west virginia department of environmental protection

Appendix F:
Washington County, MD
On-road Mobile
Emissions Inventory Documentation

Promoting a healthy environment.

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On-Road (Highway)
Mobile Emissions Inventory Documentation
for the
Washington County, Maryland $PM_{2.5}$ Nonattainment Area

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April 2013

The Washington County, Maryland $PM_{2.5}$Non-Attainment Area
On-Road (Highway) Mobile Emissions Inventory Documentation

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OVERVIEW

This document provides the on-road (highway) mobile source emissions inventory for the Washington County, Maryland (MD) PM2.5non-attainment area using Environmental Protection Agency (EPA)'s Motor Vehicle Emission Simulator (MOVES) model. The document includes a summary of the methodology and data assumptions used for the analysis. As shown in Exhibit 1, appendices have been provided with additional detail regarding the MOVES input parameters, vehicle miles traveled (VMT) and emission results for the nonattainment area.

Exhibit 1: Summary of Appendices

Appendix	Title	Description
A	(PM2.5, VOC, NOx, SO2, and NH3) Emission Results	Provides annual emission exhibits by county, road type, and source type categories in 2002, 2007, 2017 and 2025.
B	MOVES Sample Input File	Provides example of the MOVES input files.
C	MOVES Input Parameter Summary	Provides a summary of input parameters related to traffic data sources, fuel, weather, I/M, and other MOVES related input data.

Background:

The emissions inventory was developed using EPA's emissions model, MOVES2010. MOVES is now EPA's state-of-the-art tool for estimating emissions from highway vehicles. Compared to previous tools, MOVES incorporates the latest emissions data, more sophisticated calculation algorithms, increased user flexibility, new software design, and significant new capabilities. EPA announced the release of MOVES2010 in March 2010 (75 Federal Register 9411), and released a minor revision as MOVES2010a in September 2010. In April 2012, EPA released MOVES2010b to allow MOVES users to benefit from several improvements to general model performance. MOVES2010b does not affect the criteria pollutant emissions results of MOVES2010a and therefore is not a new model. Based on the timing of the analysis, this highway emissions inventory utilizes the MOVES2010a model.

Highway Emissions:

Exhibit 2 summarizes the highway emissions inventory for the Washington nonattainment area. The emission estimates for all pollutants have been developed using the MOVES2010a emission model and latest planning assumptions. Emissions have been estimated for the 2002, 2007, 2017 and 2025 analysis years. The 2002 and 2007 emission estimates were developed and provided by Maryland Department of the Environment (MDE).

Exhibit 2: Summary of Highway Emissions Inventory for Washington County
Annual Emissions (Short tons/year)

County	VMT	VOC	NOx	$PM_{2.5}$	SO2	NH3
2002	1,886,010,533	2,556.74	9,163.19	285.62	262.57	110.63
2007	2,090,061,547	1,656.90	6,021.95	217.77	45.33	91.77
2017	2,315,331,295	947.56	3,380.83	124.70	19.09	67.68
2025	2,786,455,965	725.46	2,312.19	77.79	20.82	74.45

A safety margin was applied to the emissions totals for the 2017 and 2025 analysis years to establish Motor Vehicle Emission Budgets (MVEBs) for transportation conformity. The safety margin was determined through consultation with MDE, Maryland Department of Transportation (MDOT) and

Hagerstown/ Eastern Panhandle Metropolitan Planning Organization (HEPMPO). **Exhibit 3** summarizes the MVEBs for Washington County.

Exhibit 3: Transportation Conformity Emission Budgets for Washington County

Emissions (Short Tons/Year)	**NOx**	**$PM_{2.5}$**
2017	4,057.00	149.63
2025	2,774.63	93.35

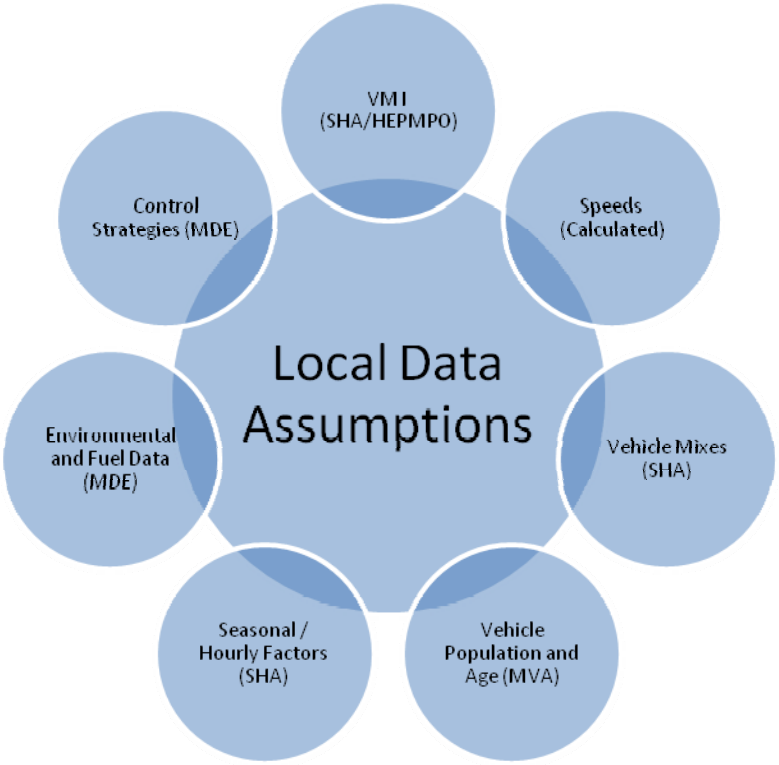
Analysis Methodology:

Guidance documents from EPA were used to develop the highway emissions inventory. They include:

- *Policy Guidance on the Use of MOVES2010 and Subsequent Minor Revisions for SIP Development, Transportation Conformity, and Other Purposes*, US EPA Office of Air and Radiation, EPA-420-B-12-010, April 2012.
- *Using MOVES to prepare Emission Inventories in State Implementation Plans and Transportation Conformity: Technical Guidance for MOVES2010, 2010a and 2010b.* US EPA Office of Air and Radiation, and Office of Transportation and Air Quality, EPA-420-B-12-028, April 2012.
- *Motor Vehicle Emission Simulator, User Guide for MOVES2010a,* EPA-420-B-10-036, August 2010.

The methodologies used to produce the emission data conform to the recommendations provided in EPA's Technical Guidance. A mix of local data and national default (internal to MOVES2010a) data has been used for this submission. As illustrated in Exhibit 4, local data has been used for the primary data items that have a significant impact on emissions. Local data inputs to the analysis process reflect the latest available planning assumptions using data obtained from MDE, Motor Vehicle Administration (MVA), Maryland State Highway Administration (SHA), HEPMPO and other local/national sources.

