Revision to Connecticut's State Implementation Plan

Annual $PM_{2.5}$ Attainment Demonstration Technical Support Document

November 18, 2008

State of Connecticut
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Acronyms and Abbreviations

AIM	Architectural and Industrial Maintenance
ASM 2525	Accelerated Simulation Mode Vehicle Emissions Test (25 mph/25% Load)
ATV	All Terrain Vehicle
BOTW	Beyond on the Way
BTU	British Thermal Unit
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAIR	Clean Air Interstate Rule
CALEV2	California Low Emission Vehicle Program – Phase 2
CARB	California Air Resources Board
CEEF	Connecticut Energy Efficiency Fund
CFR	Code of Federal Regulations
CI	Compression Ignition
CMAQ	Congestion Mitigation and Air Quality
CMAQ	EPA's Models-3/Community Multi-scale Air Quality Modeling System
CNG	Compressed Natural Gas
COPD	Chronic Obstructive Pulmonary Disease
CT	Connecticut
CTDEP	Connecticut Department of Environmental Protection
CTDOT	Connecticut Department of Transportation
DOC	Diesel Oxidation Catalyst
DPF	Diesel Particulate Filter
DV	Design Value
DV_B	Baseline Measured Concentration
DV_F	Estimated Future Design Value
ECMB	Energy Conservation Management Board
EE	Energy Efficiency
EGU	Electric Generating Unit
EPA	Environmental Protection Agency
FCM	Forward Capacity Market
FHWA	Federal Highway Administration
FMVCP	Federal Motor Vehicle Control Program
FR	Federal Register
FRM	Federal Reference Method
FTA	Federal Transit Administration
FY	Fiscal Year
GVWR	Gross Vehicle Weight Rating
HAP	Hazardous Air Pollutant
HC	Hydrocarbon
HEDD	High Electrical Demand Day
HOV	High-Occupancy Vehicle
hp	Horsepower
ICAO	United Nations International Civil Aviation Organization
ICI	Industrial/Commercial/Institutional

Acronyms and Abbreviations (continued)

I/M	Inspection and Maintenance
IMPROVE	Interagency Monitoring of Protected Visual Environments
ISO-NE	Independent Systems Operator – New England
lbs	Pounds
kg	Kilograms
KW	Kilowatt
LAER	Lowest Achievable Emission Rate
LEEDS	Leadership in Environmental Design Silver
LEV	Low Emission Vehicle
MACT	Maximum Available Control Technology
MANE-VU	Mid-Atlantic/Northeast Visibility Union
MARAMA	Mid-Atlantic Regional Air Management Association
MARPOL	International Convention for the Prevention of Pollution from Ships
MAT	Modeled Attainment Test
MD	Maryland
MFB	Mean Fractional Bias
MFGE	Mean Fractional Gross Error
MM5	Mesoscale Meteorological Model
MMBtu	Million British Thermal Units
MNGE	Mean Normalized Gross Error
MNB	Mean Normalized Bias
MOU	Memorandum of Understanding
MOBILE6 or MOBILE6.2	EPA's On-Road Mobile Source Emissions Estimation Model
MPO	Metropolitan Planning Organization
MVEB	Motor Vehicle Emission Budgets
MW	Megawatt
MWh	Megawatt Hour
MWC	Municipal Waste Combustor
NAAQS	National Ambient Air Quality Standards
NEI	National Emissions Inventory
NESCAUM	Northeast States for Coordinated Air Use Management
NH_3	Ammonia
NJ	New Jersey
NJDEP	New Jersey Department of Environmental Protection
NLEV	National Low Emission Vehicle Program
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NONROAD or NONROAD2005	EPA's Non-Road Emissions Estimation Model
NSR	New Source Review
NY	New York
NYC	New York City
NYSDEC	New York State Department of Environmental Conservation

Acronyms and Abbreviations (continued)

