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Massachusetts 2011 Periodic Emissions Inventory

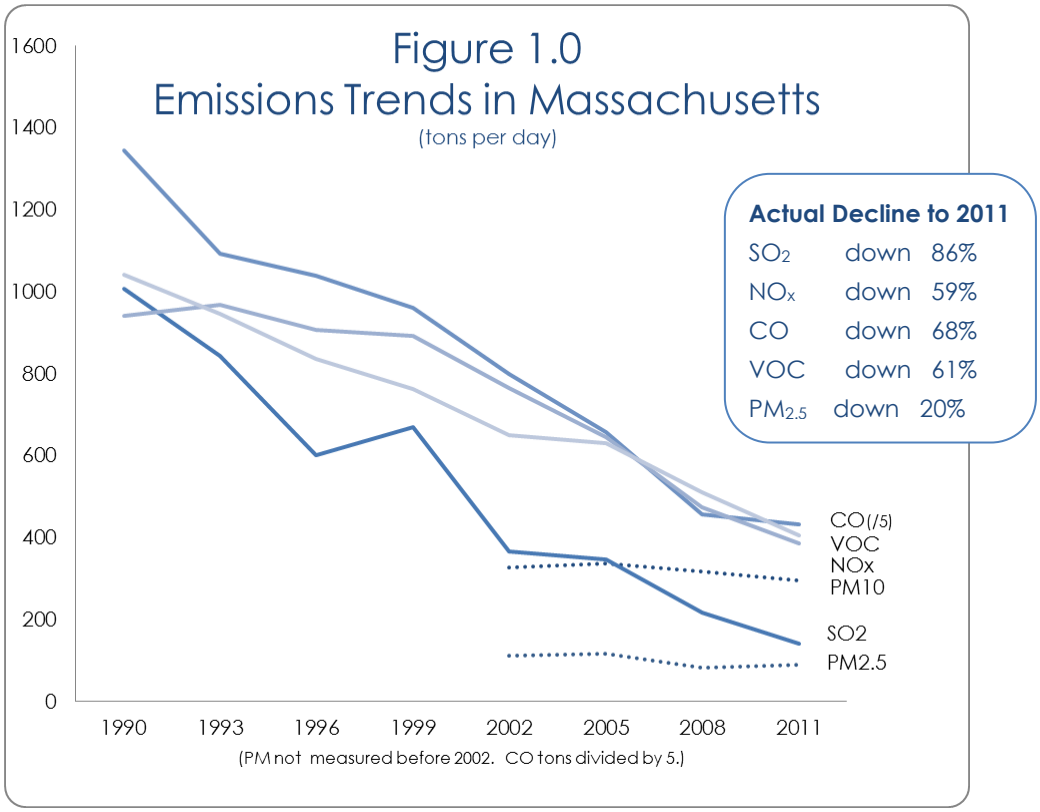
February 9, 2018

SECTION 1 – **SUMMARY**

1.1 INTRODUCTION

The Massachusetts Department of Environmental Protection (MassDEP) developed the Massachusetts 2011 air emissions inventory to support its air quality program and to meet federal inventory requirements for ozone, carbon monoxide, and regional haze (RH) pollutants. The emissions inventory serves as a platform for developing state plans for reducing emissions, demonstrating progress in emission reductions, tracking trends in emissions from various source categories, and developing future emissions projections for use in pollutant modeling.

This 2011 inventory contains estimates of emissions of volatile organic compounds (VOC), nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM), and ammonia (NH_3). It also documents the methods and data used to create the estimates. Figure 1.0 shows the overall downward trend in emissions from Massachusetts sources, demonstrating the success of Massachusetts efforts to improve air quality by reducing emissions.



MassDEP has submitted detailed stationary point, area, and mobile source emissions data to the U.S. Environmental Protection Agency (EPA) for its National Emissions Inventory (NEI)

program. Massachusetts emissions data are summarized in this report and are available separately on EPA's NEI web site (https://www.epa.gov/air-emissions-inventories). Questions about this report may be directed to Kenneth Santlal at kenneth.santlal@state.ma.us

1.2 CONTENTS AND ORGANIZATION

The Massachusetts 2011 emissions inventory includes emissions estimates for a broad range of sources. The table below shows how these are organized. In most cases MassDEP developed its own emission estimates but in some cases MassDEP either fully or partially adopted EPA emission estimates. See the contents table below for the source of each category of emissions.

The Massachusetts 2011 emissions inventory includes this summary document plus a number of text and spreadsheet files (Excel XLSX). These may be found in a zip file on MassDEP's Emissions Inventory website at: https://www.mass.gov/lists/massdep-emissions-inventories

	Auto Refinishing	MA
	Architectural Industrial Maintenance (AIM) Coatings	MA
	AIM Traffic Marking	MA
	AIM High Performance Maintenance Coatings	MA
	AIM Other Specialty Purpose Coatings	MA
	Furniture & Fixtures – Wood	MA
	Metal Furniture	MA
	Metal Can Containers	MA
	Motor Vehicles – New	MA
	Machinery & Equipment	MA
	Appliances	EPA
	Other Transport Equipment – Aircraft	EPA
	Other Transport Equipment – Marine	MA
	Other Transport Equipment – Rail	EPA
	Metal – Sheet, Strip, Coil	MA
	Factory Finished Wood	MA
	Electronic Insulation & Coating	MA
	Misc. Manufacturing & Other Product Coating	MA
	Paper Film & Foil Coating	MA
	Cutback Asphalt	MA
	Emulsified Asphalt	EPA
	Agricultural Pesticide Use	EPA
	Non-Agricultural Pesticide Use	EPA
	Bakeries	MA
	Breweries/Wineries/Distillers	MA
	Petroleum spills	MA
	Asphalt Roof, Kettles & Tanks	MA
	Leaking USTs	MA
3.4	**Fuel Combustion MA 2011.docx**	
	Fuel Use – Residential	MA/EPA
	Fuel Use –Commercial/Institutional	MA
	Fuel Use – Small Industrial	MA
	Open Burning	EPA
	Fires / Cooking	EPA/MA
3.5	**Agricultural Livestock & Other Animals**	
	Agricultural Livestock	EPA/CMU
	Humans	EPA/CMU
	Cats & Dogs	EPA/CMU

Wild Animals	EPA/CMU
Soils	EPA/CMU
Agricultural Fertilizer Application	EPA/CMU
Agricultural Tilling	EPA
3.6 Fugitive Dust	
Construction – Residential/ Non-Residential/ Road	EPA
Mining & Quarrying	EPA
Paved Roads	EPA
Unpaved Roads	EPA
SECTION 4 – ON-ROAD MOBILE SOURCES	
MOVES Inputs	EPA/MA
MOVES Inputs MIDDLESEX	EPA/MA
MOVES Inputs HAMPDEN	EPA/MA
MOVES LEV Script	EPA/MA
SECTION 5 – OFF-ROAD MOBILE SOURCES	
5.1 Aircraft	EPA
5.2 Railroad Locomotives	EPA/MA
5.3 Commercial Marine Vessels	EPA
5.4 Non-Road Engines	EPA/MA

1.3 CLEAN AIR ACT REQUIREMENTS

The federal Clean Air Act (CAA)[1] and EPA regulations require that states compile and submit to EPA estimates of certain air pollutants emitted from sources within their borders. States that do not meet one or more of the National Ambient Air Quality Standards (NAAQS)[2] must develop State Implementation Plans (SIPs) that include emission inventories of pollutants that contribute to non-attainment.

Ozone Emissions Inventory. EPA's 1991 emission inventory guidance for ozone SIPs required non-attainment states like Massachusetts to submit an emissions inventory of ozone precursors to EPA every three years starting with 1990 as the base year.[3] Massachusetts is designated unclassifiable/attainment for all NAAQS, except for the 2008 ozone standard in Dukes County, which includes Martha's Vineyard. While officially designated as marginal non-attainment for the 2008 ozone standard, Dukes County did attain the 2008 ozone standard by the deadline for marginal nonattainment areas of December 15, 2015, and then was designated

[1] CAA Sect. 172 (c)(3).
[2] NAAQS are set for six criteria pollutants: ozone, nitrogen dioxide, particulate matter, carbon monoxide, sulfur dioxide, and lead. See: http://www.epa.gov/air/criteria.html
[3] EPA *Emission Inventory Requirements for Ozone State Implementation Plans* – EPA Office of Quality Planning and Standards EPA-450/4-91-010 March 1991.

unclassifiable/attainment for the 2015 ozone standard in November 2017.[4][5] As part of the SIP for Dukes County, MassDEP must submit a 2011 emissions inventory for ozone precursors for a typical summer day, because summer is when the highest ozone levels occur.[6] Ozone precursors include VOC, NO_x, and to a lesser extent, CO. Dukes County emissions are presented in Tables 1.3 and 1.4. Dukes County contributes less than 2% of Massachusetts ozone precursor emissions.

CO Emissions Inventory. Massachusetts was previously designated non-attainment for CO in certain large metropolitan areas, including the Boston Metropolitan area, Lowell, Waltham, Worcester, and Springfield. Massachusetts now is designated attainment for CO statewide, but must continue to inventory CO as part of its 10-year Maintenance Plans. CO inventories estimate CO on a typical winter day since CO is a localized, primarily vehicle-related pollutant and the highest CO levels occur during the winter months.

Regional Haze Emissions Inventory. Pollutants that contribute to regional haze include VOC, NO_x, CO, particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), and ammonia (NH_3). EPA's regional haze rule at 40 CFR 51.308(d)(4)(v) requires all states that contribute to visibility impairment to develop regional haze SIP inventories as part of the effort to address visibility in designated Class I areas. Massachusetts does not have any Class I areas, but its emissions sources contribute to visibility degradation in several Class I areas in New Hampshire, Vermont and Maine.[7] EPA's regional haze rule requires Massachusetts to submit 5-year progress reports and 10-year SIP revisions demonstrating progress towards visibility goals based on these inventories. The 2011 inventory supports regional haze inventory projection and modeling efforts necessary for completion of the next required regional haze progress report and SIP update.

1.4 INVENTORIED POLLUTANTS

Annual Emissions and Ozone Season Day Emissions. The 2011 emissions inventory contains estimates of annual emissions for calendar year 2011 reported as tons per year (TPY). In addition, estimates of daily emissions during the summer are presented for ozone precursors (VOCs, NO_x, and CO) in tons per summer day (TPSD) and during the winter for CO in tons per winter day (TPWD).

[4] EPA designated Dukes County as marginal nonattainment on July 20, 2012 (Federal Register, Vol. 77, No. 98, Monday, May 21, 2012; 40 CFR Part 81, *Air Quality Designations for the 2008 Ozone National Ambient Air Quality Standards)*; http://www.gpo.gov/fdsys/pkg/FR-2012-05-21/pdf/2012-11618.pdf

[5] 40 CFR Part 81, Air Quality Designations for the 2015 Ozone National Ambient Air Quality Standards (NAAQS); Final rule.(82 FR 54232, November 16, 2017); https://www.federalregister.gov/documents/2017/11/16/2017-24640/air-quality-designations-for-the-2015-ozone-national-ambient-air-quality-standards-naaqs

[6] See *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements* (Federal Register / Vol. 80, No. 44 / Friday, March 6, 2015; 40 CFR Parts 50, 51, 52, 70, and 71) http://www.gpo.gov/fdsys/pkg/FR-2015-03-06/pdf/2015-04012.pdf

[7] Massachusetts Regional Haze SIP, Aug 9, 2012. http://www.mass.gov/eea/docs/dep/air/priorities/rghzsipf.pdf

EPA's ozone standards implementation rule[8] requires that states estimate ozone precursors emitted during the peak ozone season in ozone non-attainment areas. The peak ozone season for Massachusetts is May through September, with most ozone exceedances occurring during the summer months of June, July, and August. MassDEP used the operating schedules reported by point source facilities in days per week, weeks per year, and quarterly throughput to apportion annual emissions to estimate typical summer day emissions (see Section 2). MassDEP estimated summer day emissions for area sources by using daily, weekly, and monthly activity data if available for a source category, or by applying a temporal adjustment factor to annual data. As described in Sections 4 and 5, Onroad and NONROAD model emissions were estimated for a typical summer day with representative temperatures and fuel characteristics as the key inputs.