Exhibit 4: Local Data Inputs Used for Emissions Inventory



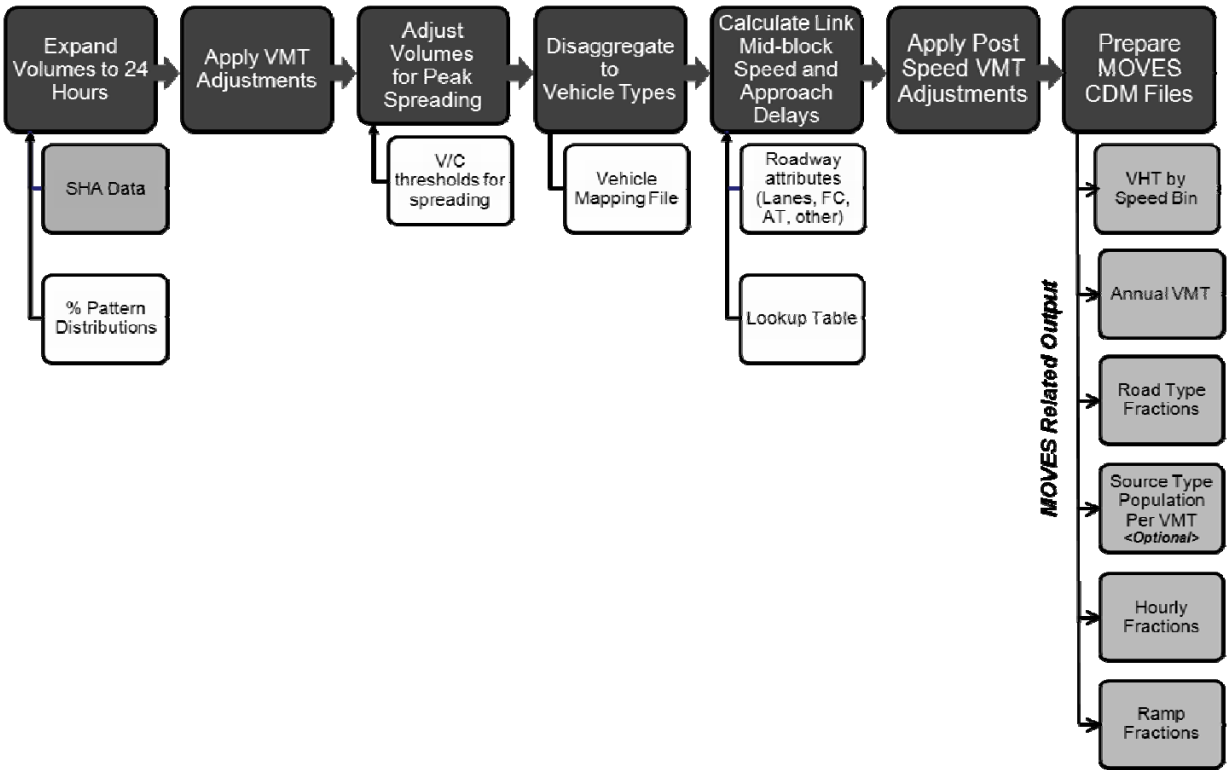
The analysis methodology is consistent with past statewide inventory efforts including the 2008 National Emissions Inventory (NEI) submission. This includes the use of statewide traffic roadway data and custom post-processing software (PPSUITE) to calculate hourly speeds and prepare key traffic input files to the MOVES2010a emission model. PPSUITE consists of a set of programs that perform the following functions:

- Analyzes highway operating conditions.
- Calculates highway speeds.
- Compiles VMT and vehicle type mix data.
- Prepares MOVES runs and processes MOVES outputs.

PPSUITE is a widely used and accepted tool for estimating speeds and processing emissions rates. It has been used for past State Implementation Plan (SIP) highway inventories in MD, Pennsylvania, and New Jersey. 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 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.

The PPSUITE process is integral to producing key input files to the MOVES emission model. Exhibit 5 summarizes the key functions of PPSUITE and the traffic-related input files prepared for MOVES.

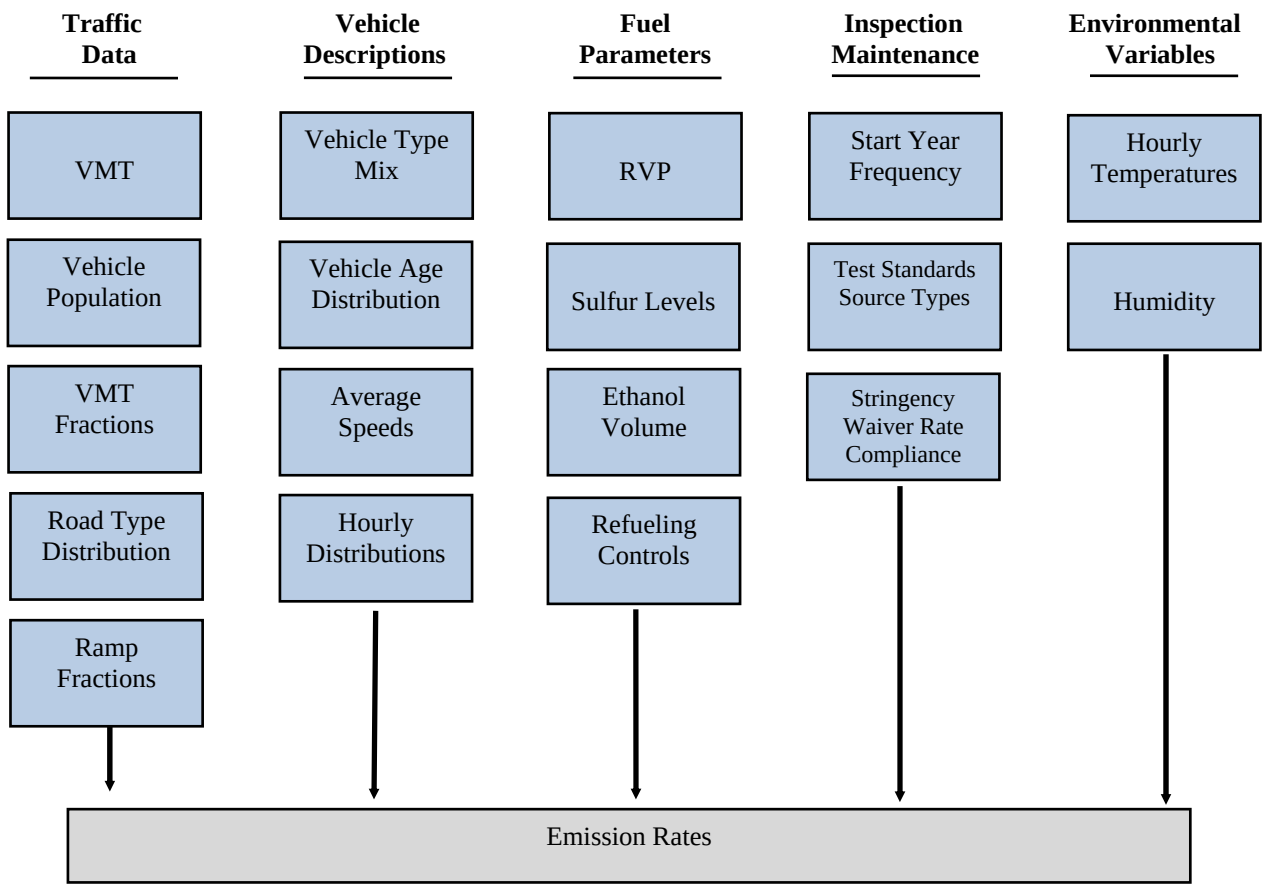
Exhibit 5: Emission Calculation Process



DESCRIPTION OF INPUT DATA

A large number of inputs to MOVES are needed to fully account for the numerous vehicle and environmental parameters that affect emissions. These include traffic flow characteristics, vehicle descriptions, fuel parameters, Inspection/Maintenance Program parameters, and environmental variables as shown in Exhibit 6.

Exhibit 6: Examples of Key MOVES Input Data



MOVES includes a default national database of meteorology, vehicle fleet, vehicle activity, fuel, and emission control program data for every county; but EPA cannot certify that the default data is the most current or best available information for any specific area. As a result, local data is recommended for use in SIP's analyses.

A mix of local and default data is used for this inventory. Local data sources are used for all inputs that have a significant impact on calculated emission rates. These data items are discussed in the following sections.

