	**UR**	**FC**	**VMT1**	**VMT2**	**VMT3**	**VMT4**	**VMT5**	**VMT6**	**VMT7**	**VMT8**	**… VMT28**
Luze	1	1	84,344	30,713	21,515	4,209	3,586	2,806	7,483	1,248	
			VHT1	**VHT2**	**VHT3**	**VHT4**	**VHT5**	**VHT6**	**VHT7**	**VHT8**	**… VHT28**
			1,298	473	331	65	55	43	115	19	
			VOC1	**VOC2**	**VOC3**	**VOC4**	**VOC5**	**VOC6**	**VOC7**	**VOC8**	**… VOC28**
			102.9	57.1	52.1	15.5	1.3	1.5	8.5	5.7	
			NOX1	**NOX2**	**NOX3**	**NOX4**	**NOX5**	**NOX6**	**NOX7**	**NOX8**	**… NOX28**
			203.3	97.1	78.7	30.1	6.6	11.6	43.7	10.9	

RESOURCES

MOBILE model

Modeling Page within EPA's Office of Mobile Sources Website (http://www.epa.gov/omswww/models.htm) contains a downloadable model, MOBILE users guide and other information. It also contains documents relating to the next version of MOBILE (MOBILE6.2) expected in 1999.

"AP-42" document, "Compilation of Air Pollutant Emission Factors, Volume II: Mobile Sources," as updated by Supplement A (January 1991), available in hard-copy only. This material is also in the process of being revised and updated. Contact AP-42 Project, Test and Evaluation Branch, EPA, 2565 Plymouth Road, Ann Arbor, MI 48105.

Highway Vehicle Emission Estimates (June 1992) and *Highway Vehicle Emission Estimates II* (May 1995) discusses how EPA obtains data for MOBILE and some of the shortcomings in earlier models. Similar discussions of the present version's shortcomings are discussed in papers available at the website.

User's Guide to MOBILE6.1 and MOBILE6.2, Mobile Source Emission Factor Model, EPA420-R-02-028, dated October 2002.

Technical Guidance on the Use of MOBILE6 for Emission Inventory Preparation, US EPA Office of Transportation and Air Quality, January 2002.

Policy Guidance on the Use of MOBILE6 for Emission Inventory Preparation, US EPA Office of Air and Radiation, January 18, 2002.

Traffic Engineering

2000 Highway Capacity Manual, Transportation Research Board, presents current knowledge and techniques for analyzing the transportation system.

Traffic Data Collection and Factor Development Report, 2001 Data, Pennsylvania Department of Transportation, Bureau of Planning and Research.

Traffic Data Collection and Factor Development Report, 2002 Data, Pennsylvania Department of Transportation, Bureau of Planning and Research.

Highway Vehicle Inventory Glossary

AADT: Average Annual Daily Traffic, average of ALL days.

AWDT: Average Weekday Daily Traffic

Basic emission rates: MOBILE emission rates based on the applicable Federal emission standards and the emission control technologies characterizing the fleet in various model years.

Cold start: parameter in MOBILE that accounts for additional emissions resulting from a cold-started engine.

Diurnals: the pressure-driven evaporative HC emissions resulting from the daily increase in temperature

Emission rate or factor: expresses the amount of pollution emitted per unit of activity. For highway vehicles, usually in grams of pollutant emitted per mile driven.

FC: Functional code, applied in data management to road segments to identify their type (freeway, local, etc.)

Fuel volatility: The ability of fuel components to evaporate, thus entering the atmosphere as pollution. Fuel volatility is usually measured as Reid Vapor Pressure (RVP) in pounds per square inch. The lower the RVP, the less volatile the fuel.

Growth factor: Factor used to convert volumes to future years

HPMS: Highway Performance Monitoring System, PENNDOT's official source of highway information and a subset of RMS.

I/M: Vehicle emissions inspection/maintenance programs ensure that vehicle emission controls are in good working order throughout the life of the vehicle. The programs require vehicles to be tested for emissions. Most vehicles that do not pass must be repaired.

MOBILE: The model EPA has developed and which Pennsylvania uses to estimate emissions from highway vehicles.

Pattern data: Extrapolations of traffic patterns (such as how traffic volume on road segment types varies by time of day, or what kinds of vehicles tend to use a road segment type) from segments with observed data to similar segments.

Program flag: In MOBILE, a numeric code which tells the program such things as how data will be provided by user (or whether default will be used) or how to tailor outputs.

PPSUITE: Post-Processor for Air Quality, a set of programs that estimate speeds and processes MOBILE emission rates.

RMS: Roadway Management System, a database maintained by PENNDOT from traffic counts and field visits

Scenario: a MOBILE run with a specific set of geographical, time period, highway facility and control strategy assumptions.

Segment: (referred to as link) division of roadway in the PENNDOT Roadway Management System. Usually represents 0.5 mile segments of roadway.

UR: Urban/rural code, applied in data management to identify whether a road segment is urban, small urban or rural.

VHT: vehicle hours traveled.

VMT: vehicle miles traveled. In modeling terms, it is the simulated traffic volumes times link length.

Vehicle Type: One of eight types, distinguished primarily by fuel type and/or weight, used in MOBILE modeling.

APPENDIX 2

MOBILE6.2 Input Parameter Summary

Table 2-1: General Parameters and Options

Input parameter	Summer Weekday
Output Pollutants	VOC, NOX
Analysis Day	Avg Summer Weekday (Jun, Jul, Aug)
Traffic Data	
PENNDOT Roadway Management System (RMS) Source Data Year	2002
HPMS VMT Adjustment Year	2002
PENNDOT Seasonal Factor Data	2002
PENNDOT Hourly Pattern Data	2001
PENNDOT RMS Truck Percentages Used for Vehicle Mixes	2002
MOBILE6 Defaults Used to Disaggregate Auto and Truck Vehicle Mix Categories	2002
Traffic Volume Forecasted Growth	2010,2015,2020,2025 forecasted using PENNDOT study growth factors
M6 Parameters	
Emissions Calendar Year	Varies by Analysis Year (2010, 2015, 2020, 2025)
Evaluation Month	7 (July)
Season	1 - Summer
CAAA Standards	Enabled
Tier2 Standards	Enabled
North-East NLEV	Included
California LEVII	Included
2007 HDDV Rule	Enabled
Refueling Emissions	Not Included
Registration Data	02 Local Data + National Truck Defaults
Diesel Sales Fractions	National Defaults
VMT by Hour	02 Local Data (varies by cty, fc)
VMT by Facility	Each facility run as separate scenario
VMT by Speed	Calculated by PPSUITE
Min/Max Temps	66.7/ 94.0
Absolute Humidity	57.2
Fuel Program	1
RVP	8.7

Table 2-2: Inspection/Maintenance Program Input Parameters
(Not Applied to 2002 Analysis Year)

MOBILE6 I/M Test Types:	Philadelphia I/M Program			
I/M Program	OBD I/M	ASM 5015 Final	EVAP OBD & GC	GC
Program Start Year	2004	1997	2004	1997
I/M Stringency	20	20		
I/M Model Years				
First Year	1996	1981	1996	1975
Last Year	2050	1995	2050	1995
I/M Waiver Rates				
Pre-81 Model Years	3.0%	3.0%	3.0%	3.0%
Post-81 Model Years	3.0%	3.0%	3.0%	3.0%
I/M Compliance	96.0%	96.0%	96.0%	96.0%
Program Type: Test Only (T/O) Test & Repair computerized (TRC) Test & Repair Manual (TRM)	TRC	TRC	TRC	TRC
Inspection Frequency Annual Biennial	Annual	Annual	Annual	Annual
I/M Vehicles 1 = I/M Benefits not calculated 2 = I/M Benefits calculated				
LDGV	2	2	2	2
LDGT1	2	2	2	2
LDGT2	2	2	2	2
LDGT3	2	2	2	2
LDGT4	2	2	2	2
HDGV2B	1	1	1	1
HDGV3	1	1	1	1
HDGV4	1	1	1	1
HDGV5	1	1	1	1
HDGV6	1	1	1	1
HDGV7	1	1	1	1
HDGV8A	1	1	1	1
HDGV8B	1	1	1	1
GAS BUS	1	1	1	1
I/M Effectiveness	1.00			
I/M TTC Credits	Included			
New Model Year Exemption	First Model Year			
I/M Exemptions	<5000 mi			