For CO non-attainment areas, EPA requires the CO emissions inventory to reflect conditions when peak CO concentrations occur. For most areas in the country, including Massachusetts, the peak CO season occurs in the winter months of December, January, and February. MassDEP estimated CO winter day emissions in tandem with the typical summer day estimation methods described above. Although Massachusetts no longer has CO non-attainment areas, MassDEP continues to estimate winter day emissions of CO to track emission trends as part of its 10-year CO Maintenance Plans.

Pollutants. The Clean Air Act requires EPA to set NAAQS for six common air pollutants known as "criteria pollutants." The criteria pollutants are ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, particulate matter (PM_{10} and $PM_{2.5}$), and lead. EPA calls these pollutants "criteria" air pollutants because it regulates them by developing human health-based and/or environmentally-based criteria (science-based guidelines) for setting permissible levels. MassDEP inventories the following criteria pollutants and precursors to criteria pollutants:

> **VOCs** (volatile organic compounds) are compounds of carbon that participate in atmospheric photochemical reactions. VOCs are not a criteria pollutant but are precursors of ozone. VOCs are emitted from solvent use or fuel combustion from industrial, commercial/institutional, and residential stationary sources; on-road and off-road mobile sources; and biogenic sources (e.g., trees).
>
> **NO_x** (nitrogen oxides) are emitted from fuel combustion by on-road and off-road mobile sources, and from industrial, electric generation, commercial/institutional, and residential stationary sources. NO_x is a precursor of ozone. Nitrogen dioxide (NO_2) is one of the major components of NO_x and EPA's NAAQS uses NO_2 as the indicator for the larger group of nitrogen oxides. NO_x also contributes to acid rain formation and regional haze.
>
> **CO** (carbon monoxide) is generally emitted from the same combustion processes that produce NO_x. CO is a criteria pollutant and also a minor precursor of ozone.

[8] See *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements* (Federal Register / Vol. 80, No. 44 / Friday, March 6, 2015; 40 CFR Parts 50, 51, 52, 70, and 71) http://www.gpo.gov/fdsys/pkg/FR-2015-03-06/pdf/2015-04012.pdf

SO_2 (sulfur dioxide) is one of a group of highly reactive gasses known as oxides of sulfur. The largest sources of SO_2 emissions are from fuel combustion at power plants and other industrial facilities. SO_2 is a criteria pollutant and also contributes to regional haze and acid rain.

PM (particulate matter) is a mixture of tiny particles in the air, including dust, dirt, soot, smoke, and liquid droplets. In this inventory, PM refers to "primary" PM – particles that enter the atmosphere as direct emissions from a stack or other source. Secondary PM refers to particles that form through chemical reactions in the ambient air. Sources of primary PM include industrial processes, solvent use, fuel combustion, incinerators, power plants, and motor vehicles. PM_{10}-PRI refers to coarse particles equal to or smaller than 10 micrometers in diameter. $PM_{2.5}$-PRI refers to particles less than or equal to 2.5 micrometers in diameter (or about one-thirtieth the diameter of an average human hair). Note that large stationary source emissions are collected through MassDEP's Source Registration program that collects PM emissions as filterable PM (primary PM less condensable PM). Therefore, emissions from large stationary sources are reported in this inventory as filterable PM ($PM_{2.5}$-FIL/PM_{10}-FIL). PM_{10} and $PM_{2.5}$ are criteria pollutants and also contribute to regional haze.

NH_3 (ammonia) is a precursor of $PM_{2.5}$ and contributes to regional haze. NH_3 is emitted from large industries, waste treatment facilities, wood-burning, animal wastes, fertilizers, soils, and mobile sources.

Pb (lead) emissions reporting has been phased out with the introduction of unleaded gasoline in the 1970s nationally by EPA. There are no sources of Pb in Massachusetts that report over the EPA point source threshold of 0.5 tons per year. The total of all point source Pb emissions in Massachusetts is 0.789 tons per year. General aviation from light aircraft piston engines also are a minor emitter of Pb and all of Massachusetts airports are below the EPA threshold. Leaded aviation gasoline used by piston engines is being phased out over time. Because Pb emissions in Massachusetts have been below EPA's reporting threshold, it is not inventoried in this report.

1.5 EMISSIONS INVENTORY BY SOURCES AND TRENDS

Emissions Sources in 2011. Figures 1.1 through 1.8 show the source contribution for each pollutant, which also is provided in Tables 1.1 and 1.2 in Section 1.7.

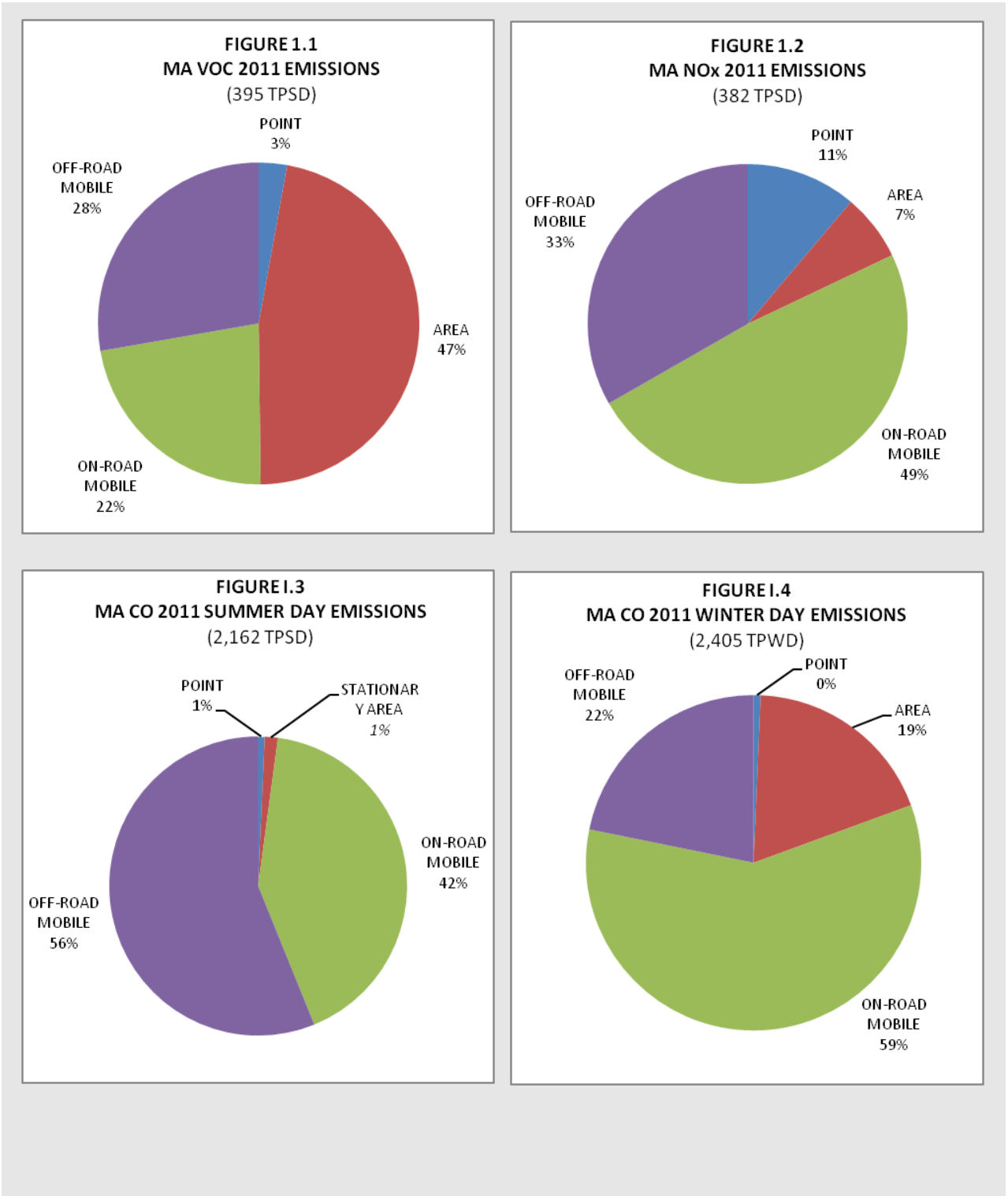


FIGURE I.5
MA SO2 2011 ANNUAL EMISSIONS
(51,742 TPY)

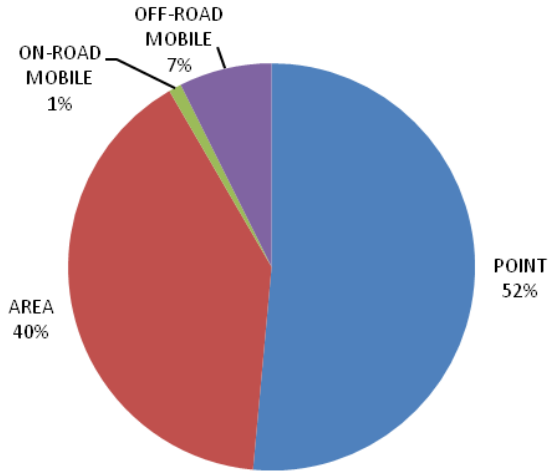


FIGURE I.6
MA NH3 2011 ANNUAL EMISSIONS
(20,687 TPY)

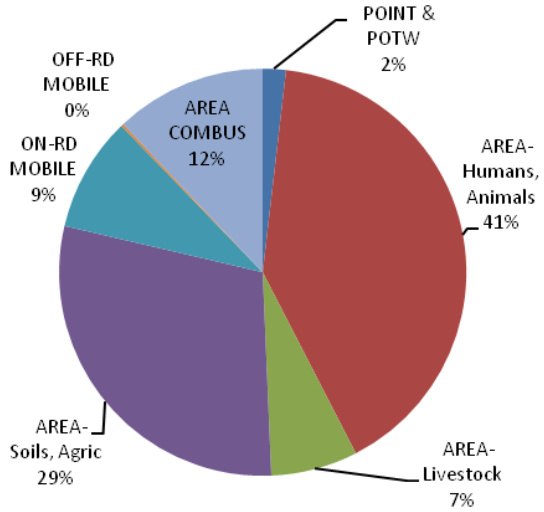


FIGURE 1.7
MA PM10-PRI 2011 ANNUAL EMISSIONS
(107,965 TPY)

