Memorandum

January 8, 2010

To: TPB Technical Committee

From: Eulalie Lucas

Department of Transportation Planning

Subject: Results of MOVESDraft2009 Model Sensitivity Tests

I. Introduction

Staff completed a series of sensitivity tests to compare MOVES emissions results with MOBILE6. Staff initially presented results using jurisdiction-specific data from MOVES default database and presented these results to this committee. Since then staff has been working to prepare local data inputs specific to jurisdictions in the Washington area and has executed a series of tests of the model for VOC and NOx in ozone season conditions, and annual emissions for PM 2.5, CO2 and precursor NOx for years 2005 and 2030. This memo describes these tests and provides draft results to date.

The following MOVES tests were executed for the District of Columbia, Fairfax and Montgomery counties for the years and pollutants listed in the previous paragraph.

II. Sensitivity Tests

Year 2005:

All default: MOVES jurisdiction-specific data based on national trends.

Test 1 inputs: MOVES 1999 default vehicle age distribution, MWCOG 2005 VIN decoded vehicle population, 2005 MOVES default annual VMT and vehicle type allocation and MOVES default percent distribution of VMT by vehicle and facility type.

Test 2 inputs: MWCOG vehicle age distribution, MWCOG 2005 VIN decoded vehicle population, 2005 MOVES default annual VMT and vehicle type allocation and MOVES default percent distribution of VMT by vehicle and facility type.

Test 3 inputs: MWCOG vehicle age distribution, MWCOG 2005 VIN decoded vehicle population, 2005 MWCOG annual VMT and MOVES vehicle type allocation and MOVES default percent distribution of VMT by vehicle and facility type.

Test 4 inputs: MWCOG vehicle age distribution, MWCOG 2005 VIN decoded vehicle population, 2005 MWCOG annual VMT and MWCOG vehicle type allocation and MOVES default percent distribution of VMT by vehicle and facility type.

Test 5 inputs: MWCOG vehicle age distribution, MWCOG 2005 VIN decoded vehicle population, 2005 MWCOG annual VMT and MWCOG vehicle type allocation and MWCOG percent distribution of VMT by vehicle and facility type.

Year 2030:

All default: MOVES jurisdiction-specific data based on national trends.

Test 1 inputs: MOVES 2030 default jurisdiction-specific data.

Test 5 inputs: MWCOG vehicle age distribution, MWCOG 2008 VIN decoded vehicle population, 2030 MWCOG annual VMT and MWCOG vehicle type allocation and MWCOG percent distribution of VMT by vehicle and facility type.

Table 1 summarizes the above information in a matrix format.

III. Assumptions and Input/Output Specifications

MOBILE6 Emissions are based on the following inputs:

MWCOG Travel Demand Model Version 2.2/ 2009 CLRP (July 2009)

COG's COOP Round 7.2 forecasts

MOBILE6.2 Rates:

2005 Vehicle Registration data for 2005 analysis

2008 Vehicle Registration data for 2030 analysis

2005 ozone day emissions were interpolated using 2002 and 2010 as data points.

IV. Preliminary Results

Staff applied the County Data Manager tool which allows the user the ability to import and edit local data, rather than using MOVES defaults. Using this MOVES utility program the following local inputs were applied:

1. Vehicle Type population from the 2005 and 2008 VIN decoded database.
2. Vehicle age distribution
3. Vehicle Miles of Travel (VMT)
4. Percent VMT by vehicle type and facility type

While these local data allowed for results that reflect local conditions versus national trends, the subtle impact of local variations in inputs such as fleet age distribution and composition appears to have a greater influence on emissions results than with EPA's MOBILE model. The attached graphs for the District of Columbia illustrate this condition. While VOC results (graph 2 A-1) decreased from the default values when local data were introduced, NOx emissions (graph 2 A-2) increased. In reviewing inputs staff discovered that local age distributions for heavy duty vehicles were older than EPA's default values which impacted NOx results.

Results are listed as follows:

Tables 2-A, 2-B, and 2-C show 2005 VOC and NOx ozone day emissions for all scenarios; followed by graphs 2 A-1 and 2 A-2 which illustrate these results for the District of Columbia.

Tables 3-A, 3-B and 3-C show 2005 CO2, NOx and PM2.5 annual emissions for selected scenarios and jurisdictions; followed by graphs 3-A, 3-B and 3-C which illustrate these emissions by pollutant, scenario and jurisdiction.

Tables 4-A, 4-B and 4-C show 2030 VOC and NOx ozone day emissions associated with inputs from MOBILE6.2, MOVES default and Test 5. Graphs 4 A-1 and 4 A-2 illustrate these emissions for the District of Columbia.

Tables 5-A, 5-B and 5-C show 2030 CO2, NOx and PM2.5 annual emissions for selected scenarios and jurisdictions; followed by graphs 5-A, 5-B and 5-C which illustrate these emissions by pollutant, scenario and jurisdiction

Attachments:

Data Tables
Graphs

Table 1

Scenario Testing

Input Item	Test 1		Test 2		Test 3		Test 4		Test 5	
	Def.	Loc.	Def.	Loc.	Def.	Loc.	Def.	Loc.	Def.	Loc.
Vehicle Age Distribution	X			X		X		X		X
Vehicle Population		X		X		X		X		X
Annual VMT by Jurisdiction	X		X			X		X		X
Annual VMT Distributed by Vehicle Type	X		X		X			X		X
Vehicle Type VMT Percentages by Facility Type	X		X		X		X			X

In the MOVES runs, annual VMT included all HPMS VMT (including local street) but excludes the additional bus VMT used in AQC inventory development. These are provided by local bus service providers such as WMATA; also excluded are VMT provided by county school bus districts and VMT associated with auto-access to transit..

Test 1: For year 2005 : **MOVES default age distribution**
Local 2005 VIN decoded vehicle population
MOVES default annual VMT distributed by MOVES vehicle type allocations
MOVES default percent VMT distributed by vehicle type and road type

Test 2: For year 2005 : **Local age distribution**
Local 2005 VIN decoded vehicle population
MOVES default annual VMT distributed by MOVES vehicle type allocations
MOVES default percent VMT distributed by vehicle type and road type

Test 3: For year 2005 : **Local age distribution**
Local 2005 VIN decoded vehicle population
Local annual VMT distributed by MOVES vehicle type allocations
MOVES default percent VMT distributed by vehicle type and road type

Test 4: For year 2005 : **Local age distribution**
Local 2005 VIN decoded vehicle population

	Local annual VMT distributed by local vehicle type allocations
	MOVES default percent VMT distributed by vehicle type and road type
Test 5: For year 2005:	**Local age distribution**
	Local 2005 VIN decoded vehicle population
	Local annual VMT distributed by local vehicle type allocations
	Local percent VMT distributed by vehicle type and road type
Test 5: For year 2030:	**Local age distribution**
	Local 2008 VIN decoded vehicle population
	Local annual VMT distributed by local vehicle type allocations
	Local percent VMT distributed by vehicle type and road type

Table 2-A. 2005 District of Columbia VOC and NOx Emissions (Daily)

	Mobile6		All Default		Test 1		Test 2		Test 3		Test 4		Test 5	
	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx
Start	2.2156	1.1670	3.1511	3.6935	2.3965	2.8111	2.3965	2.8488	2.3965	2.8488	2.3965	2.8488	2.3965	2.8488
Running	5.0379	15.1030	4.1550	24.4485	3.8915	22.8492	3.7568	24.2436	3.6320	23.4382	3.9192	23.6283	3.9505	23.9828
Vehicle Related	1.0900	0.0000	4.8519	0.0000	4.2873	0.0000	3.9610	0.0000	3.9033	0.0000	3.7985	0.0000	3.8088	0.0000
School Bus, Transit, and Auto Access	0.1644	1.6449	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	8.5079	17.9149	12.1580	28.1420	10.5753	25.6603	10.1144	27.0924	9.9318	26.2870	10.1142	26.4771	10.1558	26.8316

MOVES Default VMT used in Scenarios: All Default, Test 1 and Test 2 3,782,345,744 (+3.4%)
2009 CLRP & FY 2010-2015 TIP Annual VMT: Scenarios: Mobile6, Test3, Test4, and Test5 3,656,679,479

Table 2-B. 2005 Fairfax County VOC and NOx Emissions (Daily)

