Mid-Atlantic Regional Air Management Association

Development of Annual Nonroad Emission Inventory for 2007 in the Northeast/Mid-Atlantic Region

Prepared for:

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Acronyms and Abbreviations

Acronym	Description
CMV	Commercial marine vessels
CO	Carbon monoxide
EDMS	Emissions Data Management Systems
EPA	U.S. Environmental Protection Agency
LTO	Landing and take off
MANE-VU	Mid-Atlantic/Northeast Visibility Union
MARAMA	Mid-Atlantic Regional Air Management Association
NEI	National Emission Inventory
NH3	Ammonia
NIF3.0	National Emission Inventory Input Format Version 3.0
NMIM	National Mobile Inventory Model
NONROAD	no acronym (model name)
NOx	Oxides of nitrogen
PM-CON	Primary PM, Condensable portion only (all < 1 micron)
PM-FIL	Primary PM, Filterable portion only
PM-PRI	Primary PM, includes filterables and condensibles PM-PRI= PM-FIL + PM-CON
PM10-FIL	Primary PM10, Filterable portion only
PM10-PRI	Primary PM10, includes filterables and condensibles, PM10- PRI = PM0-FIL + PM-CON
PM25-FIL	Primary PM2.5, Filterable portion only
PM25-PRI	Primary PM2.5, includes filterables and condensibles PM25-PRI= PM25-FIL + PM-CON
SIP	State Implementation Plan
SCC	Source Classification Code
SO2	Sulfur dioxide
VISTAS	Visibility Improvement State and Tribal Association of the Southeast
VOC	Volatile organic compounds

1.0 ANNUAL EMISSIONS FOR 2007 NONROAD SOURCES

1.1 INTRODUCTION

This technical support document (TSD) explains the data sources, methods, and results for preparing Version 1 of the 2007 criteria air pollutant (CAP) and ammonia (NH3) emission inventory for nonroad sources for the Northeast and Mid-Atlantic/Northeast region. The region includes Connecticut, Delaware, the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia. Local air planning agencies include Philadelphia and Allegheny County, Pennsylvania. The inventory will be used to support air quality modeling, State Implementation Plan (SIP) development, and implementation activities for the regional haze rule and fine particulate matter (PM) and ozone National Ambient Air Quality Standards (NAAQS).

The inventory includes annual emissions for sulfur dioxide (SO2), oxides of nitrogen (NOx), volatile organic compounds (VOC), carbon monoxide (CO), ammonia (NH3), and five components of particulate matter (PM). The PM species in the inventory are categorized as: all filterable and condensable particles with an aerodynamic diameter less than or equal to a nominal 10 and 2.5 micrometers (i.e., PM10-PRI and PM25-PRI); filterable particles with an aerodynamic diameter less than or equal to a nominal 10 and 2.5 micrometers (i.e., PM10-FIL and PM25-FIL); and condensable particles (PM-CON). Note that PM10-PRI equals the sum of PM10-FIL and PM-CON, and PM25-PRI equals the sum of PM25-FIL and PM-CON.

This report provides an overview of the data sources and quality assurance steps used in preparing the 2007 nonroad sector inventory for the MANE-VU States. The nonroad sector is comprised of nonroad engines included in the EPA's NONROAD model, as well as other engines not modeled in NONROAD, including marine vessels, airports and railroad (MAR) activities. .

1.2 NONROAD Model Categories

The EPA's NONROAD model estimates emissions from equipment such as recreational marine vessels, recreational land-based vehicles, farm and construction machinery, and lawn and garden equipment. Aircraft ground support equipment (GSE) and rail maintenance equipment are also included in NONROAD. This equipment is powered by diesel, gasoline, compressed natural gas (CNG) or liquefied petroleum gas (LPG) engines.

The National Mobile Inventory Model (NMIM) was developed by EPA to develop county-level emission estimates for certain types of nonroad equipment. NMIM uses the current

version the NONROAD model. The NMIM national county database contains monthly input data to reflect countyspecific fuel parameters and temperatures. Most of the work associated with executing NMIM involved updating the NMIM county database with State-specific information. For this analysis, we used the NMIM2008 software (version NMIM20090504), the NMIM County Database (version NCD20090531), and NONROAD2008a (July 2009 version) as a starting point. Changes were made to the NCD20090531 based on review of data by the MARAMA States.

1.2.1 State Review of Meteorology Data and Fuel Characteristics

MACTEC extracted the 2007 hourly temperature data and fuel characteristics information from the NMIM model's MySQL database and provided it to each MARAMA State for review and comment.

While several States were not satisfied with the meteorology data, none of them had sufficient hourly county-level data for use in updating the meteorology data. During the review period, MACTEC determined that EPA had developed a 2007 year-specific meteorology data set that they had used to calculate 2007 emissions. MACTEC contacted EPA concerning the NCD that contained the 2007 meteorology and was able to obtain that NCD for use as a starting point for preparing the data sets used for the MARAMA modeling. The NCD obtained from EPA was NCD20090531. According to EPA, NCD20090531 contains fuel revisions for years 2006-2011, along with the revised meteorology data. These fuel values are updates to those in the 2007 EPA NMIM run which used NCD20090327. MARAMA determined that the revised NCD20090531 should be used as a starting point for the 2007 runs that MACTEC performed.

