Appendix A

Methodology to Develop On-Road Mobile Emissions and Motor Vehicle Emissions Budgets

Development of $PM_{2.5}$ On-Road Mobile Emissions Inventories

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1.INTRODUCTION

This report documents the development of on-road emissions inventories used to revise Motor Vehicle Emissions Budgets (MVEBs or mobile budgets) for the Washington, D.C. region. The revised MVEBs will update the Fine Particles ($PM_{2.5}$) Maintenance Plan. The inventories were developed by Transportation Planning Board (TPB) staff, at the request of the Metropolitan Washington Air Quality Committee (MWAQC). This report summarizes the planning assumptions and technical methods supporting the inventory development and presents results at the jurisdiction level. The inventory addresses five pollutants: Fine Particles (direct $PM_{2.5}$), precursor NOx, Sulfur Dioxide (SO_2), Volatile Organic Compounds (VOC), and Ammonia (NH_3). Pollutant estimates were prepared for three analysis years: 2007, 2017, and 2025.

2.BACKGROUND

In December 2004, EPA designated the Metropolitan Washington, DC-MD-VA region as a nonattainment area for the 1997 Fine Particles ($PM_{2.5}$) National Ambient Air Quality Standards (NAAQS). In 2009, the EPA announced that the region had attained the 1997 $PM_{2.5}$ standard, based on the readings from ambient air quality monitors. In 2013, MWAQC approved a $PM_{2.5}$ redesignation request and Maintenance Plan[1], which the state air agencies submitted to EPA. In 2014, EPA approved the redesignation request and Maintenance Plan, which included MVEBs for 2017 and 2025 for precursor Nitrogen Oxides (NOx) and direct $PM_{2.5}$.

At the time that the 2013 $PM_{2.5}$ Maintenance Plan was being developed, EPA was working on an updated version of their mobile emissions estimation tool, MOtor Vehicle Emissions Simulator (MOVES). The updated MOVES version would account for new programs, such as Tier 3 vehicle and fuel standards, which would significantly lower the mobile on-road emissions inventories relative to the 2013 analysis. Consequently, the state air agencies agreed (as per Appendix D of the 2013 Plan) to revisit and update the mobile on-road inventories and budgets using the updated MOVES version along with the most currently adopted planning assumptions. EPA released MOVES2014 in the fall of 2014, and TPB staff used the new version of the mobile model to develop inventories for the updated $PM_{2.5}$ Maintenance Plan.

3. OVERVIEW OF METHODS AND PLANNING ASSUMPTIONS

Mobile emission inventories are developed on a year-by–year basis using the regional travel demand model and the EPA MOVES model. Several sequential steps are undertaken for each year that is analyzed. First, the TPB's adopted travel demand model is used to formulate vehicle-miles-of-travel (VMT) at the network link level of analysis. The modeled VMT outputs are developed by vehicle type and by four time periods. Next, a post processor is used to disaggregate the link-level VMT and to develop Vehicle-Hours-of-Travel (VHT) among several detailed dimensions. Finally, several data preparation steps are undertaken before MOVES model is executed in order to compute mobile emissions. An overview of the travel model, post processor and MOVES data preparation steps is presented below.

[1] Washington DC-MD-VA 1997 $PM_{2.5}$ Maintenance Plan with Appendix D, Metropolitan Washington Council of Governments. May 22, 2013.
Maintenance Plan:
http://www.mwcog.org/environment/air/downloads/PM/PM2.5%20MP_Final%20Version.pdf
Appendix D:
http://www.mwcog.org/environment/air/downloads/PM/Appendix%20D_State%20Compromise_Overview%20Sept%202012.pdf

The overall planning assumptions and methods used to produce the $PM_{2.5}$ emission inventory were essentially identical to that used in the recent air quality conformity analysis of the 2015 CLRP,[2] which was approved by the Transportation Planning Board on October 21, 2015. The key planning assumptions and methods are listed in Table 1. The modeling methods include the TPB's currently adopted travel demand model, Version 2.3.57a[3][4][5], and the EPA MOVES2014 emissions model. The land activity projections used in the travel demand modeling were taken from the Round 8.4 Cooperative Forecasts.

Table 1 Travel-Related Assumptions/Methods Used in the Updated Inventories

Land Activity:	COG Round 8.4 Coop. Forecasts
Travel Demand Model:	Version 2.3.57a
Mobile Emissions Model:	MOVES2014
Vehicle Registration Data:	2008 & 2014 Vehicle Registration Inventories

The non-travel related inputs to the MOVES2014 model, relating to meteorology, inspection and maintenance programs, and fuel formulation and supply, were provided by state air agencies in coordination with COG's Department of Environmental Programs. For the year 2007, the non-travel inputs used in the original 2013 SIP analysis were used as is; however, some reformatting of the data was necessary when moving from MOVES2010a to MOVES2014. The 2017 and 2025 inputs were already compiled as part of the recent conformity analysis of the 2015 CLRP Amendments. The non-travel related assumptions and methods underlying the $PM_{2.5}$ emissions inventories are listed in Table 2.

Table 2 Non-Travel Related Assumptions and Methods Used in the Updated Inventories

Inspection& Maintenance Programs:	Year-specific programs/MOVES2014 format
Fuel Programs:	Year-specific programs/MOVES2014 format
Meteorology:	Historical 2007 meteorological data

[2] Air Quality Conformity Analysis of the 2015 Constrained Long Range Plan Amendment and the FY2015-2020 Transportation Improvement Program for the Washington Metropolitan Region, MWCOG/TPB, October 25, 2015

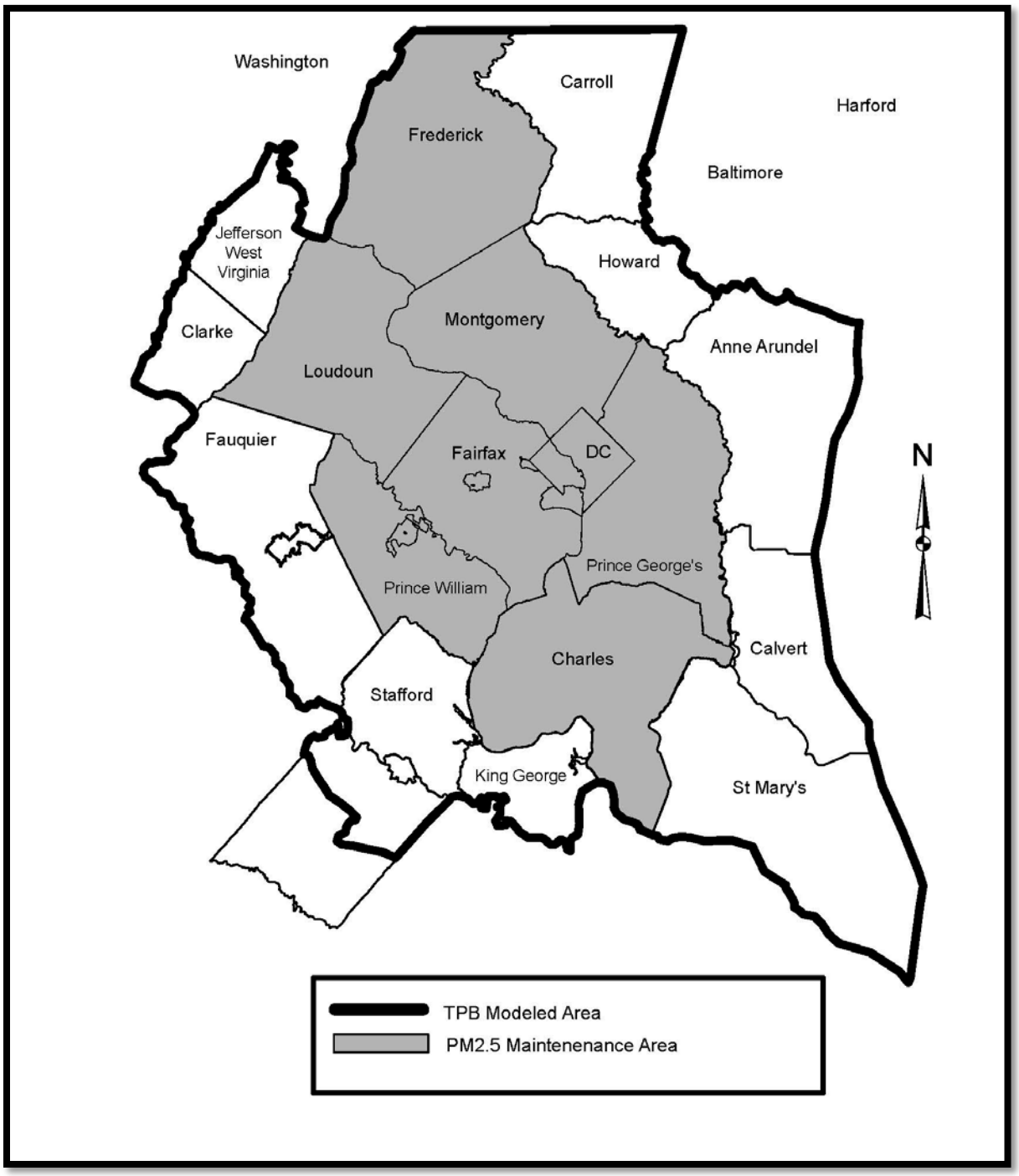
[3] Calibration Report for the TPB Travel Forecasting Model, Version 2.3, on the 3722-Zone Area System. Final Report. Washington DC: National Capital Region Transportation Planning Board, January 20, 2012.
http://www.mwcog.org/transportation/activities/models/files/FY2012/V2.3_Calibration_Report_v14.pdf

[4] "2010 Validation of the Version 2.3 Travel Demand Model", Technical Memorandum from Ronald Milone - June 30, 2013.
http://www.mwcog.org/transportation/activities/models/files/2010_Validation_Memo_v3.pdf

[5] User's Guide for the COG/TPB Travel Demand Forecasting Model, Version 2.3.57a, Volume 1 of 2: Main Report and Appendix A (Flowcharts). Washington, D.C.: Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board, October 29, 2015.
http://www.mwcog.org/transportation/activities/models/files/V2357a/mwcog_travel_model_v2.3.57a_user_guide_v2_with_app_A.pdf

The Washington, D.C region $PM_{2.5}$ Maintenance Area includes the following jurisdictions: Washington, D.C., Montgomery County, Prince George's County, Frederick County, Charles County, the City of Alexandria, Arlington County, Fairfax County, Loudoun County, and Prince William County. The cities and towns within each jurisdiction are also included. The $PM_{2.5}$ Maintenance Area and the area associated with travel modeling is shown in Figure 1.