	Mobile6		All Default		Test 1		Test 2		Test 3		Test 4		Test 5	
	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx
Start	4.3793	2.3223	9.2690	10.8299	7.5464	8.8248	7.1613	8.1925	7.1613	8.1925	7.1613	8.1925	7.1613	8.1925
Running	10.3411	42.6183	12.4970	72.4390	12.1421	68.7705	9.8865	63.1622	8.7837	56.1168	9.6379	57.4082	9.2842	56.5370
Vehicle Related	2.6348	0.0000	13.2682	2.7107	12.1398	2.0612	9.4312	1.6301	8.9782	1.4483	8.7206	1.0248	8.5089	0.9718
School Bus, Transit, and Auto Access	0.3532	2.0440	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	17.7084	46.9845	35.0342	85.9795	31.8283	79.6564	26.4790	72.9848	24.9232	65.7576	25.5197	66.6255	24.9545	65.7013

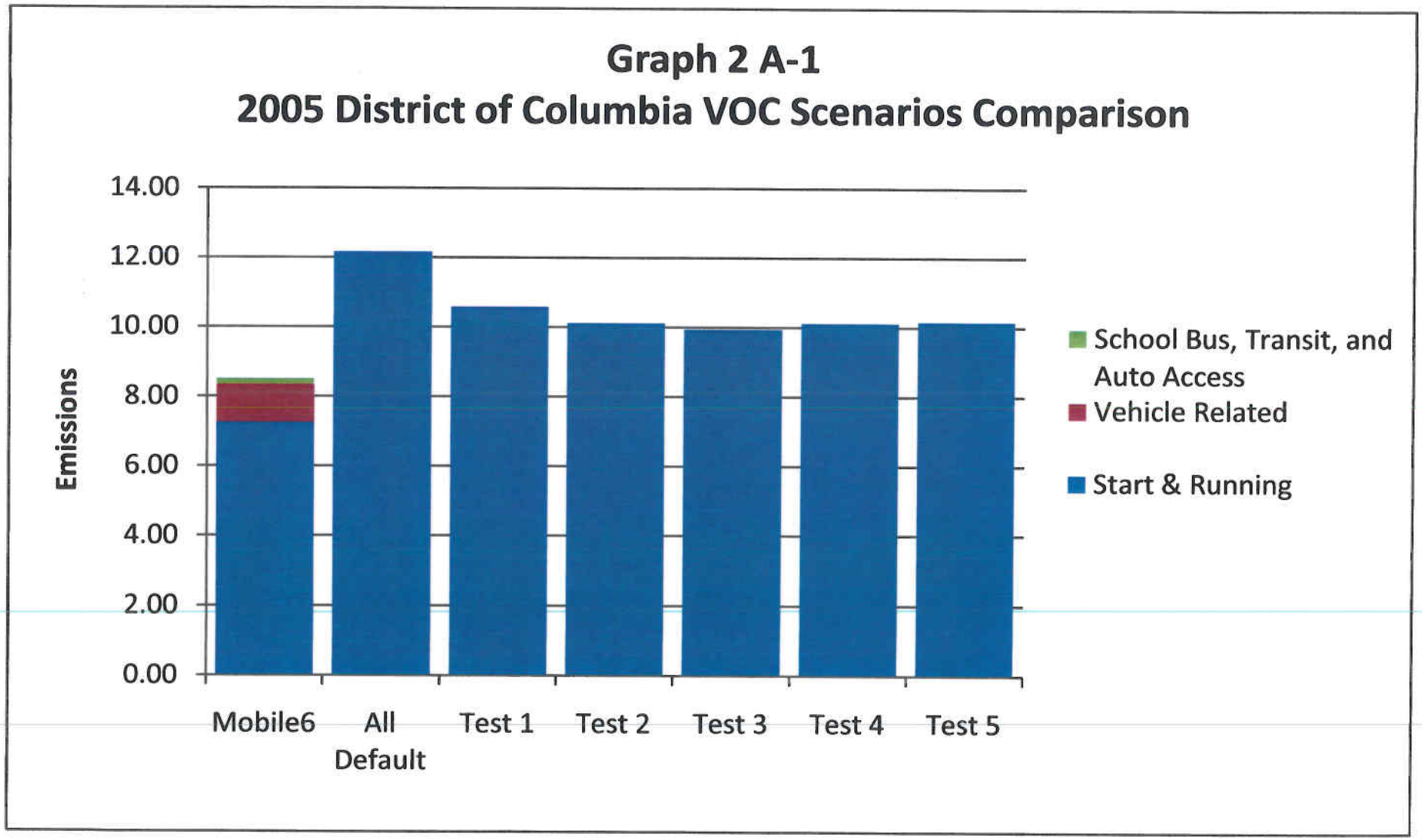
MOVES Default VMT used in Scenarios: All Default, Test 1 and Test 2 10,941,835,896 (+12.6%)
2009 CLRP & FY 2010-2015 TIP Annual VMT: Scenarios: Mobile6, Test3, Test4, and Test5 9,721,332,506

Table 2-C. 2005 Montgomery County VOC and NOx Emissions (Daily)

	Mobile6		All Default		Test 1		Test 2		Test 3		Test 4		Test 5	
	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx
Start	3.8015	2.0324	6.3665	7.4354	6.2654	7.2257	6.2587	6.9398	6.2587	6.9398	6.2587	6.9398	6.2587	6.9398
Running	8.8443	33.6277	8.3776	50.9432	6.9449	40.5545	6.1431	39.3065	6.3221	40.4516	6.4888	39.9264	7.0863	43.2809
Vehicle Related	2.2796	0.0000	9.1000	0.9249	7.9531	0.0000	6.9535	0.8292	7.0179	0.8534	6.7125	0.5223	7.0011	0.7084
School Bus, Transit, and Auto Access	0.3024	2.5402	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	15.2277	38.2003	23.8441	59.3035	21.1634	47.7802	19.3554	47.0756	19.5987	48.2448	19.4601	47.3885	20.3461	50.9291

MOVES Default VMT used in Scenarios: All Default, Test 1 and Test 2 7,631,322,240 (-2.8%)
2009 CLRP & FY 2010-2015 TIP Annual VMT: Scenarios: Mobile6, Test3, Test4, and Test5 7,853,637,397

*Vehicle Related includes "Evap Fuel Leaks" "Evap Vapor Venting" and "Evap Permeation" for VOC
*Vehicle Related of MOVES includes "Extended Idle Exhaust" "Crankcase Extended Idle E" for Nox
*Vehicle Related of MOBILE6 includes "DIURNAL"and "RESTGL" for VOC


Graph 2 A-1
2005 District of Columbia VOC Scenarios Comparison
Emissions
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Mobile6
All Default
Test 1
Test 2
Test 3
Test 4
Test 5
School Bus, Transit, and Auto Access
Vehicle Related
Start & Running