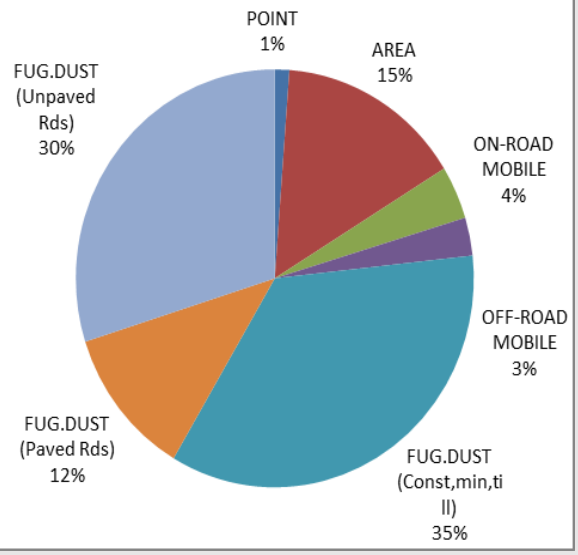
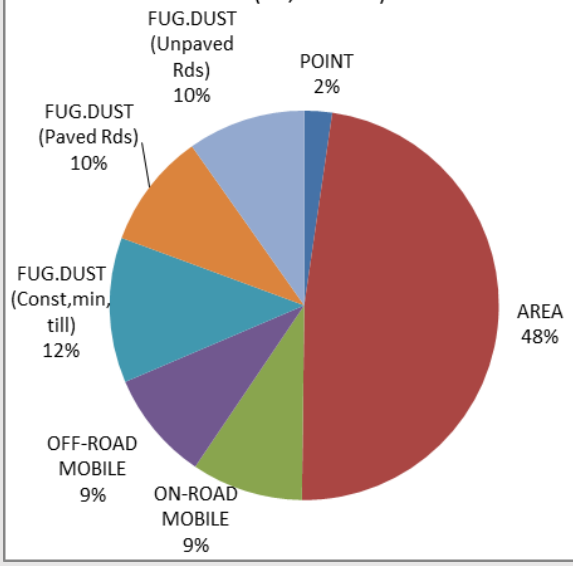
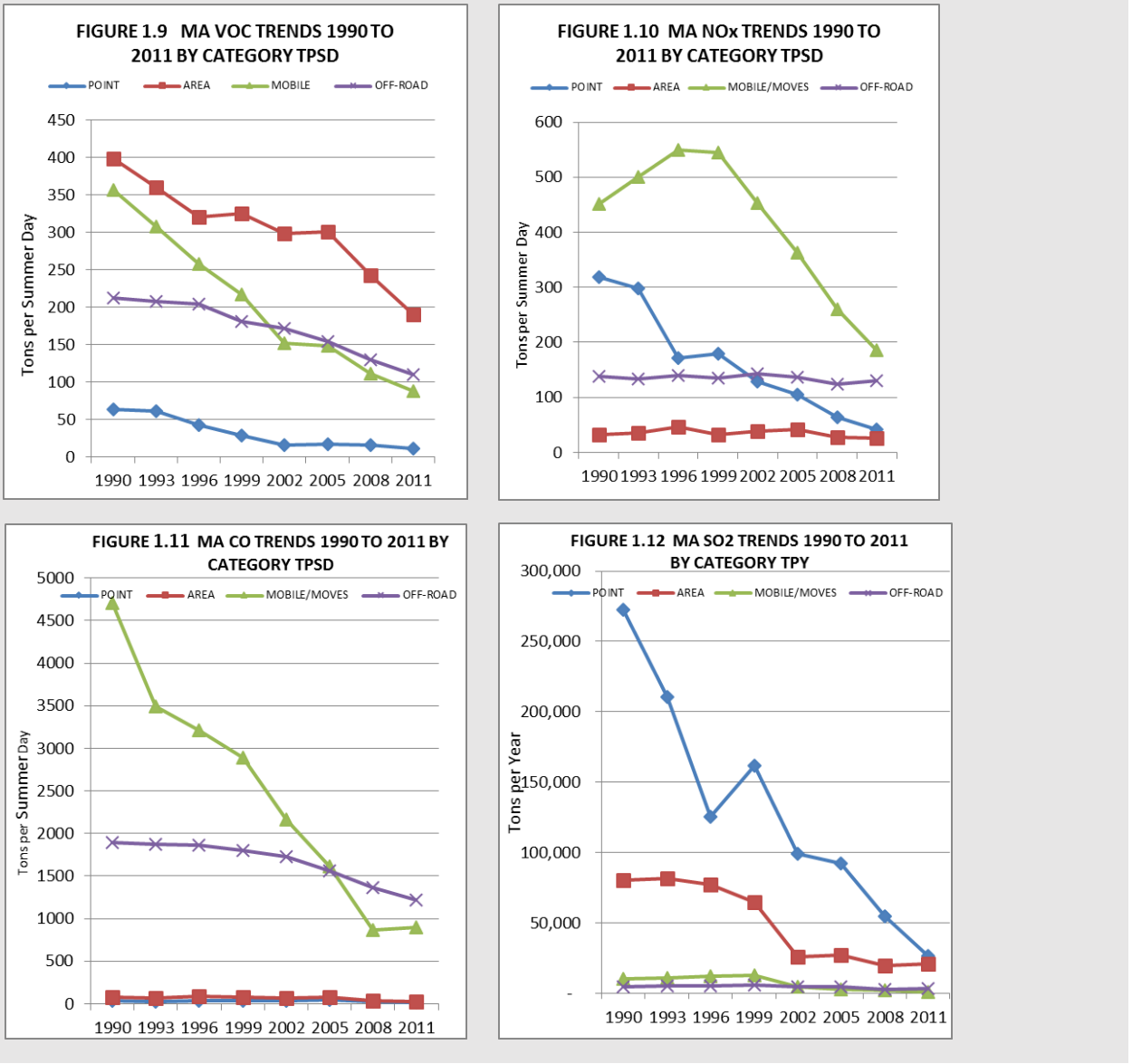


FIGURE 1.8
MA PM2.5-PRI 2011 ANNUAL EMISSIONS
(31,794 TPY)

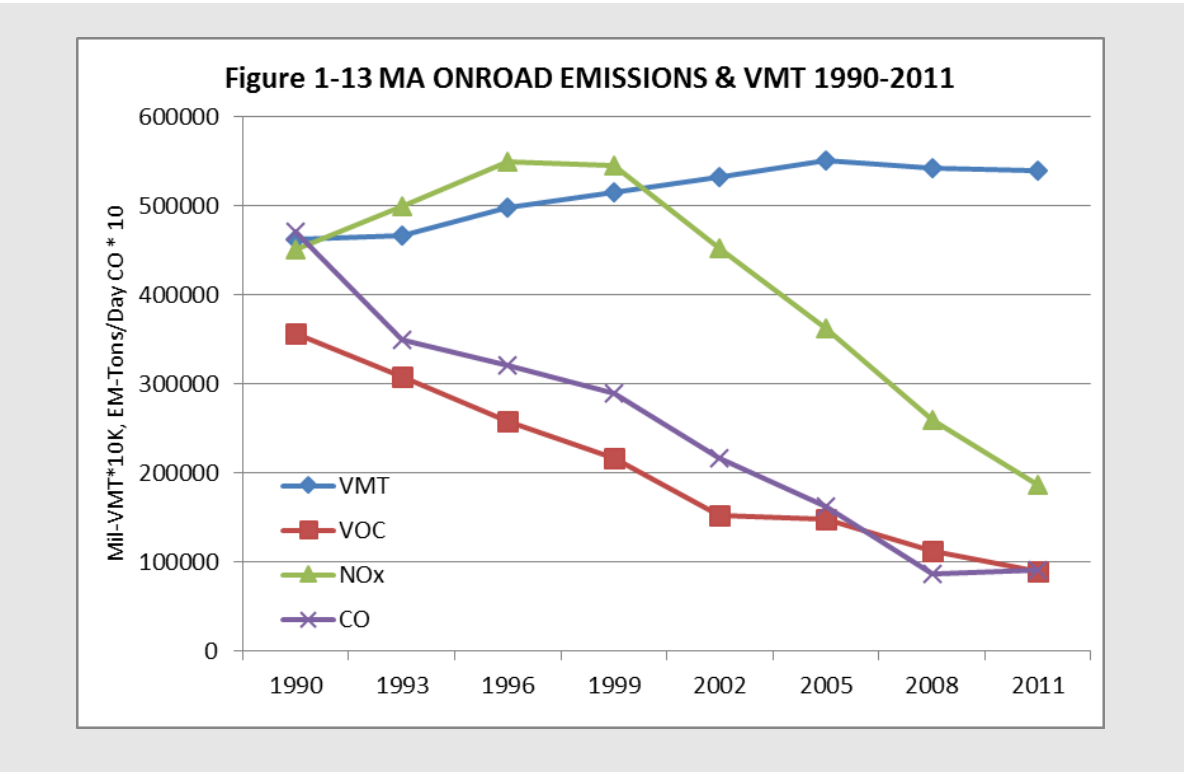


Emission Trends 1990 to 2011. Figures 1.9 through 1.13 show annual emission trends from 1990 through 2011 for each of the years for which an inventory was completed.[9] Note that PM_{10}, $PM_{2.5}$, and NH_3 emissions were reported for the first time in 2002. Table 1.5 in Section 1.7 also provides this data.

The 1990 to 2011 emissions trends demonstrate the success of various air pollution control strategies implemented in Massachusetts. For example, emissions from point sources have declined significantly as a result of emissions control requirements at large facilities, such as power plants and factories. As shown in Figure 1.13, emissions from on-road mobile sources have declined significantly despite the increase in vehicle miles traveled during this period.



[9] Note that from 1990 to 2002, on-road emissions were estimated by the MOBILE6.2 model. The 2008 and 2011 on-road emissions were estimated by EPA's MOVES-2008 and MOVES-2010 models, respectively. EPA is expected to use the updated MOVES-2014 model to revise 2011 annual emissions in the NEI.



VOCs. As shown in Figure 1.1 and Table 1.1, area sources account for about half the total anthropogenic VOC summer day emissions (48%). On-road and off-road mobile sources together contribute half of these VOC emissions. Biogenic emissions, when included, account for 57% of the total VOC emissions, and thus the area source contribution to the total VOC emissions is 21%.

Figure 1.9 and Table 1.5 show that overall VOC emissions from 1990 to 2011 were reduced by 61% (637 TPSD). Of these reductions, the majority (268 TPSD) were from on-road mobile sources. The on-road mobile source emission reductions for this period are due to numerous programs to reduce emissions from motor vehicles including the Federal Motor Vehicle Control Program (FMVCP), Massachusetts Low Emission Vehicle (LEV) program, Massachusetts Enhanced Inspection/Maintenance (I/M) program, Stage I and II Vapor Recovery for gasoline stations, and Reformulated Gasoline (RFG). Reductions from stationary and area sources are the result of various VOC control measures and a decline in overall VOC use. The VOC reductions from off-road engines are attributable to cleaner fuel and the phase-in of newer, cleaner off-road engines.