Roadway Data:

The roadway data input to emissions calculations for this inventory is based on information from the "universal" highway database maintained by the Maryland SHA. SHA obtains this information from periodic visual and electronic traffic counts. The SHA's data is dynamic, since it is continually reviewed and updated from new traffic counts. 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 SHA's database is taken and downloaded to provide an up-to-date record of the state's highway system for estimating emissions. This emissions inventory is based on 2011 data which is the most current "snapshot" of the SHA's data. The following information is extracted from the database for emission calculations:

- lanes
- distances
- volumes representing Average Annual Daily Traffic (AADT)
- truck percentages
- urban/rural classifications
- functional class codes

The 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 reflect annual conditions. In addition, the traffic volumes must be forecast to support future year emission inventories. The lane values, area type, and functional class are important inputs 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 MOVES software.

MD classifies its road segments by function, as well as whether it is located in an urban or rural area, as indicated below in Exhibit 7. The urban/rural (UR) and functional classes (FC) are important indicators of the type and function of each roadway segment. These values are also used to determine the MOVES Road Type classification that has an important impact on the emission factors for each roadway segment. Equivalencies between the SHA and MOVES indices are discussed in later sections.

Exhibit 7: MDOT Urban/Rural 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 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

The PPSUITE processing software allows for many additional variables other than those available in the SHA's database. Using these variables improves the calculation of congested speeds. Such variables include information regarding free-flow speeds and capacities and other physical roadway features (e.g. traffic signals) that can affect a roadway's calculated congested speed. This data can be determined from lookup tables based on a roadway segment's urban/rural code and functional class. Much of the lookup table data was developed from information contained in the Highway Capacity Manual.

Traffic Volumes Growth Rates:

Traffic volume projections are needed to support the forecast emission inventories. Growth factors are applied to the base year traffic volumes in the SHA's database. These growth factors are determined through and assessment of:

- Historic VMT growth from the Highway Performance Monitoring System (HPMS)
- Travel model forecasts obtained from the HEPMPO regional travel demand model
- Assessment of other factors affecting regional growth not represented in the above sources

The development and selection of growth rates has included consultation between MDOT, HEPMPO and MDE. Forecasted traffic volumes are used within the post-processing methodologies to estimate future year congested speeds.

Other Supporting Traffic Data:

Other traffic data is used to adjust and disaggregate traffic volumes. Key sources used in these processes include the following:

HPMS VMT: According to EPA's guidance, baseline inventory VMT computed from the SHA's highway segment volumes must be adjusted to be consistent with HPMS VMT totals. Although it has some limitations, the HPMS system is currently in use in all 50 states and is being improved under Federal Highway Administration (FHWA)'s direction. Adjustment factors are calculated which adjust the base year 2011 SHA's downloaded VMT to be consistent with the reported 2011 HPMS totals for that year. These factors are applied to all counties, urban/rural code, and facility group combinations within the region. These adjustments are important for accounting for missing local roadway VMT that is not contained within or represented by the state-owned roadway system.

Seasonal Factors: The SHA contains AADT volumes that are an average of all days in the year, including weekends and holidays. PM and CO analyses require volumes representing monthly average conditions (needed for producing annual totals). Therefore, the SHA's volumes must be seasonally adjusted. The seasonal factors were developed based on the 2011 report, *ATR Station Reports in the Traffic Trends System Report Module* from the SHA's website. These factors are applied to the existing SHA's AADT volumes to produce the monthly volumes. The same factors are also used to develop the MOVES daily and monthly VMT fraction files.

Hourly Patterns: Speeds and emissions vary considerably depending on the time of day. Therefore, it is important to estimate the pattern by which roadway volume varies by hour of the day. Pattern data is in the form of a percentage of the daily volumes for each hour. Distributions are provided for all the counties within the region and by each facility type grouping. This data was developed from 2011 24-hour count data obtained from the SHA's website. The same factors are also used to develop the MOVES hourly fraction file.

Vehicle Class Data:

Emission rates within MOVES vary significantly by the type of vehicle. The MOVES model produces emissions and rates by thirteen MOVES vehicle source types. However, VMT is input to MOVES by six HPMS vehicle groups. Exhibit 8 summarizes the distinction between each classification scheme.

Exhibit 8: MOVES Source Types and HPMS Vehicle Groups

SOURCE TYPES		HPMS Class Groups	
11	Motorcycle	10	Motorcycle
21	Passenger Car	20	Passenger Car
31	Passenger Truck	30	Passenger/Light Truck
32	Light Commercial Truck	40	Buses
41	Intercity Bus	50	Single Unit Trucks
42	Transit Bus	60	Combination Trucks
43	School bus		
51	Refuse Truck		
52	Single Unit Short-haul Truck		
53	Single Unit Long-haul Truck		
54	Motor Home		
61	Combination Short-haul Truck		
62	Combination Long-haul Truck		

For this regional inventory, vehicle type pattern data was developed for each county and functional class combination based on SHA's classification counts and internal MOBILE6.2 and MOVES defaults. As the first step, SHA's count data was used to develop percentage splits to the following four vehicle groups:

- Autos
- Heavy trucks
- Motorcycles
- Buses

Following procedures used for previous SIP's efforts, the vehicle groups were expanded to the 28 MOBILE6.2 weight-based vehicle types. Using procedures provided in EPA's Technical Guidance, the MOBILE6.2 vehicle classes were mapped to the MOVES source types and HPMS class groups.

The vehicle type percentages are also 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 is accounted for in the speed estimation process by adjusting capacity using information from the Highway Capacity Manual.

Vehicle Ages:

Vehicle age distributions are input to MOVES for each county by the thirteen source types. The distributions reflect the percentage of vehicles in the fleet up to 31 years old. The vehicle age distributions were prepared by MDE based on information obtained from MVA registration data.

The age distributions are based on 2011 MVA registration data that included cleaning of duplicate, expired, and non-eligible vehicles (from the emission standpoint such as trailers, farm tractors). The data

was transformed into two sets of MOBILE6 vehicle types; one conforming to MOBILE6-28 vehicle type and the other to MOBILE6-16 composite vehicle type system using a SAS-based computer program.

The MOVES model input age distributions were produced utilizing the available EPA's MS-Excel-based vehicle registration converter tool. This tool assisted in converting the MOBILE6.2-based data into the MOVES source type categories.

Vehicle Population Data:

The information on the vehicle fleet including the number and age of vehicles impacts forecasted start and evaporative emissions within MOVES. MOVES model requires the population of vehicles by the thirteen source type categories. This data was prepared and provided by MDE for the analysis year 2011 utilizing another SAS-based computer program similar to the one discussed in the previous vehicle age section. MD's county vehicle registration data was used to estimate vehicle population for light-duty and heavy-duty vehicles for all counties in the region.

For the analysis years 2017 and 2025, the vehicle population was forecasted based on projected household and population growth obtained from state and Metropolitan Planning Organization (MPO)'s sources. The growth rate methodology included:

- Choosing the highest growth rate between population, households and VMT growth.
- Default VMT/Population ratio for Trucks i.e. Truck population growth based on Truck VMT.

Environmental and Fuel Data:

Information on environmental, fuel, vehicle technology and other control strategy assumptions were determined based on a review of MOVES2010a default information by MDE.

Fuel Data: MDE obtains monthly fuel data reports regularly from the MD Fuel Laboratory which is under the jurisdiction of MD Fuel Tax Division of the Office of the Comptroller of MD. These fuel reports are generated by testing samples collected in the field (gas stations) for the purpose of fuel regulation enforcement. It covers all counties in MD. Since the data entry of these samples is a huge task, compilation of fuel data to yield input parameters for MOBILE or MOVES modeling is confined only to the years for which emission inventories are due for submission to EPA on a triennial basis beginning with the baseline year of 1990. 2011 happens to be a year of such periodic emission inventories. As such 2011 fuel data was compiled and fuel data parameters were developed separately for the 14 MD counties with EPA's mandates to dispense only reformulated gasoline requirements and the 10 remaining counties dispensing conventional gasoline.