Figure 1 Washington DC-MD-VA $PM_{2.5}$ Maintenance Area Map



4 TRAVEL DEMAND MODEL AND INPUTS

The Version 2.3.57a travel model is a trip-based (or four-step) forecasting process that operates on a 3722 Transportation Analysis Zone (TAZ) system. The model was initially calibrated using the 2007/08 Household Travel Survey and several on-board transit surveys.[6] The model was subsequently revised and re-validated using 2010 data, including traffic counts, Metrorail electronic counts, the American Community Survey, and the Geographically Focused Household Travel Survey[7]. The model also includes a long-standing policy feature that constrains peak period Metrorail trips to and through the regional "core." This feature ensures that forecasted ridership is reasonably consistent with expected capacity of the Metrorail system. The Version 2.3.57a model is documented in the most recent User's Guide[8].

The COG Round 8.4 Cooperative Forecasts are documented in a March 19, 2015 memorandum which is included as Attachment A. The Cooperative forecasts are projections of households, population, and employment (by type), prepared at the TAZ level. Household and employment summaries by jurisdiction for the specific $PM_{2.5}$ Maintenance Plan analysis years are provided in Tables 3 and 4, respectively.

Table 3 Household Data by Jurisdiction

Jurisdiction	2007	2017	2025
District of Columbia	258,728	294,489	323,191
Montgomery Co., MD	352,913	385,296	414,873
Prince George's Co., MD	301,540	328,465	348,307
Arlington Co., VA	94,543	106,349	116,624
City of Alexandria, VA	67,029	73,658	82,624
Fairfax Co., VA	394,423	425,070	461,808
Loudoun Co., VA	94,321	129,391	151,558
Prince William Co., VA	140,727	164,681	186,253
Frederick Co., MD	81,615	92,546	103,944
Charles Co., MD	48,845	60,235	70,833
Total	1,834,684	2,060,180	2,260,015

Source: Round 8.4 Cooperative Forecasts

[6] TPB, Calibration Report for the TPB Travel Forecasting Model, Version 2.3, on the 3722-Zone Area System.
[7] Milone, "2010 Validation of the Version 2.3 Travel Demand Model"
[8] TPB, User's Guide for the COG/TPB Travel Demand Forecasting Model, Version 2.3.57a, Volume 1 of 2: Main Report and Appendix A (Flowcharts).

Table 4 Employment Data by Jurisdiction

Jurisdiction	2007	2017	2025
District of Columbia	763,523	833,701	905,846
Montgomery Co., MD	504,109	544,949	598,824
Prince George's Co., MD	345,777	365,324	403,134
Arlington Co., VA	206,021	223,039	243,562
City of Alexandria, VA	104,610	111,250	130,585
Fairfax Co., VA	646,616	719,557	814,740
Loudoun Co., VA	133,395	177,217	224,249
Prince William Co., VA	144,355	170,594	205,101
Frederick Co., MD	73,789	103,707	109,802
Charles Co., MD	60,039	69,758	74,731
Total	2,982,234	3,319,096	3,710,574

Source: Round 8.4 Cooperative Forecasts; Includes Census Adjustment

The travel demand model produces a wide array of outputs including zonal origins and destinations by travel volumes and by travel network segments. Modeled VMT is the most critical output of the travel model for the purpose of estimating on-road emissions. The jurisdiction level VMT results estimated by the Version 2.3.57a travel demand model, the 2015 CLRP network and the Round 8.4 Cooperative Forecasts are shown in Table 5. The VMT estimates shown reflect on-network travel only and do not include local road VMT.

Table 5 Average Weekday Vehicle Miles Traveled by Jurisdiction

Jurisdiction	2007	2017	2025
District of Columbia	7,948,582	8,257,632	8,569,343
Montgomery Co., MD	20,873,667	22,212,188	23,744,399
Prince George's Co., MD	22,293,037	24,049,432	25,624,278
Arlington Co., VA	3,865,388	3,907,611	4,061,651
City of Alexandria, VA	2,300,400	2,543,659	2,683,157
Fairfax Co., VA	24,920,520	27,107,396	29,238,868
Loudoun Co., VA	6,732,500	8,105,776	9,413,162
Prince William Co., VA	8,627,627	9,918,695	11,131,103
Frederick Co., MD	8,369,502	9,114,122	9,850,907
Charles Co., MD	3,024,713	3,419,879	3,767,516
Total	108,955,936	118,636,390	128,084,384

Source: Version 2.3.57a Travel Demand Model Output;

5 MOVES MODEL INPUTS

This section reviews the data inputs that were prepared for the MOVES model. The MOVES model is currently executed on a year-by-year basis, for each jurisdiction in the Maintenance area. As such, jurisdiction-level databases (or Excel files) are prepared in a format that is consistent with prescribed specifications in the software documentation. Some inputs are prepared as parameters that are indicated in MOVES-related scripting. TPB currently executes the MOVES2014 model in the "inventory" mode.

When EPA released initial versions of the MOVES emissions model, a regional task force was formed to provide guidance on MOVES-related inputs that would be acceptable to regional stakeholders. Staff from both transportation and environmental agencies served on the task force. During 18 monthly meetings, between August 2009 and January 2010, the task force agreed to an approach for developing emissions inventories using MOVES. A summary table of the approach is included as Attachment B.

5.1 Post Processor

A post processor is used to reformat network link-level outputs from the travel model into MOVES compatible format. The post processor is used to create vehicle hours of travel (VHT) and vehicle miles traveled (VMT) distributions by jurisdiction. The jurisdictional distributions are further distinguished by three vehicle types (passenger vehicles, commercial vehicles, and trucks), two facility types (freeways and arterials) and 14 speed groups or "bins."

The post processor aggregates six travel markets from the travel demand model outputs into three vehicle types as follows:

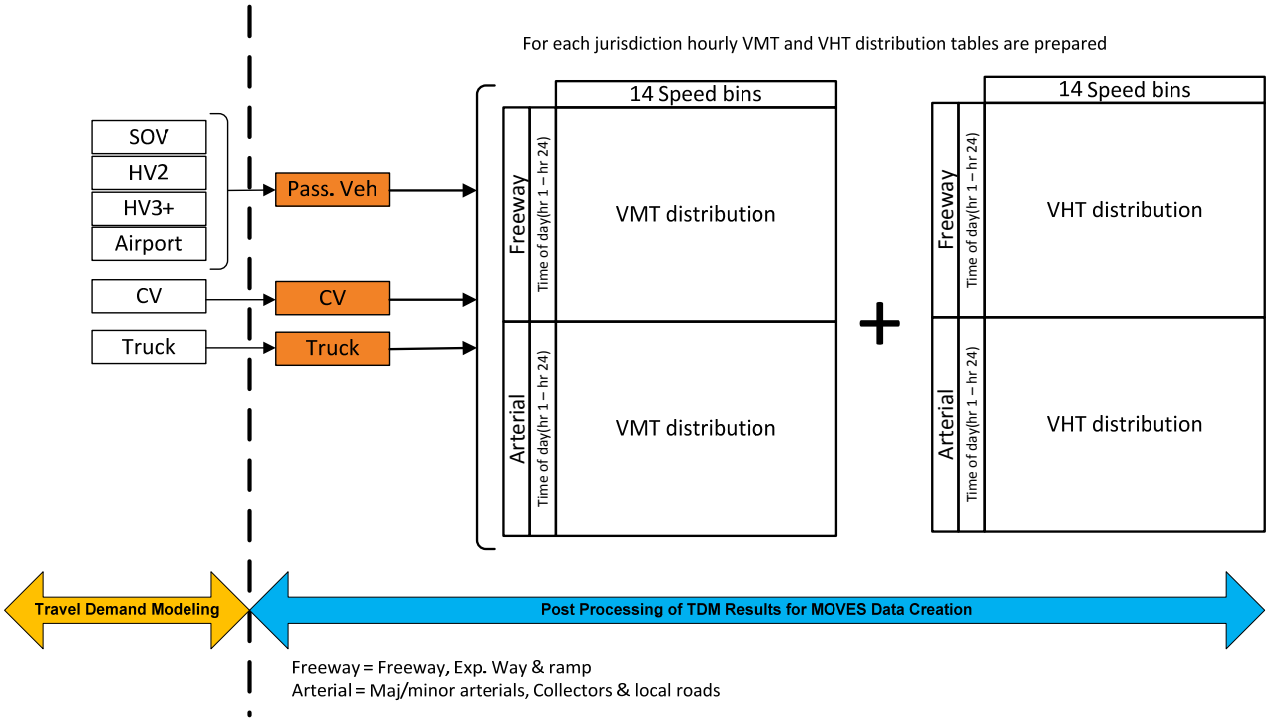
- Passenger Vehicles = SOV + HOV2 + HOV3 (or more) + Airport Passenger Trips;
- Commercial Vehicles = Commercial Vehicles;
- Heavy Duty Vehicles = Trucks;

Six facility types are grouped into two as follows:

- Freeway = freeway + expressway + freeway ramp; and
- Arterials = major arterial + minor arterial + collector.

The post processor is executed four times for each analysis year: one for each of the three vehicle types and another for all vehicle types combined. The post processor yields hourly jurisdictional VMT and VHT distributions by Mobile's 14 speed bins and two facility types. Figure 2 illustrates the post-processing of travel demand outputs. The post processor also includes provisions to add local VMT to the on-network VMT developed by the travel model, so that the full universe of travel is accounted for.

Figure 2 Post-Processing of Travel Demand Results



5.2 VMT/VHT Fractions

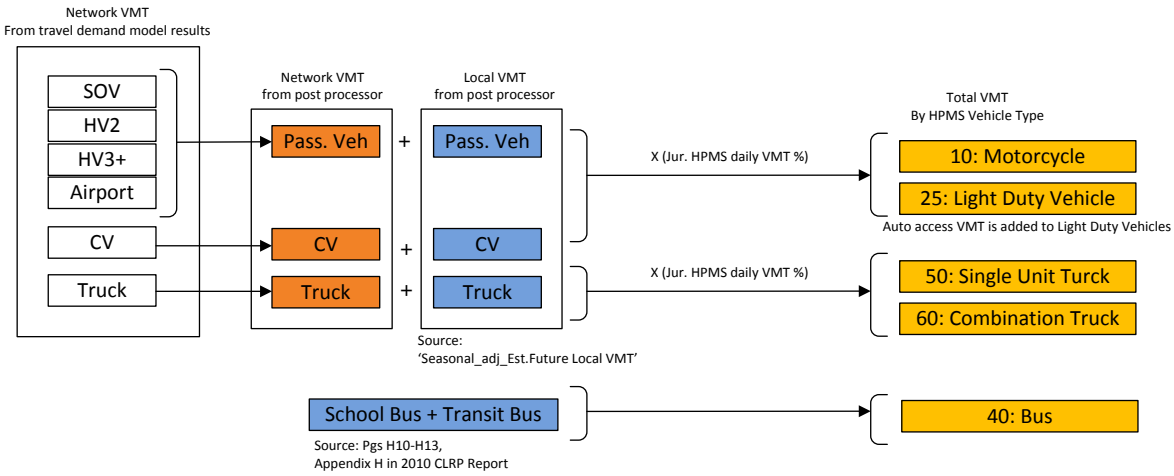
The MOVES2014 model requires annual VMT by five Highway Performance Monitoring System (HPMS) vehicle types:

- Motorcycle (sourceTypeID = 10);
- Light duty vehicle (sourceTypeID = 25);
- Buses (sourceTypeID = 40);
- Single unit trucks (sourceTypeID = 50); and
- Combination trucks (sourceTypeID =60).