**Philadelphia Counties: Bucks, Chester, Delaware, Montgomery, Philadelphia*

Table 2-2 (Continued): Inspection/Maintenance Program Input Parameters
(Not Applied to 2002 Analysis Year)

MOBILE6 I/M Test Types:	**Pittsburgh I/M Program**				
I/M Program	OBD I/M	2500/Idle	EVAP OBD & GC	GC	Idle
Program Start Year	2004	1997	2004	1997	1984
I/M Stringency	20	20			20
I/M Model Years					
First Year	1996	1981	1996	1975	1975
Last Year	2050	1995	2050	1995	1980
I/M Waiver Rates					
Pre-81 Model Years	3.0%	3.0%	3.0%	3.0%	3.0%
Post-81 Model Years	3.0%	3.0%	3.0%	3.0%	3.0%
I/M Compliance	96.0%	96.0%	96.0%	96.0%	96.0%
Program Type: Test Only (T/O) Test & Repair computerized (TRC) Test & Repair Manual (TRM)	TRC	TRC	TRC	TRC	TRC
Inspection Frequency Annual Biennial	Annual	Annual	Annual	Annual	Annual
I/M Vehicles 1 = I/M Benefits not calculated 2 = I/M Benefits calculated					
LDGV	2	2	2	2	2
LDGT1	2	2	2	2	2
LDGT2	2	2	2	2	2
LDGT3	2	2	2	2	2
LDGT4	2	2	2	2	2
HDGV2B	1	1	1	1	1
HDGV3	1	1	1	1	1
HDGV4	1	1	1	1	1
HDGV5	1	1	1	1	1
HDGV6	1	1	1	1	1
HDGV7	1	1	1	1	1
HDGV8A	1	1	1	1	1
HDGV8B	1	1	1	1	1
GAS BUS	1	1	1	1	1
I/M Effectiveness	1.00				
I/M TTC Credits	Included				
New Model Year Exemption	First Model Year				
I/M Exemptions	<5000 mi				

**Pittsburgh Counties: Allegheny, Beaver, Washington, Westmoreland*

Table 2-2 (Continued): Inspection/Maintenance Program Input Parameters
(Not Applied to 2002 Analysis Year)

MOBILE6 I/M Test Types:	South Central I/M Program			Northern I/M Program
I/M Program	OBD I/M	OBD & GC	GC	GC
Program Start Year	2004	2004	2004	1997
I/M Stringency	20			
I/M Model Years				
First Year	1996	1996	1975	1975
Last Year	2050	2050	1995	2050
I/M Waiver Rates				
Pre-81 Model Years	3.0%	3.0%	3.0%	3.0%
Post-81 Model Years	3.0%	3.0%	3.0%	3.0%
I/M Compliance	96.0%	96.0%	96.0%	96.0%
Program Type: Test Only (T/O) Test & Repair computerized (TRC) Test & Repair Manual (TRM)	TRC	TRC	TRC	TRC
Inspection Frequency Annual Biennial	Annual	Annual	Annual	Annual
I/M Vehicles 1 = I/M Benefits not calculated 2 = I/M Benefits calculated				
LDGV	2	2	2	2
LDGT1	2	2	2	2
LDGT2	2	2	2	2
LDGT3	2	2	2	2
LDGT4	2	2	2	2
HDGV2B	1	1	1	1
HDGV3	1	1	1	1
HDGV4	1	1	1	1
HDGV5	1	1	1	1
HDGV6	1	1	1	1
HDGV7	1	1	1	1
HDGV8A	1	1	1	1
HDGV8B	1	1	1	1
GAS BUS	1	1	1	1
I/M Effectiveness	1.00	1.00	1.00	1.00
I/M TTC Credits	Included	Included	Included	Included
New Model Year Exemption	First Model Year	First Model Year	First Model Year	First Model Year
I/M Exemptions	<5000 mi	<5000 mi	<5000 mi	<5000 mi

**South Central Counties: Berks, Cumberland, Dauphin, Lancaster, Lebanon, Lehigh, Northampton, York*
**Northern Counties: Blair, Cambria, Centre, Erie, Lackawanna, Luzerne, Lycoming, Mercer*

Table 2-3: Anti-Tampering Program Input Parameters
(Not Applied to 2002 Analysis Year)

ATP Parameters	Philadelphia / Pittsburgh Counties	South Central Counties	Northern / Other42 Counties
Program Start Year	97	2004	2004
I/M Model Years			
First Year	75	75	75
Last Year	50	95	50
I/M Vehicles 1 = I/M Benefits not calculated 2 = I/M Benefits calculated			
LDGV	2	2	2
LDGT1	2	2	2
LDGT2	2	2	2
LDGT3	2	2	2
LDGT4	2	2	2
HDGV2B	1	1	1
HDGV3	1	1	1
HDGV4	1	1	1
HDGV5	1	1	1
HDGV6	1	1	1
HDGV7	1	1	1
HDGV8A	1	1	1
HDGV8B	1	1	1
GAS BUS	1	1	1
Inspection Frequency: Annual Biennial	Annual	Annual	Annual
I/M Compliance	96.0%	96.0%	96.0%
Inspections Performed: 1 = Not Performed 2 = Performed			
Air Pump System	2	2	2
Catalyst Removal	2	2	2
Fuel Inlet Restrictor	2	2	2
Tailpipe Lead Deposit Test	1	1	1
EGR System	2	2	2
Evaporative Control System	2	2	2
PCV System	2	2	2
Gas Cap	2	2	2

**Other42 Counties: Adams, Armstrong, Bedford, Bradford, Butler, Cameron, Carbon, Clarion, Clearfield, Clinton, Columbia, Crawford, Elk, Fayette, Forest, Franklin, Fulton, Greene, Huntingdon, Indiana, Jefferson, Juniata, Lawrence, McKean, Mifflin, Monroe, Montour, Northumberland, Perry, Pike, Potter, Schuylkill, Snyder, Somerset, Sullivan, Susquehanna, Tioga, Union, Venango, Warren, Wayne, Wyoming*

APPENDIX 3

MOBILE6.2 LEVII Technical Data Input Files

California LEVII Exhaust Certification Bin File (LEVIISTD.D)

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0.007, 0.007, 0.007, 0.007, 0.007,
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0.051, 0.051, 0.051, 0.051, 0.051,
0.040, 0.040, 0.040, 0.040, 0.040,
0.075, 0.075, 0.075, 0.075, 0.075,
0.100, 0.100, 0.100, 0.125, 0.125,
0.075, 0.075, 0.100, 0.140, 0.140,
0.125, 0.125, 0.125, 0.160, 0.195,
0.040, 0.040, 0.050, 0.100, 0.117,
0.075, 0.075, 0.100, 0.160, 0.195,
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0.000, 0.000, 0.000, 0.000, 0.000/
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California LEVII Phase-In Percentages by Exhaust Certification Bin

*2004 Phase-In (LEVIIPH.D)

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T2 EXH PHASE-IN
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*2006 Phase-In (PAL2EXH.06)

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*2009 Phase-In (PAL2EXH.09)

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California LEVII Phase-In Percentages For Evaporative Standards

*2004 Phase-In (LEVIIEVP.D)

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T2 EVAP PHASE-IN
0.40,0.80,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
0.40,0.80,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
0.40,0.80,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
0.40,0.80,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
0.40,0.80,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00/
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*2006 Phase-In (PAL2EVP.06)

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T2 EVAP PHASE-IN
0.25,0.50,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
0.25,0.50,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
0.25,0.50,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
0.00,0.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
0.00,0.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00/
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*2009 Phase-In (PAL2EVP.09)

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T2 EVAP PHASE-IN
0.25,0.50,0.75,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
0.25,0.50,0.75,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
0.25,0.50,0.75,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
0.00,0.00,0.00,0.00,0.50,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
0.00,0.00,0.00,0.00,0.50,1.00,1.00,1.00,1.00,1.00,1.00,1.00/
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APPENDIX 4