Graph 2 A-2
2005 District of Columbia NOx Scenarios Comparison

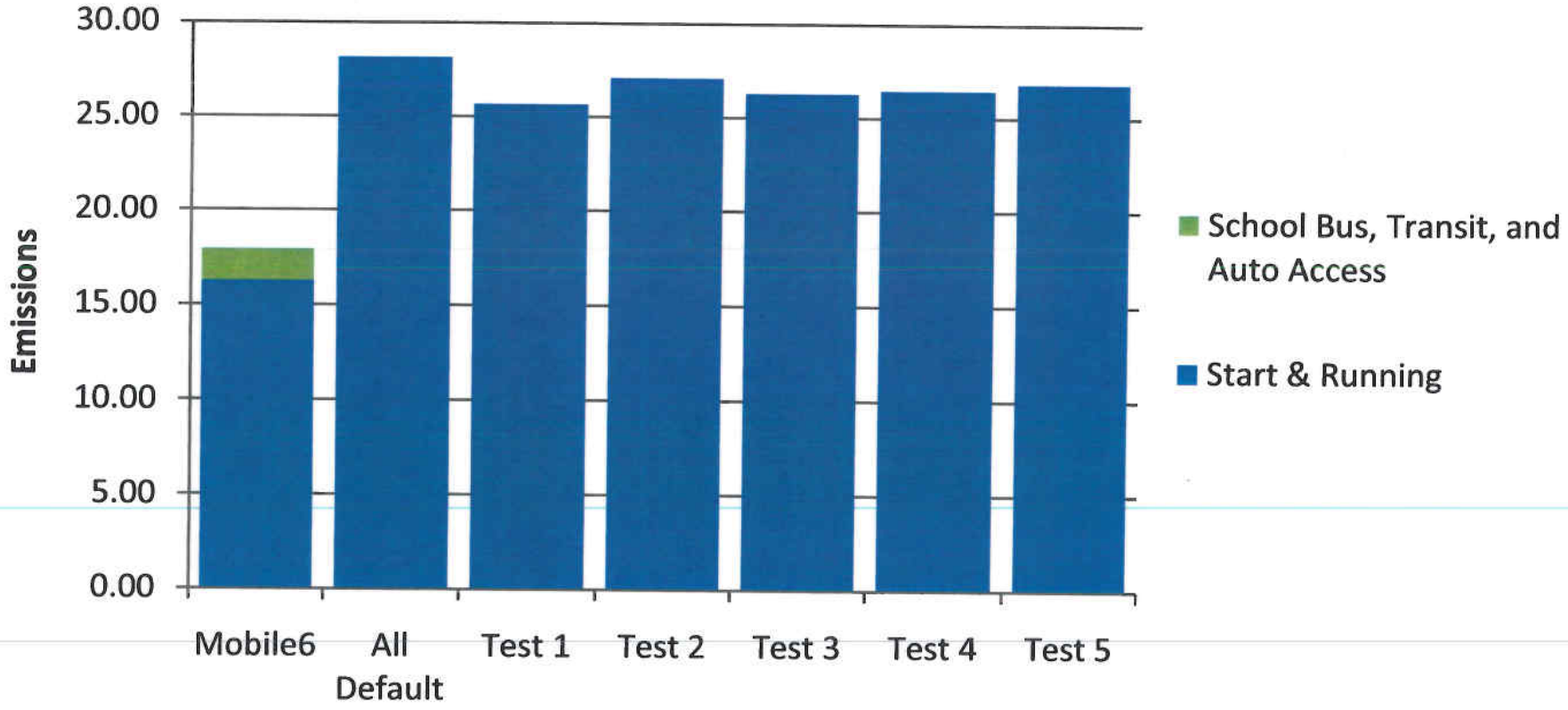


Table 3-A. 2005 District of Columbia CO_2, NOx, PM2.5 Emissions (Annual)

	Mobile6			All Default			Test 5		
DC	CO_2	NOx	PM2.5	CO_2	NOx	PM2.5	CO_2	NOx	PM2.5
Total	**2,105,545**	**7,332**	**128**	**2,196,589**	**9,052**	**259**	**2,145,919**	**8,504**	**235**

MOVES Default VMT used in Scenarios: All Default **3,782,345,744** (+3.4%)
2009 CLRP &FY 2010-2015 TIP Annual VMT used in Scenarios: Mobile6.2 and Test5 **3,656,679,479**

Table 3-B. 2005 Fairfax County CO_2, NOx, PM2.5 Emissions (Annual)

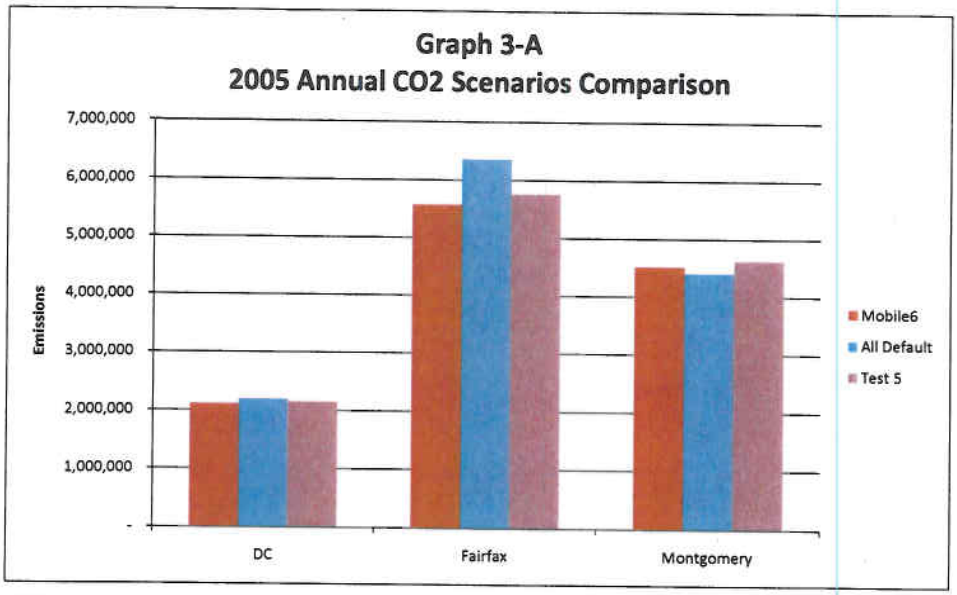
	Mobile6			All Default			Test 5		
Fairfax	CO_2	NOx	PM2.5	CO_2	NOx	PM2.5	CO_2	NOx	PM2.5
Total	**5,563,513**	**18,271**	**323**	**6,360,193**	**28,119.08**	**801**	**5,757,939**	**21,260**	**558**

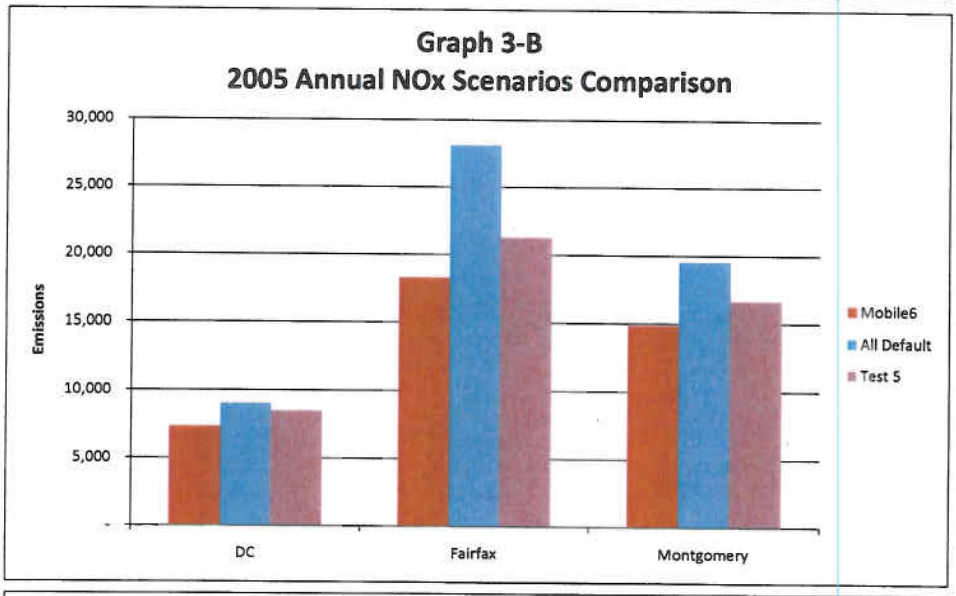
MOVES Default VMT used in Scenarios: All Default **10,941,835,896** (+12.6%)
2009 CLRP &FY 2010-2015 TIP Annual VMT used in Scenarios: Mobile6.2 and Test5 **9,721,332,506**

Table 3-C. 2005 Montgomery County CO_2, NOx, PM2.5 Emissions (Annual)

	Mobile6			All Default			Test 5		
Montgomery	CO_2	NOx	PM2.5	CO_2	NOx	PM2.5	CO_2	NOx	PM2.5
Total	**4,517,969**	**14,879**	**265**	**4,412,013**	**19,542**	**564**	**4,625,768**	**16,655**	**444**

MOVES Default VMT used in Scenarios: All Default **7,631,322,240** (-2.8%)
2009 CLRP &FY 2010-2015 TIP Annual VMT used in Scenarios: Mobile6.2 and Test5 **7,853,637,397**


Graph 3-A
2005 Annual CO2 Scenarios Comparison
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
-
Emissions
DC
Fairfax
Montgomery
Mobile6
All Default
Test 5


Graph 3-B
2005 Annual NOx Scenarios Comparison
30,000
25,000
20,000
15,000
10,000
5,000
-
Emissions
DC
Fairfax
Montgomery
Mobile6
All Default
Test 5