Several States provided comments on the fuel characteristics data and changes were made to the underlying MySQL database to incorporate those changes into the model. These included changes to Reid Vapor Pressure (RVP), sulfur and oxygenate fractions. Not all States provided changes. For those States that did provide changes, MACTEC used the default entries from the NMIM MySQL NCD database as a starting point for updating the data, but created new gasoline types and gasoline type IDs to assign to the corresponding States/counties for use in the model in calculating emissions. Any information contained in the default fuel characteristic tables related to air toxics information was maintained. Only information related to criteria pollutant emission calculations was changed. Thus the fuel types created for the NMIM modeling should NOT be used for any air toxics modeling. In order to further separate the data in the fuel characteristics tables from other modeling efforts, MACTEC created a separate NCD for use exclusively with the MARAMA States for this modeling effort.

The table below shows the number of added gasoline fuel record types added to the "gasoline" table in the MySQL NCD database. The total number of added fuel records was 118 new gasoline types. These records were given GasolineID values of 4462 to 4479 inclusive. All added records applied only to 2007.

State	Number of revised gasoline records
CT	10
MD	48
NH	15
NJ	20
NY	25

Although records were added for NY, they were not used since NY performed all of their own NONROAD modeling (see below).

1.2.2 Update of Allocation Files for Population and Housing

Several categories within the NONROAD model use housing unit or population data to allocate the emissions to the county level from State calculations. MARAMA States had identified some discrepancies with the housing and population data contained in the most current version of the NONROAD model and requested that MACTEC update the allocation files for those categories. As a consequence, MACTEC obtained 1 and 2 unit housing information and updated 2007 population estimates for use in the update process. Data for these source categories were obtained from the following sources:

Source Type	Data Source
2007 Population Data Source	http://www.census.gov/popest/counties/CO-EST2008-01.html
Total Housing Data Source	http://www.census.gov/popest/housing/HU-EST2007-CO.html
1 yr - 1 and 2 Unit Housing Data	2007 American Community Survey 1-Year Estimates
3 yr - 1 and 2 Unit Housing Data	B25024. UNITS IN STRUCTURE - Universe: HOUSING UNITS Data Set: 2005-2007 American Community Survey 3-Year Estimates, Survey: American Community Survey

Three sources for the housing unit data were required in order to completely evaluate all counties within each State for the MARAMA region. Census data are frequently withheld when the data reporting can lead to disclosure of confidential business information or due to incomplete survey response. For the 1 and 2 unit housing data, the predominant source was the 1 year 1 and 2 unit housing data. If that was unavailable due to either confidentiality issues or lack of survey response, then the 3 year data was used by

determining an average value for the three year period. Finally if no data were available for the 3 year 1 and 2 unit housing information, total housing unit data were utilized. The revised housing unit data affected the allocation of residential lawn and garden equipment. Revised allocation files for all MARAMA States (except NY) were developed and utilized in the NMIM modeling for this category.

For the population data, the latest county estimates of population were obtained from the Census Bureau. These estimates were available for all counties within the MARAMA region. Again, revised allocation files were developed for all States within the MARAMA region with the exception of NY. These revised allocation files applied to railroad maintenance equipment and AC/refrigeration equipment.

A revised population allocation file was prepared for NH as part of this effort, but those data were not obtained from the Census Bureau. The NH population data were provided by NH and were obtained from the "2007 Population Estimates of New Hampshire Cities and Towns", New Hampshire Office of Energy and Planning, June 2008." Those data were used in lieu of the Census Bureau data.

In addition, Pennsylvania provided changes to the values for 1 and 2 unit housing for 2007. The source of these data was not cited.

1.2.3 State-Specific Data Incorporated into NMIM

In addition to the global updates to the housing and population allocation files in the MARAMA region, several States submitted additional information used to update the underlying data used to calculate emissions from nonroad sources. The data submitted and the updates resulting from these submittals are discussed below by State.

1.2.3.1 Connecticut

Connecticut only provided updated information related to the gasoline characteristics. No additional changes were submitted.

1.2.3.2 Delaware

Delaware provided revised values for several additional allocation files beyond those for population and housing units. Data for 2005 were submitted and updated files were developed for the following allocation categories: golf courses, recreational marine vessels, snowblowers, number of wholesale establishments, landscaping employees, and manufacturing employees. In addition, Delaware also submitted data on the engine populations for 2005 for the following recreational marine vessels:

2282005010 2-Str Outboard
2282005015 2-Str Personal Water Craft
2282010005 4-Str Inboard/Sterndrive
2282020005 Dsl - Inboard
2282020010 Dsl - Outboard

The updated population values for 2005 were added to the corresponding file for the NONROAD model and was used for the 2007 runs. Because of the way NONROAD handles missing data, if data for 2007 are not found, the most current data (in this case 2005) are used to assist in determining a 2007 value.