Average annual weekday VMT estimates include on-network data from the travel demand model outputs as well as local road VMT estimates, which is added in exogenously. Auto access VMT for transit riders, acquired from a Metrorail Survey, is added to the VMT of Light Duty Vehicles (sourceTypeID = 25). Modeled VMT is divided into three vehicle types: passenger vehicles, commercial vehicles, and heavy duty vehicles. Local road VMT is developed by using a combination of observed and simulated data in the post-processing shown in Figure 4.

The local road VMT shares are added to VMT from the travel model to produce total VMT. The resulting total VMT of the three vehicle types is then classified by five MOVES vehicle types using observed jurisdictional Highway Performance Monitoring System (HPMS) VMT percentages. Figure 4 illustrates the process of developing annual VMT for five HPMS vehicle types.

Figure 3 Annual VMT Calculation Process



The average annual weekday VMT total by five HPMS vehicle types is entered into an EPA converter, AAD VMT Calculator HPMS.XLS, to convert average weekday VMT into average annual weekday travel. The converter includes local monthly adjustment factors and weekend-day adjustment factors. The converter generates three VMT fractions, 'monthVMTfraction,' 'dayVMTfraction' and 'hourlyVMTfraction' as outputs.

5.3 Average Speed

MOVES requires speed distributions by vehicle type and time period. Vehicle Hours of Travel (VHT) distributions are selected as a suitable proxy for average speed distribution. MWCOG/TPB's regional travel demand model outputs are first processed to derive VHT distributions for six vehicle categories:

- Single Occupancy Vehicles (SOV);
- High Occupancy Vehicles 2 (HOV2);
- High Occupancy Vehicles 3+ (HOV3 or more);
- Commercial Vehicles;
- Trucks; and
- Airport Passenger Trips.

Through post-processing, six VHT distributions are developed for three vehicle types, Mobile's 14 speed bins, hour of the day, and two facility types (i.e., freeways and arterials); and later reclassified into MOVES's 16 speed bins, hour of the day, day of the week (i.e., weekdays and weekend days), and

four facility types for non-attainment jurisdictions. Six vehicle types from the travel demand model are reclassified into three vehicle types as follows:

- Passenger Vehicles = SOV + HOV2 + HOV3 (or more) + Airport Passenger Trips;
- Commercial Vehicles = Commercial Vehicles; and
- Heavy Duty Vehicles = Trucks.

MOVES requires: (1) 16 speed bins from 2.5 mph to 75 mph in increments of 5 mph; and (2) four road types, which are a combination of two facility types (i.e., restricted and unrestricted) and two environmental settings (i.e., urban and rural settings). The restricted facilities include freeways, expressways and freeway ramps, while the unrestricted facilities include major/minor arterials, collectors, and local roads. The following assumptions are used to develop average speed distributions fulfilling the MOVES requirements stated above:

1. VHT Distribution to Restricted Facilities:

    a. All vehicle types:
        - Weekday VHT Distribution:
            - All Day: Hourly distribution for all vehicles
        - Weekend VHT Distribution:
            - 11:00 am – 7:00 pm: Distribution across the 13 MOVES vehicle type categories reflecting the 3:00 pm hour on a weekday
            - 7:01 pm – 10:59 am: Distribution across the 13 MOVES vehicle type categories reflecting the 12:00 am hour on a weekday

2. VHT Distribution to Unrestricted Facilities:

    a. All vehicle types exclusive of refuse trucks, school buses and transit buses:
        - Weekday VHT Distribution:
            - All Day: Hourly distribution for all vehicles
        - Weekend VHT Distribution:
            - 11:00 am – 7:00 pm: Distribution reflecting the 3:00 pm hour on a weekday
            - 7:01 pm – 10:59 am: Distribution reflecting the 12:00 am hour on a weekday

    b. Refuse trucks: Refuse trucks operate on a 3-phase cycle: Phase 1 is the period of driving from the dispatch garage to trash collection sites; Phase 2 is the period of the actual trash/recycle collection; Phase 3 is the period of driving back to transfer stations. Using local data from Fairfax County, VA, the average speed of Phases 1 and 3 is assumed to be in the range of 22.5-27.5 miles per hour (i.e., MOVES Speed Bin 6), and the average speed of Phase 2 is assumed to be in the range of 2.5-7.5 miles per hour (i.e., MOVES Speed Bin 2). Based on the above assumptions the refuse truck vehicle type VHT distributions are as follows:

        - Weekday VHT Distribution (see Table 6):

- 5:00 am–5:00 pm (Trash Collection): VHT hourly distributions according to Phases 1, 2 and 3.
- 5:01 pm–5:00 am (On Road Phase): VHT hourly distribution consists of Phase 2.

- Weekend VHT Distribution:
  - All Day: VHT distribution made up of Phase 1 and Phase 3 (on road phases)

c. School buses:
   - Weekday VHT Distribution:
     - 6:00 am – 6:00 pm: VHT distribution (see Table 7)
     - 6:00 pm – 6:00 am: VHT distribution of heavy duty vehicles

   - Weekend VHT Distribution:
     - 11:00 am–7:00 pm: VHT Distribution of heavy duty vehicles at 3:00 pm on a weekday
     - 7:00 pm – 11:00 am: VHT Distribution of heavy duty vehicles at 12:00 am on a weekday

d. Transit buses:
   - Weekday VHT Distributions (see Table 8):
     - 6:00 – 9:00 am: Per WMATA's bus speed distribution of the AM peak period
     - 9:00 am–3:00 pm: Per WMATA's bus speed distribution of the off-peak period
     - 3:00 - 6:00 pm: Per WMATA's bus speed distribution of the PM peak period
     - 6:00pm-6:00 am: Per WMATA's bus speed distribution of the off-peak period

   - Weekend VHT Distribution (see Table 8):
     - All Day: Per WMATA's bus speed distribution of the off-peak period.

Table 6 Average Weekday VHT Distribution for Refuse Trucks

Source: Fairfax County, VA

Speed Bins	Speed Range	5:00 AM - 5:00 PM	5:01 PM - 4:59 AM
1	speed < 2.5mph	0.00%	0.00%
2	2.5mph <= speed < 7.5mph	62.65%	0.00%
3	7.5mph <= speed < 12.5mph	0.00%	0.00%
4	12.5mph <= speed < 17.5mph	0.00%	0.00%
5	17.5mph <= speed <22.5mph	0.00%	0.00%
6	22.5mph <= speed < 27.5mph	37.35%	100.00%
7	27.5mph <= speed < 32.5mph	0.00%	0.00%
8	32.5mph <= speed < 37.5mph	0.00%	0.00%
9	37.5mph <= speed < 42.5mph	0.00%	0.00%
10	42.5mph <= speed < 47.5mph	0.00%	0.00%
11	47.5mph <= speed < 52.5mph	0.00%	0.00%
12	52.5mph <= speed < 57.5mph	0.00%	0.00%
13	57.5mph <= speed < 62.5mph	0.00%	0.00%
14	62.5mph <= speed < 67.5mph	0.00%	0.00%
15	67.5mph <= speed < 72.5mph	0.00%	0.00%
16	72.5mph <= speed	0.00%	0.00%

Table 7 VHT Distribution of School Buses (6:00 am – 6:00 pm)

Source: Fairfax County, VA

Speed Bins	Speed Range	Bus Trip 1	Bus Trip 2	Bus Trip 3	Bus Trip 4	Bus Trip 5	Bus Trip 6	Bus Trip 7	Bus Trip 8	Bus Trip 9	Bus Trip 10	Bus Trip 11	Weighted Average
1	speed < 2.5mph	35.20%	24.30%	17.58%	14.65%	7.90%	16.11%	6.65%	18.30%	25.76%	16.18%	17.67%	**19.21%**
2	2.5mph <= speed < 7.5mph	10.87%	11.57%	6.45%	11.04%	29.89%	20.20%	44.83%	11.01%	9.68%	6.49%	9.12%	**14.39%**
3	7.5mph <= speed < 12.5mph	10.90%	9.35%	12.89%	6.50%	26.31%	17.69%	3.34%	9.12%	9.52%	6.69%	8.69%	**10.92%**
4	12.5mph <= speed < 17.5mph	8.81%	9.18%	8.59%	9.45%	6.00%	11.13%	23.76%	10.12%	9.98%	8.46%	10.32%	**10.37%**
5	17.5mph <= speed <22.5mph	5.01%	10.15%	5.18%	14.04%	3.04%	5.94%	4.09%	10.36%	7.57%	9.74%	12.02%	**8.30%**
6	22.5mph <= speed < 27.5mph	8.91%	8.55%	11.62%	12.59%	6.18%	5.30%	3.54%	7.29%	7.11%	8.87%	11.73%	**8.13%**
7	27.5mph <= speed < 32.5mph	8.79%	7.97%	14.36%	11.28%	5.86%	13.33%	6.35%	9.43%	5.37%	10.06%	10.20%	**9.41%**
8	32.5mph <= speed < 37.5mph	5.33%	9.10%	5.86%	13.43%	7.62%	3.32%	6.36%	13.79%	8.68%	12.04%	6.81%	**7.81%**
9	37.5mph <= speed < 42.5mph	3.43%	6.89%	8.69%	7.02%	4.80%	3.76%	1.07%	7.94%	9.79%	13.81%	8.16%	**7.22%**
10	42.5mph <= speed < 47.5mph	1.72%	2.44%	8.79%	0.00%	2.40%	2.87%	0.00%	1.31%	5.83%	5.15%	4.75%	**3.42%**
11	47.5mph <= speed < 52.5mph	0.68%	0.00%	0.00%	0.00%	0.00%	0.36%	0.00%	0.67%	0.31%	2.27%	0.36%	**0.59%**
12	52.5mph <= speed < 57.5mph	0.34%	0.50%	0.00%	0.00%	0.00%	0.00%	0.00%	0.67%	0.41%	0.24%	0.18%	**0.23%**
13	57.5mph <= speed < 62.5mph	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
14	62.5mph <= speed < 67.5mph	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
15	67.5mph <= speed < 72.5mph	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
16	72.5mph <= speed	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**