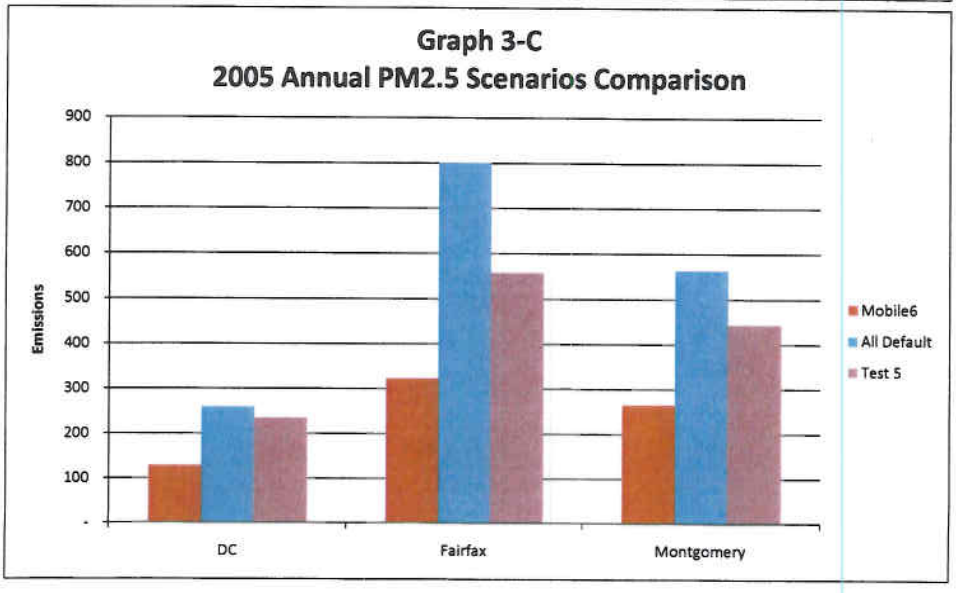

Graph 3-C
2005 Annual PM2.5 Scenarios Comparison
900
800
700
600
500
400
300
200
100
-
Emissions
DC
Fairfax
Montgomery
Mobile6
All Default
Test 5

Table 4-A. 2030 District of Columbia VOC and NOx Emissions (Daily)

	Mobile6		All Default		Test 5	
	VOC	NOx	VOC	NOx	VOC	NOx
Start	0.5800	0.2100	1.3011	1.2013	0.7706	0.6298
Running	2.6100	2.2800	0.6866	8.6973	0.4442	5.8107
Vehicle Related	0.1600	0.0000	1.4855	0.0000	0.8489	0.0000
School Bus, Transit, and Auto Access	0.0716	0.1310	0.0000	0.0000	0.0000	0.0000
Total	**3.4216**	**2.6210**	**3.4732**	**9.8986**	**2.0637**	**6.4405**

MOVES Default VMT used in Scenarios: All Default **5,915,058,949**
2009 CLRP &FY 2010-2015 TIP Annual VMT used in Scenarios: Mobile6.2 and Test5 **3,879,034,614**

Table 4-B. 2030 Fairfax County VOC and NOx Emissions (Daily)

	Mobile6		All Default		Test 5	
	VOC	NOx	VOC	NOx	VOC	NOx
Start	1.4700	0.5100	3.8279	3.5364	3.1882	2.7382
Running	6.1300	7.0700	2.0970	26.6681	1.3847	19.0519
Vehicle Related	0.6600	0.0000	4.0508	4.5139	3.0583	1.2639
School Bus, Transit, and Auto Access	0.1567	0.2279	0.0000	0.0000	0.0000	0.0000
Total	**8.4167**	**7.8079**	**9.9757**	**34.7184**	**7.6312**	**23.0540**

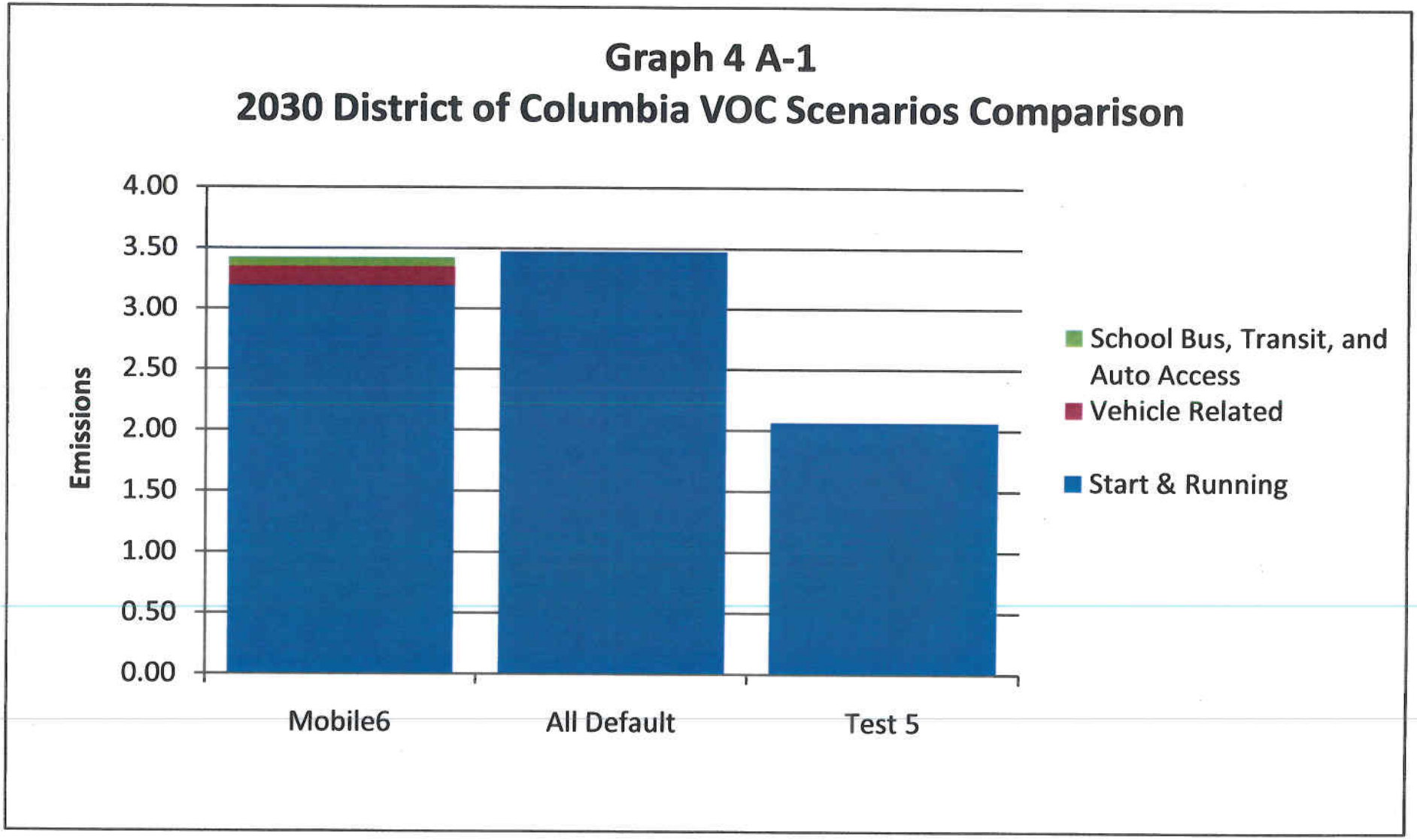
MOVES Default VMT used in Scenarios: All Default **17,124,674,874**
2009 CLRP &FY 2010-2015 TIP Annual VMT used in Scenarios: Mobile6.2 and Test5 **12,147,067,210**

Table 4-C. 2030 Montgomery County VOC and NOx Emissions (Daily)

	Mobile6		All Default		Test 5	
	VOC	NOx	VOC	NOx	VOC	NOx
Start	1.2500	0.3600	2.6292	2.4292	2.9318	2.6199
Running	4.6700	4.7200	1.4882	19.1544	1.0836	14.6409
Vehicle Related	0.5600	0.0000	2.5920	1.5402	2.8214	0.9293
School Bus, Transit, and Auto Access	0.1326	0.2369	0.0000	0.0000	0.0000	0.0000
Total	**6.6126**	**5.3169**	**6.7094**	**23.1238**	**6.8368**	**18.1901**

MOVES Default VMT used in Scenarios: All Default **11,956,770,118**
2009 CLRP &FY 2010-2015 TIP Annual VMT used in Scenarios: Mobile6.2 and Test5 **9,278,680,212**

