5.0 Base Year and Future Year Emission Estimates

CTDEP has adopted, or is currently pursuing adoption of, several regulations that provide in-state reductions of $PM_{2.5}$ and $PM_{2.5}$ precursor emissions. These in-state measures, along with national measures targeted at on-road and non-road emission sources, are expected to provide significant emission reductions through 2009 and beyond. This section presents estimates of emissions levels in Connecticut in the baseline year of 2002 and summarizes estimates of projected future emissions in 2009 resulting from these state and federal measures.

5.1 2002 Baseline Inventory

EPA recommended that states use calendar year 2002 emissions to establish baseline inventories for $PM_{2.5}$ planning efforts.[1] In light of the regional nature of ozone, $PM_{2.5}$ and visibility problems, states in the Northeast agreed to compile comprehensive multi-pollutant inventories as part of the MANE-VU planning process. Annual county-level inventories were developed for sulfur dioxide (SO_2), oxides of nitrogen (NOx), particles with an aerodynamic diameter less than or equal to a nominal 2.5 and 10 micrometers (i.e., primary $PM_{2.5}$ and PM_{10}), volatile organic compounds (VOC), carbon monoxide (CO) and ammonia (NH_3).

The MANE-VU inventory was developed using emission estimates provided by the states for point and area sources, supplemented as necessary with emission estimates from EPA's 2002 national emissions inventory (NEI) and augmentation procedures agreed to by the MANE-VU states to fill in missing data. For mobile source emissions, the NONROAD and MOBILE6.2 (as imbedded in the SMOKE software) models were used to develop non-road and highway emission estimates, respectively, using state-specific input data. Appropriate temporal, speciation, and spatial allocation profiles were applied to the 2002 MANE-VU inventory (version 3) to develop emission inputs required for attainment demonstration modeling purposes. Inventories were also obtained from other regional planning organizations and from Canadian agencies to represent 2002 emissions from areas outside the MANE-VU area. A complete description of the inventory development process[2] is provided in the MANE-VU report included as Appendix 5A.

MANE-VU 2002 base year emission estimates for Connecticut are summarized by county and emission sector in Table 5-1 for primary $PM_{2.5}$ emissions and for emissions of NOx and SO_2, significant precursors to $PM_{2.5}$ formation. On-road mobile sources were the largest contributors of NOx emissions in 2002 (57% of the total), with area sources contributing the largest fraction of primary $PM_{2.5}$ (78%) and point and area sources the largest fractions of SO_2 emissions (50% and 39%, respectively). Note that Fairfield and New Haven Counties are part of the NY-NJ-CT annual $PM_{2.5}$ nonattainment area. All other Connecticut counties are classified as attainment for the 1997 $PM_{2.5}$ NAAQS.

[1] EPA memorandum: ''2002 Base Year Emission Inventory SIP Planning: 8-hr Ozone, PM2.5 and Regional Haze Programs''; November 18, 2002; *http://www.epa.gov/ttn chief/eidocs/2002baseinven_102502new.pdf*.
[2] Additional information regarding the MANE-VU 2002 Inventory can be accessed at: http://www.marama.org/visibility/Inventory Summary/2002EmissionsInventory.htm