MOBILE6.2 Sample Input File

Summer Weekday M6Input File Settings

Bucks County, 2010

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MOBILE6 INPUT FILE

REPORT FILE         :  m6output.out       REPLACE
DATABASE OUTPUT     :
WITH FIELDNAMES     :
EMISSIONS TABLE     :  M6OUTPUT_BERK10A.TB1  REPLACE
POLLUTANTS          :  HC CO NOX
PARTICULATES        : SO4 OCARBON ECARBON GASPM LEAD BRAKE TIRE SO2 NH3
AGGREGATED OUTPUT   :
RUN DATA            : 0061

T2 CERT             : leviistd.d
T2 EXH PHASE-IN     : pal2exh.09      } CALLEVII Phase-In Files (see Appendix X-3)
T2 EVAP PHASE-IN    : pal2evp.09
94+ LDG IMP         : NLEVNE.D
MIN/MAX TEMPERATURE:  66.7  94.0      Temperatures vary by region
FUEL RVP            : 8.7             RVP varies by region
EXPRESS HC AS VOC   :
EXPAND EXHAUST      :
EXPAND EVAPORATIVE  :
NO REFUELING        :
REG DISTRIBUTION    : BERK02ag.dat  (2002 Age Data)   Varies by county
I/M PROGRAM         : 1 2004 2050 1 TRC OBD I/M       Varies by county
I/M PROGRAM         : 2 2004 2050 1 TRC EVAP OBD & GC
I/M PROGRAM         : 3 2004 2050 1 TRC GC
I/M MODEL YEARS     : 1 1996 2050
I/M MODEL YEARS     : 2 1996 2050
I/M MODEL YEARS     : 3 1975 1995
I/M VEHICLES        : 1 22222 11111111 1
I/M VEHICLES        : 2 22222 11111111 1
I/M VEHICLES        : 3 22222 11111111 1
I/M STRINGENCY      : 1 20
I/M COMPLIANCE      : 1 96.0
I/M COMPLIANCE      : 2 96.0
I/M COMPLIANCE      : 3 96.0
I/M WAIVER RATES    : 1 3.0 3.0
I/M WAIVER RATES    : 2 3.0 3.0
I/M WAIVER RATES    : 3 3.0 3.0
I/M EFFECTIVENES    : 1.00 1.00 1.00
ANTI-TAMP PROGRAM   : 04 75 95 22222 11111111 1  11 096. 22212222


SCENARIO RECORD     :[01 0061]  1

CALENDAR YEAR       :2010       Analysis years tested = 2010,2015,2020,2025
EVALUATION MONTH    : 7
ABSOLUTE HUMIDITY   :  57.2     Humidity varies by region
SEASON              : 1
VMT FRACTIONS       :           VMT Mix Depends on County / FC combination
            .281725 .070833 .235692 .072650 .033391 .096765 .009435 .007928
            .005969 .021584 .025563 .027793 .098995 .004974 .002442 .004261
```

(Speed, hourly, and facility distributions prepared by PPSUITE post processor for each Run/Scenario)

```
VMT BY FACILITY     :V006101F.def
VMT BY HOUR         :V006101H.def
SPEED VMT           :V006101S.def
END OF RUN          :
```

(Scenarios Repeated for each Area, Functional Class Combination)

Bucks County 2002 Vehicle Age Distributions Input to MOBILE6.2 (Separate Age data is input for each county in Pennsylvania)