NO_x. On-road and off-road Mobile sources contribute 82% of NO_x summer day emissions with on-road vehicles accounting for almost half of the total. Total NO_x emissions were reduced by 59% (555 TPSD) from 1990 to 2011, mostly from point and on-road mobile sources. Point sources (mainly power plants) account for 11% of the total emissions with an 87% reduction of 275 TPSD since 1990. Point source reductions

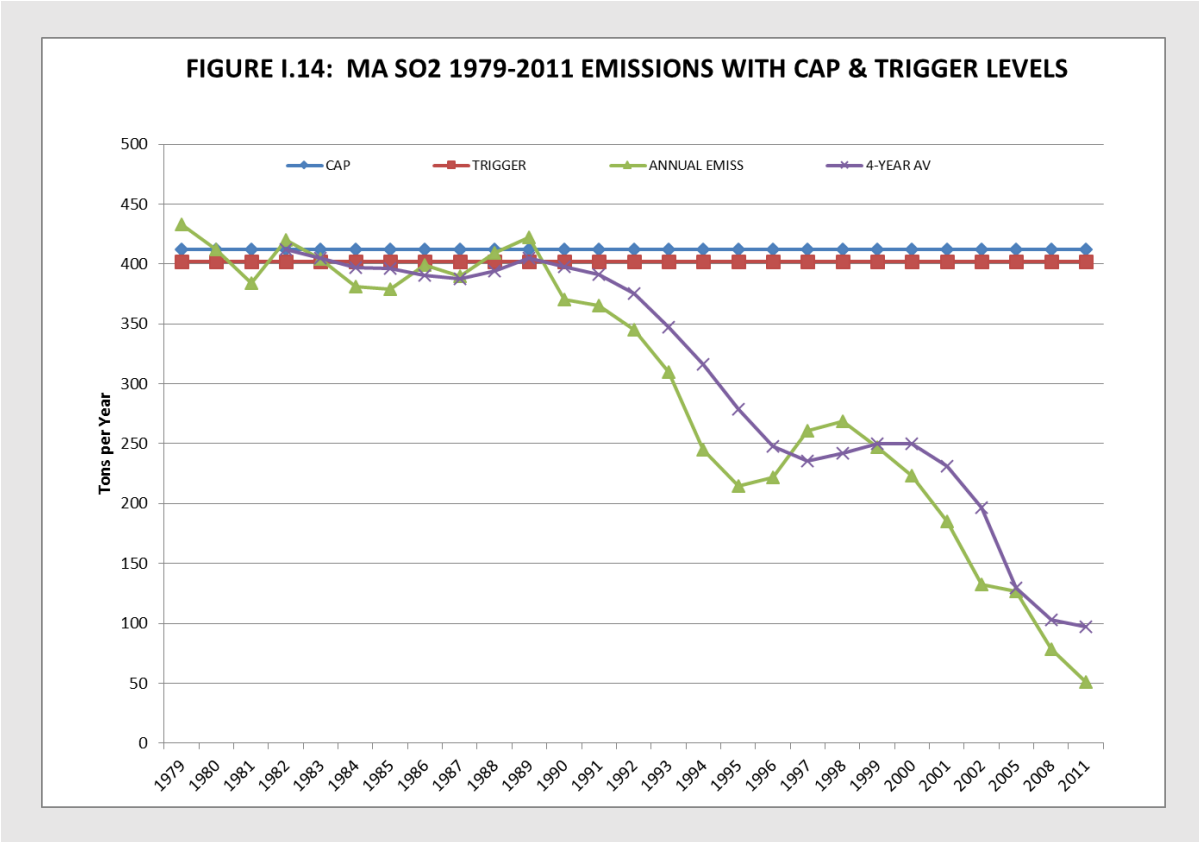
are due in large part to Reasonably Available Control Technology (RACT) requirements and reductions from power plant emissions. The 59% on-road mobile reduction is due to the Enhanced I/M and LEV programs. Further reductions are expected after 2011 as older, higher emitting vehicles are replaced with a cleaner, newer models. Off-road emissions decreased by 6% from 1990 to 2011 and newly adopted diesel control programs are expected to further reduce NO_x emissions from this category.

CO. On-road and off-road mobile sources account for 98% of CO summer day emissions, in which off-road vehicles contribute over half (56%) the total emissions. CO emission sources vary significantly between summer and winter months. Area sources are 15 times higher in the winter due to heating, and on-road mobile are over 50% higher in winter. However, emissions from off-road engines are much lower in the winter. Total CO summer day emissions were reduced by 68% (4,559 TPSD), from 1990 to 2011. Most of the reduction is due to an estimated 81% (3,809 TPSD) reduction in on-road mobile emissions.

SO_2. Point sources – mainly power plants – account for just over half the total annual SO_2 emissions. Area sources account for 40%. SO_2 emissions were reduced by 86% (316,144 TPY) from 1990 to 2011. Of these reductions, 245,793 TPY are due to controls on point sources, mainly power plants.

PM_{10} and $PM_{2.5}$. MassDEP estimated PM emissions for the first time in 2002 as required for the Regional Haze SIP. Because of this shorter period of time, PM emissions trends do not show as much reduction as the other criteria pollutants. Fugitive dust accounts for over 77% of PM_{10} emissions with 42% from paved and unpaved roads and 35% from construction activities. For $PM_{2.5}$, area sources account for 48% and fugitive dust contributes 31%. $PM_{2.5}$ and PM_{10} were reduced by 10% and 20%, respectively.

NH_3. Area sources contribute the majority of NH_3 emissions, which come primarily from humans (41%), livestock (7%) and soils (29%). No annual trends are presented because of limited emissions data from 2002 and 2005.



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1.6 INVENTORY CATEGORIES AND METHODOLOGIES

The primary methodology MassDEP used to develop the 2011 emissions inventory was to apply activity factors to emission factors specific to each source category. An emission factor relates the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant (e.g., the burning of fuel). These factors are expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., pound of particulate matter emitted per ton of coal burned or grams of a pollutant per mile travelled).

Stationary Point Sources. Stationary point sources include factories, power plants, incinerators, commercial/institutional boilers (e.g., hospitals, universities, businesses), and large residential facilities (e.g., apartment buildings). The stationary point source activity data are submitted to MassDEP by Massachusetts facilities under the Source Registration program (310 CMR 7.12). Fuel use and other activity data is entered by each facility into Source Registration forms in MassDEP's online eDEP system. The most common method for calculating point source emissions is to apply emission factors to the quantity of material or fuel used. The eDEP forms have a built-in table of EPA WebFIRE[10] emission factors that are based on source classification

[10] WebFIRE is EPA's online emissions factor repository, retrieval, and development tool. http://epa.gov/ttn/chief/webfire/index.html

codes (SCC). SCCs specify a particular source and type of emissions producing activity (e.g., the burning of oil at a commercial boiler). Facilities identify their process with an SCC and then have the option to have the form calculate emissions for their combustion units. Facilities must calculate their own emissions for process and incinerator units. Facilities also may calculate their own emissions for combustion units if they choose, using equipment-specific emission factors or emissions data when available. The forms also include control equipment and equipment effectiveness in the calculations when estimating emissions.

Data from source-specific emissions tests and continuous emissions monitors (CEMs) are preferred for estimating a stationary source's emissions because they provide the best representation of the source's emissions. However, not all facilities are required to use CEMS.

Stationary Area Sources. Area sources collectively represent individual sources that are too small and numerous to be inventoried as specific point sources (e.g., gasoline stations, dry cleaners). The Stationary Area Source section comprises the following six categories: 1. Waste Management practices; 2. Gasoline Distribution; 3. Solvent Use; 4. Combustion Processes; 5. Agricultural Activities; and 6. Fugitive Dust - Construction and Paved/Unpaved Roads.

Area source emissions are not treated as point sources because the effort required to gather data and estimate emissions for each individual facility would be too great, while emissions per facility are generally small. Point source activity (e.g., fuel use) or emissions are subtracted from the corresponding area source categories in order to prevent double counting (e.g., fuel used by point sources reporting through eDEP is subtracted from the state-wide fuel use amounts used to estimate area source emissions). MassDEP applies a rule effectiveness formula[11] to area source categories that are subject to state regulatory controls (e.g., gasoline station Stage I tank truck unloading, architectural and industrial maintenance coatings, etc.).

There are other area source categories that generate significant emissions but are not emitted from facilities such as pesticides, commercial/consumer products, and architectural coatings. These types of non-facility area sources also are included within the stationary area source categories.

Unlike point sources that are inventoried individually, area sources are inventoried collectively based on an estimated level of activity related to a particular area source category. The activity factors for these area sources are derived from material sales records, state registration records, fuel/material use, employment data, and Census population data. MassDEP used emission factors from EPA's *Compilation of Air Pollution Emission Factors*[12] (AP-42), the Emissions Inventory Improvement Project (EIIP)[13] and EPA emissions inventory FTP site.[14] MassDEP apportioned

[11] Rule effectiveness reflects the ability of a regulatory program to achieve some percentage of all the emission reductions that could be achieved with full compliance by all sources at all times. See EPA's description of rule effectiveness at: http://www.epa.gov/ttn/chief/eiip/techreport/volume02/ii01_may2001.pdf

[12] *Compilation of Air Pollutant Emission Factors*, *Volume. 1, Stationary Point and Area Sources,* AP-42, Fifth Edition and Supplements, U.S. Environmental Protection Agency, Research Triangle Park, NC, 1997. (www.epa.gov/ttn/chief/publications.html#factor)

[13] http://www.epa.gov/ttn/chief/eiip/index.html

area source emissions to counties based on fuel/material used, employment, state registration, and population data.

EPA developed emissions estimates for several area source categories that MassDEP has adopted, including agricultural production – livestock, agricultural tilling, commercial cooking, construction dust, residential open burning, wood-burning, paved and unpaved roads, ammonia from livestock and animals, and biogenics. These may be found at the EPA emissions inventory FTP site[15] and 2011 Emissions Inventory website.[16] These emissions also are presented in the relevant sections of this report.

On-Road Mobile Sources. On-road mobile sources include vehicles, such as cars, trucks, motor cycles, and buses. MassDEP adopted EPA's latest MOVES annual emissions by county as reported in the 2011 NEI. MassDEP submitted 2011 MOVES input files and other transportation data to EPA to allow EPA to run the MOVES model for Massachusetts. MassDEP obtained the activity factor, which is daily vehicle miles traveled (DVMT), from the Massachusetts Department of Transportation (MassDOT). The emissions and inputs are presented in the On-Road Mobile section of this report.

MOVES requires state-specific input parameters, such as vehicle Inspection and Maintenance program (I/M) data, temperature, vehicle mix, vehicle age distribution, and mileage accumulation rates. I/M inputs include start year, anti-tampering rates, and emissions test failure rates. MOVES calculates emission factors for all vehicle types for speeds up to 65 mph. EPA estimated annual on-road and non-road model emissions for all states but not for a typical summer day. For the 2011 inventory, MassDEP ran MOVES for a typical summer day. In accordance with EPA Mobile Source Volume 4 guidance[17], MassDEP used the average temperatures for the ten days with the highest ozone levels in the last three years (2009-2011) to generate the temperature factor used to estimate typical summer day emissions.

Off-Road Mobile Sources. Off-road mobile sources include various types of engines, such as those in aircraft, commercial vessels, locomotives, recreational boats, construction equipment, lawn and garden equipment, and numerous other types of off-road mobile operations. The basic activity factor is the number of various engines and the quantity of different types of fuel combusted. MassDEP used the latest version of the NONROAD2008a model developed by EPA's Office of Mobile Sources to generate seasonal-day off-road emissions for the smaller and numerous off-road engines. MassDEP inputs the appropriate temperatures, seasonal Reid Vapor Pressure, and fuel characteristics to run the NONROAD model for a typical summer day for ozone precursors and a typical winter day for CO (these inputs were identical to those used for the MOVES modeling noted above). However, for annual emissions, MassDEP adopted EPA's 2011

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[14] ftp://ftp.epa.gov/EmisInventory/2011nei/doc/
[15] ftp://ftp.epa.gov/EmisInventory/2011nei/doc/
[16] http://www.epa.gov/ttn/chief/net/2011inventory.html
[17] EPA hardcopy "Procedures for Emissions Inventory Preparation Volume IV: Mobile Sources. EPA OAQPS RTP NC and Office of Mobile Sources, Ann Arbor MI, July 1989 EPA-450/4-81-026d (Revised) The 1996 revision is located at :http://www.epa.gov/ttn/chief/eiip/techreport/volume04/index.html

NONROAD emissions (found at EPA's 2011 Emissions Inventory website).[18] The typical summer day and winter day emissions can be found in Section 5 – Aircraft, Locomotive, Commercial Marine Vessels and Nonroad Engines..