1.2.3.3 Maryland

Maryland only provided updated information to the gasoline characteristics. No additional changes were submitted.

1.2.3.4 New Hampshire

As indicated above, New Hampshire provided State-specific population data from their own data source for their counties for use in preparing the population allocation files. A revised population allocation file was prepared for NH as part of this effort, but those data were not obtained from the Census Bureau. The NH population data were provided by NH and were obtained from the "2007 Population Estimates of New Hampshire Cities and Towns", New Hampshire Office of Energy and Planning, June 2008." Those data were used in lieu of the Census Bureau data.

1.2.3.5 New Jersey

New Jersey provided revised gasoline characteristics values as well as NONROAD equipment population data with revised data on equipment population values for Airport Ground Support Equipment. In addition, NJ provided revised human population data for 2002, 2005, 2010, 2015 and 2020. These data (along with the 2007 data generated from the Census Bureau) were added to the NJ population allocation file.

1.2.3.6 New York

New York opted to not have MACTEC calculate emissions using NMIM for their State. Instead, NY calculated their own emissions for the nonroad category and submitted the output files to MACTEC for post processing. The output files submitted by NY were monthly output runs from the NONROAD model for each county. MACTEC simply post-processed these files to combine emissions and throughput values for each county into an

annual emissions number. Summary annual files were submitted to NY by MACTEC for approval. No other work on the NY emissions was performed by MACTEC.

1.2.3.7 Pennsylvania

Pennsylvania provided revised data for the 1 and 2 unit housing information for 2007. Those data were used in lieu of the Census Bureau data for 2007 in the allocation file. The source of these data was not cited.

1.2.4 Run Specification Development for NMIM Runs

The run specifications for each NMIM run were developed on a State-by-State basis. The settings for each specification panel within the NMIM model are detailed below.

- Description: A short descriptive term for the run was entered for each State specific run.
- Geography: The "county" option was selected for each State specific run. All counties within a State were selected for the run.
- Time: On the time panel, the year 2007 was selected in the drop down box and added to the year selections area. The Use Yearly Weather Data check box was also selected. Every month in the Months check box area was selected.
- Vehicles/Equipment: Only the nonroad vehicle/equipment area was selected. All fuels and all vehicle types were selected for each State run.
- Fleet: No selections or information was entered in this panel.
- Pollutants: All criteria pollutants (with HC reported as VOC) were selected except for CO_2. Exhaust PM10 and PM2.5 were also selected.
- Advanced features: Only the server and database were selected in this panel.
- Output: Under the Geographic Representation panel the County selection was made. In the General Output area, a new database was selected on the server for the output.

All added external files for use in each State run were placed in the externalfiles directory of the NCD. Entries for all external files included were added to the countynrfiles table of the NCD.

1.2.5 Summary of NMIM Modeling Results

Exhibit 1 summarizes 2002 emissions for NMIM sources that were developed previously for Version 3 of the MANE-VU and the VISTAS best-and-final inventory for Virginia.

Exhibit 2 summarizes the results of the NMIM modeling discussed in this report for 2007 by State and pollutant. As mentioned previously, New York decided calculate their own emissions using the NONROAD model directly and submitted the output files to MACTEC for post processing.

Exhibit 3 compares the 2002 base year emissions from previous modeling studies to the 2007 emissions. Emissions show modest decreases between 2002 and 2007. There is a large decrease in SO2 emissions largely the result of changes in fuel sulfur contents and also fuel characteristics. Some of the differences result from the application of two different versions of the NONROAD model, NONROAD2005 (for 2002) and NONROAD2008a (for 2007) which were used to calculate emissions.

Exhibit 4 summarizes the projected emissions for NMIM sources that were developed previously for Version 3 of the 2009 MANE-VU projection inventory (and the VISTAS 2009 best-and-final projection inventory for Virginia).

Exhibit 5 compares the 2007 emissions to the 2009 emissions used in previous modeling studies. For all pollutants except CO and NH3, emissions show modest decreases between 2007 and 2009. There is a large decrease in SO2 emissions largely the result of changes in fuel sulfur contents and also fuel characteristics. The increases in CO and NH3 emissions between 2007 and 2009 probably result from the application of two different versions of the NONROAD model, NONROAD2005 (for 2002) and NONROAD2008a (for 2007).which were used to calculate emissions.

Exhibits 6-12 provide a graphical representation of the information presented in Exhibits 1, 2, and 4.

Appendix A is a spreadsheet with emissions summarized by State, pollutant, and source classification code (SCC).