```
REG DIST
       1 0.0499  0.0913  0.0931  0.0868  0.0846  0.0779  0.0688  0.0745  0.0608  0.0542
         0.0454  0.0393  0.0363  0.0322  0.0278  0.0219  0.0165  0.0111  0.0076  0.0039
         0.0021  0.0017  0.0016  0.0023  0.0084
       2 0.0303  0.0455  0.0612  0.0501  0.0599  0.0580  0.0443  0.0578  0.0726  0.0504
         0.0434  0.0468  0.0484  0.0568  0.0603  0.0533  0.0464  0.0276  0.0211  0.0139
         0.0082  0.0078  0.0051  0.0087  0.0222
       3 0.0303  0.0455  0.0612  0.0501  0.0599  0.0580  0.0443  0.0578  0.0726  0.0504
         0.0434  0.0468  0.0484  0.0568  0.0603  0.0533  0.0464  0.0276  0.0211  0.0139
         0.0082  0.0078  0.0051  0.0087  0.0222
       4 0.0552  0.1070  0.0864  0.0854  0.0693  0.0964  0.0579  0.0760  0.0530  0.0384
         0.0286  0.0213  0.0322  0.0385  0.0323  0.0241  0.0253  0.0163  0.0123  0.0061
         0.0038  0.0032  0.0033  0.0079  0.0196
       5 0.0552  0.1070  0.0864  0.0854  0.0693  0.0964  0.0579  0.0760  0.0530  0.0384
         0.0286  0.0213  0.0322  0.0385  0.0323  0.0241  0.0253  0.0163  0.0123  0.0061
         0.0038  0.0032  0.0033  0.0079  0.0196
      16 0.0642  0.1232  0.0899  0.0725  0.0569  0.0487  0.0457  0.0385  0.0340  0.0278
         0.0207  0.0208  0.0155  0.0184  0.0179  0.0186  0.0328  0.0309  0.0202  0.0265
         0.0340  0.0304  0.0239  0.0166  0.0716
```

APPENDIX X-5

Appendix 5-1
Emission Results without LEVII Program

Appendix 5-2
Emission Results with 2004 Phase-In of LEVII Program

Appendix 5-3
Emission Results with 2006 Phase-In of LEVII Program

Appendix 5-4
Emission Results with 2009 Phase-In of LEVII Program

Appendix 5-5
Interpolated Emission Results with 2008 Phase-In of LEVII Program

Appendix 5-6
Emission Benefits of Pennsylvania Clean Vehicles Program vs. FMVCP/Tier2 Program

Appendix 5-1
Emission Results without LEVII Program
(Tons/Day)

County	2010			2015			2020			2025		
	VMT	VOC (tpd)	NOX (tpd)	VMT	VOC (tpd)	NOX (tpd)	VMT	VOC (tpd)	NOX (tpd)	VMT	VOC (tpd)	NOX (tpd)
Adams	2,928,327	2.89	2.29	3,184,602	2.01	1.81	3,451,342	1.67	1.45	3,727,739	1.55	1.33
Allegheny	31,519,346	15.97	15.86	33,702,558	10.44	9.67	35,943,694	8.77	6.34	38,240,392	8.61	5.57
Armstrong	2,125,145	1.58	1.58	2,270,236	1.10	1.19	2,418,542	0.93	0.93	2,570,119	0.87	0.86
Beaver	5,005,081	2.71	2.74	5,348,422	1.73	1.69	5,701,161	1.36	1.07	6,061,576	1.22	0.91
Bedford	3,864,577	3.45	3.07	4,204,187	2.41	2.43	4,558,770	1.99	1.92	4,928,422	1.82	1.76
Berks	11,307,588	9.00	6.98	12,376,544	5.55	4.66	13,498,113	4.18	2.99	14,667,531	3.77	2.44
Blair	3,638,966	2.93	2.80	3,928,545	2.05	2.14	4,227,883	1.75	1.70	4,536,032	1.64	1.59
Bradford	1,802,685	1.57	1.44	1,928,439	1.04	1.09	2,057,037	0.89	0.85	2,188,113	0.84	0.78
Bucks	16,993,536	8.45	8.87	18,337,732	5.29	5.78	19,729,473	4.25	3.75	21,160,656	3.99	3.15
Butler	5,881,739	3.24	3.40	6,343,605	2.38	2.57	6,821,530	2.08	2.09	7,315,005	1.98	1.99
Cambria	3,854,018	2.84	2.77	4,116,470	2.00	2.07	4,384,305	1.72	1.65	4,657,227	1.59	1.53
Cameron	260,564	0.23	0.18	279,298	0.16	0.14	298,476	0.14	0.11	317,878	0.13	0.10
Carbon	2,632,913	2.41	1.98	2,883,815	1.66	1.58	3,146,808	1.39	1.27	3,421,242	1.29	1.17
Centre	5,325,689	3.60	3.58	5,759,535	2.53	2.69	6,209,141	2.23	2.15	6,672,516	2.16	2.04
Chester	14,659,246	6.87	7.46	15,782,911	4.33	4.77	16,943,006	3.50	3.12	18,135,176	3.32	2.65
Clarion	2,226,469	1.39	1.41	2,419,975	0.99	1.06	2,621,279	0.85	0.85	2,831,336	0.81	0.81
Clearfield	3,886,072	2.68	2.55	4,205,844	1.86	1.92	4,538,799	1.60	1.53	4,883,516	1.51	1.44
Clinton	2,311,254	1.85	1.63	2,500,398	1.27	1.23	2,697,539	1.10	0.97	2,901,796	1.05	0.91
Columbia	2,447,680	2.21	1.99	2,656,742	1.49	1.55	2,874,926	1.25	1.22	3,101,143	1.17	1.12
Crawford	2,911,284	2.00	1.94	3,138,671	1.42	1.43	3,375,503	1.23	1.15	3,619,007	1.17	1.09
Cumberland	9,830,559	6.33	5.35	10,791,288	3.98	3.51	11,800,572	3.10	2.29	12,849,382	2.94	1.93
Dauphin	10,632,121	7.91	6.28	11,638,725	5.04	4.14	12,693,251	4.00	2.71	13,793,654	3.93	2.27
Delaware	12,368,702	6.89	6.65	13,399,286	4.44	4.42	14,468,782	3.84	2.91	15,574,164	4.04	2.51
Elk	1,461,118	1.04	0.89	1,562,503	0.74	0.64	1,666,981	0.66	0.52	1,773,235	0.64	0.50
Erie	8,151,392	4.69	4.99	8,797,002	3.33	3.60	9,467,513	2.97	2.90	10,161,425	2.91	2.81
Fayette	3,419,887	2.78	2.64	3,656,055	1.95	2.02	3,897,118	1.63	1.60	4,142,848	1.48	1.46
Forest	472,777	0.41	0.30	505,917	0.29	0.23	541,677	0.25	0.18	576,344	0.24	0.17
Franklin	5,221,286	4.86	3.85	5,721,417	3.38	3.08	6,245,829	2.83	2.49	6,794,015	2.64	2.30
Fulton	1,689,530	1.48	1.32	1,847,022	1.04	1.05	2,012,826	0.86	0.84	2,186,158	0.79	0.77
Greene	1,500,289	1.15	1.09	1,624,180	0.80	0.83	1,752,298	0.68	0.67	1,885,440	0.64	0.62
Huntingdon	1,809,411	1.87	1.52	1,937,902	1.27	1.18	2,069,238	1.06	0.92	2,203,557	0.97	0.84
Indiana	2,742,734	2.16	2.07	2,937,730	1.49	1.55	3,134,447	1.26	1.22	3,337,287	1.18	1.13
Jefferson	2,097,570	1.33	1.35	2,272,781	0.93	0.99	2,454,979	0.81	0.79	2,643,830	0.77	0.75
Juniata	946,630	0.96	0.80	1,013,783	0.65	0.63	1,082,260	0.53	0.49	1,152,594	0.49	0.44
Lackawanna	6,664,716	4.97	4.85	7,254,442	3.46	3.71	7,868,778	3.11	2.97	8,507,217	3.13	2.83
Lancaster	13,804,243	10.26	8.42	15,107,800	6.16	5.48	16,472,451	4.78	3.50	17,896,439	4.46	2.91
Lawrence	2,704,524	2.11	2.01	2,906,623	1.50	1.51	3,115,509	1.27	1.20	3,330,027	1.20	1.12