Biogenic Sources. Biogenic sources are natural, biological sources of ozone precursor emissions, such as trees, agricultural crops, and microbial activity in soils and water. MassDEP adopted EPA's 2011 biogenic emissions estimated by the Biogenic Estimation Inventory System (BEIS3.14) model and reported in the 2011 National Emission Inventory (NEI).[19] These estimates are presented in Table 1.7. (Table 1.8 is an expanded version and is found in a separate spreadsheet file). The BEIS3.14 model incorporates EPA's default land use, crop acreage, and forest type by county, and assigns emission rates to different land use types. It applies meteorological data inputs, including temperature and solar radiation for a typical summer day. Earlier biogenic emission models estimated VOC emissions only, whereas BEIS3.14 also estimates a small amount of NO_x and CO.

1.7 INVENTORY SUMMARY TABLES

Statewide pollutant emissions are summarized in broad categories in Table 1.1 and detailed categories in Table 1.2. Dukes County emissions are summarized by broad categories in Table 1.3 and in more detail in Table 1.4. VOC, NO_x, and CO emissions are shown with and without biogenic emissions.

Table 1.5 presents the statewide annual trends from 1990 through 2011 for point, area, on-road and off-road categories for each of the years for which an inventory was completed. Note that PM_{10}, $PM_{2.5}$, and NH_3 emissions were reported for the first time in 2002. Table 1.10 presents emissions by county for all pollutants (this table is found in a separate spreadsheet file).

Spreadsheet versions of these tables are available in Excel (XLSX) files that are part of the zip file for the 2011 inventory. The zip contains all of the files that comprise the 2011 inventory and is available at MassDEP's Emissions Inventory website: https://www.mass.gov/lists/massdep-emissions-inventories

[18] http://www.epa.gov/ttn/chief/net/2011inventory.html

[19] EPA's National Emissions Inventory (NEI) is a database that incorporates emissions data received from a variety of sources into a comprehensive national inventory for the 6 criteria pollutants and 188 hazardous air pollutants. It is updated every three years. The NEI can be accessed at: http://www.epa.gov/ttn/chief/net/2011inventory.html

TABLE 1.1
SUMMARY 2011 MASSACHUSETTS EMISSIONS VOC, NOx, CO, SO2, NH3, PM10 and PM2.5

TONS PER YEAR (TPY), SUMMER & WINTER DAY (TPSD, TPWD)

ks/inv2011/Emiss Summary/ Section-1-2011-Summary-Charts-em-chart Nov 3 2015, Paved/Unpaved Roads Revision July 25 2016

					VOC with Biogenics:		
VOC (Figure 1.1)	**VOC TPY**	**TPY %**	**TPSD**	**TPSD %**	**VOC TPY**	**TPSD**	**TPSD %**
1 POINT	4,119	2.7%	11.3	2.8%	4,119	11.3	1.2%
2 AREA	74,662	49.6%	196.3	48.4%	74,662	196.3	21.0%
3 ON-ROAD MOBILE	35,866	23.8%	88.6	21.9%	35,866	88.6	9.5%
4 OFF-ROAD MOBILE	35,856	23.8%	109.3	27.0%	35,856	109.3	11.7%
5 BIOGENICS (BELD)					***77,172***	***528.7***	*56.6%*
TOTAL	**150,503**	100%	**405.5**	100.0%	*227,675*	*934.2*	*100.0%*

					NOx With Biogenics:	
NOx (Figure 1.2)	**NOX TPY**	**TPY %**	**TPSD**	**TPSD %**	**NOx TPY**	**TPSD**
1 POINT	15,686	10.8%	42.6	11.1%	15,686	42.6
2 AREA	21,216	14.7%	25.9	6.7%	21,216	25.9
3 ON-ROAD MOBILE	66,997	46.3%	186.5	48.4%	66,997	186.5
4 OFF-ROAD MOBILE	40,778	28.2%	130.4	33.8%	40,778	130.4
5 BIOGENICS (BELD)					***939***	***4.0***
TOTAL	**144,676**	100%	**385.4**	100.0%	*145,615*	*389.4*

CO (Figures 1.3 & 1.4)	**CO TPY**	**TPY %**	**TPSD**	**TPSD %**	**TPWD**	**TPWD %**
1 POINT	5,542	0.7%	15.2	0.7%	16.1	0.7%
2 AREA	93,286	11.6%	30.6	1.4%	450.9	18.8%
3 ON-ROAD MOBILE	408,702	51.0%	902.8	41.7%	1,413.9	58.8%
4 OFF-ROAD MOBILE	293,767	36.7%	1,214.1	56.1%	523.5	21.8%
Anthropogenic Total	**801,297**	100%	**2,162.7**	100.0%	**2,404.4**	100.0%
5 BIOGENICS (BELD)	***11,618***		***70.5***		***4.2***	
TOTAL with Biogenics	*812,915*		*2,233.1*		*2,408.6*	

REGIONAL HAZE POLLUTANTS: (Figures 1.5 to 1.8)				**NH3 TPY**	**TPY %**
	SO2 TPY	**TPY %**	POINT & POT	380	1.8%
1 POINT	26,626	51.4%	AREA-Human	8399	40.6%
2 AREA	20,779	40.2%	AREA-Livesto	1426	6.9%
3 ON-ROAD MOBILE	526	1.0%	AREA-Soils, A	6066	29.3%
4 OFF-ROAD MOBILE	3,821	7.4%	ON-RD MOBIl	1888	9.1%
			OFF-RD MOE	40	0.2%
TOTAL	**51,752**	100%	AREA COMBUS	2488	12.0%
			TOTAL	**20,687**	100.0%

	PM10 TPY	**TPY %**	**PM2.5 TPY**	**TPY %**
1 POINT	1,265	1.2%	757	2.3%
2 AREA	16,216	15.0%	15,703	47.9%
3 ON-ROAD MOBILE	4,453	4.1%	3,039	9.3%
4 OFF-ROAD MOBILE	3,179	2.9%	2,988	9.1%
5 FUG.DUST (Const,min,till)	38,035	35.2%	3,954	12.1%
6 FUG.DUST (Paved Rds)	12,534	11.6%	3,142	9.6%
FUG.DUST (Unpaved Rds)	32,284	29.9%	3,211	9.8%
TOTAL	**107,965**	100%	**32,794**	100.0%

TABLE 1.2

MA STATEWIDE 2011 EMISSIONS BY CATEGORIES ALL POLLUTANTS (Revised Unpaved/Paved Roads July 25, 2016)

ks/inv2011/Emissions Section-1-MA 2-11 PEI Summary Charts Nov 3 2			VOC	VOC	NOx	NOx	CO	CO	CO	SO2	PM10 PRI	PM25 PRI	NH3
SOURCE CATEGORY	**SCC**	Origin	**TPY**	**TPSD**	**TPY**	**TPSD**	**TPY**	**TPSD**	**TPWD**	**TPY**	**TPY**	**TPY**	**TPY**
1.POINT SOURCES													
EGU Point Sources		MA	259.6	0.79	5043.8	14.07	1615.9	4.58	5.43	22788.4	352.2	314.1	223.7
Non-EGU Point Sources		MA	3858.9	10.46	10642.3	28.57	3925.6	10.59	10.64	3837.5	912.6	443.2	131.6
TOTAL POINT SOURCES			**4118.5**	**11.25**	**15686.1**	**42.64**	**5541.5**	**15.17**	**16.07**	**26625.9**	**1264.8**	**757.3**	**355.3**
2.AREA SOURCES													
Waste Treatment													
1. POTW's	2630020000	EPA	123.3	0.34									24.5
2. HW TSDF	2640000000	EPA	16.9	0.06									
3. MSW Landfills	2620030000	MA	1079.5	2.96									
Total Waste Treatment			**1219.7**	**3.36**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**24.5**
Gasoline Distribution													
1. Tank Truck Unl. (Stage I)	2501060053	MA	2030.4	6.66									
2. Vehicle Refuel. (Stage II)	2501060100	EPA/M	Estimated in On-Road Mobile category										
3. Underground Tank Breath.	2501060201	MA	1390.7	3.87									
4. Transit Losses	2505030120	MA	208.1	0.68									
5. Gasoline Bulk Plants/Terminals	2501055120	EPA	1147.2	3.19									
6. Gasoline Pipelines	2505040120	EPA	2820.0	7.83									
7. Petro Vessel Unload/Losses	2505020120	MA	403.0	1.10		Revised June 20, 2014 - new 2011 data							
8. Portable Fuel Contain Reside	250101101x	EPA	971.2	4.22		Changed June 11 2014 -used EPA new estimates							
9. Portable Fuel Contain Comm	250101201x	EPA	541.7	2.06		Changed June 11 2014 -used EPA new estimates							
10. Aviation Gas Refuel Stage I	2501080050	MA	21.9	0.06									
11. Aviation Gas Refuel Stage II	2501080100	MA	15.4	0.04									
12.Aviation Gas Ref.U.Tank Br	2501080201	MA	6.0	0.02									
Total Gasoline Distribution			**9555.6**	**29.73**									
Stationary Source Solvent Evap.													
1. Dry Cleaning	2420000000	MA	14.7	0.05									
2. Surface Cleaning -degrease	2415000000	MA	4429.7	14.20									
3. Commerc/Consumer Solvents	2460000000	MA	19499.1	53.42									
4. Graphic Arts:	2425000000	MA	1243.0	4.78	Accepted EPA's estimates using NEI Support request.								
5. Industrial Adhesives -Total	2440020000	MA	3616.2	11.59									
Total Solvent Evaporation			**28802.7**	**84.04**									
Non-Indus. Surface Coating:													
1. Auto. Refinish	2401005000	MA	1480.8	5.70									
2. AIM Architect. Coating	2401001000	MA	8363.5	29.79									
3. AIM Traffic Marking	2401008000	MA	909.1	3.24									
3.AIM High Perf. Maintenance	2401100000	MA	1454.5	5.18									
4. AIM Oth. Speclty Purp Coat	2401200000	MA	1454.5	5.18									
Total Auto Ref & AIM Coating			**13662.4**	**49.09**									
Industrial Coating:													
1. Furniture & Fixtures -Wood	2401020000	MA	170.4	0.66									
2. Metal Furniture	2401025000	MA	568.1	2.19									
2. Metal Can Containers	2401040000	MA	105.0	0.40									
3. Motor Vehicles New	2401070000	MA	188.8	0.73									
4. Machinery & Equip.	2401055000	MA	215.4	0.83									
5. Appliances	2401060000	EPA	18.1	0.07									
6. Other Transport Eq. Aircraft	2401075000	EPA	21.5	0.08									
7. Other Transport Eq. Marine	2401080000	MA	30.4	0.12									
8. Other Transport Eq. Rail	2401085000	EPA	5.2	0.02									
9. Metal Sheet, Strip,Coil	2401045000	MA	203.7	0.78									
10. Factory Finished Wood	2401015000	MA	33.1	0.13									
11. Electronic Insulation & Coat	2401065000	MA	22.4	0.09									
12. Misc Mfg, Other Prod. Coat	2401090000	MA	912.1	4.00									
14. Paper Film & Foil Coat	2401030000	MA	561.0	2.16									
Total Industrial Coating			**3055.2**	**12.26**									