Two sets of fuel data inputs (Fuel Formulation and Fuel Supply tables) required by MOVES model were developed in-house for every county in MD. The fuel parameters changed from the MOVES defaults are as follows:

fuelFormulationID	Unique ID used for easy recognition
fuelSubtypeID	Selected per guidance based on ethanol content of gasoline
sulfurLevel	Computed from the local fuel data
ETOHVolume	Computed from the local fuel data
aromaticContent	Computed from the local fuel data
olefinContent	Computed from the local fuel data
benzineContent	Computed from the local fuel data
E200	Computed from the local fuel data

E300	Computed from the local fuel data
RVP	Computed from the local fuel data

Meteorological Data: Evaporative emissions are influenced significantly by the temperatures of the surrounding air. PM analysis temperature and humidity values were determined by MDE using the procedures documented in EPA's Technical Guidance. On a triennial basis, meteorology data including hourly temperature and relative humidity is compiled to be used for periodic emission inventories and hence this data was obtained for the year 2011. The month by month raw hourly-data sets were obtained from the National Climate Data Center of National Oceanic and Atmospheric Administration (NOAA) based on weather data collected at the Hagerstown Regional Airport situated in the Washington County. Hourly average temperature and humidity computations were developed from the 24 hourly values for every hour in a given month for Washington County.

Other Vehicle Technology and Control Strategy Data:

The MOVES2010a default I/M data was reviewed and updated by MDE for all the counties in the region. The current I/M Program known as Vehicle Emission Inspection Program (VEIP)'s assumption for these analysis runs is described below.

MD Vehicle Emission Inspection Program: This Program tests model year 1977 and newer gasoline powered vehicles weighing up to 26,000 lb. The test is done biennially, and on change of ownership. There is a two year grace period for new vehicles. Light duty vehicles model year 1996 and newer, and model year 2008 and newer vehicles weighing up to 14,000 lb get the OBD test. All other vehicles get an idle test with a gas cap pressure test and a visual check for the presence of a catalytic converter. The compliance factors reflect the observed fail and waiver rates observed in this Program, combined with an assumed 96% compliance rate for vehicles showing up for testing. Heavy duty vehicles have an additional factor, reflecting the fraction of vehicles in the weight range covered by the Program. This was derived from documentation comparing the MOVES and MOBILE vehicle classes. The significantly higher compliance rate for the gas cap check reflects the much higher retest pass rate for this check.

Federal Programs: Current federal vehicle emissions control and fuel programs are incorporated into the MOVES2010a software. These include the National Program standards covering model year vehicles through 2016. Modifications of default emission rates are required to reflect the early implementation of the National Low Emission Vehicle (NLEV) Program in MD. To reflect these impacts, EPA has released instructions and input files that can be used to model these impacts. This inventory utilized the August 2010 version of the files (http://www.epa.gov/oms/models/moves/tools.htm).

State Vehicle Technology Programs:

MD Clean Car Program: Under the MD Clean Cars Act of 2007, MD adopted the California Low Emission Vehicle (CAL LEV II) Program. This Program began implementation in 2011 and requires all 2011 model year and newer vehicles (GVWR up to 14,000 lbs.) registered in MD to meet California emission standards for both criteria and greenhouse gas pollutants. This Program also contains a zero emission vehicles component that requires the manufacturers to produce a certain percentage of zero emission vehicles (electric, fuel cell, etc.) for purchase in the state. California has just adopted new amendments to the Low-Emission Vehicle (LEV) regulation entitled LEV III (third generation low emission vehicle standards). These amendments create more stringent emission standards for new motor vehicles. These new standards will be phased-in over the 2015-2025 model years.

The impacts of this Program were modeled for all analysis years using EPA's guidance document, *Instructions for Using LEV and NLEV Inputs for MOVES, EPA-420-B-10-003 January, 2010*. EPA provided input files to reflect the CAL LEVII Program with the standard phase-in schedules for new

emission standards. Modifications to those schedules were done as per EPA's instructions, to reflect a later start for the State of MD beginning with vehicle model year 2011.

ANALYSIS METHODOLOGY

The previous sections have summarized the input data used for computing speeds and emission rates for this highway emissions inventory. This section explains how PPSUITE and MOVES uses that input data to produce emission estimates. Exhibit 9 provides a more detailed overview of the PPSUITE analysis procedure using the available traffic data information described in the previous section.

VMT Preparation:

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 for each of the 24 hours of the day. This data needs to be processed individually to determine the distribution of vehicle hours traveled (VHT) by speed and then aggregated by vehicle class to determine the input VMT to the MOVES emission model. Key steps in the preparation of VMT include:

- *Apply Growth Factors* - The SHA's database contains the base 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 SHA's volumes to obtain future year estimates that can be utilized by PPSUITE.

- *Apply Seasonal Adjustments* - PPSUITE takes the input daily volumes from SHA (which represents AADT traffic) and adjusts the volumes to an average day in a month. This adjustment utilizes factors developed for each functional class and urban/rural code. VMT can then be calculated for each link using the adjusted average day volumes.

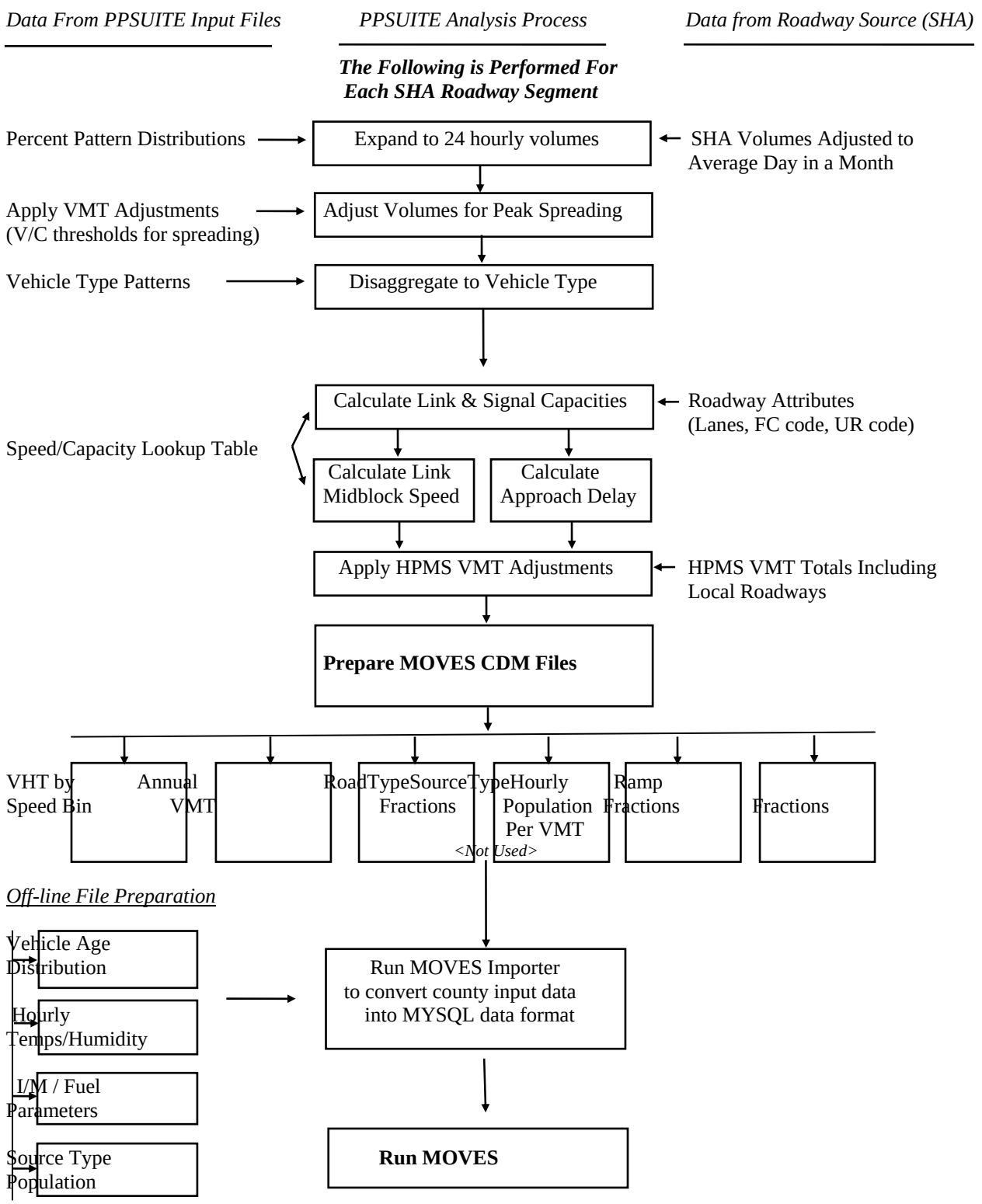
- *Disaggregate to Hours* - After adjusting the link volume, the volume is split to each hour of the day. This allows for more accurate speed calculations (effects of congested hours) and allows PPSUITE to prepare the hourly VMT and speeds for input to the MOVES model.