*Vehicle Related includes "Evap Fuel Leaks" "Evap Vapor Venting" and "Evap Permeation" for VOC
*Vehicle Related of MOVES includes "Extended Idle Exhaust" "Crankcase Extended Idle E" for Nox
*Vehicle Related of MOBILE6 includes "DIURNAL"and "RESTGL" for VOC


Graph 4 A-1
2030 District of Columbia VOC Scenarios Comparison
Emissions
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Mobile6
All Default
Test 5
School Bus, Transit, and Auto Access
Vehicle Related
Start & Running

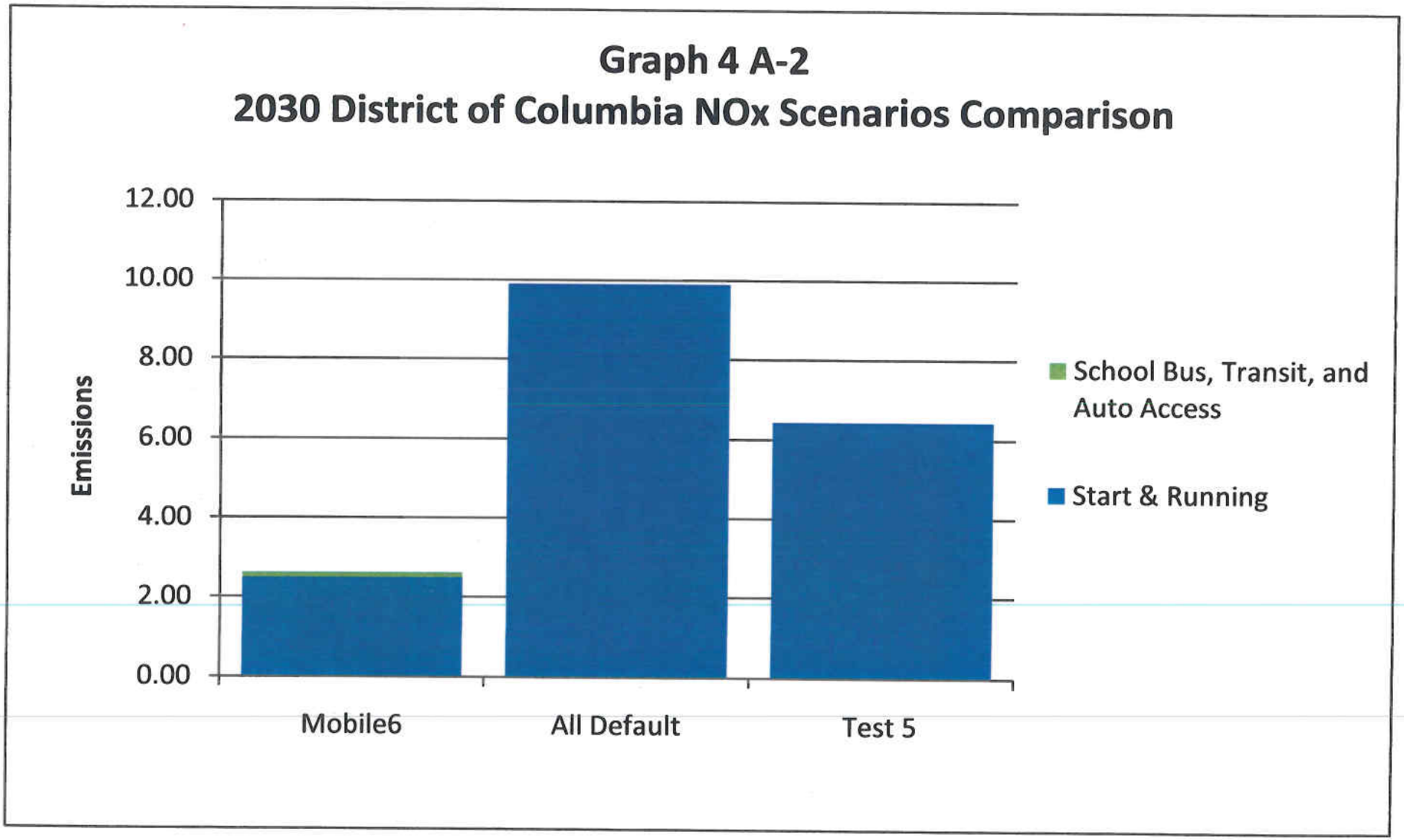

Graph 4 A-2
2030 District of Columbia NOx Scenarios Comparison
Emissions
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Mobile6
All Default
Test 5
School Bus, Transit, and Auto Access
Start & Running

Table 5-A. 2030 District of Columbia CO_2, NOx, PM2.5 Emissions (Annual)

	Mobile6			All Default			Test 5		
	CO_2	NOx	PM2.5	CO_2	NOx	PM2.5	CO_2	NOx	PM2.5
Total	**2,385,764**	**930**	**53**	**3,430,922**	**3,186**	**76**	**2,328,144**	**2,101**	**53**

MOVES Default VMT used in Scenarios: All Default **5,915,058,949** (+52.5%)
2009 CLRP &FY 2010-2015 TIP Annual VMT used in Scenarios: Mobile6.2 and Test5 **3,879,034,614**

Table 5-B. 2030 Fairfax County CO_2, NOx, PM2.5 Emissions (Annual)

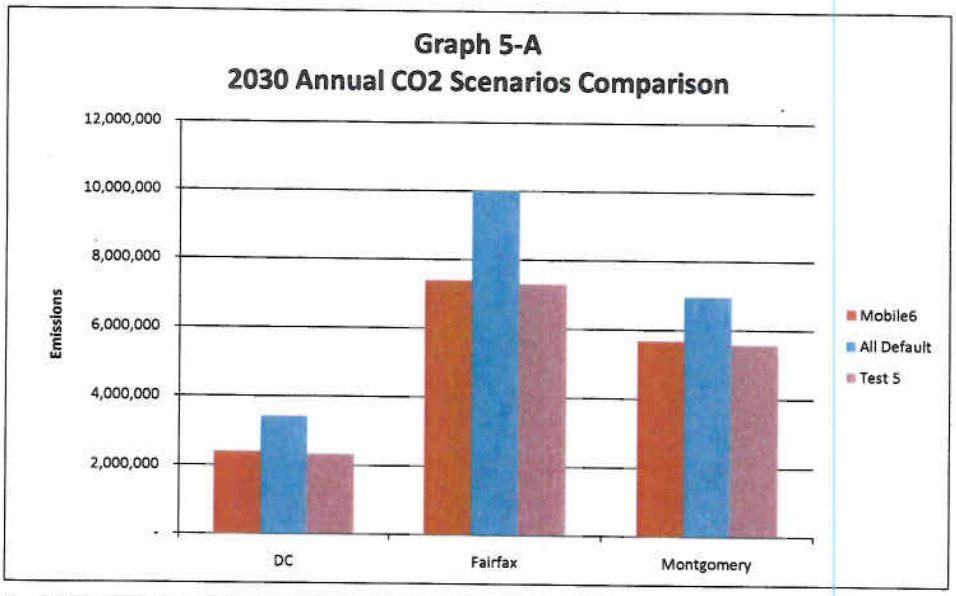
	Mobile6			All Default			Test 5		
	CO_2	NOx	PM2.5	CO_2	NOx	PM2.5	CO_2	NOx	PM2.5
Total	**7,376,825**	**2,819**	**166**	**10,010,415**	**11,513**	**236**	**7,295,234**	**7,698**	**181**