Table 5-1. 2002 MANE-VU Base Year Connecticut Emissions

CT County	Pollutant Code	POINT (Tons/Yr)	AREA (Tons/Yr)	ONROAD (Tons/Yr)	NONROAD (Tons/Yr)	TOTAL (Tons/Yr)
Fairfield County*	$PM_{2.5}$-PRI	190.5	2349.0	253.0	512.3	3304.8
Hartford County	$PM_{2.5}$-PRI	293.8	2585.2	261.3	340.5	3480.8
Litchfield County	$PM_{2.5}$-PRI	20.0	1831.5	42.3	116.9	2010.7
Middlesex County	$PM_{2.5}$-PRI	60.7	1123.8	61.1	95.5	1341.1
New Haven County*	$PM_{2.5}$-PRI	202.3	2426.7	234.2	437.6	3300.8
New London County	$PM_{2.5}$-PRI	289.4	1808.4	102.8	160.9	2361.5
Tolland County	$PM_{2.5}$-PRI	11.2	1105.4	52.6	56.2	1225.4
Windham County	$PM_{2.5}$-PRI	215.2	1017.4	34.3	73.9	1340.8
CT Total	**$PM_{2.5}$-PRI**	**1,283**	**14,247**	**1,042**	**1,794**	**18,366**
Fairfield County*	NO_X	3891.9	3133.9	16495.9	7099.1	30620.8
Hartford County	NO_X	2128.1	3360.8	17363.5	4891.2	27743.6
Litchfield County	NO_X	103.3	729.9	2756.9	1118.3	4708.4
Middlesex County	NO_X	1536.1	610.0	4106.7	1137.5	7390.3
New Haven County*	NO_X	2304.9	2936.9	15358.5	7886.7	28487.0
New London County	NO_X	2384.7	1028.2	6863.7	1845.1	12121.7
Tolland County	NO_X	103.1	467.3	3553.7	650.1	4774.2
Windham County	NO_X	471.1	421.6	2317.4	832.1	4042.2
CT Total	**NO_X**	**12,923**	**12,689**	**68,816**	**25,460**	**119,888**
Fairfield County*	SO_2	5070.1	2951.2	378.1	607.7	9007.1
Hartford County	SO_2	120.9	2674.7	424.7	334.9	3555.2
Litchfield County	SO_2	30.6	852.1	77.3	71.1	1031.1
Middlesex County	SO_2	964.9	734.1	97.4	75.5	1871.9
New Haven County*	SO_2	5512.3	2849.3	375.0	755.7	9492.3
New London County	SO_2	3956.7	1198.3	168.2	127.7	5450.9
Tolland County	SO_2	23.6	637.9	87.0	51.5	800.0
Windham County	SO_2	308.9	520.7	59.2	63.3	952.1
CT Total	**SO_2**	**15,988**	**12,418**	**1,667**	**2,087**	**32,160**

* Fairfield and New Haven Counties are part of the NY/NJ/CT $PM_{2.5}$ nonattainment area.

5.2 Post-2002 Control Measures Included in Future Year Projections

Numerous federal and state emission control programs are in place or planned for adoption to secure significant post-2002 emission reductions that will provide for attainment of the annual $PM_{2.5}$ NAAQS by the required 2010 attainment date. Federal measures largely target the on-road and non-road source sectors, while measures initiated by CTDEP include both mobile source and stationary source programs. Some measures referenced in this demonstration were developed as part of a regional planning process coordinated by the Ozone Transport Commission (OTC). These regional planning activities primarily focused on the evaluation of potential emission control measures for OTC member state 1-hour and 8-hour ozone attainment planning. Many of these OTC ozone control measures also serve to reduce emissions of pollutants that contribute to ambient $PM_{2.5}$ levels. All of the measures relied upon as sources of emissions reductions to meet attainment requirements are discussed in Section 4.0.

5.2.1 On-Road and Non-Road Mobile Sources and Fuels

Various federal and state measures have been adopted for on-road and non-road mobile sources that reduce $PM_{2.5}$-related emissions through more stringent emission standards for vehicles, engines and equipment and changes to fuel type and quality. As a result of phased-in implementation of these requirements, as well as gradual fleet turnover to new vehicles and equipment, the level of emission reductions is expected to increase through 2009 and beyond.

Tables 4-1 and 4-3 include the on-road mobile source control programs relied on in this attainment demonstration to provide post-2002 emission reductions of $PM_{2.5}$, NOx, and/or SO_2.[3] Programs producing reductions in emissions of VOC, a less significant contributor to $PM_{2.5}$ formation in Connecticut, are also noted. A brief summary of each program or control measure is provided in Section 4.0 of this demonstration.

Non-road engines are used in a variety of applications such as construction equipment, outdoor power equipment, farm equipment, lawn and garden equipment, marine vessels, locomotives and aircraft. Prior to the mid-1990's, emissions from these engines were largely unregulated. EPA has since issued several rules regulating emissions from new non-road engines.[4]

As listed in Table 4-2 and described in Section 4.2.1, non-road mobile source controls relied upon in this attainment demonstration include engine standards for compression-ignition engines, spark-ignition engines, marine diesel engines, locomotive engines and aircraft engines and associated low-sulfur fuel standards.

5.2.2 Connecticut's Control of Stationary and Area Sources

Given federal efforts to address emissions from mobile sources, Connecticut has focused the majority of its post-2002 efforts on reducing emissions from large stationary sources that contribute to the formation of $PM_{2.5}$ and ozone in the atmosphere. These stationary and area source control measures, which are described in Section 4.3.2 and summarized in Table 4-3 have been included in the regional $PM_{2.5}$ modeling analysis. In addition, as part of Connecticut's ozone planning efforts, several area source VOC strategies are being implemented that should also provide some reductions in the formation of organic carbon particles that can contribute to elevated $PM_{2.5}$ levels.[5]