OBD-II	On-Board Diagnostics – Phase 2
OC	Organic Carbon
OEM	Original Equipment Manufacturer
ORVR	Onboard Refueling Vapor Recovery
OTB	On The Books
OTC	Ozone Transport Commission
OTR	Ozone Transport Region
PEI	Periodic Emission Inventory
PFC	Portable Fuel Container
PL	Public Law
$PM_{2.5}$	Fine Particulate Matter (particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers)
PM_{10}	Particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers
ppb	Parts per billion
ppm	Parts per million
PSU/NCAR	Pennsylvania State University/National Center for Atmospheric Research
PV	Pressure Vacuum
RACM	Reasonably Available Control Measure
RACT	Reasonably Available Control Technology
RCSA	Regulations of Connecticut State Agencies
RE	Rule Effectiveness
RFG	Reformulated Gasoline
RFP	Reasonable Further Progress
RMSE	Root Mean Square Error
ROP	Rate of Progress
RPO	Regional Planning Organization
RRF	Relative Response Factor
RRF	Resource Recovery Facility
RVP	Reid Vapor Pressure
SAFETEA	Safe, Accountable, Flexibility, Efficient Transportation Equity Act of 2003
SAFETEA- LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act, A Legacy for Users
SCAQMD	South Coast Air Management Quality District
SI	Spark Ignition
SIP	State Implementation Plan
SLAMS/ NAMS	State & Local Air Monitoring System and National Air Monitoring System
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	Sulfur Dioxide
SO_4	Sulfate
SOA	Secondary Organic Aerosol
STIP	Statewide Transportation Improvement Program
STN	Speciation Trends Network
SUV	Sport Utility Vehicle

Acronyms and Abbreviations (continued)

TBD	To be determined
TCM	Transportation Control Measure
TEA-21	Transportation Equity Act for the 21st Century
TIP	Transportation Improvement Program
TNMOC	Total Non-Methane Organic Carbon
tpd	Tons per day
tpy	Tons per year
TSD	Technical Support Document
ULSD	Ultra-Low Sulfur Diesel
UMD	University of Maryland at College Park
USCA	United States Code Annotated
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
VA	Virginia
VADEQ	Virginia Department of Environmental Quality
VISTAS	Visibility Improvement State and Tribal Association of the Southeast
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compound
WOE	Weight-of-Evidence

ABSTRACT

This document sets out the Connecticut Department of Environmental Protection's (CTDEP's) demonstration of attainment of the 1997 annual national ambient air quality standard (NAAQS) for fine particulate matter less than a nominal 2.5 micrometers in diameter ($PM_{2.5}$). The demonstration has two major components: (1) a description of the national, regional and local control measures that have been or will be implemented to reduce emissions in future years; and (2) air quality modeling and other analyses of air quality and meteorological data to assess the likelihood of reaching attainment by the mandated 2010 attainment deadline.

Only two counties in Connecticut, Fairfield and New Haven, are designated as nonattainment for the annual $PM_{2.5}$ NAAQS. These two counties, along with counties in downstate New York and northern New Jersey, are included by EPA in a single multistate $PM_{2.5}$ nonattainment area based on measured violations in the New York and New Jersey portions of the area. All Connecticut monitors measure compliance with the annual $PM_{2.5}$ NAAQS, with monitored $PM_{2.5}$ levels in Connecticut exhibiting a general downward trend from 2001 through 2006 as a result of control program implementation. Control measures implemented to reduce emissions of $PM_{2.5}$ and its precursors are identified, including reasonably available control measures, as required by Section 172(c)(1) of the Clean Air Act.

Results of the analyses described in this attainment demonstration lead CTDEP to conclude that attainment in the New York-New Jersey-Connecticut nonattainment area will be achieved by the April 2010 attainment date. Air quality modeling of emissions, grown and controlled to 2009, monitored data trends, plus other evidence of forthcoming emission reductions indicate that the previously non-attaining air quality levels in New York City and northern New Jersey will reach compliant levels by the April 2010 attainment date.

Connecticut's continued monitored compliance with the annual $PM_{2.5}$ NAAQS and the anticipated attainment by 2010 throughout the multistate area should not be taken as evidence that no air challenges remain. Those small accomplishments for $PM_{2.5}$ belie the seriousness of the remaining challenges and the urgent need, in light of mounting public health data, for additional air quality improvements to address other persistent public health and environmental problems. The emission control strategies described within this SIP revision not only serve to demonstrate attainment for the 1997 annual $PM_{2.5}$ NAAQS but also to position Connecticut to reduce future levels of greenhouse gases, daily $PM_{2.5}$, ozone precursors and air toxics; improve visibility and support environmental justice initiatives.