Table 1.2 continued . . .

ks/inv2011/Emissions Section-1-MA 2-11 PEI Summary -Tables-Charts May 15, 2015												PM10	PM25	
		Estimate	VOC	VOC	NOx	NOx	CO	CO	CO	SO2		PRI	PRI	NH3
SOURCE CATEGORY	SCC	Origin	TPY	TPSD	TPY	TPSD	TPY	TPSD	TPWD	TPY		TPY	TPY	TPY
Miscelleneous Solvents:														
1. Cutback Asphalt	2461021000	MA	308.3	3.42										
2. Emulsified Asphalt	2461022000	EPA	21.1	0.23	Used EPA's estimate									
3. Agricultural Pesticide Use	2461850000	EPA	249.1	1.16										
4. Non-Agric Pesticide Use	2461870999	EPA	316.1	1.48										
5. Bakeries	2302050000	MA	326.1	1.05										
6. Breweries/Wineries/Distiller	2302070000	MA	106.4	0.29										
7. Petroleum Spills	2830000000	MA	161.6	0.44										
8. Asphalt Roof, Kettles & Tanks	2461023000	MA	536.7	2.41	10.4	0.05	34.6	0.16	0.16	7.6		10.4	10.4	0.0
9. Leaking USTs	2660000000	MA	10.5	0.03										
Total Miscellaneous Solvents			**2035.9**	**10.51**	**10.4**	**0.05**	**34.6**	**0.16**	**0.16**	**7.6**		**10.4**	**10.4**	**0.0**
Small Statonary Fuel Combustion														
1. Residential Bituminous Coal	2104002000	MA	0.0	0.00	0.0	0.00	0.0	0.00	0.00	0.0		0.0	0.0	0.0
2. Residential Distillate Oil	2104004000	MA	224.5	0.22	5667.2	5.54	1574.2	1.54	8.05	13412.4		749.3	670.6	314.8
3. Residential Natural Gas	2104006000	MA	345.0	0.34	5895.8	5.77	2508.9	2.45	12.82	37.6		32.6	27.0	1254.4
		1.14												
4. Residential Wood-burn-Indoor	2104008000	EPA	12132.5	0.00	1105.6	0.00	67925.9	0.00	347.18	185.3		9781.3	9772.8	575.6
5. Residential Woodburn-Outdoor	2104008610	EPA	1087.9	1.48	29.7	0.04	5811.1	7.90	29.70	32.7		1033.2	1033.2	29.1
5. Residential Kerosene	2104011000	MA	1.4	0.00	36.5	0.04	10.1	0.01	0.05	89.5		4.9	4.4	2.0
6. Residential LPG	2104007000	MA	18.4	0.02	474.7	0.46	134.6	0.13	0.69	2.1		1.8	1.4	1.8
Total Residential Fuel			**13809.7**	**2.06**	**13209.5**	**11.85**	**77964.8**	**12.03**	**398.49**	**13759.6**		**11603.1**	**11509.4**	**2177.8**
1. Commercial/Instit Bitum Coal	2103002000	MA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
2. Commercial/Instit Dist.Oil	2103004000	MA	38.1	0.04	2242.5	2.59	560.6	0.65	3.31	4776.5		266.9	238.8	112.1
3. Commercial/Instit Res.Oil	2103005000	MA	10.2	0.01	497.5	0.57	45.2	0.05	0.27	957.9		46.6	25.9	7.2
4. Commercial/Instit N.Gas	2103006000	MA	144.2	0.17	2621.3	3.03	2201.9	2.54	12.99	15.7		13.6	11.3	12.8
5. Commercial/Instit Kerosene	2103011000	MA	0.2	0.00	11.2	0.01	2.8	0.00	0.02	82.5		1.4	1.2	0.1
6. Commercial/Instit LPG	2103007000	MA	6.3	0.01	115.8	0.13	145.8	0.17	0.86	0.7		0.6	0.5	0.6
7. Commercial/Instit Wood & Prod	2103081000	MA	9.3	0.11	120.4	0.14	328.3	0.38	1.94	13.7		275.3	237.7	6.6
Total Commercial/Instit Fuel			**208.3**	**0.34**	**5608.7**	**6.47**	**3284.6**	**3.79**	**19.39**	**5847.0**		**604.3**	**515.4**	**139.4**
1. Small Industrial Bitum Coal	2102001000	MA	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0		0.0	0.0	0.0
2. Small Industrial Dist.Oil	2102004000	MA	5.0	0.02	499.4	1.92	124.8	0.48	0.88	1063.7		57.4	38.7	20.0
3. Small Industrial Res.Oil	2102005000	MA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0
4. Small Industrial N.Gas	2102006000	MA	62.2	0.24	1131.0	4.35	950.1	3.65	6.72	6.8		7.8	6.8	36.2
5. Small Industrial Kerosene	2102011000	MA	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0		0.0	0.0	0.0
6. Small Industrial LPG	2102007000	MA	3.5	0.01	96.0	0.37	53.8	0.21	0.38	0.4		0.3	0.3	0.3
7. Small Industrial Wood-Products	2102008000	MA	35.5	0.05	459.6	0.64	1253.5	1.74	8.87	52.2		1051.3	907.8	25.1
Total Industrial Fuel			**106.2**	**0.32**	**2186.1**	**7.28**	**2382.2**	**6.08**	**16.85**	**1123.1**		**1116.9**	**953.5**	**81.6**
TOTAL ALL FUEL USE			**14124.3**	**2.71**	**21004.3**	**25.60**	**83631.6**	**21.90**	**434.7**	**20729.7**		**13324.3**	**12978.3**	**2398.8**
1. Open Burn -Household Waste	2610030000	EPA	55.3	0.04	38.8	0.03	549.3	0.42	1.53	6.5		245.6	224.9	0.0
2. Open Burn -Land Clearing D	2610000500	EPA	160.2	0.12	69.0	0.05	2333.3	1.78	6.48	0.0		234.7	180.9	0.0
3. Open Burn - Leaf Waste	2610000000	EPA	8.1	0.01	1.8	0.00	32.3	0.03	0.09	0.2		6.3	4.9	0.0
4. Open Burning -Yard Waste	2610040400	EPA	5.5	0.00	1.4	0.00	40.4	0.03	0.11	0.5		5.7	4.4	0.0
Total Waste Burning			**229.1**	**0.17**	**111.0**	**0.09**	**2955.3**	**2.25**	**8.21**	**7.2**		**492.3**	**415.1**	**0.0**
2.Forest/Prescribed Fires - EPA	2810015999	EPA/M	1228.1	0.14	73.9	0.08	5362.7	2.94	4.04	34.1		549.7	466.0	89.2
2. Structural Fires	2810030000	MA	115.2	0.26	14.7	0.03	628.35	1.49	1.95	0.0		113.1	108.6	0.0
3. Vehicle Fires	2810050000	MA	12.0	0.03	1.5	0.00	47.0	0.14	0.12	0.0		37.6	36.1	0.0
4. Food Prep - Commercial-All	2302000000	EPA	238.3	0.65	0.0	0	626.3	1.72	1.72	0.0		1688.6	1688.3	0.0
5. Food Preparation Backyard Grills	2810025000	MA	384.1	3.34										
Total Fires/ Cooking			**1977.6**	**4.42**	**90.1**	**0.11**	**6664.34**	**6.29**	**7.83**	**34.10**		**2389.0**	**2299.0**	**89.2**
TOTAL COMBUSTION CATEGORY			**16330.9**	**7.31**	**21205.3**	**25.80**	**93251.2**	**30.44**	**450.77**	**20771.0**		**16205.6**	**15692.4**	**2488.0**
Agricultural, Human, Pets, Wildlife, Soils														
1. Agricultural Livestock	28050xxxxx	EPA/CMU												1426.2
2. Humans	2810010000	EPA/CMU	-grown from 2002 -pop											3150.1
3. Cats	2806010000	EPA/CMU	-grown from 2002 -pop											1228.9
4. Dogs	2806015000	EPA/CMU	-grown from 2002 -pop											3415.0
5. Wild Animals	2807030000	EPA/CMU												605.1
6. Soils	2701420000	EPA/CMU												5654.6
7. Agricultural Fertilizer Applic	2801700000	EPA/CMU												411.1
Total Agricultural, Human, Pets, Wildlife, Soils														**15891.0**
3.TOTAL AREA SOURCE			**74662.4**	**196.3**	**21215.7**	**25.85**	**93285.9**	**30.60**	**450.9**	**20778.6**		**16216.0**	**15702.8**	**18403.5**

Table 1.2 continued . . .

ks/inv2011/Emissions Section-1-MA 2-11 PEI Summary -Tables-Charts May 15, 2015											PM10	PM25	
		Estimate	VOC	VOC	NOx	NOx	CO	CO	CO	SO2	PRI	PRI	NH3
SOURCE CATEGORY	**SCC**	Origin	**TPY**	**TPSD**	**TPY**	**TPSD**	**TPY**	**TPSD**	**TPWD**	**TPY**	**TPY**	**TPY**	**TPY**
4.ON-ROAD MOBILE													
HDDV		EPA/M	2070.7	5.1	24408.2	67.9	9530.8	21.1	33.0	39.4	1644.1	1457.4	51.7
LDDV		EPA/M	199.7	0.5	1341.3	3.7	918.2	2.0	3.2	2.7	89.4	77.7	6.8
HDGV		EPA/M	1571.4	3.9	2350.4	6.5	25565.3	56.5	88.4	20.2	113.5	61.4	61.8
LDGV		EPA/M	32024.3	79.1	38896.6	108.3	372688.0	823.2	1289.3	464.1	2605.7	1442.7	1767.6
TOTAL ON-ROAD MOBILE			**35866.1**	**88.6**	**66996.5**	**186.5**	**408702.3**	**902.8**	**1413.9**	**526.4**	**4452.7**	**3039.2**	**1887.9**
4.OFF-ROAD													
1. Aircraft	2275050000	EPA	538.1	1.31	3037.4	8.30	8654.2	23.70	23.70	262.9	212.2	184.9	0.0
2. Railroads	2285002000	EPA/M	245.0	0.67	5018.7	13.75	627.0	1.72	1.14	264.1	153.8	140.9	2.4
3. Commercial Marine Vessels	2280020010	EPA	275.5	0.84	9862.9	30.02	1536.1	4.68	3.93	3218.9	557.7	523.2	5.5
4. NONROAD Equipment		EPA/M	34797.8	106.52	22858.7	78.36	282949.7	1184.00	494.70	74.9	2255.0	2139.0	32.0
Total Off-Road			**35856.4**	**109.34**	**40777.7**	**130.43**	**293767.0**	**1214.10**	**523.47**	**3820.8**	**3178.7**	**2988.0**	**39.9**
5.FUGITIVE DUST PM CATEGORIES													
1. Residential Construction	2311010000	EPA									320.7	32.1	
2. Non-Residential Construction	2311020001	EPA									7743.9	774.4	
3. Road Construction	2311030000	EPA									26966.5	2696.7	
4. Mining & Quarrying	2325000000	EPA									1999.8	250.0	
5. Paved Roads (MANEVU)	2294000000	EPA									12534.4	3142.0	
6. Unpaved Roads (MANEVU)	2296000000	EPA									32283.5	3210.5	
8. Agricultural Tilling	2801000003	MA									1003.8	200.8	
Total Fugitive Dust Categories											**82852.6**	**10306.5**	
GRAND TOTAL EMISSIONS - ALL CATEGORIES			**150503.4**	**405.5**	**144676.0**	**385.4**	**801296.7**	**2162.7**	**2404.4**	**51751.8**	**107964.8**	**32793.8**	**20686.6**