Table 8 VHT Distribution of Transit Buses

Source: Washington Metropolitan Area Transit Authority (WMATA)

avgSpeedBinID	avgBinSpeed	avgSpeedBinDesc	6:00AM-9:00AM	3:00PM-6:00PM	9:01AM-2:59PM/6:01PM-5:59AM
1	2.5	speed < 2.5mph	**9.94%**	**9.10%**	**7.92%**
2	5	2.5mph <= speed < 7.5mph	**13.79%**	**18.95%**	**14.49%**
3	10	7.5mph <= speed < 12.5mph	**34.07%**	**37.86%**	**31.36%**
4	15	12.5mph <= speed < 17.5mph	**28.52%**	**23.97%**	**29.17%**
5	20	17.5mph <= speed <22.5mph	**10.02%**	**5.92%**	**10.77%**
6	25	22.5mph <= speed < 27.5mph	**1.88%**	**1.84%**	**3.91%**
7	30	27.5mph <= speed < 32.5mph	**0.92%**	**0.85%**	**1.04%**
8	35	32.5mph <= speed < 37.5mph	**0.34%**	**0.60%**	**0.72%**
9	40	37.5mph <= speed < 42.5mph	**0.14%**	**0.50%**	**0.35%**
10	45	42.5mph <= speed < 47.5mph	**0.05%**	**0.15%**	**0.15%**
11	50	47.5mph <= speed < 52.5mph	**0.31%**	**0.28%**	**0.06%**
12	55	52.5mph <= speed < 57.5mph	**0.00%**	**0.00%**	**0.06%**
13	60	57.5mph <= speed < 62.5mph	**0.00%**	**0.00%**	**0.00%**
14	65	62.5mph <= speed < 67.5mph	**0.00%**	**0.00%**	**0.00%**
15	70	67.5mph <= speed < 72.5mph	**0.00%**	**0.00%**	**0.00%**
16	75	72.5mph <= speed	**0.00%**	**0.00%**	**0.00%**

5.4 Road Type

MWCOG/TPB travel demand model has six facility types; and these facilities are grouped into two as follows for MOVES:

- Restricted facility = freeway + expressway + freeway ramp; and
- Unrestricted facility = major arterial + minor arterial + collector.

Restricted and Unrestricted facilities are further divided into urban or rural facilities. Thus five facility types were created as urban restricted, urban unrestricted, rural restricted, rural unrestricted, and off network.

5.5 Age Distribution

Every three years since 2005, the Departments of Motor Vehicles of the District of Columbia, Maryland, and Virginia have been supplying MWCOG/TPB with vehicle registration data for use in Air Quality Conformity (AQC) Determinations and State Implementation Plan (SIP) updates. The most recent 2014 Vehicle Identification Number (VIN) data are a snapshot of vehicle registrations by year, collected by Departments of Motor Vehicles in the three states. The VIN data contain a broad range of attributes of the vehicles registered in the jurisdictions of the Metropolitan Washington DC non-attainment area. The latest data are used in the development of future year vehicle population profiles (i.e., vehicle age and vehicle type distribution) for all the analysis years in the $PM_{2.5}$ Maintenance Plan Update.

Prior to using the VIN data as input to MOVES, the 'raw' vehicle registration data were decoded using a commercial decoding software program[9]. Following EPA's guidelines, the data were decoded in two steps: (1) the 'raw' data were decoded to a Mobile 6.2 format; and (2) the Mobile 6.2 format vehicle population distributions were converted to a MOVES format using an EPA converter[10]. Thus, 16 Mobile vehicle types and 25 vehicle age categories were mapped into MOVES' 13 vehicle and 31 vehicle age categories. The vehicle population of the 2014 VIN data was reviewed by the MWCOG/TPB technical oversight committees prior to becoming approved for transportation planning applications.

5.6 Fuel Formulation

The state air agencies of the District of Columbia, the state of Maryland, and the Commonwealth of Virginia provided fuel characteristics data for the analysis years in a MOVES2014 ready format. For year 2015, the gasoline sulfur content was 30 ppm or lower. For analysis year 2017 and beyond, the gasoline sulfur content used was 10 ppm, which is an assumption that is consistent with the 2014 Tier 3 rule of EPA.

5.7 Meteorology Data

The meteorology data used for the 2015 $PM_{2.5}$ Maintenance Plan Update are the same as were used in the 2013 $PM_{2.5}$ Maintenance Plan submitted to EPA in May 2013. Since the original data was already in MOVES2010a ready format, which is the same as MOVES2014's format, no further data conversion was necessary.

5.8 Ramp Fraction

Local data were used to estimate the local ramp fraction using a method approved by the MOVES Task Force. The locally-derived percentage is equal to 8 percent of VHT, which, coincidentally, is the same as the MOVES default value.

5.9 Road Type Distribution

Vehicle Miles Traveled (VMT) was distributed into MOVES 13 vehicle types and four road (facility) types. The method of developing VMT distribution was as follows:

1. Through post-processing of travel demand results, jurisdictional VMT distributions of six vehicle types were reclassified to VMT distributions by three vehicle types as follows:

    - Passenger Vehicles = SOV + HOV2 + HOV3 (or more) + Airport Passenger Trips;

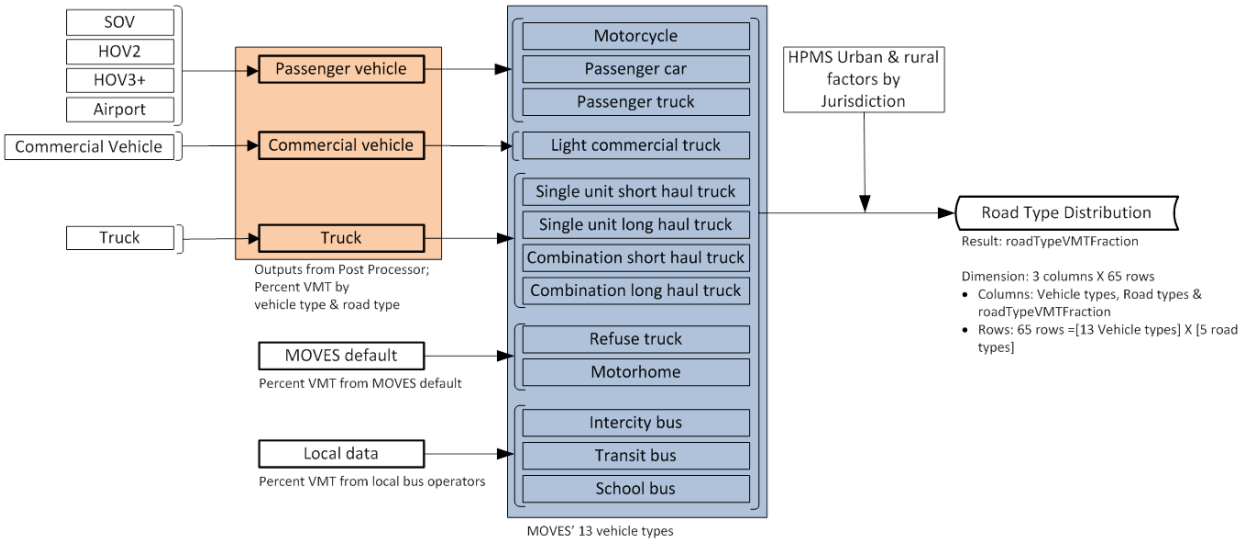
[9] VinPower, Copyright; ESP Data Solutions Inc., Product version 4.0.0.16
[10] RegistrationDistributionConverter_Veh16

- Commercial Vehicles = Commercial Vehicles; and
- Heavy Duty Vehicles = Trucks.

2. VMT percentages by three vehicle types were allocated to MOVES vehicle types as follows:

   - Passenger Vehicles: VMT percentages by facility type were applied to motorcycles, passenger cars and passenger trucks;
   - Commercial Vehicles: VMT percentages by facility type were applied to commercial trucks;
   - Heavy Duty Vehicles: VMT percentages by facility type were applied to single unit short and long haul trucks, and combination short and long haul trucks;
   - Refuse Trucks and Motor Homes: MOVES default percentage values;
   - School, Transit and Intercity Buses (Tables 7 and 8): Local network percentages from local data sources (i.e., local bus operators); and
   - Urban and rural percentage split factors were used to further allocate facility type VMT between urban and rural facilities. These factors vary by jurisdiction, and were based on the latest HPMS VMT data provided by the three state transportation agencies. Figure 5 illustrates the process of allocating VMT by vehicle type, facility type, and urban/rural split.

Figure 4 Road Type Distribution Development Process



5.10 Source Type (Vehicle) Population

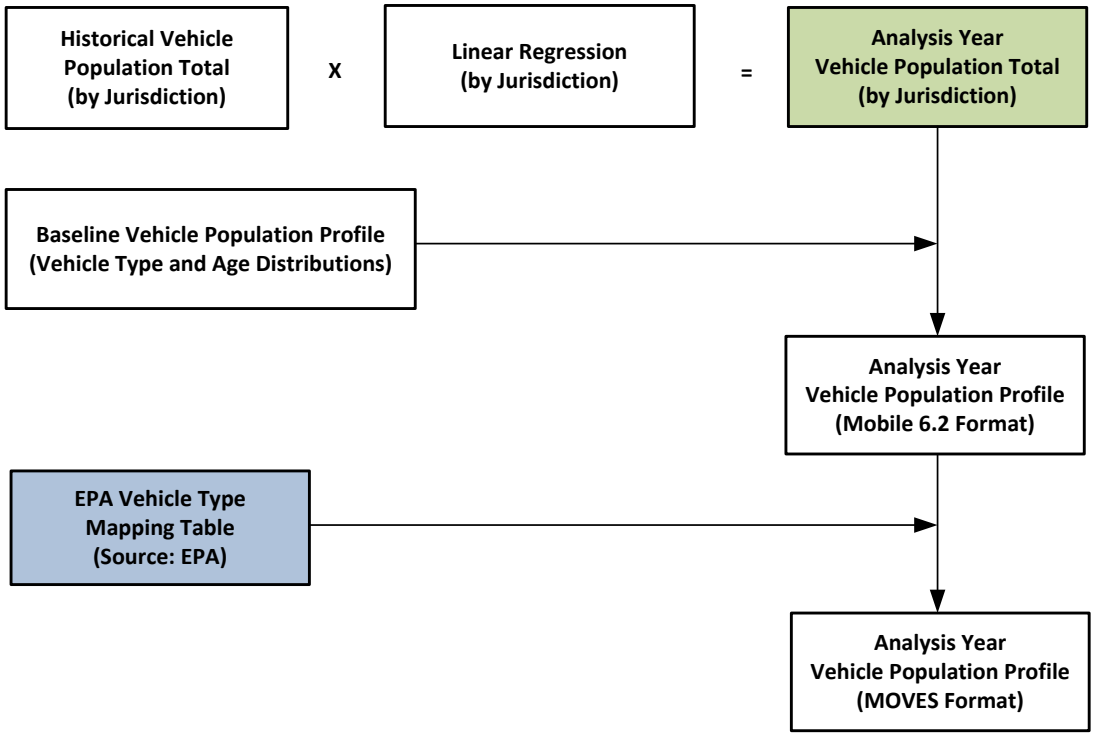
Source type population, or vehicle population, was acquired from the vehicle registration (VIN) data. The VIN decoding software output vehicle population totals by Mobile 6.2 vehicle types. The vehicle population from the VIN data was then used to estimate vehicle population for each analysis year. Methods of estimating vehicle population vary by analysis year and availability of VIN data. For 2007, which is historical and is between two VIN data years, vehicle population total was calculated using an interpolation method based on the two sets of VIN data. For 2017 and 2025, regression analysis was used to project future vehicle population totals based on available VIN data (collected from 1975 to 2014), which draws the 'best fitting' line among scattered VIN data points.