- *Peak Spreading* - 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 Types* - EPA requires VMT estimates to be prepared by source type, reflecting specific local characteristics. As a result, for MD's emission inventory runs, the hourly volumes are disaggregated to the six HPMS MOVES vehicle grouping based on count data assembled by SHA in combination with MOVES defaults as described in the previous section.

- *Apply HPMS 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 the latest HPMS download (conducted triennially); however, they are also applied to any future year runs. The VMT added or subtracted to the SHA's database assumes he speeds calculated using the original volumes for each roadway segment for each hour of the day.

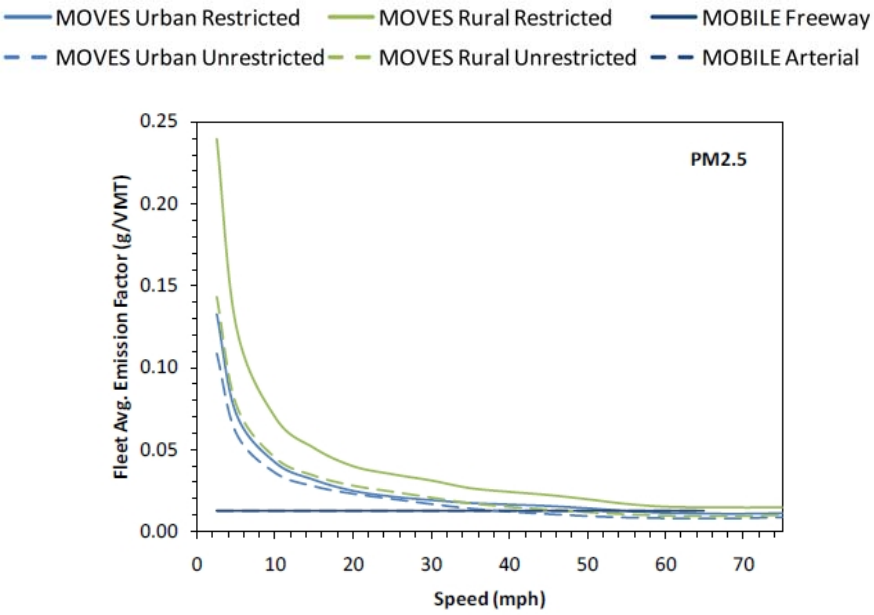
Exhibit 9: PPSUITE Speed/Emission Estimation Procedure



Speed Estimation:

Emissions for many pollutants (including PM and precursors) vary significantly with travel speed. For PM, higher emission rates are associated with lower speeds and lower rates are associated with higher speeds, as illustrated in Exhibit 10.

Exhibit 10: Emission Factor vs. Speed Variances (PM2.5)



Source: Figure 3 from Implications of the MOVES2010 Model on Mobile Source Emission Estimates, Air & Waste Management Association, July 2010.

EPA recognizes that the estimation of vehicle speeds is a difficult and complex process. Because emissions are so sensitive to speeds, EPA recommends that 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 road type.

The computational framework used for this analysis meets and exceeds that recommendation. Speeds are individually calculated for each roadway segment per hour and include the estimated delays encountered at signals. Rather than accumulating the roadway segments into a particular road type and calculating an average speed, each individual link hourly speed is represented in the MOVES VHT by speed bin file. This MOVES input file allows the specification of a distribution of hourly speeds. For example, if 5% of a county's arterial VHT operates at 5 mph during the AM peak hour and the remaining 95% operates at 65mph, this can be represented in the MOVES speed input file. For the highway emissions inventory, distributions of speeds are input to MOVES by road type and source type by each hour of the day.

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 SHA's 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 characteristics, and other capacity adjustment information

used for calculating congested delays and speeds. The result of this process is an estimated average travel time for each hour of the day for each highway segment. The average time multiplied by the volume produces VHT.

Developing the MOVES Traffic Input Files:

The PPSUITE software is responsible for producing the following MOVES input files during any analysis run:

- VMT by HPMS vehicle class
- VHT by speed bin
- Road type distributions
- Ramp fractions

These files are text formatted files with a *.csv extension. The files are provided as inputs within the MOVES county data importer.

*VMT Input File:*VMT is the primary traffic input that affects emission results. The roadway segment distances and traffic volumes are used to prepare estimates of VMT. PPSUITE performs these calculations and outputs the MOVES annual VMT input file to the County Data Manager (CDM).

VHT by Speed Bin File: As described in the previous section, the PPSUITE software prepares the MOVES VHT by speed bin file which summarizes the distribution of speeds across all links into each of the 16 MOVES speed bins for each hour of the day by road type. This robust process ensures that MOVES emission rates are used to the fullest extent and is consistent with the methods and recommendations provided in EPA's Technical Guidance.

Road Type Distributions: In MOVES, typical drive cycles and associated operating conditions vary by the type of roadway. MOVES defines five different road types as follows:

1 Off-Network
2 Rural Restricted Access
3 Rural Unrestricted Access
4 Urban Restricted Access
5 Urban Unrestricted Access

For this inventory, the MOVES road type distribution file is automatically generated by PPSUITE using defined equivalencies. The off-network road type includes emissions from vehicle starts, extended idle activity, and evaporative emissions. Off-network activity in MOVES is primarily determined by the Source Type Population input. The remaining distribution among road types is determined by equating the functional class with each MOVES road type as follows:

- MOVES Road Type (2) = SHA Functional Class (1)
- MOVES Road Type (3) = SHA Functional Class (2,6,7,8,9)
- MOVES Road Type (4) = SHA Functional Class (11,12)
- MOVES Road Type (5) = SHA Functional Class (14,16,17,19)

Ramp Fractions: Since ramps are not directly represented within the SHA's database information, it is assumed that 8% of the Freeway VHT is ramp VHT. This is consistent with national default values within MOVES and recommendations provided in EPA's Technical Guidance.

MOVES Runs:

After computing speeds and aggregating VMT and VHT, PPSUITE prepares traffic-related inputs needed to run EPA's MOVES2010a software. Additional required MOVES inputs are prepared external to the processing software and include temperatures, I/M Program parameters, fuel characteristics, vehicle fleet age distributions and source type population.

The MOVES county importer is run in batch mode. This program converts all data files into the MYSQL formats used by the MOVES model. At that point a MOVES run specification file (*.mrs) is created which specifies options and key data locations for the run. MOVES is then executed in batch mode.

MOVES can be executed using either the *inventory* or *rate-based* approaches. For this highway emissions inventory, MOVES is applied using the *inventory-based* approach. Under this method, actual VMT and population are provided as inputs to the model; MOVES is responsible for producing the total emissions for the region. Under the rate-based approach, MOVES would produce emission factors, after which PPSUITE would apply the emission factors to the link data and calculate total regional emissions.