TABLE 1.3

SUMMARY 2011 DUKES COUNTY MA OZONE NON-ATTAINMENT AREA EMISSIONS

VOC, NOx and CO Tons per year (TPY) and summer day (TPSD)

ks/inv2011/Emiss Summary/ Section-1-2011-Summary-Charts-em-chart May 15, 2015

					VOC with Biogenics:		
VOC (Figures 1 and 2)	**VOC TPY**	**TPY %**	**TPSD**	**TPSD %**	**VOC TPY**	**TPSD**	**TPSD %**
1 POINT	14.7	0.6%	0.01	0.1%	14.7	0.01	0.1%
2 AREA	1,012.9	41.1%	4.04	50.3%	1,012.9	4.04	35.6%
3 ON-ROAD MOBILE	178.8	7.3%	0.10	1.2%	178.8	0.10	0.9%
4 OFF-ROAD MOBILE	1,259.4	51.1%	3.88	48.3%	1,259.4	3.88	34.2%
5 BIOGENICS (BELD)					***540.6***	***3.31***	*29.2%*
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DUKES TOTAL	**2,465.8**	**100%**	**8.03**	**100.0%**	***3,006.4***	***11.34***	***100.0%***
MASSACHUSETTS TOTAL	**146,531.0**		**394.60**		**223,703.0**	**923.30**	
DUKES % OF MA TOTAL	**1.7%**		**2.0%**		**1.3%**	**1.2%**	
					NOx With Biogenics:		
NOx (Figure 3)	**NOX TPY**	**TPY %**	**TPSD**	**TPSD %**	**NOx TPY**	**TPSD**	
1 POINT	115.5	4.5%	0.07	1.3%	115.5	0.07	
2 AREA	97.1	3.8%	0.16	3.1%	97.1	0.16	
3 ON-ROAD MOBILE	204.0	8.0%	0.21	4.0%	204.0	0.21	
4 OFF-ROAD MOBILE	2,137.4	83.7%	4.79	91.5%	2,137.4	4.79	
5 BIOGENICS (BELD)					***48.3***	***0.19***	
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DUKES TOTAL	**2,554.0**	**100%**	**5.23**	**100.0%**	***2,602.3***	***5.42***	
MASSACHUSETTS TOTAL	**144,565.0**		**382.10**		***145,504.0***	***386.10***	
DUKES % OF MA TOTAL	**1.8%**		**1.4%**		**1.8%**	**1.4%**	
CO (Figures 4 and 5)	**CO TPY**	**TPY %**	**TPSD**	**TPSD %**			
1 POINT	38.9	0.3%	0.02	0.1%			
2 AREA	4,219.1	34.4%	1.00	3.3%			
3 ON-ROAD MOBILE	1,772.9	14.4%	1.00	3.3%			
4 OFF-ROAD MOBILE	6,249.9	50.9%	28.19	93.3%			
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DUKES TOTAL	**12,280.8**	**100%**	**30.21**	**100.0%**			
MASSACHUSETTS TOTAL	***801,282.0***		***2,162.30***				
DUKES % OF MA TOTAL	**1.5%**		**1.4%**				

TABLE 1.4

DUKES COUNTY MA 2011 EMISSIONS BY CATEGORIES ALL POLLUTANTS

ks/inv2011/Emiss Summary/ Section-1-2011-Summary-Charts-em-chart May 18, 2015

SOURCE CATEGORY	SCC	Estimate Origin	VOC TPY	VOC TPSD	NOx TPY	NOx TPSD	CO TPY	CO TPSD
1.POINT SOURCES								
EGU Point Sources			14.70	0.090	115.50	0.670	38.90	0.230
Non-EGU Point Sources			0.00	0.000	0.00	0.000	0.00	0.000
TOTAL POINT SOURCES			**14.70**	**0.090**	**115.50**	**0.670**	**38.90**	**0.230**
2.AREA SOURCES								
Waste Treatment								
1. POTW's	2630020000	EPA	0.29	0.001				
2. HW TSDF	2640000000	EPA	0.00	0.000				
3. MSW Landfills	2620030000	MA	6.22	0.017				
Total Waste Treatment			**6.51**	**0.018**	**0.00**	**0.000**	**0.00**	**0.000**
Gasoline Distribution								
1. Tank Truck Unl. (Stage I)	2501060053	MA	3.84	0.013				
2. Vehicle Refuel. (Stage II)		MA	In On-Road Mobile category					
3. Underground Tank Breath.	2501060201	MA	2.63	0.007				
4. Transit Losses	2505030120	MA	0.39	0.001				
5. Petro Vessel Unload/Losses	2505020120	MA	0.30	0.001	**Revised June 20, 2014 - new 2011 data**			
6. Portable Fuel Contain Reside	250101101x	EPA	20.80	0.090	Changed June 11 2014 -used EPA new estimates			
7. Portable Fuel Contain Comm	250101201x	EPA	14.10	0.050	Changed June 11 2014 -used EPA new estimates			
8. Aviation Gas Refuel Stage I	2501080050	MA	0.52	0.001				
9. Aviation Gas Refuel Stage II	2501080100	MA	0.36	0.001				
10.Aviation Gas Ref.U.Tank Br	2501080201	MA	0.14	0.000				
Total Gasoline Distribution			**43.08**	**0.164**				
Stationary Source Solvent Evap.								
1. Dry Cleaning	2420000000	MA	0.04	0.000				
2. Surface Cleaning -degrease	2415000000	MA	0.40	0.001				
3. Commerc/Consumer Solvents	2460000000	MA	49.60	0.140				
4. Graphic Arts:	2425000000	MA	4.00	0.020	Accepted EPA's estimates using NEI Support request.			
5. Industrial Adhesives -Total	2440020000	MA	10.10	0.030				
Total Solvent Evaporation			**64.14**	**0.191**				
Non-Indus. Surface Coating:								
1. Auto. Refinish	2401005000	MA	1.90	0.010				
2. AIM Architect. Coating	2401001000	MA	21.30	0.080				
3. AIM Traffic Marking	2401008000	MA	2.30	0.010				
3.AIM High Perf. Maintenance	2401100000	MA	3.70	0.010				
4. AIM Oth. Specity Purp Coat	2401200000	MA	3.70	0.010				
Total Auto Ref & AIM Coating			**32.90**	**0.120**				
Industrial Coating:								
1. Furniture & Fixtures -Wood	2401020000	MA	0.00	0.000				
2. Metal Furniture	2401025000	MA	0.27	0.000				
2. Metal Can Containers	2401040000	MA	0.01	0.000				
3. Motor Vehicles New	2401070000	MA	0.00	0.000				
4. Machinery & Equip.	2401055000	MA	0.00	0.000				
5. Appliances	2401060000	EPA	0.70	0.003				
6. Other Transport Eq. Aircraft	2401075000	EPA	0.00	0.000				
7. Other Transport Eq. Marine	2401080000	MA	0.60	0.001				
8. Other Transport Eq. Rail	2401085000	EPA	0.00	0.000				
9. Metal Sheet, Strip,Coil	2401045000	MA	0.00	0.000				
10. Factory Finished Wood	2401015000	MA	0.10	0.000				
11. Electronic Insulation & Coat	2401065000	MA	0.00	0.000				
12. Misc Mfg, Other Prod. Coat	2401090000	MA	0.40	0.001				
14. Paper Film & Foil Coat	2401030000	MA	0.00	0.000				
Total Industrial Coating			**2.08**	**0.005**				
Miscelleneous Solvents:								
1. Cutback Asphalt	2461021000	MA	0.60	0.006				
2. Emulsified Asphalt	2461022000	EPA	0.04	0.000				
3. Agricultural Pesticide Use	2461850000	EPA	0.80	0.000				
4. Non-Agric Pesticide Use	2461870999	EPA	1.90	0.010				
		1-17						
5. Bakeries	2302050000	MA	2.90	0.010				
6. Breweries/Wineries/Distiller	2302070000	MA	0.00	0.000				
7. Petroleum Spills	2830000000	MA	2.10	0.001				
8. Asphalt Roof, Kettles & Tanks	2461023000	MA	1.30	0.010	0.00	0.000	0.00	0.000
9. Leaking USTs	2660000000	MA	0.00	0.000				
Total Miscellaneous Solvents			**9.64**	**0.037**	**0.00**	**0.000**	**0.00**	**0.000**

Table 1.4 continued . . .