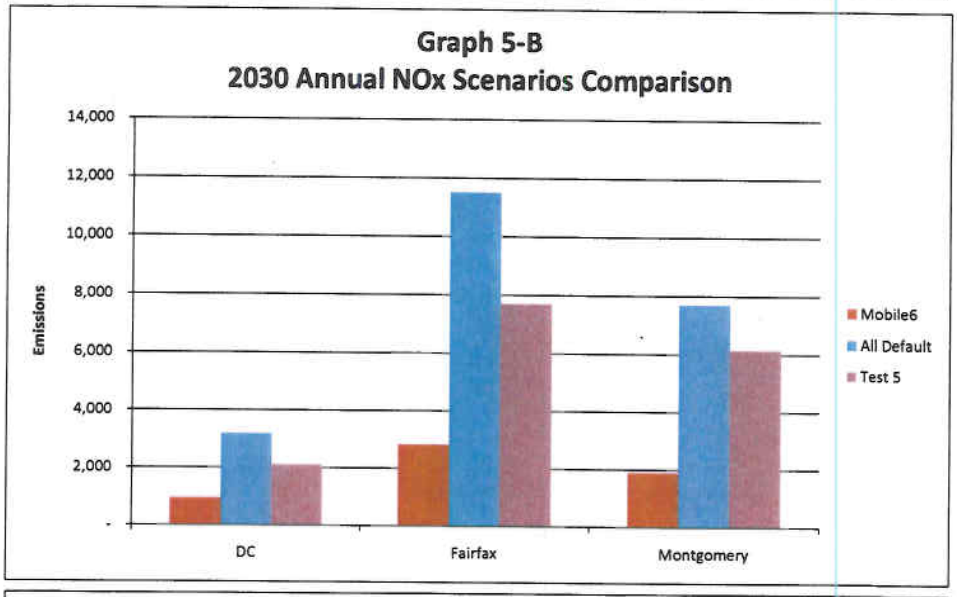
MOVES Default VMT used in Scenarios: All Default **17,124,674,874** (+41.0%)
2009 CLRP &FY 2010-2015 TIP Annual VMT used in Scenarios: Mobile6.2 and Test5 **12,147,067,210**

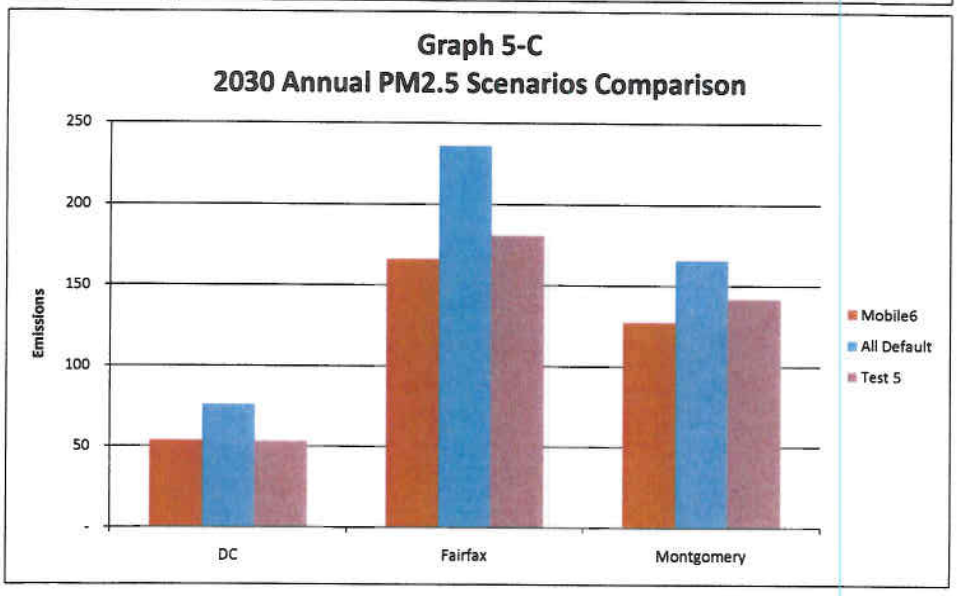
Table 5-C. 2030 Montgomery County CO_2, NOx, PM2.5 Emissions (Annual)

	Mobile6			All Default			Test 5		
	CO_2	NOx	PM2.5	CO_2	NOx	PM2.5	CO_2	NOx	PM2.5
Total	**5,667,991**	**1,884**	**127**	**6,962,133**	**7,695**	**166**	**5,575,079**	**6,156**	**142**

MOVES Default VMT used in Scenarios: All Default **11,956,770,118** (-28.9%)
2009 CLRP &FY 2010-2015 TIP Annual VMT used in Scenarios: Mobile6.2 and Test5 **9,278,680,212**


Graph 5-A
2030 Annual CO2 Scenarios Comparison
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
-
Emissions
DC
Fairfax
Montgomery
Mobile6
All Default
Test 5


Graph 5-B
2030 Annual NOx Scenarios Comparison
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
Emissions
DC
Fairfax
Montgomery
Mobile6
All Default
Test 5


Graph 5-C
2030 Annual PM2.5 Scenarios Comparison
250
200
150
100
50
-
Emissions
DC
Fairfax
Montgomery
Mobile6
All Default
Test 5

Tech Item 7

EPA Releases MOVES2010 Mobile Source Emissions Model: Questions and Answers

Questions and Answers

Q1. What is MOVES2010?

A1. MOVES2010 is the state-of-the-art upgrade to EPA's modeling tools for estimating emissions from highway vehicles, based on analysis of millions of emission test results and considerable advances in the Agency's understanding of vehicle emissions. MOVES2010 replaces the previous model for estimating on-road mobile source emissions, MOBILE6.2.

Q2. Why is EPA replacing MOBILE6.2 with MOVES2010?

A2. The Clean Air Act (CAA) requires EPA to regularly update its mobile source emission models. EPA continuously collects data and measures vehicle emissions to make sure the Agency has the best possible understanding of mobile source emissions. This assessment, in turn, informs the development of EPA's mobile source emission models. MOVES2010 represents the Agency's most up-to-date assessment of on-road mobile source emissions. MOVES2010 also incorporates several changes to the EPA's approach to mobile source emission modeling based upon recommendations made to the Agency by the National Academy of Sciences.

Q3. Can MOVES2010 be used for state implementation plans and transportation conformity?

A3. MOVES2010 can be used to estimate air pollution emissions from cars, trucks, motorcycles, and buses. It will be approved for use in official state implementation plan (SIP) submissions to EPA and for transportation conformity analyses outside of California. It can also be used to estimate the benefits from a range

EPA United States Environmental Protection Agency

Office of Transportation and Air Quality
EPA-420-F-09-073
December 2009

of mobile source control strategies, for more general analyses of national or local emissions trends, and for policy evaluation. MOVES2010 is EPA's best available tool for quantifying criteria pollutant and precursor emissions, as well as for other emissions analyses of the transportation sector.

Prior to this official release of MOVES2010, the MOBILE6.2 motor vehicle emission factor model was the only model approved for performing SIP and transportation conformity analyses outside of California (where the approved model for these analyses is currently the EMFAC2007 model). EPA will be publishing a Federal Register notice of availability in the near future to approve MOVES2010 for official purposes. Upon publication of the Federal Register notice, MOVES2010 will become EPA's approved motor vehicle emission factor model for estimating volatile organic compounds (VOCs), nitrogen oxides (NOx), carbon monoxide (CO), direct particulate matter (PM10 and PM2.5) and other pollutants and precursors from cars, trucks, motorcycles, and buses by state and local agencies outside of California. EPA intends to include in the notice a two-year grace period for using MOVES2010 for transportation conformity purposes.

Q4. When should MOVES2010 be used for SIP and transportation conformity analyses?

A4. In general, EPA believes that MOVES2010 should be used in ozone, CO, PM, and nitrogen dioxide SIP development outside of California as expeditiously as possible. The CAA requires that SIP inventories and control measures be based on the most current information and applicable models that are available when a SIP is developed.

Regarding transportation conformity, EPA and DOT intend to establish a two-year grace period before MOVES2010 is required for new transportation conformity analyses outside of California. EPA will publish a Federal Register notice of availability in the near future to approve MOVES2010 for official purposes.

For more information on the requirements regarding the use of MOVES2010 for SIP and transportation conformity analyses, including implementation of the MOVES2010 conformity grace period, see EPA's "Policy Guidance on the Use of MOVES2010 for State Implementation Plan Development, Transportation Conformity, and Other Purposes," available at www.epa.gov/otaq/stateresources/transconf/policy.htm#models.

Q5. Can MOVES2010 be used to estimate greenhouse gas emissions?

A5. MOVES2010 is currently the best tool EPA has for estimating greenhouse gas (GHG) emissions from the transportation sector. It is a significant improvement over MOBILE6.2 and previous versions of MOVES for GHG estimation. State and local agencies estimating GHG emissions in the transportation planning process should consider using MOVES2010 for GHG emissions analyses in the future.

Q6. Can MOVES2010 be used to estimate mobile source air toxics?