Lebanon	4,143,101	3.07	2.50	4,536,807	1.85	1.65	4,950,040	1.36	1.05	5,381,105	1.21	0.85
Lehigh	10,086,402	8.34	6.24	11,105,823	5.23	4.20	12,179,561	4.22	2.75	13,305,454	4.19	2.30
Luzerne	10,025,509	7.81	7.43	10,917,727	5.37	5.76	11,847,906	4.68	4.58	12,815,462	4.57	4.30
Lycoming	4,081,310	3.32	3.09	4,389,765	2.27	2.37	4,708,482	1.93	1.87	5,035,998	1.82	1.73
McKean	1,494,076	0.99	0.90	1,598,840	0.70	0.65	1,705,913	0.63	0.52	1,815,764	0.62	0.50
Mercer	4,685,673	2.98	3.03	5,071,478	2.13	2.26	5,473,432	1.84	1.82	5,889,410	1.75	1.73
Mifflin	1,430,500	1.32	1.16	1,533,465	0.90	0.89	1,638,913	0.75	0.70	1,746,916	0.70	0.64
Monroe	5,662,096	4.16	3.95	6,230,418	2.88	3.07	6,828,497	2.55	2.49	7,455,531	2.55	2.37
Montgomery	23,637,752	10.75	10.85	25,572,607	7.04	7.15	27,579,357	6.01	4.82	29,650,123	6.03	4.19
Montour	1,036,593	0.76	0.71	1,130,351	0.54	0.55	1,228,336	0.46	0.44	1,330,485	0.43	0.41
Northampton	7,056,483	5.86	4.56	7,753,969	3.62	3.02	8,487,154	2.85	1.93	9,254,707	2.73	1.60
Northumberland	2,745,594	2.34	2.07	2,960,831	1.60	1.62	3,183,629	1.34	1.28	3,413,111	1.26	1.18
Perry	1,923,675	1.80	1.45	2,090,887	1.25	1.13	2,265,378	1.04	0.91	2,445,523	0.99	0.85
Philadelphia	19,930,360	18.46	13.99	21,537,700	11.77	9.81	23,202,060	9.88	6.33	24,919,451	10.26	5.16
Pike	2,189,452	1.39	1.37	2,414,834	0.96	1.05	2,652,651	0.85	0.86	2,902,350	0.85	0.82
Potter	860,080	0.69	0.60	921,552	0.48	0.44	985,108	0.42	0.35	1,049,854	0.41	0.33
Schuylkill	5,081,550	4.52	4.04	5,523,947	3.12	3.19	5,983,745	2.59	2.53	6,462,964	2.42	2.33
Snyder	1,470,218	1.29	1.19	1,577,292	0.86	0.91	1,687,260	0.73	0.71	1,800,405	0.70	0.65
Somerset	3,838,859	2.76	2.63	4,149,054	1.97	2.00	4,471,407	1.68	1.61	4,804,702	1.55	1.50
Sullivan	342,566	0.32	0.25	367,137	0.21	0.19	392,164	0.18	0.15	417,454	0.17	0.14
Susquehanna	2,085,771	1.44	1.46	2,270,512	0.98	1.09	2,463,944	0.86	0.86	2,665,136	0.84	0.82
Tioga	1,910,318	1.55	1.45	2,045,488	1.04	1.07	2,184,207	0.91	0.84	2,326,283	0.87	0.79
Union	1,890,057	1.44	1.35	2,044,350	0.99	1.03	2,204,604	0.84	0.82	2,369,832	0.80	0.76
Venango	2,125,607	1.41	1.39	2,285,718	0.99	1.03	2,453,557	0.85	0.82	2,625,669	0.81	0.78
Warren	1,594,977	1.12	1.02	1,705,404	0.79	0.74	1,818,450	0.69	0.59	1,934,297	0.68	0.57
Washington	7,952,301	3.93	4.15	8,608,910	2.54	2.58	9,290,938	2.03	1.66	9,996,935	1.86	1.43
Wayne	1,551,388	1.25	1.14	1,705,690	0.85	0.88	1,867,953	0.76	0.71	2,038,020	0.75	0.67
Westmoreland	12,369,693	6.70	6.75	13,328,379	4.34	4.22	14,318,084	3.47	2.72	15,338,431	3.14	2.31
Wyoming	958,387	0.77	0.72	1,028,588	0.51	0.54	1,100,806	0.44	0.42	1,174,695	0.42	0.39
York	10,368,091	7.88	6.42	11,355,528	4.87	4.25	12,390,243	3.66	2.74	13,470,644	3.29	2.25
State Total	**365,628,107**	**249.49**	**226.77**	**396,106,036**	**164.82**	**159.37**	**427,785,615**	**137.02**	**115.23**	**460,580,749**	**131.63**	**102.97**

Appendix 5-2
Emission Results with 2004 Phase-In of LEVII Program
(Tons/Day)

County	2010		2015		2020		2025	
	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)
Adams	2.87	2.26	1.96	1.75	1.60	1.37	1.47	1.25
Allegheny	15.68	15.44	9.99	8.98	8.18	5.54	7.96	4.77
Armstrong	1.56	1.55	1.07	1.14	0.88	0.87	0.81	0.80
Beaver	2.67	2.68	1.66	1.58	1.27	0.94	1.12	0.78
Bedford	3.43	3.03	2.36	2.35	1.91	1.81	1.73	1.65
Berks	8.92	6.86	5.40	4.44	3.96	2.67	3.52	2.13
Blair	2.90	2.76	2.00	2.06	1.67	1.60	1.55	1.49
Bradford	1.56	1.42	1.01	1.05	0.85	0.79	0.80	0.73
Bucks	8.32	8.66	5.08	5.45	3.96	3.30	3.67	2.72
Butler	3.19	3.33	2.29	2.45	1.97	1.94	1.85	1.84
Cambria	2.80	2.72	1.94	1.98	1.63	1.54	1.50	1.43
Cameron	0.23	0.18	0.16	0.13	0.14	0.10	0.13	0.10
Carbon	2.39	1.95	1.63	1.53	1.33	1.19	1.22	1.09
Centre	3.56	3.52	2.45	2.57	2.12	2.01	2.04	1.90
Chester	6.76	7.27	4.14	4.48	3.25	2.73	3.04	2.28
Clarion	1.37	1.38	0.95	1.01	0.81	0.80	0.76	0.75
Clearfield	2.65	2.50	1.81	1.85	1.53	1.43	1.43	1.34
Clinton	1.83	1.60	1.23	1.18	1.05	0.91	0.99	0.85
Columbia	2.19	1.96	1.46	1.49	1.19	1.14	1.11	1.05
Crawford	1.98	1.90	1.38	1.37	1.17	1.08	1.10	1.02
Cumberland	6.26	5.24	3.85	3.32	2.92	2.04	2.73	1.67
Dauphin	7.82	6.16	4.89	3.93	3.79	2.42	3.69	1.98
Delaware	6.80	6.50	4.28	4.17	3.62	2.57	3.78	2.17
Elk	1.02	0.87	0.71	0.61	0.63	0.48	0.60	0.46
Erie	4.62	4.89	3.20	3.43	2.81	2.70	2.73	2.62
Fayette	2.75	2.60	1.90	1.94	1.55	1.50	1.40	1.37
Forest	0.40	0.30	0.28	0.22	0.24	0.17	0.23	0.16
Franklin	4.82	3.79	3.30	2.98	2.72	2.34	2.51	2.16
Fulton	1.47	1.31	1.02	1.02	0.82	0.79	0.75	0.72
Greene	1.14	1.07	0.78	0.80	0.65	0.62	0.61	0.58
Huntingdon	1.85	1.50	1.24	1.14	1.01	0.87	0.93	0.78
Indiana	2.14	2.04	1.45	1.49	1.20	1.14	1.11	1.06
Jefferson	1.31	1.32	0.90	0.95	0.77	0.74	0.73	0.70
Juniata	0.95	0.79	0.64	0.61	0.51	0.46	0.46	0.41
Lackawanna	4.92	4.77	3.36	3.57	2.96	2.78	2.96	2.65
Lancaster	10.15	8.26	5.97	5.21	4.50	3.11	4.14	2.54
Lawrence	2.09	1.98	1.46	1.45	1.21	1.13	1.13	1.05
Lebanon	3.04	2.46	1.80	1.57	1.28	0.94	1.12	0.74
Lehigh	8.26	6.12	5.09	4.00	4.00	2.45	3.93	2.01
Luzerne	7.73	7.32	5.22	5.55	4.46	4.29	4.32	4.02
Lycoming	3.29	3.04	2.21	2.28	1.84	1.75	1.72	1.62
McKean	0.98	0.88	0.68	0.62	0.60	0.48	0.58	0.47
Mercer	2.94	2.97	2.06	2.16	1.75	1.70	1.65	1.61
Mifflin	1.31	1.15	0.88	0.86	0.72	0.66	0.66	0.60
Monroe	4.11	3.88	2.79	2.96	2.43	2.33	2.40	2.21
Montgomery	10.55	10.55	6.74	6.70	5.61	4.22	5.58	3.60
Montour	0.76	0.69	0.53	0.53	0.44	0.42	0.41	0.39