Appendices B and C provide a summary of the 13 MOVES CDM input files as well as the MOVES run specification file.

RESOURCES

MOVES Model

Modeling Page within EPA's Office of Mobile Sources Website (http://www.epa.gov/omswww/models.htm) contains a downloadable model, MOVES users guide and other information.

Policy Guidance on the Use of MOVES2010 and Subsequent Minor Revisions for SIP Development, Transportation Conformity, and Other Purposes, US EPA Office of Air and Radiation, EPA-420-B-12-010, April 2012.

Using MOVES to prepare Emission Inventories in State Implementation Plans and Transportation Conformity: Technical Guidance for MOVES2010, 2010a and 2010b. US EPA Office of Air and Radiation, and Office of Transportation and Air Quality, EPA-420-B-12-028, April 2012.

Motor Vehicle Emission Simulator, User Guide for MOVES2010a, EPA-420-B-10-036, August 2010.

Traffic Engineering

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

Traffic Trends System Report Module, 2011 Data, State Highway Administration

Highway Vehicle Inventory Glossary

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

County Data Manager (CDM): User interface developed to simplify importing specific local data for a single county or a user-defined custom domain without requiring direct interaction with the underlying MySQL database.

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

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

Growth factor: Factor used to convert volumes to future years.

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

I/M: Vehicle Emission Inspection/Maintenance Program ensures that vehicle emission controls are in good working order throughout the life of the vehicle. This Program requires vehicles to be tested for emissions. Most vehicles that do not pass must be repaired.

MOVES: The latest model EPA has developed with which MD 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.

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

Road Type: Functional code, applied in data management to road segments to identify their type (rural/urban highways, rural/urban arterials, etc.)

Source Type: One of thirteen vehicle types used in MOVES modeling.

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 multiply by link length.

APPENDIX A
Washington County, MD Area Emission Summary Tables

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2002 Annual Emissions

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Appendix A4
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Emission Summary by Process

Appendix A1

2002 Washington County Emission Summary

Annual (Tons/Year)

County	VMT	VOC	NOX	PM2.5	SO2	NH3
Washington	1,886,010,533	2,556.74	9,163.19	285.62	262.57	110.63

Appendix A1

2002 Washington County Emission Summary by Road Type

Annual (Tons/Year)

Area	Road Type	VMT	VOC	NOX	PM2.5	SO2	NH3
Washington	Off-Network	0	1,239.09	806.57	22.03	8.10	0.01
	Rural Restricted Access	688,603,444	386.48	3,849.25	120.17	109.53	41.62
	Rural Unrestricted Access	510,340,319	360.19	1,568.07	46.57	51.61	29.19
	Urban Restricted Access	249,760,757	142.03	1,525.80	48.76	43.09	14.78
	Urban Unrestricted Access	437,306,012	428.95	1,413.49	48.09	50.23	25.04
	Total	***1,886,010,533***	***2,556.74***	***9,163.19***	***285.62***	***262.57***	***110.63***

Appendix A1

2002 Washington County Emission Summary by Source Type

Annual (Tons/Year)

County	Sourcetype	VMT		VOC		NOX		PM2.5		SO2		NH3	
		Miles	Pct.	Emissions	Pct	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.
Washington	Motorcycle	9,034,893	0.5%	35.31	1.4%	18.14	0.2%	0.49	0.2%	0.59	0.2%	0.22	0.2%
	Passenger Car	814,506,065	43.2%	1,120.68	43.8%	1,559.51	17.0%	37.32	13.1%	52.55	20.0%	50.61	45.7%
	Passenger Truck	648,996,338	34.4%	872.68	34.1%	1,929.02	21.1%	34.72	12.2%	58.05	22.1%	41.49	37.5%
	Light Commercial Truck	215,293,372	11.4%	291.39	11.4%	712.83	7.8%	19.76	6.9%	21.92	8.3%	12.67	11.5%
	Intercity Bus	4,119,687	0.2%	3.02	0.1%	118.22	1.3%	5.62	2.0%	2.75	1.0%	0.10	0.1%
	Transit Bus	1,537,750	0.1%	1.09	0.0%	34.58	0.4%	1.42	0.5%	0.77	0.3%	0.03	0.0%
	School Bus	4,774,864	0.3%	8.76	0.3%	66.62	0.7%	3.16	1.1%	1.61	0.6%	0.11	0.1%
	Refuse Truck	1,541,541	0.1%	1.13	0.0%	36.71	0.4%	1.37	0.5%	0.98	0.4%	0.04	0.0%
	Single Unit Short-haul Truck	42,654,561	2.3%	63.93	2.5%	410.71	4.5%	16.77	5.9%	12.40	4.7%	1.26	1.1%
	Single Unit Long-haul Truck	3,161,421	0.2%	4.57	0.2%	28.55	0.3%	1.24	0.4%	0.86	0.3%	0.09	0.1%
	Motor Home	2,171,953	0.1%	6.28	0.2%	21.55	0.2%	0.66	0.2%	0.49	0.2%	0.08	0.1%
	Combination Short-haul Truck	73,636,735	3.9%	52.75	2.1%	2,077.25	22.7%	78.93	27.6%	55.85	21.3%	2.05	1.9%
	Combination Long-haul Truck	64,581,354	3.4%	95.15	3.7%	2,149.49	23.5%	84.18	29.5%	53.75	20.5%	1.85	1.7%
	Total	***1,886,010,533***	***100.0%***	***2,556.74***	***100.0%***	***9,163.19***	***100.0%***	***285.62***	***100.0%***	***262.57***	***100.0%***	***110.63***	***100.0%***

Appendix A1

2002 Washington County Emission Summary by Process

Annual (Tons/Year)

County	Process	VOC		NOX		PM2.5		SO2		NH3	
		Emissions	Pct	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.
Washington	Running Exhaust	1,037.89	40.6%	8,354.17	91.2%	219.97	77.0%	231.61	88.2%	110.62	100.0%
	Start Exhaust	955.81	37.4%	626.87	6.8%	17.81	6.2%	5.43	2.1%	0.00	0.0%
	Brakewear	0.00	0.0%	0.00	0.0%	6.90	2.4%	0.00	0.0%	0.00	0.0%
	Tirewear	0.00	0.0%	0.00	0.0%	3.10	1.1%	0.00	0.0%	0.00	0.0%
	Evap Permeation	53.07	2.1%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Evap Fuel Vapor Venting	380.54	14.9%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Evap Fuel Leaks	53.33	2.1%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Crankcase Running Exhaust	14.38	0.6%	2.45	0.0%	33.63	11.8%	22.85	8.7%	0.00	0.0%
	Crankcase Start Exhaust	12.66	0.5%	0.02	0.0%	0.33	0.1%	0.11	0.0%	0.00	0.0%
	Crankcase Extended Idle Exhaust	0.96	0.0%	0.09	0.0%	0.65	0.2%	0.43	0.2%	0.00	0.0%
	Refueling Displacement Vapor Loss	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Refueling Spillage Loss	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Extended Idle Exhaust	48.10	1.9%	179.59	2.0%	3.24	1.1%	2.13	0.8%	0.01	0.0%
	Total	***2,556.74***	***100.0%***	***9,163.19***	***100.0%***	***285.62***	***100.0%***	***262.57***	***100.0%***	***110.63***	***100.0%***

Appendix A2

2007 Washington County Emission Summary

Annual (Tons/Year)

County	VMT	VOC	NOX	PM2.5	SO2	NH3
Washington	2,090,061,547	1,656.90	6,021.95	217.77	45.33	91.77

Appendix A2

2007 Washington County Emission Summary by Road Type

Annual (Tons/Year)