5.3 Future Year Emission Projections

Future year multi-pollutant emission projections were developed through a collaborative effort of the states in the MANE-VU region. The 2002 MANE-VU inventory served as the starting point for developing future year projections. As with the 2002 base year inventory, annual county-level inventories were developed by MANE-VU for SO_2, NOx, VOC, CO, PM_{10} and $PM_{2.5}$. Appropriate growth estimates and control factors, representing the post-2002 controls described above (so-called "beyond-on-the-way", or BOTW controls), were incorporated to obtain projected emissions for 2009 and 2012. For mobile source emissions, the NONROAD and

[3] Note that the CALEV2 regulation (RCSA Section 22a-174-36b) has not been submitted to EPA as of the date of this submission. Emission estimates presented in this document do not take credit for the CALEV2 program.
[4] *See* http://www.epa.gov/nonroad/index.htm.
[5] *See* Connecticut's ozone attainment demonstration for a complete description of VOC control programs: http://www.ct.gov/dep/lib/dep/air/regulations/proposed_and_reports/att_d_full_tsd.pdf.

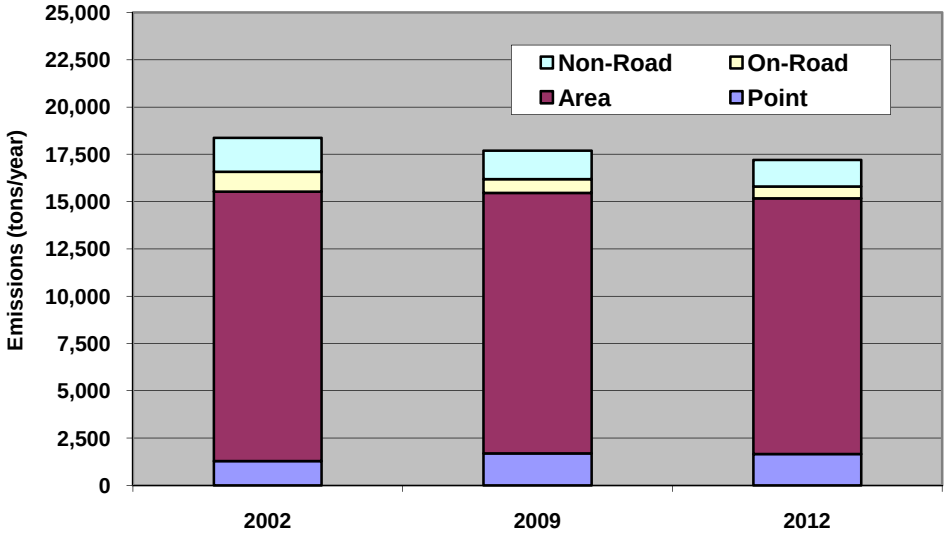
MOBILE6.2 (as imbedded in the SMOKE software) models were used to develop non-road and highway emission estimates, respectively, using state-specific input data representative of the future year. Appropriate temporal, spatial and speciation allocation profiles were applied to the resulting MANE-VU annual inventory to develop emission inputs required for attainment demonstration modeling purposes. Future year inventories were also obtained from other regional planning organizations and from Canadian agencies to represent projected emissions from areas outside the MANE-VU area. Descriptions of the inventory development process are provided in the MANE-VU reports[6] included as Appendix 5B (for non-EGU, area, and non-road mobile sources), Appendix 5C (for on-road mobile sources) and Appendix 5D (for EGU sources).

MANE-VU emission estimates for Connecticut for the years 2002, 2009 and 2012 are summarized in Tables 5-2 through 5-4 and Figures 5-1 through 5-3 for $PM_{2.5}$, NOx and SO_2, respectively. Total primary $PM_{2.5}$ emissions are projected to decline slightly between 2002 and 2009 (by 4%), with an additional reduction of 3% by 2012. Emission increases in the point source sector are more than offset by projected decreases in the area, non-road and on-road sectors.

Table 5-2. MANE-VU $PM_{2.5}$ Emissions Projections for Connecticut (2002-2012)

	Annual Emissions (tons/year)				
Year	**Area**	**Non-Road**	**On-Road**	**Point**	**Total**
2002	14,247	1,794	1,042	1,283	18,366
2009	13,766	1,508	723	1,690	17,687
2012	13,517	1,408	620	1,660	17,205

Figure 5-1. MANE-VU $PM_{2.5}$ Emissions Projections for Connecticut (2002-2012)