Table 9 shows vehicle population forecasts for each of the analysis years. Vehicle profiles of the 2014 VIN data are used to develop future year vehicle profiles by jurisdiction. Vehicle profiles were prepared in a Mobile format in this data processing first, and were converted to a MOVES vehicle type using a vehicle mapping table provided by EPA. Figure 6 shows the process of calculating source type population.

Table 9 Vehicle Population by Analysis Year

State	Jurisdiction	2007	2017	2025
DC	District of Columbia	260,385	300,237	328,864
MD	Charles Co.	130,846	140,899	159,547
	Frederick Co.	218,156	232,657	262,998
	Montgomery Co.	710,180	777,623	848,000
	Prince George's Co.	607,341	635,257	676,513
	Sub Total	1,666,523	1,786,436	1,947,058
VA	City of Alexandria	133,303	135,672	147,093
	Arlington Co.	129,440	151,709	160,608
	Fairfax Co.	814,869	986,753	1,098,015
	Loudoun Co.	215,230	286,855	341,626
	Prince William Co.	339,123	411,349	479,319
	Sub Total	1,631,965	1,972,338	2,226,661
Total		3,558,873	4,059,011	4,502,583

Figure 5 Source Type Population Development Process of Future Analysis Year



5.11 Inspection/Maintenance (I/M) Programs & Hoteling

The air agencies of the District of Columbia, Maryland, and Virginia provided details of Inspection/Maintenance (I/M) programs for all analysis years in a MOVES2014 ready format. Hoteling data are not provided by local air agencies, so the MOVES default hoteling data were used.

5.12 Federal and State Specific Control Programs

In addition to the environmental inputs there are state-specific programs that were taken into account in the analyses:

- Early NLEV: The District of Columbia, Maryland, and Virginia adopted an Early NLEV program, which was reflected in all analysis years. Early NLEV input database file – MOVES2014_early_NLEV

- Stage II: Varies by jurisdiction as follows:

- District of Columbia: 1999 onwards - Refueling vapor program adjustment- 0.9, Refueling spill program adjustment- 0.5 (MOVES2014 defaults)

- Maryland: 1999 onwards - Refueling vapor program adjustment- 0.7, Refueling spill program adjustment- 0.7, MOVES2014 Stage II database file - md_stageii_yy

- Virginia: 2015 onwards - Refueling vapor program adjustment- 0, Refueling spill program adjustment- 0, MOVES2014 Stage II database file - va_stage2_input_20140507

- CAL-LEV /ZEV Programs: Since 2011 Maryland adopted CAL-LEV program and as such, it is reflected in all analysis years. The following auxiliary files, provided by the Maryland Department of the Environment (MDE), were used to model these programs in the Maryland jurisdictions: MOVES2014 Cal-Lev Database File, MOVES2014_caleviii2011; and MOVES2014 ZEV Program Information is included in all MD MS-Excel input files as a tab (ZEV_AVFT_MD_moves2014).

6.0 RESULTS

On-road mobile inventories for the entire $PM_{2.5}$ Maintenance Area are shown on Table 10. The inventories were produced using MOVES2014, which reflects federal fuel and vehicle technology (Tier 3) programs.

Table 10 $PM_{2.5}$ Maintenance Plan Annual On-Road Emission Inventories (in Short Tons)

Analysis Year/Pollutant	$PM_{2.5}$ Maintenance Plan
Year 2007	
Ammonia (NH_3)	1,862
Precursor NOx	81,001
$PM_{2.5}$	3,002
Sulfur Dioxide (SO_2)	570
Volatile Organic Compounds (VOC)	34,441
Year 2017	
Ammonia (NH_3)	1,229
Precursor NOx	32,790
$PM_{2.5}$	1,523
Sulfur Dioxide (SO_2)	162
Volatile Organic Compounds (VOC)	16,768
Year 2025	
Ammonia (NH_3)	1,181
Precursor NOx	15,434
$PM_{2.5}$	926
Sulfur Dioxide (SO_2)	142
Volatile Organic Compounds (VOC)	11,765

Emission summaries by jurisdiction are shown in Tables 11, 12 and 13.

Table 11 $PM_{2.5}$ Maintenance Plan Update: 2007 Emissions by Jurisdiction (short tons)

State	Jurisdiction	VOC	NOx	$PM_{2.5}$	NH_3	SO_2
DC	District of Columbia	2,809	5,724	216	171	43
MD	Charles County	1,244	2,696	102	48	18
	Frederick County	2,588	8,105	294	143	49
	Montgomery County	6,717	14,023	521	340	123
	Prince George's County	6,944	17,652	631	394	127
	MD Total	17,493	42,477	1,549	924	317
VA	City of Alexandria	895	1,467	56	35	11
	Arlington County	1,141	2,088	73	69	17
	Fairfax County	7,135	16,459	610	409	110
	Loudoun County	1,990	5,412	227	108	32
	Prince William County	2,977	7,374	272	145	40
	VA Total	14,138	32,800	1,237	767	211
	Total	**34,441**	**81,001**	**3,002**	**1,862**	**570**

Table 12 $PM_{2.5}$ Maintenance Plan Update: 2017 Emissions by Jurisdiction (short tons)

State	Jurisdiction	VOC	NOx	$PM_{2.5}$	NH_3	SO_2
DC	District of Columbia	1,379	2,205	126	107	14
MD	Charles County	663	1,276	55	34	4
	Frederick County	1,305	3,716	142	97	12
	Montgomery County	3,045	5,361	262	219	27
	Prince George's County	3,162	6,862	300	258	30
	MD Total	8,175	17,214	759	608	73
VA	City of Alexandria	450	639	31	26	4
	Arlington County	535	715	37	40	5
	Fairfax County	3,533	6,471	312	263	37
	Loudoun County	1,102	2,438	124	82	13
	Prince William County	1,593	3,108	134	103	15
	VA Total	7,213	13,371	638	513	74
	Total	**16,768**	**32,790**	**1,523**	**1,229**	**162**

Table 13 $PM_{2.5}$ Maintenance Plan Update: 2025 Emissions by Jurisdiction (short tons)

State	Jurisdiction	VOC	NOx	$PM_{2.5}$	NH_3	SO_2
DC	District of Columbia	930	971	84	96	12
MD	Charles County	471	581	30	34	4
	Frederick County	961	1,946	74	95	10
	Montgomery County	2,074	2,447	163	209	23
	Prince George's County	2,074	3,073	173	238	26
	MD Total	5,579	8,048	439	576	64
VA	City of Alexandria	310	296	20	24	3
	Arlington County	367	351	25	37	4
	Fairfax County	2,514	3,014	194	256	33
	Loudoun County	844	1,226	80	89	12
	Prince William County	1,220	1,528	84	104	14
	VA Total	5,255	6,415	403	509	67
	Total	**11,765**	**15,434**	**926**	**1,181**	**142**

ATTACHMENT A

METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS

One Region Moving Forward

Date: March 19, 2015

To: Ron Milone
Department of Transportation Planning

From: Paul DesJardin PD
Greg Goodwin
Department of Community Planning and Services

Subject: Round 8.4 Cooperative Forecast TPB TAZ file

We have completed the compilation of the Round 8.4 Cooperative Forecast 3,722 zone TAZ file for use in this year's Air Quality Conformity Analysis of the TIP and CLRP.

The file, rd84_tpb3722.dat, contains base year 2010 estimates and forecasts through 2040, and is located on the SAS server at \\cogsas\dtp_sas$\zteam\coop5.

The file includes 2005 estimates from the COG Round 8.2 Cooperative Forecasts for the complete TPB modeled region to only be used for internal COG and COG/TPB analysis. These estimates for 2005 were developed prior to the release of the 2010 Census and other data sets, and may show variability at the TAZ level when compared to the Round 8.4 2010 base year data and projections.

A record layout / file format and summaries of the control totals are also attached.

Should you have any questions concerning the file, please don't hesitate to contact me on extension 3293.

Round 8.4 Control Totals for 3722 Zone System 13:09 Tuesday, March 17, 2015 1
Total Population 2005 to 2040
File: "rd83_3722.dat"

JURIS	_FREQ_	TPOP05	TPOP10	TPOP15	TPOP20	TPOP25	TPOP30	TPOP35	TPOP40
District of Columbia	394	582,049	601,764	660,528	715,494	764,267	808,718	852,428	883,568
Montgomery County	376	929,097	972,603	1,020,036	1,067,030	1,109,953	1,153,912	1,184,641	1,202,769
Prince Georges County	635	835,705	863,420	881,379	899,912	926,944	950,030	973,126	995,503
Arlington County	141	199,189	207,627	222,213	232,650	247,357	259,757	271,245	282,998
City of Alexandria	65	135,853	140,012	147,669	162,681	171,292	176,259	184,478	191,405
Fairfax County/Cities	549	1,066,666	1,116,549	1,158,653	1,198,897	1,255,627	1,310,772	1,360,105	1,406,187
Loudoun County	282	247,333	312,310	367,957	417,986	452,242	468,664	478,635	484,498
Prince William County/Cities	378	405,298	454,094	481,855	528,485	557,549	581,616	601,314	617,427
Frederick County/City	130	220,876	233,383	241,616	258,849	278,654	297,708	314,297	329,955
Howard County	68	272,008	287,085	309,043	332,273	346,517	357,094	363,501	366,352
Anne Arundel County	98	513,500	537,655	559,618	580,006	593,594	606,688	618,176	628,047
Charles County	113	136,363	144,594	160,098	175,953	191,475	202,552	213,651	224,871
Carroll County	58	169,229	167,134	170,549	175,900	179,437	183,258	186,180	189,574
Calvert County	47	86,451	91,748	96,500	100,450	103,253	105,099	106,980	108,882
St Mary's County	75	96,091	104,854	118,184	130,098	141,135	151,403	162,572	173,832
King George County	25	21,486	23,584	26,911	30,226	34,029	37,819	41,273	44,707
Fredericksburg City	14	22,638	24,286	25,728	27,160	28,870	30,570	32,095	33,610
Stafford County	93	108,125	128,950	149,386	169,774	191,249	212,671	232,289	251,851
Spotsylvania County (northern portion)	62	88,862	95,973	107,675	119,355	129,406	139,424	147,448	155,442
Fauquier County	50	60,135	65,201	69,658	74,114	78,710	83,306	88,163	93,022
Clarke County	9	13,315	14,031	14,530	15,026	15,447	15,872	16,252	16,632
Jefferson County	13	47,967	53,498	57,889	62,688	67,071	71,203	75,300	79,065
	3675	6,258,236	6,640,355	7,047,675	7,475,007	7,864,078	8,204,395	8,504,149	8,760,197