A6. MOVES2010 estimates emissions for the following mobile source air toxics (MSATs): benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, naphthalene, ethanol, and MTBE. MOVES2010 is EPA's best available tool for quantifying emissions of these MSATs. State and local agencies, academic institutions, and other interested parties who are interested in analyzing MSAT emissions from transportation projects are encouraged to use MOVES2010. EPA is working to integrate additional MSATs into the MOVES modeling framework in the near future.

EPA notes that there are no SIP and transportation conformity requirements for air toxics. Regarding the analysis of MSAT emissions in the National Environmental Policy Act (NEPA) process, DOT has responsibility for implementing NEPA for federally-funded or approved transportation projects.

Q7. Why has EPA changed the name of its mobile source model from "MOBILE" to "MOVES"?

A7. The name "MOVES" is an acronym for "Motor Vehicle Emission Simulator." The name change signals the new approach to projecting mobile source emissions being taken in the new model. The MOVES generation of models is not merely an upgrade of the previous MOBILE model using more recent emissions data; it is brand-new software, designed from the ground up to estimate emissions at a more detailed level.

The more detailed approach to modeling allows EPA to easily incorporate large amounts of in-use data from a wide variety of sources, such as data from vehicle inspection and maintenance (I/M) programs, remote sensing device (RSD) testing, certification testing, portable emission measurement systems (PEMS), etc. This approach also allows users to incorporate a variety of activity data to better estimate emission differences such as those resulting from changes to vehicle speed and acceleration patterns. For example, the improvements in MOVES2010 will allow project-level PM2.5 and PM10 emissions to be estimated.

The current version of the model – MOVES2010 – is so named to indicate the first year in which the model may be used in SIPs and conformity determinations, and to clearly distinguish the model from its precursor, Draft MOVES2009.

Q8. What has EPA done to prepare users for the release of MOVES2010?

A8. In April 2009, EPA released "Draft MOVES2009" as a work-in-progress to solicit user comments that were then used to improve the official final version: MOVES2010. In addition to aiding EPA as it worked toward finalizing MOVES2010, the draft model allowed potential users to gain valuable experience with the new input formats for the

MOVES generation of models.

Between the release of Draft MOVES2009 and MOVES2010, EPA and the Federal Highway Administration (FHWA) conducted a total of 20 training sessions across the country for state and local users of the MOVES model. EPA also made training materials available on its website at http://www.epa.gov/otaq/models/moves/index.htm.

In addition to the above training, EPA has developed several documents to assist in implementing MOVES2010, including the following:

"MOVES2010 User Guide": This guide provides detailed instructions for setting up and running MOVES2010. Available at www.epa.gov/otaq/models/moves/index.htm.

"Policy Guidance on the Use of MOVES2010 for State Implementation Plan Development, Transportation Conformity, and Other Purposes": This document describes how and when to use the MOVES2010 emissions model for SIP development, transportation conformity determinations, and other purposes. Available at www.epa.gov/otaq/stateresources/transconf/policy.htm#models.

"Technical Guidance on the Use of MOVES2010 for Emission Inventory Preparation in State Implementation Plans and Transportation Conformity": This document provides guidance on appropriate input assumptions and sources of data for the use of MOVES2010 in SIP submissions and regional emissions analyses for transportation conformity purposes. Available at www.epa.gov/otaq/models/moves/index.htm.

"Transportation Conformity Guidance for Quantitative Hot-spot Analyses in PM2.5 and PM10 Nonattainment and Maintenance Areas": This document explains how to use MOVES2010 to complete hot-spot analyses required for projects of local air quality concern in PM2.5 and PM10 nonattainment and maintenance areas. This guidance is presently under development. When it is available, it will be posted on the EPA's transportation conformity policy guidance website (www.epa.gov/otaq/stateresources/transconf/policy.htm). EPA will be making a draft available for public comment prior to finalizing this guidance.

Q9. How do MOVES2010's inputs and outputs compare to EPA's previous mobile source emission models?

A9. Unlike EPA's previous mobile source emission models, MOVES2010 has a graphical user interface (GUI) which allows users to more easily set up and run the model. More fundamentally, it has been designed to do calculations with information in databases, using the open source database management software known as MySQL.

The database-centered design provides users much greater flexibility regarding output choices. Unlike earlier models which provided emission factors in grams-per-mile in fixed output formats, MOVES2010 output can be expressed as total mass (in tons, pounds, kilograms, or grams) or as emission factors (grams-per-mile and in some cases grams-per-vehicle). Output can be easily aggregated or disaggregated to examine emissions in a range of scales, from national emissions impacts down to the emissions impacts of individual transportation projects.

The database-centered design also allows EPA to update emissions data incorporated in MOVES2010 more easily and will allow users to incorporate a much wider array of activity data to improve estimation of local emissions. For example, the improvements in MOVES2010 will allow project-level PM2.5 and PM10 emissions to be estimated.

Q10. How does MOVES2010 compare to previously released drafts of MOVES?

A10. The first draft release in the MOVES generation of mobile source emission models – MOVES2004 – was a proof-of-concept model that only looked at two aspects of mobile source activity: energy consumption and GHG impacts. MOVES2004 was followed by the MOVES Demo model, which was released in May 2007. MOVES Demo allowed potential users to gain familiarity with what would be the basic structure for subsequent iterations of the model but included only placeholder values for emission rates. MOVES Demo was released to get comments from likely users on the user interface and other model functions. With the release of Draft MOVES2009 in April 2009, EPA provided a more refined version of the model for likely users to test and comment upon.

In response to the comments received regarding Draft MOVES2009, EPA has made many improvements to the model. For example, MOVES2010 runs faster. It includes an improved emission rate calculator that provides "lookup table" results for starts and evaporative emissions as well as exhaust emissions. It eases entry of local fuels, heavy-duty reflash parameters, and other user inputs. MOVES2010 includes the ability to model new pollutants and precursors (sulfur dioxide, ammonia, nitrogen dioxide, and nitric oxide) and includes estimates of emissions from motorcycles. EPA has also expanded the capabilities of MOVES2010 for project-level analyses by including a graphical user interface for such analyses.

EPA also made emission rate improvements based upon newly available data and the comparisons of Draft MOVES2009 results to real-world emission measurements. These changes include improved estimates of emissions from heavy-duty trucks and older light-duty vehicles, as well as improved estimates of emissions at high speeds and accelerations. Because of these changes, inventories and emission rates generated by MOVES2010 will differ from those generated using Draft MOVES2009.

Q11. How do MOVES2010 emission estimates compare to those of MOBILE6.2?

A11. As part of its own internal testing, EPA performed a preliminary comparison of MOVES2010 to MOBILE6.2 using approximate local data for several different urban

counties, each with its own fleet age distribution, fraction of light- and heavy-duty vehicle miles travelled (VMT), local fuel specifications, meteorology, and other input factors. The differences between MOVES2010 and MOBILE6.2 found in this analysis are described below, by criteria pollutant. Actual results will vary based on local inputs in a given area, with local variations in the fleet age distribution and composition having a significant influence on the final results.

For volatile organic compounds (VOCs): For all the urban counties modeled, mobile source VOC emissions were lower using MOVES2010 than previously estimated using MOBILE6.2. This difference is most noticeable for Tier 1 and newer vehicles, especially for evaporative emissions.

For oxides of nitrogen (NOx): Emissions from both light- and heavy-duty trucks are higher than previously estimated. Using MOVES2010 and assuming no change in extended idle activity as a fraction of total activity, EPA projects that uncontrolled extended idle emissions from heavy-duty vehicles will become a significant share of the on-road mobile source NOx inventory in the future. In some urban areas of the country, in fact, extended idle emissions could comprise approximately one quarter of total heavy-duty NOx emissions by 2020. This increase in the fraction of overall emissions represented by idling emissions is due to the fact that new heavy-duty vehicle standards are driving down regular exhaust emissions, making the idle fraction bigger by comparison.

For PM2.5: EPA's estimate of mobile source PM2.5 emissions using MOVES2010 is significantly higher compared to MOBILE6.2 for both light- and heavy-duty vehicles and for all of the urban areas modeled. For passenger cars and light trucks, these increases are based on data developed as part of EPA's Kansas City study, which showed much higher PM2.5 emissions at low ambient temperatures than previously known. For heavy-duty trucks, MOVES2010 incorporates new data from a large study of trucks conducted by the Coordinating Research Council (known as the CRC E-55 study) which includes deterioration effects on in-use emissions. MOVES2010 also models the impact of vehicle speed and load on PM emissions, showing very high rates of PM generation in stop-and-go traffic conditions. This high emission rate consists of the emissions produced while the engine is under increased load while accelerating (i.e., the "go" phase of stop-and-go driving) as well as the emissions produced while the vehicle is stopped and therefore not accumulating any mileage, thus resulting in higher overall emissions per total mile driven.