Northampton	5.81	4.48	3.51	2.87	2.70	1.72	2.56	1.40
Northumberland	2.32	2.04	1.56	1.56	1.28	1.20	1.20	1.10
Perry	1.78	1.43	1.22	1.09	1.00	0.86	0.94	0.79
Philadelphia	18.33	13.77	11.50	9.40	9.46	5.70	9.75	4.54
Pike	1.38	1.34	0.92	1.01	0.81	0.80	0.80	0.77
Potter	0.68	0.59	0.47	0.42	0.40	0.33	0.39	0.31
Schuylkill	4.48	3.99	3.05	3.09	2.48	2.38	2.29	2.18
Snyder	1.28	1.17	0.84	0.87	0.69	0.66	0.66	0.61
Somerset	2.73	2.59	1.91	1.92	1.60	1.50	1.46	1.40
Sullivan	0.32	0.24	0.21	0.18	0.17	0.14	0.16	0.13
Susquehanna	1.43	1.43	0.95	1.04	0.82	0.80	0.79	0.77
Tioga	1.54	1.43	1.01	1.03	0.86	0.78	0.82	0.73
Union	1.42	1.33	0.96	0.99	0.80	0.76	0.76	0.71
Venango	1.40	1.36	0.96	0.99	0.81	0.77	0.76	0.72
Warren	1.10	1.00	0.76	0.71	0.66	0.55	0.64	0.53
Washington	3.86	4.05	2.43	2.41	1.88	1.46	1.70	1.23
Wayne	1.23	1.12	0.83	0.85	0.73	0.66	0.71	0.63
Westmoreland	6.59	6.60	4.17	3.95	3.23	2.39	2.88	1.99
Wyoming	0.76	0.71	0.50	0.52	0.42	0.39	0.40	0.37
York	7.79	6.30	4.73	4.04	3.45	2.45	3.05	1.96
State Total	**246.54**	**222.38**	**159.68**	**151.88**	**129.75**	**105.18**	**123.40**	**93.16**

Appendix 5-3
Emission Results with 2006 Phase-In of LEVII Program
(Tons/Day)

County	2010		2015		2020		2025	
	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)
Adams	2.88	2.28	1.97	1.77	1.61	1.38	1.47	1.26
Allegheny	15.77	15.62	10.06	9.18	8.22	5.64	7.97	4.78
Armstrong	1.57	1.56	1.07	1.15	0.89	0.88	0.82	0.80
Beaver	2.68	2.71	1.67	1.61	1.27	0.96	1.12	0.78
Bedford	3.44	3.05	2.37	2.38	1.92	1.84	1.73	1.65
Berks	8.95	6.92	5.43	4.51	3.98	2.73	3.52	2.14
Blair	2.91	2.78	2.01	2.08	1.68	1.61	1.55	1.49
Bradford	1.56	1.43	1.02	1.06	0.85	0.80	0.80	0.73
Bucks	8.36	8.76	5.11	5.54	3.99	3.38	3.67	2.73
Butler	3.20	3.36	2.31	2.49	1.98	1.96	1.85	1.84
Cambria	2.81	2.74	1.95	2.01	1.64	1.55	1.50	1.43
Cameron	0.23	0.18	0.16	0.13	0.14	0.10	0.13	0.10
Carbon	2.39	1.96	1.63	1.54	1.34	1.21	1.23	1.10
Centre	3.57	3.55	2.46	2.61	2.13	2.03	2.04	1.90
Chester	6.79	7.36	4.17	4.56	3.27	2.80	3.05	2.29
Clarion	1.38	1.39	0.96	1.03	0.81	0.80	0.76	0.75
Clearfield	2.66	2.53	1.82	1.87	1.53	1.45	1.43	1.34
Clinton	1.84	1.61	1.24	1.20	1.05	0.92	0.99	0.85
Columbia	2.20	1.97	1.46	1.51	1.20	1.16	1.11	1.05
Crawford	1.99	1.92	1.38	1.39	1.18	1.09	1.10	1.02
Cumberland	6.28	5.29	3.87	3.37	2.93	2.08	2.73	1.68
Dauphin	7.85	6.22	4.92	3.99	3.81	2.47	3.69	1.99
Delaware	6.83	6.57	4.31	4.25	3.64	2.64	3.78	2.18
Elk	1.03	0.88	0.72	0.62	0.63	0.49	0.60	0.46
Erie	4.64	4.95	3.23	3.48	2.82	2.73	2.73	2.62
Fayette	2.76	2.62	1.91	1.97	1.56	1.52	1.40	1.37
Forest	0.41	0.30	0.28	0.22	0.24	0.17	0.23	0.16
Franklin	4.83	3.82	3.32	3.01	2.73	2.37	2.51	2.16
Fulton	1.48	1.32	1.02	1.03	0.83	0.80	0.75	0.72
Greene	1.15	1.08	0.78	0.81	0.65	0.63	0.61	0.58
Huntingdon	1.86	1.52	1.24	1.16	1.02	0.88	0.93	0.78
Indiana	2.14	2.05	1.46	1.51	1.21	1.16	1.12	1.06
Jefferson	1.32	1.34	0.90	0.96	0.77	0.75	0.73	0.70
Juniata	0.95	0.80	0.64	0.62	0.52	0.47	0.46	0.41
Lackawanna	4.94	4.81	3.38	3.62	2.97	2.81	2.96	2.65
Lancaster	10.20	8.34	6.00	5.29	4.53	3.19	4.15	2.55
Lawrence	2.09	1.99	1.46	1.47	1.22	1.14	1.13	1.05
Lebanon	3.05	2.48	1.81	1.60	1.29	0.96	1.12	0.75
Lehigh	8.29	6.18	5.11	4.06	4.03	2.51	3.94	2.02
Luzerne	7.75	7.38	5.25	5.62	4.49	4.34	4.33	4.03
Lycoming	3.30	3.07	2.22	2.31	1.85	1.77	1.72	1.62
McKean	0.98	0.89	0.68	0.63	0.60	0.49	0.58	0.47
Mercer	2.95	3.00	2.07	2.19	1.75	1.71	1.65	1.61
Mifflin	1.32	1.16	0.88	0.87	0.72	0.67	0.66	0.60
Monroe	4.13	3.92	2.81	2.99	2.44	2.36	2.41	2.22
Montgomery	10.61	10.68	6.78	6.81	5.64	4.32	5.58	3.62
Montour	0.76	0.70	0.53	0.54	0.44	0.42	0.41	0.39
Northampton	5.83	4.52	3.53	2.92	2.72	1.77	2.56	1.41
Northumberland	2.33	2.05	1.56	1.58	1.29	1.22	1.20	1.10
Perry	1.79	1.44	1.22	1.11	1.00	0.87	0.94	0.79
Philadelphia	18.37	13.88	11.55	9.53	9.51	5.85	9.76	4.57
Pike	1.38	1.36	0.93	1.02	0.81	0.81	0.80	0.77
Potter	0.69	0.60	0.47	0.43	0.41	0.33	0.39	0.31
Schuylkill	4.49	4.02	3.06	3.12	2.49	2.41	2.30	2.19
Snyder	1.28	1.18	0.85	0.89	0.70	0.67	0.66	0.61
Somerset	2.74	2.61	1.92	1.94	1.61	1.52	1.46	1.40
Sullivan	0.32	0.25	0.21	0.19	0.17	0.14	0.16	0.13
Susquehanna	1.43	1.45	0.96	1.06	0.82	0.81	0.79	0.77
Tioga	1.54	1.44	1.02	1.04	0.87	0.79	0.82	0.73
Union	1.43	1.34	0.96	1.00	0.81	0.77	0.76	0.71
Venango	1.40	1.37	0.97	1.00	0.81	0.78	0.76	0.72
Warren	1.11	1.02	0.77	0.72	0.66	0.56	0.64	0.53
Washington	3.88	4.10	2.45	2.46	1.89	1.49	1.70	1.23
Wayne	1.24	1.13	0.83	0.86	0.73	0.67	0.71	0.63
Westmoreland	6.63	6.67	4.20	4.03	3.25	2.44	2.89	2.00
Wyoming	0.76	0.72	0.50	0.53	0.42	0.40	0.40	0.37
York	7.82	6.36	4.75	4.11	3.47	2.50	3.06	1.97
State Total	**247.55**	**224.53**	**160.57**	**154.13**	**130.42**	**106.93**	**123.52**	**93.44**

Appendix 5-4
Emission Results with 2009 Phase-In of LEVII Program
(Tons/Day)

County	2010		2015		2020		2025	
	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)
Adams	2.89	2.29	1.99	1.79	1.63	1.40	1.48	1.26
Allegheny	15.92	15.82	10.27	9.39	8.31	5.79	7.99	4.82
Armstrong	1.58	1.57	1.09	1.17	0.90	0.90	0.82	0.81
Beaver	2.70	2.74	1.70	1.64	1.29	0.99	1.13	0.79
Bedford	3.45	3.07	2.39	2.40	1.94	1.87	1.74	1.66
Berks	8.99	6.97	5.49	4.58	4.03	2.81	3.54	2.16
Blair	2.93	2.80	2.03	2.11	1.69	1.64	1.56	1.49
Bradford	1.57	1.44	1.03	1.08	0.86	0.82	0.80	0.74
Bucks	8.43	8.85	5.21	5.65	4.04	3.48	3.69	2.75
Butler	3.23	3.40	2.34	2.52	2.00	1.99	1.86	1.85