Exhibit 1 – 2002* NMIM Model Results by State (tons/year)

State	CO	NH3	NOX	PM10-PRI	PM25-PRI	SO2	VOC
Connecticut	274,388	17	17,897	1,713	1,578	1,377	33,519
Delaware	65,954	5	5,798	570	525	513	7,531
District of Columbia	18,775	2	3,066	298	288	341	2,053
Maine	148,555	11	8,229	1,204	1,135	772	30,741
Maryland	424,777	28	27,789	3,119	2,870	2,569	53,035
Massachusetts	448,399	28	30,047	2,887	2,659	2,428	54,836
New Hampshire	128,572	9	8,150	947	872	673	22,238
New Jersey	692,548	43	43,515	4,285	3,951	3,525	81,900
New York	1,219,168	79	78,601	8,332	7,670	6,961	155,463
Pennsylvania	903,168	55	62,265	6,281	5,784	5,292	99,241
Rhode Island	71,573	4	4,564	403	371	335	7,699
Vermont	61,732	5	4,170	518	477	368	10,520
Virginia	582,895	42	40,788	4,901	4,665	3,982	53,487
	5,040,503	**328**	**334,878**	**35,459**	**32,844**	**29,136**	**612,262**

* Based on Version 3 of the 2002 MANE-VU emission inventory (and the VISTAS 2002 best-and-final emission inventory for Virginia).

Exhibit 2 – 2007 NMIM Model Results by State (tons/year)

State	CO	NH3	NOX	PM10-PRI	PM25-PRI	SO2	VOC
Connecticut	195,987	18	16,518	1,490	1,414	780	25,593
Delaware	54,473	5	4,949	475	452	265	7,088
District of Columbia	14,895	3	2,760	245	236	193	1,541
Maine	131,347	13	7,468	1,153	1,082	418	29,875
Maryland	305,229	30	25,936	2,692	2,558	1,444	40,157
Massachusetts	349,347	30	27,156	2,513	2,387	1,343	43,245
New Hampshire	95,608	10	7,682	870	821	366	19,878
New Jersey	498,893	46	39,976	3,687	3,501	1,937	63,439
New York*	971,601	100	72,109	7,208	6,847	1,151	126,329
Pennsylvania	726,138	60	55,159	5,595	5,320	2,913	85,060
Rhode Island	54,029	5	4,224	365	347	198	6,708
Vermont	52,503	5	3,749	482	455	203	10,335
Virginia	478,509	45	40,293	4,150	3,954	2,376	54,503
	3,928,559	**369**	**307,979**	**30,927**	**29,375**	**13,586**	**513,750**

* New York emissions were estimated by the State using the NONROAD model directly; other State emissions were calculated by MACTEC using NMIM.

Exhibit 3 – Percentage Change from 2002 to 2007 by State

State	CO	NH3	NOX	PM10-PRI	PM25-PRI	SO2	VOC
Connecticut	-40.0%	6.4%	-8.3%	-15.0%	-11.6%	-76.5%	-31.0%
Delaware	-21.1%	10.5%	-17.2%	-20.0%	-16.1%	-93.5%	-6.2%
District of Columbia	-26.0%	9.1%	-11.1%	-21.8%	-21.9%	-76.9%	-33.2%
Maine	-13.1%	10.4%	-10.2%	-4.5%	-4.9%	-84.7%	-2.9%
Maryland	-39.2%	6.9%	-7.1%	-15.9%	-12.2%	-77.9%	-32.1%
Massachusetts	-28.4%	6.8%	-10.6%	-14.9%	-11.4%	-80.7%	-26.8%
New Hampshire	-34.5%	8.7%	-6.1%	-8.8%	-6.2%	-83.8%	-11.9%
New Jersey	-38.8%	5.6%	-8.9%	-16.2%	-12.8%	-82.0%	-29.1%
New York	-25.5%	21.4%	-9.0%	-15.6%	-12.0%	-504.4%	-23.1%
Pennsylvania	-24.4%	8.6%	-12.9%	-12.3%	-8.7%	-81.7%	-16.7%
Rhode Island	-32.5%	11.1%	-8.0%	-10.2%	-6.9%	-69.5%	-14.8%
Vermont	-17.6%	10.8%	-11.2%	-7.3%	-4.6%	-81.4%	-1.8%
Virginia	-21.8%	5.5%	-1.2%	-18.1%	-18.0%	-67.6%	1.9%
	-28.3%	**11.1%**	**-8.7%**	**-14.7%**	**-11.8%**	**-114.4%**	**-19.2%**

Exhibit 4 – 2009 Projected* NMIM Model Results by State (tons/year)

State	CO	NH3	NOX	PM10-PRI	PM25-PRI	SO2	VOC
Connecticut	280,253	18	14,849	1,407	1,296	249	24,546
Delaware	71,877	6	4,755	456	420	90	5,943
District of Columbia	20,671	3	2,561	226	208	59	1,540
Maine	158,715	13	6,957	1,119	1,030	132	29,030
Maryland	482,312	31	23,431	2,534	2,333	452	39,731
Massachusetts	490,895	31	24,606	2,370	2,184	429	41,473
New Hampshire	139,288	10	6,749	834	768	119	19,476
New Jersey	741,792	45	34,447	3,424	3,154	607	60,878
New York	1,333,923	89	66,645	6,871	6,327	1,208	126,265
Pennsylvania	1,003,480	62	49,982	5,282	4,866	917	82,094
Rhode Island	78,764	4	3,624	337	311	60	5,956
Vermont	67,802	5	3,403	462	426	64	10,076
Virginia	711,278	53	36,653	3,884	3,697	727	54,191
	5,581,048	**371**	**278,662**	**29,205**	**27,018**	**5,114**	**501,197**

* Based on Version 3 of the 2009 MANE-VU projection emission inventory (and the VISTAS 2009 best-and-final projection emission inventory for Virginia).