SOURCE CATEGORY	SCC	Estimate Origin	VOC TPY	VOC TPSD	NOx TPY	NOx TPSD	CO TPY	CO TPSD
Small Statonary Fuel Combustion								
1. Residential Bituminous Coal	2104002000	MA	0.00	0.000	0.00	0.000	0.00	0.000
2. Residential Distillate Oil	2104004000	MA	0.73	0.001	18.60	0.018	5.20	0.005
3. Residential Natural Gas	2104006000	MA	1.10	0.001	19.30	0.019	8.20	0.008
4. Residential Wood-burn-Indoor	2104008000	EPA	51.60	0.050	6.40	0.002	555.60	0.350
5. Residential Woodburn-Outdoor	2104008610	EPA	88.90	0.070	2.40	0.001	474.80	0.300
5. Residential Kerosene	2104011000	MA	0.01	0.000	0.12	0.000	0.03	0.000
6. Residential LPG	2104007000	MA	0.06	0.000	1.55	0.002	0.44	0.000
Total Residential Fuel			**142.40**	**0.122**	**48.37**	**0.042**	**1044.27**	**0.663**
1. Commercial/Instit Bitum Coal	2103002000	MA	0.00	0.000	0.00	0.000	0.00	0.000
2. Commercial/Instit Dist.Oil	2103004000	MA	0.07	0.000	3.97	0.005	0.99	0.001
3. Commercial/Instit Res.Oil	2103005000	MA	0.02	0.000	0.88	0.001	0.08	0.000
4. Commercial/Instit N.Gas	2103006000	MA	0.26	0.000	4.64	0.005	3.90	0.004
5. Commercial/Instit Kerosene	2103011000	MA	0.00	0.000	0.02	0.000	0.00	0.000
6. Commercial/Instit LPG	2103007000	MA	0.01	0.000	0.20	0.000	0.26	0.000
7. Commercial/Instit Wood & Prod	2103081000	MA	0.02	0.000	0.20	0.000	0.60	0.001
Total Commercial/Instit Fuel			**0.38**	**0.000**	**9.91**	**0.011**	**5.83**	**0.006**
1. Small Industrial Bitum Coal	2102001000	MA	0.00	0.000	0.00	0.000	0.00	0.000
2. Small Industrial Dist.Oil	2102004000	MA	0.00	0.000	0.23	0.001	0.10	0.000
3. Small Industrial Res.Oil	2102005000	MA	0.00	0.000	0.00	0.000	0.00	0.000
4. Small Industrial N.Gas	2102006000	MA	0.03	0.000	0.52	0.002	0.44	0.002
5. Small Industrial Kerosene	2102011000	MA	0.00	0.000	0.00	0.000	0.00	0.000
6. Small Industrial LPG	2102007000	MA	0.00	0.000	0.04	0.000	0.02	0.000
7. Small Industrial Wood-Products	2102008000	MA	0.02	0.000	0.21	0.000	0.58	0.000
Total Industrial Fuel			**0.05**	**0.000**	**1.00**	**0.003**	**1.14**	**0.002**
TOTAL ALL FUEL USE			**142.83**	**0.122**	**59.28**	**0.056**	**1051.24**	**0.671**
1. Open Burn -Household Waste	2610030000	EPA	2.70	0.000	1.90	0.000	27.20	0.020
2. Open Burn -Land Clearing D	2610000500	EPA	12.40	0.009	5.40	0.004	181.30	0.138
3. Open Burn - Leaf Waste	2610000000	EPA	0.21	0.000	0.05	0.000	0.82	0.001
4. Open Burning -Yard Waste	2610040400	EPA	0.10	0.000	0.00	0.000	1.00	0.001
Total Waste Burning			**15.41**	**0.009**	**7.35**	**0.004**	**210.32**	**0.160**
2.Forest/Prescribed Fires - EPA	2810015999	EPA/MA	694.40	0.000	30.40	0.000	2955.20	0.000
2. Structural Fires	2810030000	MA	0.10	0.000	0.01	0.000	0.55	0.000
3. Vehicle Fires	2810050000	MA	0.00	0.000	0.00	0.000	0.02	0.000
4. Food Prep - Commercial-All	2302000000	EPA	0.61	0.002	0.00	0.000	1.59	0.004
5. Food Preparation Backyard Grills	2810025000	MA	0.98	0.010	0.00	0.000	0.00	0.000
Total Fires/ Cooking			**696.09**	**0.012**	**30.41**	**0.000**	**2957.36**	**0.004**
TOTAL COMBUSTION CATEGORY			**854.33**	**0.143**	**97.04**	**0.060**	**4218.92**	**0.835**
TOTAL AREA SOURCE			**1012.68**	**0.678**	**97.04**	**0.060**	**4218.92**	**0.835**
3.OFF-ROAD MOBILE								
1. Aircraft	2275050000	EPA	12.70	0.030	5.90	0.020	331.60	0.910
2. Railroads	2285002000	EPA/MA	0.00	0.000	0.00	0.000	0.00	0.000
3. Commercial Marine Vessels	2280020010	EPA	48.20	0.132	1686.10	4.619	256.30	0.702
4. NONROAD Equipment			1198.47	3.830	445.45	1.320	5661.98	22.650
Total Off-ROAD MOBILE			**1259.37**	**3.992**	**2137.45**	**5.959**	**6249.88**	**24.262**
5.ON-ROAD MOBILE								
HDDV		EPA/MA	3.60	0.002	40.70	0.042	20.40	0.012
LDDV		EPA/MA	0.50	0.000	3.20	0.003	2.10	0.001
HDGV		EPA/MA	10.90	0.006	10.20	0.010	146.70	0.083
LDGV		EPA/MA	163.70	0.092	150.00	0.154	1603.70	0.905
TOTAL ON-ROAD MOBILE			**178.70**	**0.100**	**204.10**	**0.210**	**1772.90**	**1.000**
GRAND TOTAL EMISSIONS - ALL CATEGORIES			**2465.45**	**4.86**	**2554.09**	**6.90**	**12280.60**	**26.33**

TABLE 1.5

MA 1990 TO 2011 VOC, NOx, CO & SO2 EMISSIONS TRENDS

TPSD for VOC, NOx & CO AND TPY for SO2 ** Area Source VOC adjusted for 1990-2008 to include EPA's new categories: Gasoline Bulk Plants/Terminals & Pipelines*

ks/inv2011/Emiss Summary/ Section-1-2011-Summary-Charts-em-chart Nov 3 201, Unpaved/Paved Roads revised July 25, 2016

VOC TPSD (See Figure 1.9)	1990	1993	1996	1999	2002	2005	MOVES Model Starts 2008	2011	%Reduction 1990-2011	Emission Reductions 1990-2011
POINT	64	61	43	28	16	17	16	**11**	82%	53
AREA*	408	370	331	336	310	312	253	**196**	52%	212
MOBILE	357	308	258	217	152	148	112	**89**	75%	268
OFF-ROAD	213	208	204	181	172	154	130	**109**	49%	104
TOTAL	1,042	947	836	762	650	631	511	**406**	61%	637

NOx TPSD (See Figure 1.10)	1990	1993	1996	1999	2002	2005	MOVES Model Starts 2008	2011	%Change 1990-2011	Emission Reductions 1990-2011
POINT	318	298	171	180	130	105	64	**43**	87%	275
AREA	33	36	46	33	39	42	27	**26**	22%	7
MOBILE/MOVES	451	500	549	545	453	362	260	**187**	59%	265
OFF-ROAD	139	134	141	134	142	137	124	**130**	6%	8
TOTAL	941	968	907	893	764	646	475	**385**	59%	555

CO TPSD (See Figure 1.11)	1990	1993	1996	1999	2002	2005	MOVES Model Starts 2008	2011	%Change 1990-2011	Emission Reductions 1990-2011
POINT	40	29	40	35	33	43	28	**15**	62%	25
AREA	76	69	83	79	71	74	36	**31**	60%	45
MOBILE/MOVES	4,712	3,496	3,209	2,891	2,163	1,619	864	**903**	81%	3,809
OFF-ROAD	1,893	1,872	1,867	1,802	1,727	1,558	1,360	**1,214**	36%	679
TOTAL	6,721	5,466	5,199	4,807	3,994	3,294	2,288	**2,163**	68%	4,559

SO2 TPY (See Figure 1.12 & 1.14)	1990	1993	1996	1999	2002	2005	2008	2011	%Change 1990-2011	Emission Reductions 1990-2011
POINT	272,419	210,610	125,373	161,459	99,057	92,149	54,547	**26,626**	90%	245,793
AREA	80,305	81,652	76,966	64,888	25,585	26,952	19,691	**20,779**	74%	59,526
MOBILE/MOVES	10,514	10,608	12,116	12,770	4,399	2,936	2,048	**526**	95%	9,988
OFF-ROAD	4,658	4,943	5,284	5,740	4,262	4,521	2,561	**3,821**	18%	837
TOTAL TPY	367,896	307,813	219,739	244,857	133,303	126,558	78,847	**51,752**	86%	316,144
TOTAL TPD	1,007.9	843.3	602.0	670.8	365.2	346.7	216.0	**141.8**	86%	866

PM10 TPY	1990	1993	1996	1999	2002	2005	2008	2011	%Change 2002-2011	Emission Reductions 2002-2011
POINT					839	1,429	2,173	**1,265**	-51%	-426
AREA					27778	29,903	13,864	**16,216**	42%	11,562
MOBILE/MOVES					3408	3247	6,567	**4453**	-31%	-1,045
OFF-ROAD					3450	3349	3,162	**3178.7**	8%	271
FUG.DUST*					84249	85153	90,545	**82853**	2%	1,396
TOTAL TPY					**119,724**	**123,081**	**116,311**	**107,965**	10%	11,759

**Unpaved/Paved Roads emissions 2002-2011 revised July 25,2016*

PM2.5 TPY	1990	1993	1996	1999	2002	2005	2008	2011	%Change 2002-2011	Reductions 2002-2011
POINT					157	157	1,231	**757**	-382%	-600
AREA					24932	26117	12,142	**15703**	37%	9,229
MOBILE/MOVES					2410	2248	4,934	**3039**	-26%	-629
OFF-ROAD					3152	3143	2,963	**2988**	5%	164
FUG.DUST*					10542	10659	9,204	**10307**	2%	235
TOTAL TPY					**41,193**	**42,324**	**30,474**	**32,794**	20%	8,399

**Unpaved/Paved Roads emissions revised July 25,2016*

TABLE 1.6

MA SO2 EMISSIONS WITH CAP & TRIGGER 1979-2012

TONS PER YEAR

ks/inv 2011/Emiss Summary / Section-1-2011-Summary-Charts-em-chart May 15, 2015

1979-82 4-YEAR AVERAGE CAP = 412 K TONS, TRIGGER = 402 K TONS

	CAP	TRIGGER	ANNUAL EMISS	4-YEAR AV	4-YEAR AV PERIOD	DIFF 4-YR AVG AND CAP
1979	412	402	433			
1980	412	402	412			
1981	412	402	384			
1982	412	402	420	412	1979-82	0
1983	412	402	404	405	1980-83	-7
1984	412	402	381	397	1981-84	-15
1985	412	402	379	396	1982-85	-16
1986	412	402	399	391	1983-86	-21
1987	412	402	390	387	1984-87	-25
1988	412	402	409	394	1985-88	-18
1989	412	402	422	405	1986-89	-7
1990	412	402	370	398	1987-90	-14
1991	412	402	365	392	1988-91	-21
1992	412	402	345	376	1989-92	-37
1993	412	402	310	348	1990-93	-65
1994	412	402	245	316	1991-94	-96
1995	412	402	215	279	1992-95	-133
1996	412	402	222	248	1993-96	-164
1997	412	402	261	236	1994-97	-176
1998	412	402	269	242	1995-98	-170
1999	412	402	247	250	1996-99	-162
2000	412	402	223	250	1997-00	-162
2001	412	402	185	231	1998-01	-181
2002	412	402	133	197	1999-02	-215
2005	412	402	127	130	2002-05	-282
2008	412	402	79	103	2005-08	-309
2011	412	402	52	98	2008-2011	-315

TABLE 1.7
EPA 2011 MASSACHUSETTS BIOGENIC EMISSIONS

County	TPY CO	TPSD CO	TPWD CO	TPY NO	TPSD NO	TPY VOC	TPSD VOC
Barnstable Co Total	484.91	2.67	0.11	170.32	0.68	3378.39	22.68
Berkshire Co Total	1359.14	8.30	0.24	61.37	0.27	7760.20	51.26
Bristol Co Total	765.52	4.59	0.24	73.84	0.31	5157.54	35.56
Dukes Co Total	117.43	0.61	0.24	48.28	0.19	540.62	3.31
Essex Co Total	681.32	4.18	0.24	38.85	0.17	4730.76	33.36
Franklin Co Total	1217.19	7.41	0.24	63.10	0.28	7407.11	49.59
Hampden Co Total	979.32	6.01	0.24	52.28	0.23	6353.27	43.57
Hampshire Co Total	941.62	5.79	0.24	63.67	0.28	5273.11	35.30
Middlesex Co Total	1196.81	7.40	0.24	63.53	0.28	8346.33	58.56
Nantucket Co Total	47.74	0.23	0.24	20.83	0.08	181.67	0.99
Norfolk Co Total	604.56	3.68	0.24	35.03	0.15	3937.05	27.29
Plymouth Co Total	946.18	5.58	0.24	124.19	0.52	6579.52	45.02
Suffolk Co Total	115.89	0.71	0.24	19.99	0.09	622.22	4.31
Worcester Co Total	2160.40	13.28	0.24	104.19	0.45	16903.91	118.16
Massachusetts Total	**11618.02**	**70.45**	**3.29**	**939.46**	**3.98**	**77171.70**	**528.97**

File: Section 1 2011 PEI Summary Charts 11/ From: http://www.epa.gov/ttn/chief/net/2011inventory.html