Cambria	2.83	2.77	1.98	2.04	1.66	1.58	1.51	1.44
Cameron	0.23	0.18	0.16	0.14	0.14	0.11	0.13	0.10
Carbon	2.41	1.97	1.65	1.57	1.35	1.23	1.23	1.10
Centre	3.60	3.58	2.50	2.65	2.15	2.06	2.04	1.91
Chester	6.86	7.44	4.26	4.66	3.31	2.88	3.06	2.31
Clarion	1.39	1.40	0.97	1.04	0.82	0.82	0.76	0.76
Clearfield	2.67	2.54	1.84	1.90	1.55	1.47	1.44	1.35
Clinton	1.85	1.63	1.25	1.21	1.06	0.94	1.00	0.86
Columbia	2.20	1.98	1.48	1.53	1.21	1.18	1.12	1.06
Crawford	2.00	1.94	1.40	1.41	1.19	1.10	1.11	1.02
Cumberland	6.32	5.34	3.93	3.43	2.97	2.14	2.75	1.70
Dauphin	7.90	6.27	4.98	4.06	3.85	2.54	3.71	2.01
Delaware	6.88	6.63	4.38	4.32	3.68	2.71	3.79	2.20
Elk	1.03	0.89	0.73	0.63	0.63	0.50	0.60	0.47
Erie	4.68	4.99	3.28	3.54	2.85	2.77	2.74	2.63
Fayette	2.77	2.64	1.93	2.00	1.58	1.54	1.41	1.37
Forest	0.41	0.30	0.28	0.22	0.24	0.17	0.23	0.16
Franklin	4.85	3.84	3.35	3.05	2.76	2.41	2.52	2.17
Fulton	1.48	1.32	1.03	1.04	0.84	0.81	0.75	0.73
Greene	1.15	1.08	0.79	0.82	0.66	0.64	0.61	0.58
Huntingdon	1.87	1.52	1.25	1.17	1.03	0.89	0.93	0.79
Indiana	2.16	2.07	1.47	1.53	1.22	1.18	1.12	1.06
Jefferson	1.33	1.35	0.92	0.98	0.78	0.76	0.73	0.71
Juniata	0.96	0.80	0.65	0.62	0.52	0.48	0.46	0.42
Lackawanna	4.97	4.85	3.42	3.67	3.00	2.86	2.97	2.66
Lancaster	10.25	8.41	6.09	5.39	4.59	3.28	4.17	2.57
Lawrence	2.11	2.01	1.48	1.49	1.23	1.16	1.14	1.06
Lebanon	3.07	2.50	1.83	1.62	1.30	0.99	1.13	0.75
Lehigh	8.33	6.23	5.18	4.13	4.07	2.58	3.95	2.04
Luzerne	7.79	7.43	5.31	5.69	4.53	4.42	4.34	4.04
Lycoming	3.32	3.09	2.25	2.34	1.87	1.80	1.72	1.63
McKean	0.99	0.90	0.70	0.64	0.60	0.50	0.58	0.47
Mercer	2.98	3.02	2.10	2.22	1.77	1.74	1.66	1.62
Mifflin	1.32	1.16	0.89	0.88	0.73	0.68	0.67	0.60
Monroe	4.15	3.95	2.85	3.04	2.47	2.40	2.41	2.22
Montgomery	10.71	10.82	6.92	6.97	5.70	4.43	5.60	3.64
Montour	0.76	0.71	0.53	0.55	0.45	0.43	0.41	0.39
Northampton	5.86	4.55	3.58	2.97	2.75	1.82	2.57	1.42
Northumberland	2.34	2.07	1.58	1.60	1.30	1.24	1.20	1.11
Perry	1.79	1.45	1.24	1.12	1.01	0.88	0.94	0.80
Philadelphia	18.44	13.97	11.66	9.71	9.61	6.01	9.80	4.62
Pike	1.39	1.37	0.94	1.04	0.82	0.82	0.80	0.77
Potter	0.69	0.60	0.48	0.43	0.41	0.34	0.39	0.31
Schuylkill	4.51	4.04	3.09	3.16	2.52	2.45	2.31	2.20
Snyder	1.29	1.18	0.85	0.90	0.71	0.68	0.66	0.61
Somerset	2.76	2.63	1.95	1.97	1.63	1.54	1.47	1.41
Sullivan	0.32	0.25	0.21	0.19	0.17	0.14	0.16	0.13
Susquehanna	1.44	1.46	0.97	1.07	0.83	0.83	0.79	0.77
Tioga	1.55	1.45	1.03	1.06	0.88	0.81	0.83	0.74
Union	1.43	1.35	0.98	1.02	0.82	0.78	0.76	0.71
Venango	1.41	1.39	0.98	1.01	0.82	0.79	0.76	0.73
Warren	1.12	1.02	0.78	0.73	0.67	0.57	0.64	0.53
Washington	3.92	4.14	2.50	2.51	1.92	1.53	1.71	1.24
Wayne	1.24	1.14	0.84	0.87	0.74	0.68	0.71	0.63
Westmoreland	6.68	6.74	4.27	4.12	3.29	2.51	2.90	2.01
Wyoming	0.76	0.72	0.51	0.53	0.43	0.40	0.40	0.37
York	7.87	6.41	4.82	4.18	3.51	2.57	3.07	1.99
State Total	**249.06**	**226.43**	**162.84**	**156.71**	**131.87**	**109.21**	**123.97**	**94.04**

Appendix 5-5
Interpolated Emission Results with 2008 Phase-In of LEVII Program
(Tons/Day)

County	2010		2015		2020		2025	
	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)
Adams	2.89	2.29	1.99	1.78	1.62	1.40	1.48	1.26
Allegheny	15.87	15.76	10.20	9.32	8.28	5.74	7.98	4.80
Armstrong	1.58	1.57	1.08	1.16	0.89	0.89	0.82	0.81
Beaver	2.70	2.73	1.69	1.63	1.29	0.98	1.12	0.79
Bedford	3.45	3.06	2.38	2.40	1.93	1.86	1.73	1.66
Berks	8.98	6.95	5.47	4.56	4.02	2.79	3.53	2.16
Blair	2.92	2.79	2.02	2.10	1.69	1.63	1.56	1.49
Bradford	1.57	1.44	1.03	1.07	0.86	0.81	0.80	0.74
Bucks	8.41	8.82	5.18	5.62	4.02	3.44	3.68	2.74
Butler	3.22	3.38	2.33	2.51	1.99	1.98	1.86	1.85
Cambria	2.83	2.76	1.97	2.03	1.65	1.57	1.51	1.44
Cameron	0.23	0.18	0.16	0.13	0.14	0.11	0.13	0.10
Carbon	2.40	1.97	1.64	1.56	1.35	1.22	1.23	1.10
Centre	3.59	3.57	2.49	2.63	2.15	2.05	2.04	1.91
Chester	6.84	7.41	4.23	4.63	3.30	2.85	3.06	2.30
Clarion	1.38	1.40	0.97	1.04	0.81	0.81	0.76	0.76
Clearfield	2.67	2.54	1.83	1.89	1.54	1.46	1.43	1.34
Clinton	1.84	1.62	1.25	1.21	1.06	0.93	1.00	0.86
Columbia	2.20	1.98	1.47	1.52	1.21	1.17	1.12	1.06
Crawford	2.00	1.93	1.40	1.40	1.18	1.10	1.11	1.02
Cumberland	6.31	5.32	3.91	3.41	2.96	2.12	2.74	1.69
Dauphin	7.88	6.26	4.96	4.04	3.84	2.51	3.70	2.00
Delaware	6.86	6.61	4.36	4.30	3.67	2.68	3.79	2.20
Elk	1.03	0.89	0.72	0.63	0.63	0.49	0.60	0.46
Erie	4.67	4.97	3.26	3.52	2.84	2.75	2.74	2.63
Fayette	2.77	2.63	1.93	1.99	1.57	1.53	1.41	1.37
Forest	0.41	0.30	0.28	0.22	0.24	0.17	0.23	0.16
Franklin	4.85	3.84	3.34	3.04	2.75	2.40	2.52	2.17
Fulton	1.48	1.32	1.03	1.04	0.83	0.81	0.75	0.73
Greene	1.15	1.08	0.79	0.82	0.65	0.64	0.61	0.58
Huntingdon	1.86	1.52	1.25	1.16	1.03	0.89	0.93	0.79
Indiana	2.15	2.06	1.47	1.52	1.22	1.17	1.12	1.06
Jefferson	1.32	1.34	0.91	0.97	0.77	0.75	0.73	0.71
Juniata	0.96	0.80	0.64	0.62	0.52	0.47	0.46	0.41
Lackawanna	4.96	4.84	3.41	3.65	2.99	2.84	2.97	2.66
Lancaster	10.23	8.39	6.06	5.36	4.57	3.25	4.16	2.56
Lawrence	2.10	2.00	1.48	1.48	1.22	1.15	1.14	1.05
Lebanon	3.06	2.49	1.83	1.61	1.30	0.98	1.13	0.75
Lehigh	8.32	6.21	5.16	4.11	4.06	2.56	3.95	2.03
Luzerne	7.78	7.41	5.29	5.67	4.52	4.39	4.34	4.04
Lycoming	3.31	3.08	2.24	2.33	1.86	1.79	1.72	1.62
McKean	0.99	0.90	0.69	0.63	0.60	0.49	0.58	0.47
Mercer	2.97	3.01	2.09	2.21	1.76	1.73	1.65	1.62
Mifflin	1.32	1.16	0.89	0.88	0.73	0.68	0.67	0.60
Monroe	4.14	3.94	2.83	3.02	2.46	2.38	2.41	2.22
Montgomery	10.68	10.77	6.88	6.92	5.68	4.39	5.60	3.64