Exhibit 5 – Percentage Change from 2007 to 2009 by State

State	CO	NH3	NOX	PM10-PRI	PM25-PRI	SO2	VOC
Connecticut	43.0%	2.8%	-10.1%	-5.6%	-8.3%	-68.1%	-4.1%
Delaware	32.0%	0.2%	-3.9%	-4.0%	-7.1%	-65.9%	-16.2%
District of Columbia	38.8%	3.9%	-7.2%	-7.9%	-12.0%	-69.2%	-0.1%
Maine	20.8%	3.8%	-6.8%	-3.0%	-4.8%	-68.5%	-2.8%
Maryland	58.0%	3.0%	-9.7%	-5.9%	-8.8%	-68.7%	-1.1%
Massachusetts	40.5%	2.9%	-9.4%	-5.7%	-8.5%	-68.0%	-4.1%
New Hampshire	45.7%	3.4%	-12.1%	-4.2%	-6.5%	-67.4%	-2.0%
New Jersey	48.7%	-1.0%	-13.8%	-7.1%	-9.9%	-68.7%	-4.0%
New York	37.3%	-11.3%	-7.6%	-4.7%	-7.6%	4.9%	-0.1%
Pennsylvania	38.2%	3.4%	-9.4%	-5.6%	-8.5%	-68.5%	-3.5%
Rhode Island	45.8%	-2.2%	-14.2%	-7.7%	-10.5%	-69.4%	-11.2%
Vermont	29.1%	4.0%	-9.2%	-4.1%	-6.5%	-68.5%	-2.5%
Virginia	48.6%	17.8%	-9.0%	-6.4%	-6.5%	-69.4%	-0.6%
	42.1%	**0.4%**	**-9.5%**	**-5.6%**	**-8.0%**	**-62.4%**	**-2.4%**