EXECUTIVE SUMMARY

Overview

This document sets out the Connecticut Department of Environmental Protection's (CTDEP's) plan for attaining the 1997 annual national ambient air quality standard (NAAQS) for fine particulate matter less than a nominal 2.5 micrometers in diameter ($PM_{2.5}$). The plan has two major components: (1) a description of the national, regional and local control measures that have been or will be implemented to reduce emissions in future years; and (2) air quality modeling and other analyses of air quality and meteorological data to assess the likelihood of reaching attainment by the 2010 attainment deadline.

Only two counties in Connecticut, Fairfield and New Haven, are designated as nonattainment for the annual $PM_{2.5}$ NAAQS. These two counties are included by the U.S. Environmental Protection Agency (EPA) in a multistate $PM_{2.5}$ nonattainment area that includes ten downstate New York counties and ten northern New Jersey counties. This multistate area is classified by EPA as nonattainment for the 1997 annual $PM_{2.5}$ NAAQS based on measured violations in the New York and New Jersey portions of the nonattainment area; all Connecticut monitors measure compliance with the annual $PM_{2.5}$ NAAQS.

Results of the analyses described in this attainment demonstration lead CTDEP to conclude that attainment in the New York-New Jersey-Connecticut (NY-NJ-CT) nonattainment area will be achieved by the April 2010 attainment date. Air quality modeling of emissions, grown and controlled to 2009, monitored data trends, plus other evidence of forthcoming emission reductions indicate that the previously non-attaining air quality levels in New York City and northern New Jersey will achieve compliance by the April 2010 attainment date.

The $PM_{2.5}$ Demonstration air quality modeling analyses relied in part on the Clean Air Interstate Rule (CAIR) to achieve reductions in emissions of sulfur dioxide (SO_2) and nitrogen oxides (NOx) from upwind sources to help the NY-NJ-CT nonattainment area achieve timely attainment. On July 11, 2008, the U.S. Court of Appeals for the District of Columbia Circuit vacated CAIR in its entirety. On September 24, 2008, EPA filed a petition for rehearing, on which a decision is pending. Although the eventual fate of the CAIR program is in question, the conclusions of the $PM_{2.5}$ Demonstration will not change. Emissions in the NY-NJ-CT area are being reduced sufficiently to attain, provided that upwind states are required to satisfy CAA section 110(a)(2)(D) by reducing transported air pollution so as to no longer contribute significantly to nonattainment in downwind areas. EPA's technical support documents for the CAIR program demonstrated that numerous upwind states have significant contributions in the NY-NJ-CT area. In approving the $PM_{2.5}$ Demonstration, EPA will assure that Connecticut is accountable for reducing emissions to satisfy the transport provisions of the CAA. CTDEP expects that EPA will in turn ensure that states upwind of the NY-NJ-CT nonattainment area are similarly accountable.

Particulate Matter and Public Health

The anticipated attainment of the 1997 annual $PM_{2.5}$ NAAQS is significant from the vantage of public health. The annual average and 24-hour average $PM_{2.5}$ NAAQS were established by EPA based on the results of numerous studies implicating exposure to elevated levels of $PM_{2.5}$ as a factor in many serious health problems, including:

- premature mortality,
- aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions, emergency room visits, absences from school or work, and restricted activity days),
- decreased lung function and difficulty breathing,
- asthma attacks, and
- certain cardiovascular problems such as heart attacks and cardiac arrhythmia.[1, 2]

[1] 72 FR 20586-87 (April 25, 2007).

Individuals particularly sensitive to $PM_{2.5}$ exposure include older adults, children and people with pre-existing respiratory and cardiac disease.[3]

Although fine particulate matter from all sources contributes to adverse health effects, particulate matter emitted from diesel engines is particularly troublesome, for three reasons: (1) diesel engines emit toxic air pollutants along with direct $PM_{2.5}$ and NOx; (2) many ultra-fine particles are produced; and (3) emissions tend to be emitted near ground-level and are concentrated in urban areas. Control measures that target diesel engine emissions are, therefore, particularly important to addressing public health impacts of $PM_{2.5}$.

EPA has estimated that attainment of the 1997 annual and daily $PM_{2.5}$ standards nationally would prolong tens of thousands of lives and prevent tens of thousands of hospital admissions each year.[4] In addition, these standards would prevent hundreds of thousands of doctor visits, absences from work and school, and respiratory illnesses in children. Health studies have shown that there is no clear threshold below which adverse effects are not experienced by at least certain segments of the population.