Montour	0.76	0.70	0.53	0.54	0.45	0.43	0.41	0.39
Northampton	5.85	4.54	3.56	2.95	2.74	1.80	2.57	1.42
Northumberland	2.33	2.06	1.58	1.59	1.30	1.23	1.20	1.11
Perry	1.79	1.45	1.23	1.12	1.01	0.88	0.94	0.80
Philadelphia	18.42	13.94	11.63	9.65	9.58	5.96	9.79	4.60
Pike	1.39	1.36	0.94	1.03	0.82	0.82	0.80	0.77
Potter	0.69	0.60	0.48	0.43	0.41	0.33	0.39	0.31
Schuylkill	4.51	4.03	3.08	3.15	2.51	2.44	2.30	2.19
Snyder	1.28	1.18	0.85	0.89	0.70	0.68	0.66	0.61
Somerset	2.75	2.63	1.94	1.96	1.62	1.54	1.47	1.41
Sullivan	0.32	0.25	0.21	0.19	0.17	0.14	0.16	0.13
Susquehanna	1.44	1.45	0.97	1.07	0.83	0.82	0.79	0.77
Tioga	1.55	1.44	1.03	1.05	0.87	0.80	0.83	0.74
Union	1.43	1.35	0.97	1.01	0.81	0.78	0.76	0.71
Venango	1.41	1.38	0.98	1.01	0.82	0.78	0.76	0.73
Warren	1.11	1.02	0.77	0.72	0.67	0.56	0.64	0.53
Washington	3.91	4.13	2.48	2.49	1.91	1.51	1.71	1.24
Wayne	1.24	1.13	0.84	0.86	0.73	0.68	0.71	0.63
Westmoreland	6.66	6.72	4.25	4.09	3.28	2.48	2.90	2.01
Wyoming	0.76	0.72	0.50	0.53	0.42	0.40	0.40	0.37
York	7.85	6.39	4.79	4.16	3.50	2.55	3.07	1.99
State Total	**248.56**	**225.80**	**162.08**	**155.85**	**131.39**	**108.45**	**123.82**	**93.84**

Appendix 5-6
Emission Benefits of Pennsylvania Clean Vehicles Program vs. FMVCP/Tier2 Program
(Tons/Day - Negative Values Represent LEVII Program Benefits)

County	2010		2015		2020		2025	
	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)	VOC (tpd)	NOX (tpd)
Adams	-0.01	-0.01	-0.02	-0.02	-0.05	-0.05	-0.07	-0.07
Allegheny	-0.10	-0.11	-0.25	-0.35	-0.49	-0.61	-0.63	-0.76
Armstrong	-0.01	-0.01	-0.02	-0.02	-0.03	-0.04	-0.05	-0.05
Beaver	-0.01	-0.01	-0.04	-0.05	-0.08	-0.09	-0.10	-0.12
Bedford	-0.01	-0.01	-0.03	-0.03	-0.06	-0.07	-0.09	-0.10
Berks	-0.03	-0.03	-0.08	-0.10	-0.17	-0.20	-0.24	-0.28
Blair	-0.01	-0.01	-0.03	-0.04	-0.06	-0.07	-0.09	-0.10
Bradford	0.00	0.00	-0.01	-0.02	-0.03	-0.03	-0.04	-0.05
Bucks	-0.04	-0.05	-0.11	-0.16	-0.23	-0.30	-0.31	-0.41
Butler	-0.02	-0.02	-0.05	-0.06	-0.09	-0.11	-0.12	-0.14
Cambria	-0.01	-0.01	-0.03	-0.04	-0.06	-0.08	-0.09	-0.10
Cameron	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01
Carbon	-0.01	-0.01	-0.02	-0.02	-0.04	-0.05	-0.06	-0.07
Centre	-0.01	-0.01	-0.04	-0.05	-0.09	-0.10	-0.12	-0.13
Chester	-0.04	-0.04	-0.10	-0.15	-0.20	-0.27	-0.27	-0.35
Clarion	0.00	-0.01	-0.02	-0.02	-0.03	-0.04	-0.05	-0.05
Clearfield	-0.01	-0.01	-0.03	-0.03	-0.06	-0.07	-0.08	-0.09
Clinton	-0.01	-0.01	-0.02	-0.02	-0.04	-0.04	-0.05	-0.06
Columbia	0.00	-0.01	-0.02	-0.02	-0.04	-0.05	-0.06	-0.06
Crawford	-0.01	-0.01	-0.02	-0.03	-0.05	-0.05	-0.07	-0.07
Cumberland	-0.02	-0.02	-0.07	-0.09	-0.14	-0.17	-0.20	-0.24
Dauphin	-0.03	-0.03	-0.08	-0.10	-0.16	-0.20	-0.23	-0.27
Delaware	-0.03	-0.04	-0.09	-0.12	-0.18	-0.23	-0.25	-0.31
Elk	0.00	0.00	-0.01	-0.01	-0.02	-0.03	-0.03	-0.03
Erie	-0.02	-0.02	-0.06	-0.09	-0.13	-0.15	-0.17	-0.19
Fayette	-0.01	-0.01	-0.03	-0.03	-0.06	-0.07	-0.08	-0.09
Forest	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01
Franklin	-0.01	-0.01	-0.04	-0.04	-0.08	-0.09	-0.12	-0.13
Fulton	0.00	0.00	-0.01	-0.01	-0.03	-0.03	-0.04	-0.04
Greene	0.00	0.00	-0.01	-0.01	-0.03	-0.03	-0.04	-0.04
Huntingdon	0.00	0.00	-0.01	-0.02	-0.03	-0.04	-0.04	-0.05
Indiana	-0.01	-0.01	-0.02	-0.03	-0.04	-0.05	-0.06	-0.07
Jefferson	0.00	0.00	-0.02	-0.02	-0.03	-0.04	-0.04	-0.05
Juniata	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02
Lackawanna	-0.02	-0.02	-0.05	-0.06	-0.11	-0.13	-0.16	-0.18
Lancaster	-0.03	-0.03	-0.10	-0.13	-0.21	-0.25	-0.30	-0.35
Lawrence	-0.01	-0.01	-0.02	-0.03	-0.05	-0.05	-0.06	-0.07
Lebanon	-0.01	-0.01	-0.03	-0.04	-0.06	-0.07	-0.08	-0.10
Lehigh	-0.03	-0.02	-0.08	-0.09	-0.16	-0.19	-0.24	-0.27
Luzerne	-0.02	-0.03	-0.08	-0.09	-0.16	-0.19	-0.24	-0.26
Lycoming	-0.01	-0.01	-0.03	-0.04	-0.07	-0.08	-0.10	-0.11
McKean	0.00	0.00	-0.01	-0.02	-0.03	-0.03	-0.03	-0.03
Mercer	-0.01	-0.01	-0.04	-0.05	-0.07	-0.09	-0.10	-0.11
Mifflin	0.00	0.00	-0.01	-0.01	-0.02	-0.03	-0.03	-0.04
Monroe	-0.01	-0.02	-0.05	-0.05	-0.09	-0.11	-0.13	-0.15
Montgomery	-0.07	-0.08	-0.16	-0.24	-0.33	-0.42	-0.43	-0.55
Montour	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.03
Northampton	-0.02	-0.02	-0.05	-0.07	-0.11	-0.13	-0.16	-0.19
Northumberland	-0.01	-0.01	-0.02	-0.03	-0.04	-0.05	-0.06	-0.07
Perry	0.00	0.00	-0.02	-0.02	-0.03	-0.04	-0.05	-0.05
Philadelphia	-0.04	-0.05	-0.14	-0.15	-0.30	-0.38	-0.47	-0.56
Pike	-0.01	-0.01	-0.02	-0.02	-0.04	-0.04	-0.05	-0.06
Potter	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
Schuylkill	-0.01	-0.01	-0.04	-0.05	-0.08	-0.10	-0.12	-0.13
Snyder	0.00	0.00	-0.01	-0.01	-0.02	-0.03	-0.04	-0.04
Somerset	-0.01	-0.01	-0.03	-0.04	-0.06	-0.07	-0.08	-0.09
Sullivan	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01
Susquehanna	0.00	0.00	-0.02	-0.02	-0.03	-0.04	-0.05	-0.05
Tioga	0.00	0.00	-0.02	-0.02	-0.03	-0.04	-0.04	-0.05
Union	0.00	0.00	-0.01	-0.02	-0.03	-0.04	-0.04	-0.05
Venango	-0.01	-0.01	-0.02	-0.02	-0.03	-0.04	-0.05	-0.05
Warren	0.00	0.00	-0.01	-0.02	-0.03	-0.03	-0.04	-0.04
Washington	-0.02	-0.02	-0.06	-0.09	-0.12	-0.15	-0.16	-0.19
Wayne	0.00	0.00	-0.01	-0.02	-0.03	-0.03	-0.04	-0.04
Westmoreland	-0.03	-0.03	-0.09	-0.13	-0.19	-0.23	-0.25	-0.30
Wyoming	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
York	-0.02	-0.02	-0.08	-0.09	-0.16	-0.19	-0.22	-0.26
State Total	**-0.93**	**-0.97**	**-2.74**	**-3.52**	**-5.63**	**-6.79**	**-7.81**	**-9.13**