Household Population 2005 to 2040

File: "rd84_3722.dat"

JURIS	POP05	POP10	POP15	POP20	POP25	POP30	POP35	POP40
District of Columbia	540,518	561,746	616,552	667,271	714,735	758,190	800,908	830,387
Montgomery County	918,400	961,209	1,006,329	1,053,259	1,093,995	1,136,857	1,167,393	1,185,019
Prince Georges County	815,646	844,292	861,846	880,136	906,770	929,662	952,465	974,224
Arlington County	195,035	204,735	219,030	229,367	244,074	256,474	267,962	279,715
City of Alexandria	133,953	138,185	145,761	160,668	169,173	174,028	182,139	188,961
Fairfax County/Cities	1,052,131	1,108,552	1,148,505	1,188,749	1,245,479	1,300,624	1,349,957	1,396,039
Loudoun County	246,482	311,139	365,977	415,745	449,513	465,935	475,906	481,769
Prince William County/Cities	401,700	451,522	479,283	525,913	554,977	579,044	598,742	614,855
Frederick County/City	216,221	229,203	237,436	254,669	274,474	293,528	310,117	325,775
Howard County	268,426	284,763	306,721	329,951	344,195	354,772	361,179	364,030
Anne Arundel County	496,905	523,523	545,486	565,874	579,462	592,556	604,044	613,915
Charles County	134,939	143,049	158,397	174,043	189,283	200,051	210,789	221,594
Carroll County	165,650	163,815	167,193	172,465	175,951	179,716	182,594	185,938
Calvert County	85,787	91,026	95,724	99,584	102,248	103,912	105,609	107,327
St Mary's County	92,875	101,278	114,360	125,922	136,420	146,063	156,519	166,972
King George County	21,131	23,283	26,596	29,897	33,678	37,449	40,886	44,306
Fredericksburg City	20,319	21,690	22,978	24,260	25,783	27,300	28,663	30,019
Stafford County	106,631	125,356	145,519	165,644	186,834	207,981	227,339	246,651
Spotsylvania County (northern portion)	88,361	95,505	107,132	118,738	128,708	138,647	146,599	154,521
Fauquier County	59,747	64,813	69,270	73,726	78,322	82,918	87,775	92,634
Clarke County	13,060	13,776	14,275	14,771	15,192	15,617	15,997	16,377
Jefferson County	46,576	52,107	56,498	61,297	65,680	69,812	73,909	77,674
	6,120,493	6,514,567	6,910,868	7,331,949	7,714,946	8,051,136	8,347,491	8,598,702

Group Quarters Population 2005 to 2040

File: "rd84_3722.dat"

JURIS	GQS05	GQS10	GQS15	GQS20	GQS25	GQS30	GQS35	GQS40
District of Columbia	41,531	40,018	43,976	48,223	49,532	50,528	51,520	53,181
Montgomery County	10,697	11,394	13,707	13,771	15,958	17,055	17,248	17,750
Prince Georges County	20,059	19,128	19,533	19,776	20,174	20,368	20,661	21,279
Arlington County	4,154	2,892	3,183	3,283	3,283	3,283	3,283	3,283
City of Alexandria	1,900	1,827	1,908	2,013	2,119	2,231	2,339	2,444
Fairfax County/Cities	14,535	7,997	10,148	10,148	10,148	10,148	10,148	10,148
Loudoun County	851	1,171	1,980	2,241	2,729	2,729	2,729	2,729
Prince William County/Cities	3,598	2,572	2,572	2,572	2,572	2,572	2,572	2,572
Frederick County/City	4,655	4,180	4,180	4,180	4,180	4,180	4,180	4,180
Howard County	3,582	2,322	2,322	2,322	2,322	2,322	2,322	2,322
Anne Arundel County	16,595	14,132	14,132	14,132	14,132	14,132	14,132	14,132
Charles County	1,424	1,545	1,701	1,910	2,192	2,501	2,862	3,277
Carroll County	3,579	3,319	3,356	3,435	3,486	3,542	3,586	3,636
Calvert County	664	722	776	866	1,005	1,187	1,371	1,555
St Mary's County	3,216	3,576	3,824	4,176	4,715	5,340	6,053	6,860
King George County	355	301	315	329	351	370	387	401
Fredericksburg City	2,319	2,596	2,750	2,900	3,087	3,270	3,432	3,591
Stafford County	1,494	3,594	3,867	4,130	4,415	4,690	4,950	5,200
Spotsylvania County (northern portion)	501	468	543	617	698	777	849	921
Fauquier County	388	388	388	388	388	388	388	388
Clarke County	255	255	255	255	255	255	255	255
Jefferson County	1,391	1,391	1,391	1,391	1,391	1,391	1,391	1,391
	137,743	125,788	136,807	143,058	149,132	153,259	156,658	161,495

Households 2005 to 2040
File: "rd84_3722.dat"

JURIS	HHS05	HHS10	HHS15	HHS20	HHS25	HHS30	HHS35	HHS40
District of Columbia	253,415	266,707	287,112	305,550	323,191	340,307	356,923	370,758
Montgomery County	347,500	361,030	377,524	396,955	414,873	434,767	449,928	460,161
Prince Georges County	299,867	304,042	323,364	336,107	348,307	359,878	369,847	379,020
Arlington County	92,213	98,050	104,317	109,394	116,624	122,230	127,632	133,319
City of Alexandria	66,311	68,101	71,202	77,352	82,624	85,830	89,827	93,188
Fairfax County/Cities	389,959	401,127	417,625	436,288	461,808	486,298	508,114	528,472
Loudoun County	87,482	104,583	122,644	139,505	151,558	158,142	162,221	164,297
Prince William County/Cities	135,991	147,819	157,614	175,294	186,253	195,251	202,464	208,220
Frederick County/City	79,493	84,800	89,935	96,471	103,944	111,118	117,365	123,247
Howard County	100,246	104,749	112,173	123,899	130,948	135,517	138,513	139,497
Anne Arundel County	192,450	199,378	206,441	213,504	220,565	227,626	234,647	241,542
Charles County	47,445	50,950	57,528	64,299	70,833	75,847	80,876	85,901
Carroll County	59,401	62,406	64,142	66,219	68,025	69,692	71,305	72,853
Calvert County	29,900	32,046	34,298	36,027	37,374	38,348	39,322	40,301
St Mary's County	35,052	38,870	44,443	49,352	53,960	58,143	62,326	66,509
King George County	7,606	8,373	9,808	11,237	12,808	14,366	15,761	17,142
Fredericksburg City	8,754	9,507	10,239	10,969	11,761	12,547	13,147	13,739
Stafford County	34,665	41,769	49,673	57,533	65,473	73,367	80,539	87,670
Spotsylvania County (northern portion)	29,705	32,824	37,503	42,153	46,117	50,057	52,825	55,567
Fauquier County	21,830	23,658	25,337	26,954	28,616	30,272	32,028	33,801
Clarke County	5,223	5,507	5,779	5,979	6,150	6,322	6,475	6,631
Jefferson County	18,764	19,931	23,599	26,085	28,633	31,025	33,419	35,740
	2,343,272	2,466,227	2,632,300	2,807,126	2,970,445	3,116,950	3,245,504	3,357,575

Total Employment-UNDADJUSTED

File: "rd84_3722.dat"

JURIS	TEMP05	TEMP10	TEMP15	TEMP20	TEMP25	TEMP30	TEMP35	TEMP40
District of Columbia	750,245	783,457	814,957	861,814	905,846	944,096	972,955	1,001,814
Montgomery County	500,000	510,277	532,004	564,377	598,824	635,264	673,976	715,121
Prince Georges County	347,885	342,588	356,958	377,879	403,134	427,514	457,275	497,652
Arlington County	195,158	222,319	219,147	228,892	243,562	265,677	280,741	301,276
City of Alexandria	105,750	102,895	108,712	115,060	130,585	145,288	157,564	163,401
Fairfax County/Cities	639,331	657,546	693,803	758,260	814,740	866,739	900,065	930,665
Loudoun County	125,594	145,083	163,850	197,265	224,249	248,803	264,159	278,216
Prince William County/Cities	139,429	151,745	162,143	183,305	205,101	227,276	250,063	273,954
Frederick County/City	57,185	98,695	102,014	106,242	109,802	114,558	116,332	125,556
Howard County	176,800	181,381	196,381	211,381	226,381	241,381	251,710	260,309
Anne Arundel County	318,435	323,148	342,011	361,688	376,085	391,312	404,986	424,061
Charles County	58,552	62,199	68,405	71,695	74,695	77,499	80,298	83,097
Carroll County	76,306	70,889	73,063	76,107	78,421	80,888	82,996	85,351
Calvert County	32,431	35,200	41,097	44,501	46,305	47,206	48,102	49,003
St Mary's County	57,652	62,994	68,202	71,601	74,599	76,596	78,637	80,731
King George County	6,705	16,233	17,804	19,377	20,947	22,490	24,124	25,747
Fredericksburg City	25,448	31,492	35,586	39,662	43,729	47,779	51,298	54,819
Stafford County	35,579	46,664	52,681	58,399	64,304	70,170	77,198	84,159
Spotsylvania County (northern portion)	27,615	40,093	43,173	46,219	49,168	52,086	56,731	61,356
Fauquier County	19,721	22,371	23,902	25,426	27,007	28,581	30,241	31,917
Clarke County	4,722	4,241	4,391	4,539	4,668	4,797	4,912	5,026
Jefferson County	14,768	15,937	17,247	18,675	19,989	21,212	22,434	23,555
	3,715,311	3,927,447	4,137,531	4,442,364	4,742,141	5,037,212	5,286,797	5,556,786

Office Employment 2005 to 2040

File: "rd84_3722.dat"