Exhibit 6 – Comparison of 2002/2007 Actual and 2009 Projected CO Emissions

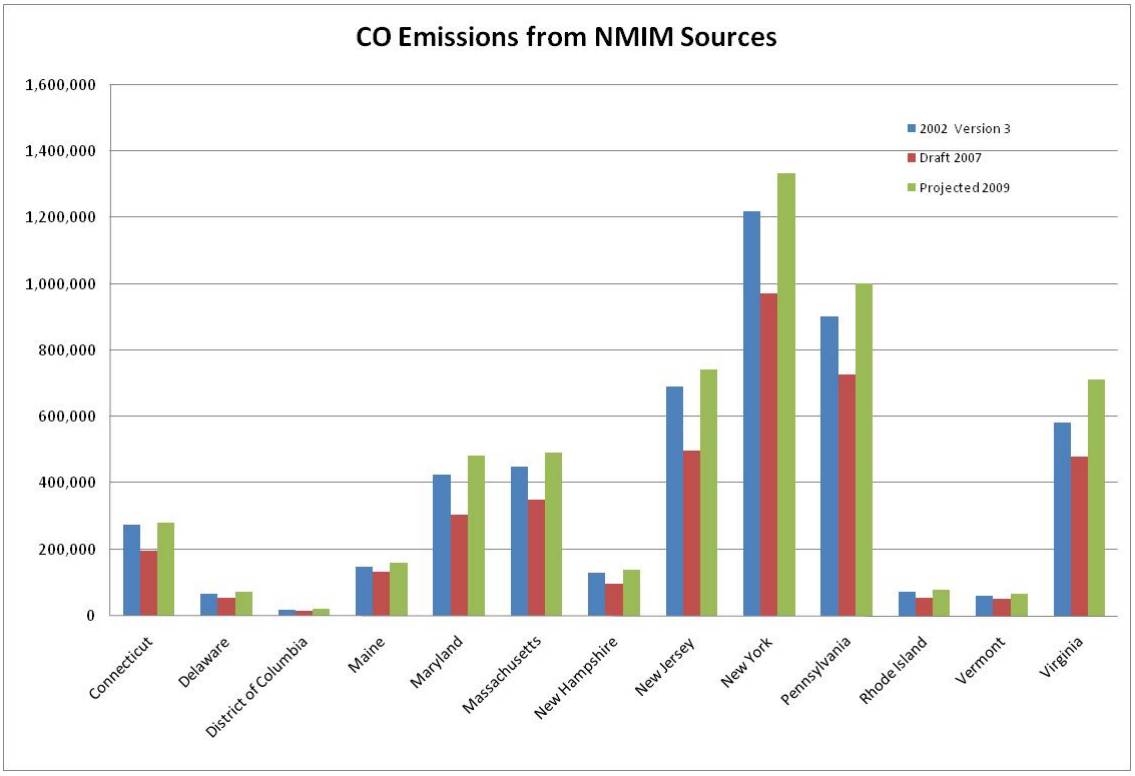


Exhibit 7 – Comparison of 2002/2007 Actual and 2009 Projected VOC Emissions

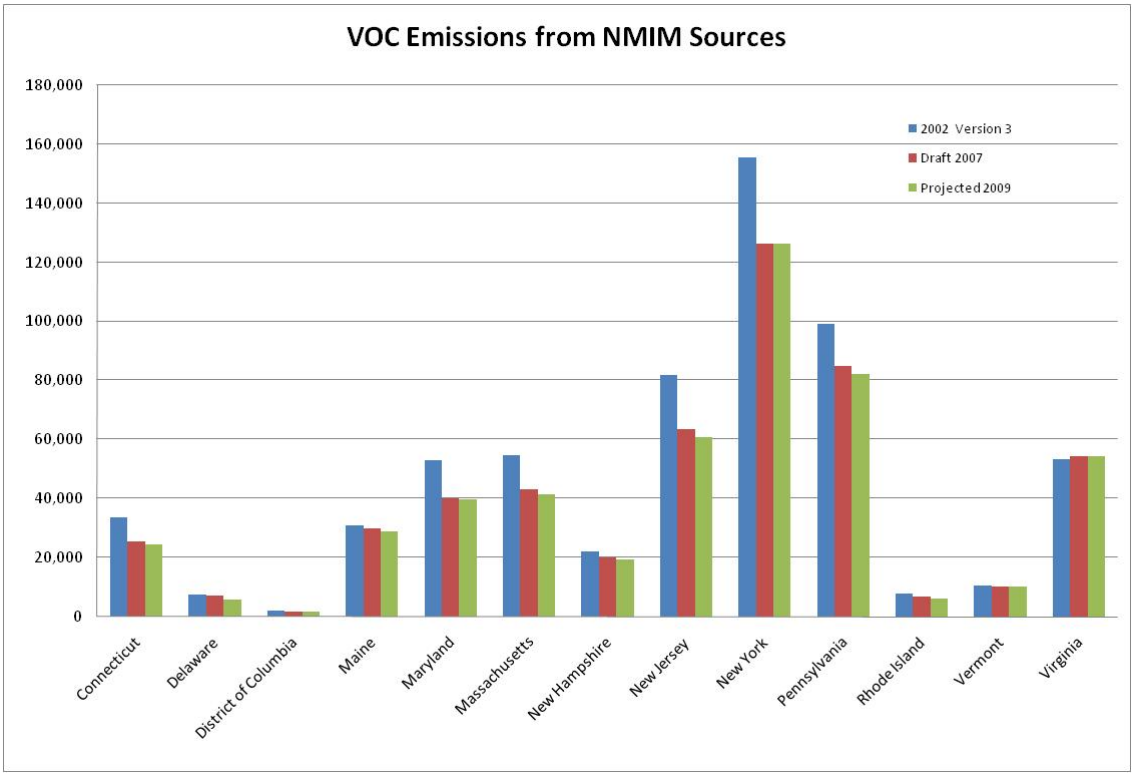


Exhibit 8 – Comparison of 2002/2007 Actual and 2009 Projected NOx Emissions