Area	Road Type	VMT	VOC	NOX	PM2.5	SO2	NH3
Washington	Off-Network	0	1,019.54	754.33	18.02	1.92	0.00
	Rural Restricted Access	569,679,236	151.92	1,784.38	64.75	11.36	25.92
	Rural Unrestricted Access	520,393,980	150.15	865.95	32.27	10.49	22.09
	Urban Restricted Access	502,585,658	138.39	1,729.68	63.77	9.98	22.49
	Urban Unrestricted Access	497,402,672	196.91	887.61	38.96	11.58	21.28
	Total	***2,090,061,547***	***1,656.90***	***6,021.95***	***217.77***	***45.33***	***91.77***

Appendix A2

2007 Washington County Emission Summary by Source Type

Annual (Tons/Year)

County	Sourcetype	VMT		VOC		NOX		PM2.5		SO2		NH3	
		Miles	Pct.			Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.
Washington	Motorcycle	9,824,726	0.5%	35.94	2.2%	11.46	0.2%	0.53	0.2%	0.20	0.4%	0.41	0.4%
	Passenger Car	894,850,789	42.8%	723.66	43.7%	907.48	15.1%	31.45	14.4%	16.89	37.3%	41.63	45.4%
	Passenger Truck	717,909,013	34.3%	504.94	30.5%	1,143.38	19.0%	25.87	11.9%	18.42	40.6%	32.90	35.9%
	Light Commercial Truck	238,794,664	11.4%	179.67	10.8%	491.78	8.2%	15.19	7.0%	5.52	12.2%	10.40	11.3%
	Intercity Bus	1,474,394	0.1%	1.05	0.1%	30.81	0.5%	1.45	0.7%	0.02	0.0%	0.04	0.0%
	Transit Bus	498,097	0.0%	0.34	0.0%	8.01	0.1%	0.34	0.2%	0.01	0.0%	0.01	0.0%
	School Bus	10,104,644	0.5%	9.15	0.6%	103.24	1.7%	5.09	2.3%	0.13	0.3%	0.22	0.2%
	Refuse Truck	1,511,086	0.1%	0.86	0.1%	20.76	0.3%	0.90	0.4%	0.03	0.1%	0.04	0.0%
	Single Unit Short-haul Truck	48,230,863	2.3%	47.09	2.8%	316.09	5.2%	12.98	6.0%	1.02	2.3%	1.39	1.5%
	Single Unit Long-haul Truck	4,989,042	0.2%	4.75	0.3%	31.50	0.5%	1.36	0.6%	0.10	0.2%	0.14	0.2%
	Motor Home	2,411,407	0.1%	4.47	0.3%	17.62	0.3%	0.51	0.2%	0.09	0.2%	0.08	0.1%
	Combination Short-haul Truck	76,722,330	3.7%	43.59	2.6%	1,233.20	20.5%	52.37	24.1%	1.33	2.9%	2.14	2.3%
	Combination Long-haul Truck	82,740,491	4.0%	101.41	6.1%	1,706.64	28.3%	69.72	32.0%	1.57	3.5%	2.37	2.6%
	Total	***2,090,061,547***	***100.0%***	***1,656.90***	***100.0%***	***6,021.95***	***100.0%***	***217.77***	***100.0%***	***45.33***	***100.0%***	***91.77***	***100.0%***

Appendix A2
2007 Washington County Emission Summary by Process
Annual (Tons/Year)

County	Process	VOC		NOX		PM2.5		SO2		NH3	
		Emissions	Pct	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.
Washington	Running Exhaust	487.31	29.4%	5,265.93	87.4%	163.62	75.1%	42.51	93.8%	91.77	100.0%
	Start Exhaust	748.05	45.1%	516.38	8.6%	13.97	6.4%	1.83	4.0%	0.00	0.0%
	Brakewear	0.00	0.0%	0.00	0.0%	7.63	3.5%	0.00	0.0%	0.00	0.0%
	Tirewear	0.00	0.0%	0.00	0.0%	3.44	1.6%	0.00	0.0%	0.00	0.0%
	Evap Permeation	75.14	4.5%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Evap Fuel Vapor Venting	218.15	13.2%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Evap Fuel Leaks	58.13	3.5%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Crankcase Running Exhaust	7.20	0.4%	1.68	0.0%	25.06	11.5%	0.90	2.0%	0.00	0.0%
	Crankcase Start Exhaust	9.92	0.6%	0.02	0.0%	0.27	0.1%	0.02	0.0%	0.00	0.0%
	Crankcase Extended Idle Exhaust	1.04	0.1%	0.12	0.0%	0.63	0.3%	0.01	0.0%	0.00	0.0%
	Refueling Displacement Vapor Loss	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Refueling Spillage Loss	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Extended Idle Exhaust	51.96	3.1%	237.81	3.9%	3.15	1.4%	0.06	0.1%	0.00	0.0%
	Total	***1,656.90***	***100.0%***	***6,021.95***	***100.0%***	***217.77***	***100.0%***	***45.33***	***100.0%***	***91.77***	***100.0%***

Appendix A3

2017 Washington County Emission Summary

Annual (Tons/Year)

County	*VMT*	*VOC*	*NOX*	*PM2.5*	*SO2*	*NH3*
Washington	2,315,331,295	947.56	3,380.83	124.70	19.09	67.68

2017 Washington County Emission Summary by Road Type
Annual (Tons/Year)

County	Road Type	VMT	VOC	NOX	PM2.5	SO2	NH3
Washington	Off-Network	0	621.08	680.87	10.67	0.69	0.00
	Rural Restricted Access	604,230,975	74.48	903.21	33.49	4.73	18.54
	Rural Unrestricted Access	581,689,679	73.78	471.10	21.40	4.28	15.93
	Urban Restricted Access	539,324,619	67.25	805.12	30.38	4.17	16.32
	Urban Unrestricted Access	590,086,022	110.96	520.53	28.75	5.21	16.90
	Total	***2,315,331,295***	***947.56***	***3,380.83***	***124.70***	***19.09***	***67.68***

Appendix A3
2017 Washington County Emission Summary by Source Type
Annual (Tons/Year)

County	Sourcetype	VMT		VOC		NOX		PM2.5		SO2		NH3	
		Miles	Pct.	EM	Pct	EM	Pct.	EM	Pct.	EM	Pct.	EM	Pct.
Washington	Motorcycle	9,929,539	0.4%	40.41	4.3%	8.16	0.2%	0.51	0.4%	0.08	0.4%	0.56	0.8%
	Passenger Car	1,137,842,700	49.1%	415.46	43.8%	542.70	16.1%	24.20	19.4%	7.84	41.1%	33.35	49.3%
	Passenger Truck	591,735,180	25.6%	227.89	24.1%	427.88	12.7%	15.34	12.3%	5.46	28.6%	17.31	25.6%
	Light Commercial Truck	201,363,970	8.7%	82.80	8.7%	202.11	6.0%	6.57	5.3%	1.75	9.2%	5.95	8.8%
	Intercity Bus	1,513,152	0.1%	0.68	0.1%	18.02	0.5%	0.80	0.6%	0.02	0.1%	0.04	0.1%
	Transit Bus	3,438,794	0.1%	1.60	0.2%	28.35	0.8%	1.26	1.0%	0.03	0.1%	0.07	0.1%
	School Bus	8,468,466	0.4%	1.53	0.2%	23.68	0.7%	0.94	0.8%	0.05	0.3%	0.18	0.3%
	Refuse Truck	890,434	0.0%	0.20	0.0%	4.32	0.1%	0.18	0.1%	0.01	0.0%	0.02	0.0%
	Single Unit Short-haul Truck	124,392,330	5.4%	71.38	7.5%	428.59	12.7%	13.87	11.1%	1.18	6.2%	3.52	5.2%
	Single Unit Long-haul Truck	17,415,842	0.8%	10.20	1.1%	61.46	1.8%	2.18	1.7%	0.16	0.8%	0.50	0.7%
	Motor Home	1,018,773	0.0%	1.38	0.1%	5.31	0.2%	0.12	0.1%	0.02	0.1%	0.03	0.0%
	Combination Short-haul Truck	91,070,185	3.9%	18.31	1.9%	494.66	14.6%	20.71	16.6%	0.99	5.2%	2.54	3.8%
	Combination Long-haul Truck	126,251,930	5.5%	75.71	8.0%	1,135.58	33.6%	38.02	30.5%	1.51	7.9%	3.61	5.3%
	Total	***2,315,331,295***	***100.0%***	***947.56***	***100.0%***	***3,380.83***	***100.0%***	***124.70***	***100.0%***	***19.09***	***100.0%***	***67.68***	***100.0%***