JURIS	OFF05	OFF10	OFF15	OFF20	OFF25	OFF30	OFF35	OFF40
District of Columbia	431,388	440,007	452,840	484,215	506,458	524,418	536,224	548,070
Montgomery County	254,477	291,741	305,201	330,447	357,805	388,603	411,376	434,023
Prince Georges County	82,656	78,138	82,597	88,190	95,648	103,724	112,822	121,130
Arlington County	101,305	147,740	140,116	148,517	161,493	180,262	194,659	213,789
City of Alexandria	55,822	56,518	61,887	68,290	82,729	97,110	108,787	113,758
Fairfax County/Cities	431,021	447,650	477,630	532,009	578,535	621,587	648,029	671,938
Loudoun County	40,774	49,501	54,913	68,853	80,932	94,925	103,866	112,191
Prince William County/Cities	55,520	51,215	54,138	56,068	60,133	63,997	67,454	70,541
Frederick County/City	22,368	37,560	38,590	40,184	41,770	43,508	44,229	46,956
Howard County	51,087	84,704	91,167	98,086	104,943	111,730	116,257	120,105
Anne Arundel County	86,357	136,480	144,660	153,549	160,470	167,525	173,778	181,956
Charles County	22,875	24,424	26,892	28,207	29,410	30,526	31,642	32,756
Carroll County	20,795	23,084	23,792	24,788	25,543	26,337	27,028	27,795
Calvert County	13,268	14,535	17,119	18,655	19,523	19,979	20,394	20,809
St Mary's County	25,429	28,025	30,424	32,081	33,429	34,359	35,237	36,146
King George County	2,068	4,914	5,381	5,852	6,320	6,782	7,275	7,766
Fredericksburg City	7,086	9,204	10,431	11,654	12,873	14,089	15,174	16,262
Stafford County	10,644	13,775	15,489	17,118	18,798	20,474	22,477	24,470
Spotsylvania County (northern portion)	7,506	10,627	11,492	12,355	13,172	13,988	15,324	16,663
Fauquier County	5,664	6,389	6,802	7,200	7,628	8,056	8,503	8,959
Clarke County	564	506	524	541	556	571	585	599
Jefferson County	5,738	6,192	6,701	7,253	7,763	8,239	8,714	9,150
	1,734,412	1,962,929	2,058,786	2,234,112	2,405,931	2,580,789	2,709,834	2,835,832

Retail Employment 2005 to 2040

File: "rd84_3722.dat"

JURIS	RET05	RET10	RET15	RET20	RET25	RET30	RET35	RET40
District of Columbia	81,734	84,642	89,306	94,236	99,363	104,090	110,061	116,020
Montgomery County	87,796	77,007	81,086	86,682	91,599	93,799	102,735	111,783
Prince Georges County	80,854	80,718	84,473	89,816	96,511	102,872	110,354	123,988
Arlington County	36,266	31,040	33,191	34,046	35,638	38,579	38,889	40,168
City of Alexandria	26,947	23,118	23,411	23,343	24,121	24,390	24,879	25,493
Fairfax County/Cities	113,625	114,917	118,771	124,923	130,293	135,171	138,643	142,205
Loudoun County	26,507	34,112	37,046	42,970	47,128	49,673	51,249	52,355
Prince William County/Cities	42,806	47,891	48,096	58,435	64,775	71,535	78,491	85,726
Frederick County/City	15,773	28,098	28,976	30,117	30,984	32,460	32,941	36,570
Howard County	23,547	30,526	34,493	36,865	39,326	42,256	44,146	46,019
Anne Arundel County	59,379	66,082	70,333	73,837	76,318	78,830	81,308	84,844
Charles County	19,342	20,638	22,750	23,864	24,839	25,735	26,646	27,556
Carroll County	13,928	15,717	16,201	16,876	17,388	17,932	18,405	18,926
Calvert County	8,693	9,392	10,753	11,526	11,942	12,157	12,362	12,565
St Mary's County	12,218	14,030	15,338	16,166	16,949	17,455	18,001	18,570
King George County	501	1,491	1,661	1,821	1,987	2,144	2,299	2,449
Fredericksburg City	4,190	3,880	4,293	4,700	5,110	5,512	5,776	6,033
Stafford County	3,647	5,339	6,214	7,045	7,910	8,748	9,767	10,749
Spotsylvania County (northern portion)	5,097	8,212	8,697	9,154	9,652	10,122	10,759	11,367
Fauquier County	11,113	12,638	13,532	14,431	15,347	16,258	17,225	18,193
Clarke County	3,458	3,105	3,215	3,325	3,420	3,516	3,599	3,683
Jefferson County	3,433	3,703	4,009	4,341	4,645	4,931	5,214	5,475
	680,854	716,296	755,845	808,519	855,245	898,165	943,749	1,000,737

Industrial Employment 2005 to 2040

File: "rd84_3722.dat"

JURIS	IND05	IND10	IND15	IND20	IND25	IND30	IND35	IND40
District of Columbia	60,997	62,528	67,923	73,047	80,000	86,283	90,532	94,773
Montgomery County	46,680	46,255	47,462	47,512	48,822	49,658	52,917	59,642
Prince Georges County	55,683	54,114	55,494	57,029	59,230	60,848	62,808	65,618
Arlington County	22,538	7,894	8,126	8,263	8,454	9,089	9,241	9,416
City of Alexandria	7,471	7,751	7,756	7,699	7,779	7,779	7,796	7,825
Fairfax County/Cities	61,935	62,573	63,803	66,119	69,080	71,890	74,328	76,753
Loudoun County	25,410	27,319	31,584	37,494	42,983	47,539	50,559	53,560
Prince William County/Cities	27,480	26,711	26,693	29,621	33,635	36,805	40,034	43,450
Frederick County/City	7,271	13,097	13,635	14,181	14,641	15,284	15,536	16,974
Howard County	51,087	16,916	17,969	19,428	21,033	22,417	23,312	24,089
Anne Arundel County	86,342	26,537	27,925	29,711	31,300	32,631	34,069	35,508
Charles County	9,482	9,769	10,677	11,129	11,555	11,971	12,390	12,810
Carroll County	20,788	9,082	9,356	9,737	10,039	10,365	10,626	10,931
Calvert County	6,679	7,092	8,352	9,042	9,342	9,454	9,640	9,830
St Mary's County	9,879	12,139	12,957	13,478	13,891	14,149	14,457	14,754
King George County	2,068	4,914	5,381	5,852	6,320	6,782	7,275	7,766
Fredericksburg City	7,086	9,204	10,431	11,654	12,873	14,089	15,174	16,262
Stafford County	10,644	13,775	15,489	17,118	18,798	20,474	22,477	24,470
Spotsylvania County (northern portion)	7,506	10,627	11,492	12,355	13,172	13,988	15,324	16,663
Fauquier County	967	1,097	1,173	1,245	1,325	1,403	1,484	1,567
Clarke County	266	239	248	256	263	270	277	283
Jefferson County	3,660	3,951	4,274	4,631	4,957	5,259	5,563	5,840
	531,919	433,584	458,200	486,601	519,492	548,427	575,819	608,784

Other Employment 2005 to 2040

File: "rd84_3722.dat"

JURIS	OTH05	OTH10	OTH15	OTH20	OTH25	OTH30	OTH35	OTH40
District of Columbia	176,126	196,280	204,888	210,316	220,025	229,305	236,138	242,951
Montgomery County	111,047	95,274	98,255	99,736	100,598	103,204	106,948	109,673
Prince Georges County	128,692	129,618	134,394	142,844	151,745	160,070	171,291	186,916
Arlington County	35,049	35,645	37,714	38,066	37,977	37,747	37,952	37,903
City of Alexandria	15,510	15,508	15,658	15,728	15,956	16,009	16,102	16,325
Fairfax County/Cities	32,750	32,406	33,599	35,209	36,832	38,091	39,065	39,769
Loudoun County	32,903	34,151	40,307	47,948	53,206	56,666	58,485	60,110
Prince William County/Cities	13,623	25,928	33,216	39,181	46,558	54,939	64,084	74,237
Frederick County/City	11,773	19,940	20,813	21,760	22,407	23,306	23,626	25,056
Howard County	51,079	49,235	52,752	57,002	61,079	64,978	67,995	70,096
Anne Arundel County	86,357	94,049	99,093	104,591	107,997	112,326	115,831	121,753
Charles County	6,853	7,368	8,086	8,495	8,891	9,267	9,620	9,975
Carroll County	20,795	23,006	23,714	24,706	25,451	26,254	26,937	27,699
Calvert County	3,791	4,181	4,873	5,278	5,498	5,616	5,706	5,799
St Mary's County	10,126	8,800	9,483	9,876	10,330	10,633	10,942	11,261
King George County	2,068	4,914	5,381	5,852	6,320	6,782	7,275	7,766
Fredericksburg City	7,086	9,204	10,431	11,654	12,873	14,089	15,174	16,262
Stafford County	10,644	13,775	15,489	17,118	18,798	20,474	22,477	24,470
Spotsylvania County (northern portion)	7,506	10,627	11,492	12,355	13,172	13,988	15,324	16,663
Fauquier County	1,977	2,247	2,395	2,550	2,707	2,864	3,029	3,198
Clarke County	434	391	404	417	429	440	451	461
Jefferson County	1,937	2,091	2,263	2,450	2,624	2,783	2,943	3,090
	768,126	814,638	864,700	913,132	961,473	1,009,831	1,057,395	1,111,433

File Format

Programmer: DesJardin **Date:** 3/23/2015 9:44 AM

Data File: rd83_tpb3722.dat LRECL 437 3,669 records

Description of Contents:
Format for the Round 8.4 Cooperative Forecasts of population, households and employment to 2040 by COG / TPB 3722 Zone TAZ system

Field Number	Characters First	Last	#	A / N	Field Description
1	1	2	2	A	Jurisdiction 00 = District of Columbia 01 = Montgomery County 02 = Prince George's County 03 = Arlington County 04 = City of Alexandria 05 = Fairfax County / City / Falls Church 06 = Loudoun County 07 = Prince William / Manassas / Manassas Park 09 = Frederick County 10 = Howard County 11 = Anne Arundel County 12 = Charles County 14 = Carroll County 15 = Calvert County 16 = St. Mary's County 17 = King George County 18 = City of Fredericksburg 19 = Stafford County 20 = Spotsylvania County 21 = Fauquier County 22 = Clarke County 23 = Jefferson County
2	5	8	4	N	TAZ (3722 Zone System)
3	9	13	5	A	FIPS State and County Code
4	14	53	40	A	Jurisdiction Name
					2005 Data ***(Round 8.2)***
5	54	59	6	N	Households
6	60	65	6	N	Household Population
7	66	71	6	N	Group Quarters Population
8	72	77	6	N	Total Employment
9	78	83	6	N	Industrial Employment
10	84	89	6	N	Retail Employment
11	90	95	6	N	Office Employment
12	96	101	6	N	Other Employment
					2010 Data
13	102	107	6	N	Households
14	108	113	6	N	Household Population
15	114	119	6	N	Group Quarters Population
16	120	125	6	N	Total Employment
17	126	131	6	N	Industrial Employment