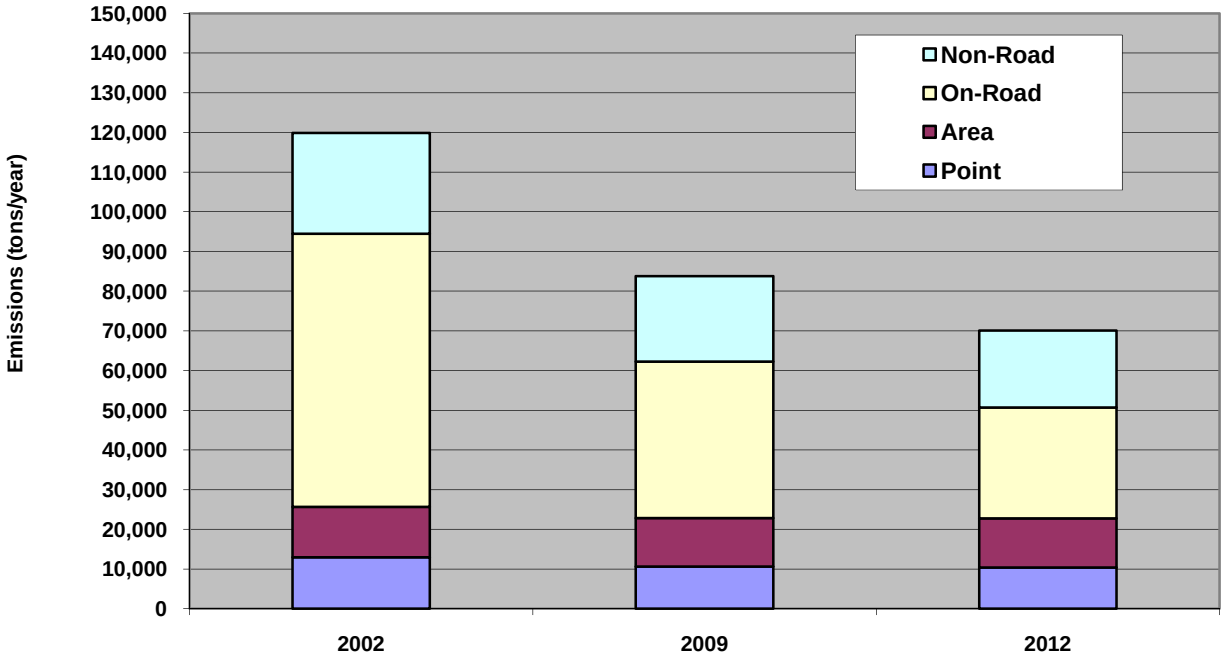
[6] Additional information regarding the MANE-VU future year inventories can be accessed at: http://www.marama.org/visibility/Inventory%20Summary/FutureEmissionsInventory.htm.

Total NOx emissions in Connecticut are projected to decrease by 30% and 41% in 2009 and 2012 from 2002 levels. Significant decreases are expected from the on-road, non-road and point source sectors due to the post-2002 control measures described in Section 5.2.

Table 5-3. MANE-VU NO_x Emissions Projections for Connecticut (2002-2012)

	Annual Emissions (tons/year)				
Year	**Area**	**Non-Road**	**On-Road**	**Point**	**Total**
2002	12,689	25,460	68,816	12,923	119,888
2009	12,245	21,512	39,468	10,547	83,722
2012	12,389	19,316	28,010	10,300	70,015

Figure 5-2. MANE-VU NOx Emission Estimates for Connecticut 2002-2012 Beyond-On-the-Way (BOTW) Controls