Appendix A3
2017 Washington County Emission Summary by Process
Annual (Tons/Year)

County	Process	VOC		NOX		PM2.5		SO2		NH3	
		Emissions	Pct	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.
Washington	Running Exhaust	241.18	25.5%	2,699.30	79.8%	88.62	71.1%	18.09	94.7%	67.68	100.0%
	Start Exhaust	388.58	41.0%	326.73	9.7%	8.47	6.8%	0.62	3.2%	0.00	0.0%
	Brakewear	0.00	0.0%	0.00	0.0%	9.98	8.0%	0.00	0.0%	0.00	0.0%
	Tirewear	0.00	0.0%	0.00	0.0%	4.07	3.3%	0.00	0.0%	0.00	0.0%
	Evap Permeation	49.93	5.3%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Evap Fuel Vapor Venting	121.09	12.8%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Evap Fuel Leaks	89.76	9.5%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Crankcase Running Exhaust	3.45	0.4%	0.66	0.0%	11.35	9.1%	0.31	1.6%	0.00	0.0%
	Crankcase Start Exhaust	5.11	0.5%	0.01	0.0%	0.12	0.1%	0.01	0.0%	0.00	0.0%
	Crankcase Extended Idle Exhaust	0.49	0.1%	0.06	0.0%	0.29	0.2%	0.00	0.0%	0.00	0.0%
	Refueling Displacement Vapor Loss	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Refueling Spillage Loss	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Extended Idle Exhaust	47.94	5.1%	354.07	10.5%	1.80	1.4%	0.07	0.3%	0.00	0.0%
	Total	***947.56***	***100.0%***	***3,380.83***	***100.0%***	***124.70***	***100.0%***	***19.09***	***100.0%***	***67.68***	***100.0%***

Appendix A4

2025 Washington County Emission Summary

Annual (Tons/Year)

County	VMT	VOC	NOX	PM2.5	SO2	NH3
Washington	2,786,455,965	725	2,312.19	77.79	20.82	74.45

Appendix A4

2025 Washington County Emission Summary by Road Type

Annual (Tons/Year)

Area	Road Type	VMT	VOC	NOX	PM2.5	SO2	NH3
Washington	Off-Network	0	485.20	689.22	8.64	0.74	0.40
	Rural Restricted Access	727,192,808	50.02	531.69	16.77	5.11	20.14
	Rural Unrestricted Access	700,097,140	53.27	289.32	14.45	4.57	17.02
	Urban Restricted Access	649,040,157	45.17	470.89	15.44	4.49	17.64
	Urban Unrestricted Access	710,125,860	91.79	331.07	22.49	5.91	19.26
	Total	***2,786,455,965***	***725.46***	***2,312.19***	***77.79***	***20.82***	***74.45***

Appendix A4

2025 Washington County Emission Summary by Source Type

Annual (Tons/Year)

County	Sourcetype	VMT		VOC		NOX		PM2.5		SO2		NH3	
		Miles	Pct.	EM	Pct	EM	Pct.	EM	Pct.	EM	Pct.	EM	Pct.
Washington	Motorcycle	12,147,350	0.4%	48.64	6.7%	9.66	0.4%	0.64	0.8%	0.10	0.5%	0.72	1.0%
	Passenger Car	1,369,351,900	49.1%	334.96	46.2%	371.14	16.1%	23.40	30.1%	8.59	41.3%	35.67	47.9%
	Passenger Truck	712,136,400	25.6%	157.15	21.7%	291.33	12.6%	16.96	21.8%	5.66	27.2%	18.35	24.6%
	Light Commercial Truck	242,329,490	8.7%	57.98	8.0%	148.60	6.4%	5.82	7.5%	1.84	8.9%	6.49	8.7%
	Intercity Bus	1,858,886	0.1%	0.29	0.0%	7.97	0.3%	0.34	0.4%	0.02	0.1%	0.05	0.1%
	Transit Bus	3,942,878	0.1%	0.54	0.1%	12.48	0.5%	0.44	0.6%	0.03	0.1%	0.08	0.1%
	School Bus	9,737,258	0.3%	0.97	0.1%	14.41	0.6%	0.53	0.7%	0.06	0.3%	0.21	0.3%
	Refuse Truck	1,034,442	0.0%	0.10	0.0%	2.20	0.1%	0.07	0.1%	0.01	0.0%	0.03	0.0%
	Single Unit Short-haul Truck	149,173,600	5.4%	51.34	7.1%	325.60	14.1%	6.89	8.9%	1.40	6.7%	4.30	5.8%
	Single Unit Long-haul Truck	21,746,813	0.8%	7.40	1.0%	47.71	2.1%	1.13	1.5%	0.19	0.9%	0.63	0.8%
	Motor Home	1,184,480	0.0%	0.88	0.1%	4.21	0.2%	0.09	0.1%	0.02	0.1%	0.04	0.1%
	Combination Short-haul Truck	105,285,738	3.8%	6.60	0.9%	235.90	10.2%	7.31	9.4%	1.10	5.3%	2.96	4.0%
	Combination Long-haul Truck	156,526,730	5.6%	58.61	8.1%	840.98	36.4%	14.18	18.2%	1.80	8.6%	4.92	6.6%
	Total	***2,786,455,965***	***100.0%***	***725.46***	***100.0%***	***2,312.19***	***100.0%***	***77.79***	***100.0%***	***20.82***	***100.0%***	***74.45***	***100.0%***

Appendix A4
2025 Washington County Emission Summary by Process
Annual (Tons/Year)

County	Process	VOC		NOX		PM2.5		SO2		NH3	
		Emissions	Pct	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.	Emissions	Pct.
Washington	Running Exhaust	159.81	22.0%	1,622.81	70.2%	48.12	61.9%	19.88	95.5%	74.05	99.5%
	Start Exhaust	267.04	36.8%	235.95	10.2%	7.53	9.7%	0.65	3.1%	0.00	0.0%
	Brakewear	0.00	0.0%	0.00	0.0%	13.49	17.3%	0.00	0.0%	0.00	0.0%
	Tirewear	0.00	0.0%	0.00	0.0%	5.01	6.4%	0.00	0.0%	0.00	0.0%
	Evap Permeation	38.06	5.2%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Evap Fuel Vapor Venting	96.60	13.3%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Evap Fuel Leaks	110.36	15.2%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Crankcase Running Exhaust	1.93	0.3%	0.15	0.0%	2.54	3.3%	0.19	0.9%	0.00	0.0%
	Crankcase Start Exhaust	3.45	0.5%	0.01	0.0%	0.08	0.1%	0.01	0.0%	0.00	0.0%
	Crankcase Extended Idle Exhaust	0.13	0.0%	0.02	0.0%	0.06	0.1%	0.00	0.0%	0.00	0.0%
	Refueling Displacement Vapor Loss	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Refueling Spillage Loss	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%
	Extended Idle Exhaust	48.08	6.6%	453.25	19.6%	0.97	1.2%	0.09	0.4%	0.40	0.5%
	Total	***725.46***	***100.0%***	***2,312.19***	***100.0%***	***77.79***	***100.0%***	***20.82***	***100.0%***	***74.45***	***100.0%***