18	132	137	6	N	Retail Employment
19	138	143	6	N	Office Employment
20	144	149	6	N	Other Employment
					2015 Data
21	150	155	6	N	Households
22	156	161	6	N	Household Population
23	162	167	6	N	Group Quarters Population
24	168	173	6	N	Total Employment
25	174	179	6	N	Industrial Employment
26	180	185	6	N	Retail Employment
27	186	191	6	N	Office Employment
28	192	197	6	N	Other Employment
					2020 Data
29	198	203	6	N	Households
30	204	209	6	N	Household Population
31	210	215	6	N	Group Quarters Population
32	216	221	6	N	Total Employment
33	222	227	6	N	Industrial Employment
34	228	233	6	N	Retail Employment
35	234	239	6	N	Office Employment
36	240	245	6	N	Other Employment
					2025 Data
37	246	251	6	N	Households
38	252	257	6	N	Household Population
39	258	263	6	N	Group Quarters Population
40	264	269	6	N	Total Employment
41	270	275	6	N	Industrial Employment
42	276	281	6	N	Retail Employment
43	282	287	6	N	Office Employment
44	288	293	6	N	Other Employment
					2030 Data
45	294	299	6	N	Households
46	300	305	6	N	Household Population
47	306	311	6	N	Group Quarters Population
48	312	317	6	N	Total Employment
49	318	323	6	N	Industrial Employment
50	324	329	6	N	Retail Employment
51	330	335	6	N	Office Employment
52	336	341	6	N	Other Employment
					2035 Data
53	342	347	6	N	Households
54	348	353	6	N	Household Population
55	354	359	6	N	Group Quarters Population
56	360	365	6	N	Total Employment
57	366	371	6	N	Industrial Employment
58	372	377	6	N	Retail Employment
59	378	383	6	N	Office Employment
60	384	389	6	N	Other Employment
					2040 Data
61	390	395	6	N	Households
62	396	401	6	N	Household Population
63	402	407	6	N	Group Quarters Population

64	408	413	6	N	Total Employment
65	414	419	6	N	Industrial Employment
66	420	425	6	N	Retail Employment
67	426	431	6	N	Office Employment
68	432	437	6	N	Other Employment

ATTACHMENT B

MOVES TASK FORCE

Summary of Local Data Development for the County Data Manager (Emissions Inventory Approach)*

as of January 11, 2011

	LOCAL INPUT DATA CATEGORIES	DATA DESCRIPTION	DATA FORMAT	DATA DEVELOPMENT	LOCAL INPUT DATA APPROVAL DATE
			MOVES	METHODOLOGY	
1	**Age Distribution**	Registered vehicles stratified by age and vehicle type	31 Age Groups (covering 0-30+ years of vehicle age) 13 Vehicle Types	DTP used an EPA Converter to convert local registration data from MOBILE6.2 format to MOVES format	4/20/2010
2	**Average Speed Distribution**	Average vehicle speeds stratified by vehicle type, road type, time of day/type of day (i.e., weekday vs weekend)	Distributions of hourly average vehicle speeds by vehicle type, road type, and type of day (weekday/weekend)	DTP used MOBILE6.2 post-processor speed distribution augmented by local input data for school and transit buses and refuse trucks	Local VHT 7/20/2010 School Buses 9/21/2010 Refuse Trucks 9/21/2010 Transit Buses 10/19/2010
3	**Fuel Supply**	Market share of available fuels by county, month, year, state	MD/VA - EPA Methodology/local data in MOVES format DC - EPA Default Values	None Required (Direct Data Input from DC, MD, and VA air agencies)	Not Required
4	**Fuel Formulation**	Fuel formulation data stratified by state			
5	**I/M Programs**	Available Inspection/Maintenance Programs stratified by state			
6	**Meteorology Data**	Hourly temperature and relative humidity readings	Hourly Records of temperature and relative humidity in MOVES format Start Time: 12:00 am End Time: 11:00 pm	For Conformity Determinations - DEP converted meteorology data from existing SIPs to MOVES format using an EPA converter For Upcoming SIP Development - DEP compiled meteorology datasets from two weather stations based on a 3-yr period (2007-09) pending EPA approval	06/22/2010 (SIP for 2008 or Later Ozone Standard) 07/20/2010 (Conformity for Ozone & PM2.5 – 1997 Standards, CO – 1971 Standard)
7	**Ramp Fraction**	Percentage of driving time on ramps stratified by road type	8% of VHT (EPA National Default)	DTP tested local input data and found consistent with the EPA National Default value	7/20/2010
8	**Road Type Distribution**	Percentages of VMT allocated to each road type by vehicle type	VMT percentages by road type and vehicle type	DTP combined VMT from the travel demand model; and VMT distributions from the travel demand model, NEI data, and MOVES default data	4/20/2010
9	**Source Type Population**	Population of registered vehicles by county and vehicle type	13 Vehicle Types	DTP used vehicle registration and source type fractions	
10	**Vehicle Type VMT**	Annual VMT by HPMS vehicle type	Annual VMT allocated by HPMS vehicle type	DTP used daily VMT and an EPA converter	4/20/2010

*** The Task Force adopted the Emissions Inventory Approach (October 19, 2010)**

**** Documents can be found on the MOVES Task Forc** http://www.mwcog.org/committee/committee/documents.asp?COMMITTEE_ID=253

MOVES TASK FORCE

Summary of MOVES Data Development Documentation

as of January 11, 2011

	LOCAL INPUT DATA CATEGORIES	DATA DESCRIPTION	DATA DOCUMENTATION	
			METHODOLOGY	SENSITIVITY TESTING
1	**Age Distribution**	Registered vehicles stratified by age and vehicle type	Memorandum titled "Development of Local Transportation Data Inputs for MOVES2010 Model" D. Sivasailam Memorandum Drafted: 4/13/2010 Memorandum Presented: 4/20/2010 (Item 3) Memorandum Revised: 5/14/2010 (Item 3b)	Memorandum titled "Results of MOVES 2010 Model Sensitivity...", E. Lucas, Drafted/presented 4/20/2010 (Item 4) Memorandum titled "Results of MOVES2010 Model Sensitivity..." E. Lucas, Drafted/presented 5/18/2010 (Item 4a)
2	**Average Speed Distribution**	Average vehicle speeds stratified by vehicle type, road type, time of day/type of day (i.e., weekday vs weekend)	Memorandum titled "Local Vehicle Hours of Travel (VHT) Distributions," D. Sivasailam Drafted/presented 7/20/10 (Item 3b) Tables titled "School Bus Average Speed Distribution," Drafted/presented 9/21/2010 (Item 3a) Memorandum titled "Vehicle Hours of Travel (VHT) for Refuse Trucks," D. Sivasailam and E. Morrow, Drafted/presented on 9/21/2010 (Item 3a) Memorandum titled "MOVES Vehicle Hours of Travel (VHT) Distribution for Transit Buses," Y. Gao" Drafted/presented on 10/19/2010 (Item 3)	Memorandum titled "Results of MOVES2010 Model Sensitivity Tests: Final Scenario for Average Speed Testing," E. Lucas Memorandum Drafted: 10/16/2010 Memorandum Presented: 10/19/2010 (Item 4) Memorandum titled "Proposed Sensitivity Tests with Different Average Speed Distributions/SIP Temperatures" Drafted/presented 9/21/2010 (Item 3a)
3	**Fuel Supply**	Market share of available fuels by county, month, year, state	Memorandum titled "Development of Methodologies for Meteorology, I/M Program, and Fuel Inputs for Upcoming Ozone SIP (2008 or 2010 Standard) and Existing Conformity Analyses (Ozone & PM2.5 - 1997 Standards, CO - 1971 Standard)," S. Kumar Drafted/presented 6/22/2010 (Item 4a)	Memorandum titled "Results of MOVES2010 Model Sensitivity Tests:...Maryland Clean Car Program-ZEV," E. Lucas, Drafted/presented 5/18/2010 (Item 4a)
4	**Fuel Formulation**	Fuel formulation data stratified by state		
5	**I/M Programs**	Available Inspection/Maintenance Programs stratified by state		
6	**Meteorology Data**	Hourly temperature and relative humidity readings	Memorandum titled "Development of Methodologies for Meteorology, I/M Program, and Fuel Inputs for Upcoming Ozone SIP (2008 or 2010 Standard) and Existing Conformity Analyses (Ozone & PM2.5 - 1997 Standards, CO - 1971 Standard)," S. Kumar Drafted/presented 6/22/2010 (Item 4a) Memorandum titled "Development of Meteorology Inputs for existing Conformity Analyses (Ozone & PM2.5 – 1997 Standards, CO – 1971 Standard)",)," S. Kumar Drafted/presented 7/20/2010 (Item3a)"	Memorandum titled "Results of MOVES2010 Model Sensitivity Tests:...Maryland Clean Car Program-ZEV," E. Lucas, Drafted/presented 5/18/2010 (Item 4a)
7	**Ramp Fraction**	Percentage of driving time on ramps stratified by road type	Memorandum titled "Results of MOVES 2010 Model Ramp Analysis," E. Lucas, Drafted/presented 7/20/2010 (Item 4a)	Memorandum titled "Results of MOVES 2010 Model Ramp Analysis," E. Lucas, Drafted/presented 7/20/2010 (Item 4a)
8	**Road Type Distribution**	Percentages of VMT allocated to each road type by vehicle type	Memorandum titled "Development of Local Transportation Data Inputs for MOVES2010 Model," D. Sivasailam Memorandum Drafted: 4/13/2010 Memorandum Presented: 4/20/2010 (Item 3) Memorandum Revised: 5/14/2010 (Item 3b)	Memorandum titled "Results of MOVES 2010 Model Sensitivity...", E. Lucas, Drafted/presented 4/20/2010 (Item 4) Memorandum titled "Results of MOVES2010 Model Sensitivity..." E. Lucas, Drafted/presented 5/18/2010 (Item 4a)
9	**Source Type Population**	Population of registered vehicles by county and vehicle type		
10	**Vehicle Type VMT**	Annual VMT by HPMS vehicle type	Memorandum titled "Development of Annual VMT for MOVES2010,"D. Sivasailam Memorandum Drafted: 4/16/2010 Memorandum Presented: 4/20/2010 (Item 3) Memorandum Revised: 5/14/2010 (Item 3b)	Memorandum titled "Results of MOVES 2010 Model Sensitivity...", E. Lucas, Drafted/presented 4/20/2010 (Item 4) Memorandum titled "Results of MOVES2010 Model Sensitivity..." E. Lucas, Drafted/presented 5/18/2010 (Item 4a)