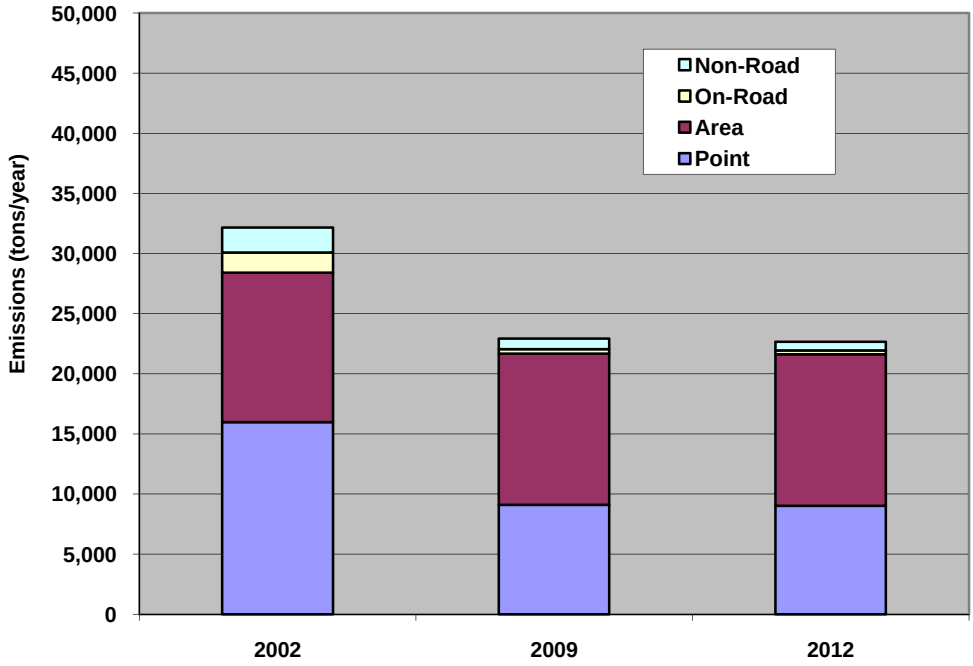


Total SO_2 emissions in Connecticut are projected to decrease by 29% between 2002 and 2009. Reductions are due to low sulfur fuels mandated for on-road vehicles and non-road equipment, as well as new sulfur emission limits for large industrial and electric generating facilities, as described in Section 5.2.

Table 5-4. MANE-VU SO_2 Emissions Projections for Connecticut (2002-2012)

	Annual Emissions (tons/year)				
Year	**Area**	**Non-Road**	**On-Road**	**Point**	**Total**
2002	12,418	2,087	1,667	15,988	32,160
2009	12,581	887	357	9,102	22,927
2012	12,604	711	326	9,010	22,651

Figure 5-3. MANE-VU SO2 Emission Estimates for Connecticut 2002-2012 Beyond-On-the-Way (BOTW) Controls



5.4 Additional Control Programs Not Included in Modeling

In addition to the SIP control strategies included in the MANE-VU inventory and modeling, several state and federal control programs have or will be implemented that will serve to further reduce $PM_{2.5}$-related emissions by 2009 and beyond.

5.4.1 Additional Connecticut Control Measures

Connecticut is pursuing implementation of a number of non-SIP initiatives in the stationary and mobile source sectors that should provide emission reductions beyond those accounted for in the 2009 MANE-VU emission inventory and SIP modeling.

Retail Electricity Use Reduction and Time of Use Policies

As a result of State executive and legislative policies and programs, and administrative agency programs, Connecticut is implementing various approaches to reduce peak electric demand and increase efficient use of electricity by retail consumers, thereby reducing electric generator operating hours and emissions and reducing future demand for the construction and operation of new electric generating capacity. Such approaches are described in Section 4.4.1. The emissions reductions from such State efforts are difficult to quantify but will work to reduce emissions beyond those accounted for in the 2009 MANE-VU emissions inventory and modeling.

Diesel Retrofit and Anti-Idling Programs

Connecticut is implementing several non-SIP emission control programs targeted at reducing in-use emissions from on-road and non-road vehicles. Table 4-5 summarizes these programs, which are targeted primarily at retrofits of school and transit buses, construction equipment and recycling trucks. These retrofit projects provide localized reductions in direct-$PM_{2.5}$ emissions, primarily in urban areas and locations with sensitive receptor populations such as schools.

Pursuant to Public Act No. 02-56, which prohibits (with limited exceptions) the idling of school bus engines for more than three consecutive minutes, CTDEP has implemented an extensive public education outreach effort. Outreach has included notifications to bus companies and school districts, as well as the placement of signage at schools to remind drivers of the restriction. This effort provides additional reductions of both $PM_{2.5}$ and NOx emissions.

Transportation Control Measures

As part of the transportation planning process, the Connecticut Department of Transportation, in concert with local metropolitan planning organizations, is implementing numerous transportation control measures (TCMs). As more fully described in Section 4.4.1 and Tables 4-6 and 4-7, TCMs include transit improvements, rideshare programs, incident management systems and travel demand management. Although emission reductions from these programs are relatively small, many are focused on urban areas where ambient $PM_{2.5}$ levels are typically highest.

5.4.2 Additional Federal Control Measures

Two new sets of federal non-road regulations will have a positive impact, albeit minimal due to their 2008 effective dates, on April 2010 attainment. However, the new regulations will help to ensure that emissions continue to decrease through 2012 and beyond. Emissions reductions from the two control categories, locomotives/marine diesel engines and spark-ignition engines, are

described in Section 4.4.2 and identified as weight-of-evidence towards attainment in Section 8.6.7.

5.5 Conclusion

All Connecticut counties monitor attainment for the annual $PM_{2.5}$ NAAQS from the 2002 base year forward. The emissions reductions from control measures described in Section 4.0 will provide significant emissions reductions through 2009 and beyond, based on the projected 2009 emissions, allowing for attainment in 2010 throughout the NY-NJ-CT nonattainment area.