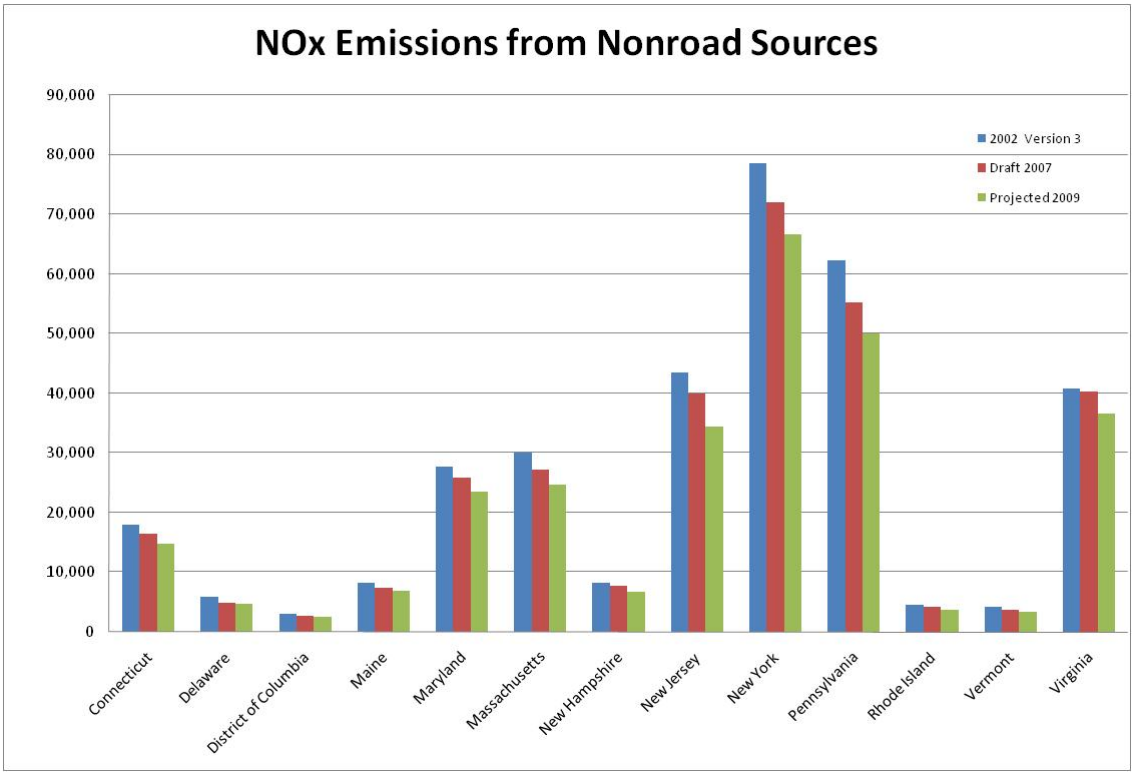


Exhibit 9 – Comparison of 2002/2007 Actual and 2009 Projected SO2 Emissions

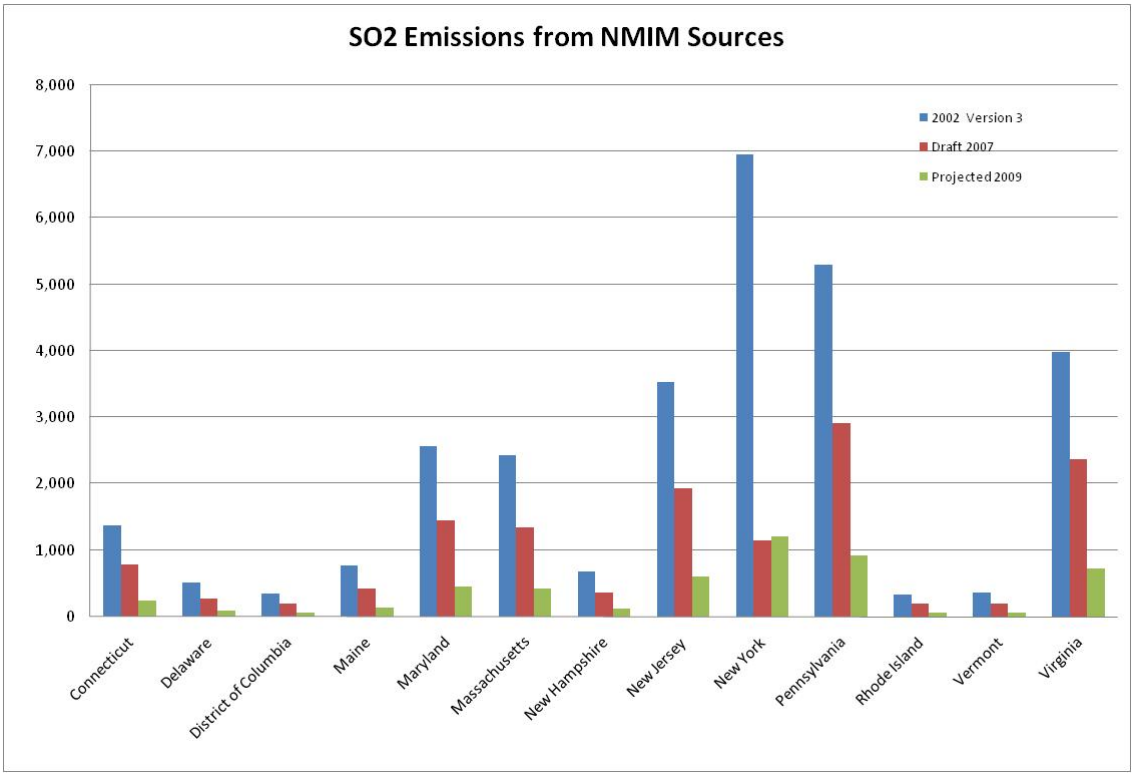


Exhibit 10 – Comparison of 2002/2007 Actual and 2009 Projected PM10 Emissions

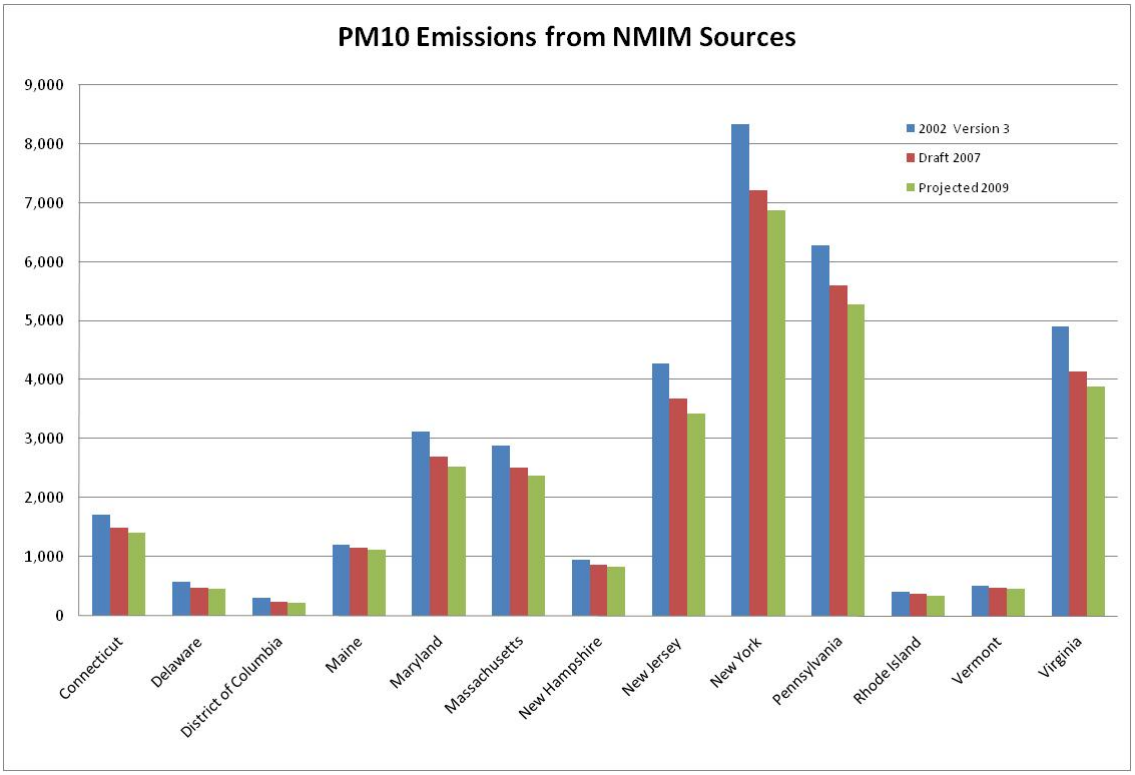
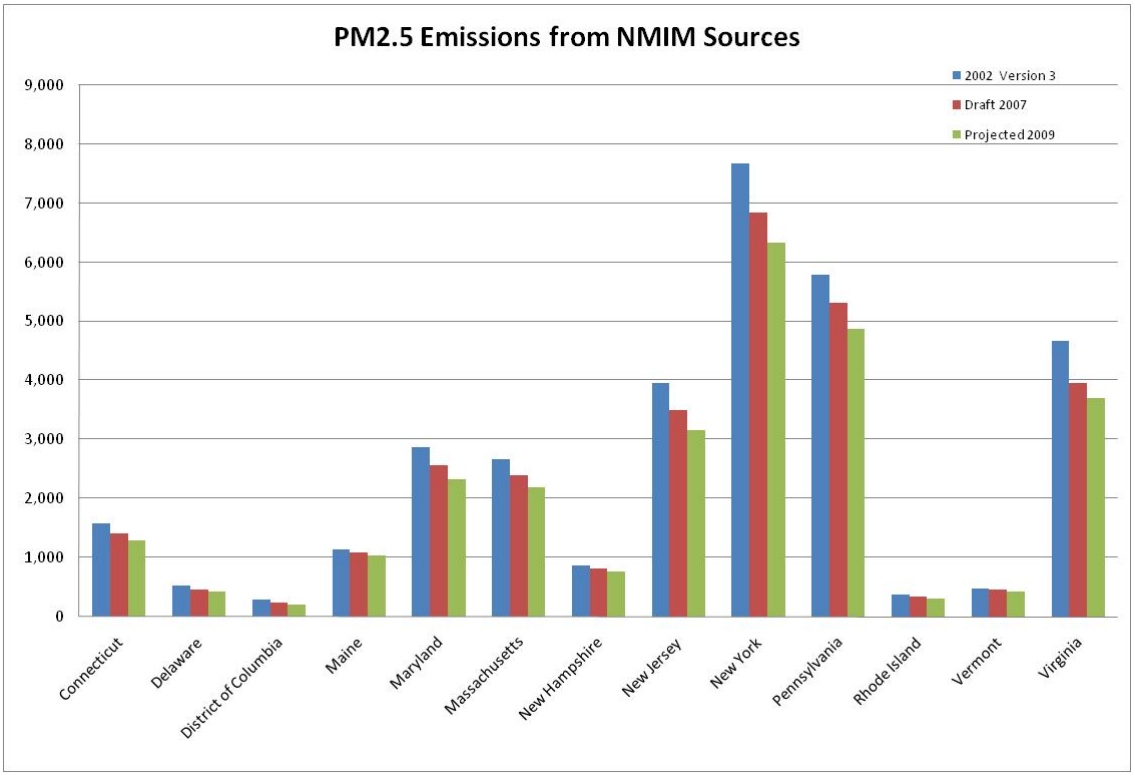


Exhibit 11 – Comparison of 2002/2007 Actual and 2009 Projected PM2.5 Emissions



1.3 Marine, Airport, and Rail (MAR) Categories

Under development

1.3.1 Commercial Marine Vessels

1.3.2 Airports (Aircraft and Ground Support Equipment)

1.3.3 Railroad Locomotives and Railyards

1.4 Stakeholder Review and Comment

Under development