Q12. What sort of data did EPA use to improve its estimates of vehicle emissions?

A12. Over the last ten years, EPA's in-use data about technologies such as Tier 2, second-generation onboard diagnostics (OBD II), and enhanced evaporative emission control systems have dramatically improved. For MOVES2010, EPA has been able to carefully study these newer technologies, examining millions of results for light-duty vehicles. A detailed analysis of 70,000 vehicles in Arizona's I/M program provided information on how vehicles from the late-1990's and early 2000's age. Other I/M and remote sensing data and special purpose studies helped EPA to better understand trends in VOC, CO,

and NOx emissions for light-duty cars and trucks. In reviewing these data, EPA found little change in CO from our original MOBILE6.2 projections, lower VOC emissions, and a noticeable increase in NOx emissions.

Also in support of MOVES2010 development, the Agency conducted a landmark study of PM emissions, testing nearly 500 gasoline-fueled light-duty cars and trucks in Kansas City, Missouri. Due to the technical difficulties associated with measuring PM emissions, the Kansas City study – a collaborative effort including EPA, DOT, the Department of Energy (DOE), and the automotive and petroleum industries – is currently the largest such study ever conducted. The Kansas City study confirmed that PM emissions from light-duty gasoline-fueled vehicles are higher than earlier predicted, and clearly showed that cold ambient temperatures can dramatically increase PM start emissions. The MOVES2010 model includes these increases in PM start emissions at low temperatures.

EPA's understanding of emissions from heavy-duty vehicles has continued to improve since MOBILE6.2 was issued. Most earlier heavy-duty emission rates were based on certification tests of then-new, mid-1990's engines. For MOVES2010, EPA has been able to analyze data on more than 400 in-use trucks, some in the laboratory and some with on-road measurement equipment. This allowed the Agency to understand how real trucks pollute at a range of speeds and driving conditions. EPA also has been able to better incorporate emissions from heavy-duty diesel crankcase ventilation and from extended idling (also known as "hotelling") – two emission processes that were relatively unstudied at the time MOBILE6.2 was developed. The incorporation of this additional data accounts for the increases in heavy-duty NOx and PM emissions reflected in MOVES2010. Emission differences in MOVES2010 are especially large for heavy-duty PM emissions because they reflect updated data on the effects of both speed and vehicle deterioration not previously available.

Q13. How are the changes in MOVES2010 expected to affect I/M program credit?

A13. In moving from MOBILE6.2 to MOVES2010 users will notice that the emission reductions estimated for individual I/M programs have gone down significantly between the two models. The magnitude of the difference depends upon the criteria pollutant and evaluation year being considered, the design of the I/M program, and local variables, such as fuel composition, average temperature, and the age distribution of the in-use fleet. The main reason for this reduced credit is the continuation of a previously observed trend toward improved, in-use vehicle durability first seen in MOBILE6.2 which is continued for MOVES2010. This is a "good news" story for the environment because it means that in-use, light-duty vehicles are continuing to stay cleaner longer than was previously thought to be the case. One side-effect of the continuation of this trend is that I/M programs (which reduce emissions by identifying cars in need of repair and getting them fixed) will continue to achieve less SIP credit than previously projected because there are fewer and fewer vehicles in need of repair than originally projected.

As part of its testing of MOVES2010, EPA modeled a typical I/M program including onboard diagnostic (OBD) testing on model year (MY) 1996 and newer vehicles and a

loaded-mode tailpipe test on MY1995 and older vehicles; this program was modeled for a 2008 evaluation year using both MOBILE6.2 and MOVES2010. For VOC and NOx, MOBILE6.2 estimated emission reductions from this I/M program of roughly 12% and 17% respectively compared to the no I/M case while MOVES2010 estimated reductions of approximately 5% and 10% from the same I/M program compared to the no I/M case. In other words, for a typical I/M program in 2008, MOVES2010 estimated approximately 40-60% fewer reductions than originally projected by MOBILE6.2. The difference between the two models only grows as a user models later evaluation years because while MOBILE6.2 projects a steady increase in percent I/M reductions for both VOC and NOx, MOVES2010 estimates a relatively constant 5% reduction in VOCs from I/M from 2008 through 2020, while it projects that NOx reductions from I/M drop from approximately 10% in 2008 to 6% in 2020. It should be noted, however, that this comparison is for illustration purposes only. As indicated above, the results for individual I/M program areas will vary significantly due to local variables, such as the design of the I/M program, local fuel composition, average temperature, and the age distribution of the in-use fleet.

Q14. How are the changes in emission rates in MOVES2010 expected to affect attainment demonstrations?

A14. The answer to this question depends upon the unique circumstances of each nonattainment or maintenance area. The emission comparisons depend very heavily on the pollutants of concern, the dates of concern, and on existing local control measures, traffic patterns, fleet age, and the mix of cars and trucks. In some cases, a change from MOBILE6.2 to MOVES2010 may result in increased emissions estimates, while in other cases it may result in decreased emissions estimates for various time periods.

Moreover, because of the complex chemistry and meteorology involved in air pollution, the implications of changes in highway vehicle emissions may not be clear until multiple years are examined and the new emissions levels are applied in an air quality model. Relative differences in emissions over time from MOBILE6.2 to MOVES2010 may be as important as, or more important than, differences between the two models in any one year. Therefore, MOVES2010 users should not immediately assume that increases or decreases in emissions in any single year imply the need for more or fewer SIP control measures until those changes in emissions have been put in the complete SIP context.

When considering how the transition from MOBILE6.2 to MOVES2010 may affect attainment demonstrations, the relative reduction in emissions between a base year and an attainment year is often more important than absolute increases or decreases in emissions. To give users an illustration of how transitioning to MOVES2010 could potentially affect such demonstrations, EPA has performed a comparison of MOVES2010 to MOBILE6.2 using local data for several different urban counties, varying the local data used by fleet age distribution, fraction of light- and heavy-duty VMT, local fuel specifications, meteorology, and other input factors. This preliminary comparison indicates significantly larger relative reductions in PM2.5 using MOVES2010 compared to MOBILE6.2 for all of the urban areas modeled and lower relative reductions of NOx. For VOCs, the results are

mixed, with MOVES2010 projecting higher relative reductions of VOCs in two out of three urban areas modeled, but lower relative reductions in at least one area. As the results for VOCs highlight, results will vary based on local inputs in a given nonattainment area, with local variations in fleet age distribution and composition having a significant influence on the final results.

An increase in emissions due to the use of MOVES2010 may affect an area's ability to demonstrate conformity for their transportation plan and/or transportation improvement program. Areas are encouraged, through the interagency consultation process, to consider if and how MOVES2010 may impact their future conformity determinations and discuss any concerns with the appropriate EPA Regional Office.

Q15. What do users need to know to run MOVES2010?

A15. Users who have participated in the MOVES training offered jointly by EPA and FHWA or who have practical experience with running the model in the form of Draft MOVES2009 will find that, although some new features have been added, their experience will apply well to using the official MOVES2010. In addition, EPA plans to work with FHWA to offer another round of training in support of the release of MOVES2010, including both on-site and webinar-based training. Information concerning these additional training opportunities will be posted on EPA's mobile source model web page at www.epa.gov/otaq/models/moves/index.htm as they are scheduled.

Concerning other recommended training, knowledge of the MySQL database query language is not necessary for simple runs, but it will give users greater flexibility to customize MOVES2010 outputs to meet their needs. For more advanced analyses such as official SIP and/or conformity submissions, it is highly recommended that modelers develop in-house MySQL skills as soon as possible. MySQL training is commercially available from a variety of vendors.

Q16. What are the minimum system requirements for running MOVES2010?

A16. EPA recommends the following minimum system specifications for running MOVES2010: processor – dual-core; memory – 1 GB RAM; storage – 40 GB; operating system: Windows XP or higher. As is often the case when running resource-intensive applications, a faster processor and more memory will allow MOVES2010 to perform user runs more quickly. See the "MOVES2010 User Guide" posted at http://www.epa.gov/otaq/models/moves/index.htm for more details on MOVES system requirements.