Contextual Issues for Connecticut

Recognition of the relationship between public health and air quality is necessary to provide the proper context for this attainment demonstration. Connecticut's continued monitored compliance with the annual $PM_{2.5}$ NAAQS and the anticipated attainment by 2010 throughout the multistate area should not be taken as evidence that the work of air quality improvements is done. Those small accomplishments belie the seriousness of the remaining challenges and the urgent need for additional improvement. For example, Connecticut and other states now face the challenge of meeting the more stringent 2006 daily $PM_{2.5}$ standard of 35 $\mu g/m^3$ and better addressing other persistent public health and environmental problems. The emission control strategies described within this SIP revision not only serve the purpose of demonstrating attainment for the 1997 annual $PM_{2.5}$ NAAQS but also positioning Connecticut to achieve goals for:

- Reducing greenhouse gas emissions to help Connecticut meet its obligations under the State's Global Warming Solutions Act;
- Continuing to reduce direct and indirect $PM_{2.5}$ emissions in an effort to meet the 2006 daily $PM_{2.5}$ standard of 35 $\mu g/m^3$;
- Supporting the State's efforts to meet the commitments in its 8-hour ozone attainment demonstration SIP, submitted to EPA on February 1, 2008;
- Building a foundation for the attainment of the March 27, 2008 revised ozone NAAQS;
- Continuing the State's on-going efforts to reduce emissions of air toxics;
- Achieving the reasonable progress goals and protecting visibility, as set out in the State's soon-to-be-completed Regional Haze SIP; and
- Supporting the State's environmental justice and urban initiatives.

It is within the above context that CTDEP has been developing this $PM_{2.5}$ plan to demonstrate that the entire New York-New Jersey-Connecticut nonattainment area will attain the 1997 annual $PM_{2.5}$ NAAQS by the April 5, 2010 deadline.

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[2] EPA. Air Quality Criteria for Particulate Matter. United States Environmental Protection Agency, Research Triangle Park, North Carolina: National Center for Environmental Assessment—RTP, Office of Research and Development; report no. EPA/600/P–99/002aF and EPA/600/P–99/002bF. October 2004.

[3] 62 FR 38652-690 (July 18, 1997).

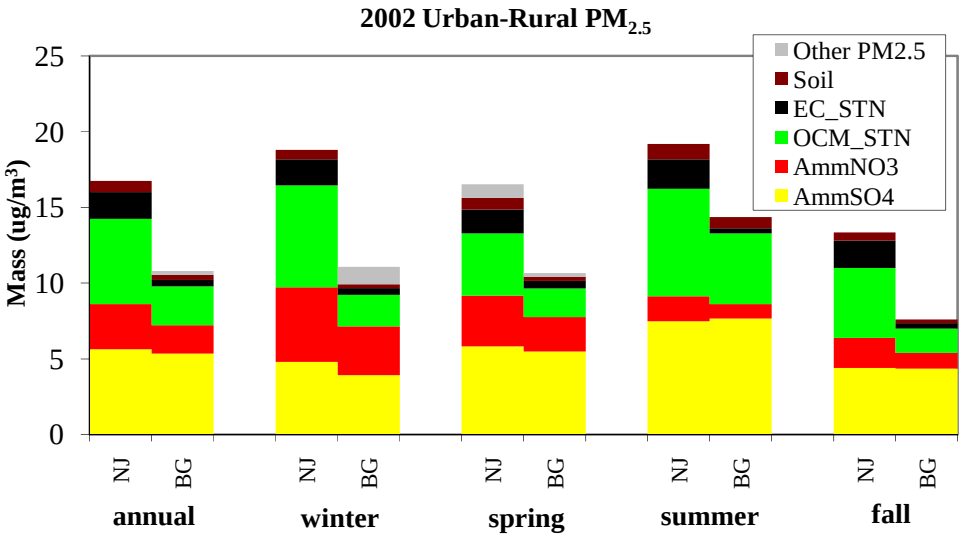
[4] 62 FR 38652-690 (July 18, 1997).

Conceptual Model

The conceptual underpinnings of this attainment demonstration were developed in a November 2006 report of the Northeast States for Coordinated Air Use Management.[5] That report recognizes two basic concepts concerning $PM_{2.5}$ emissions and ambient levels: (1) emission sources, atmospheric chemistry and meteorological phenomena that influence ambient concentrations of $PM_{2.5}$ pollution act on scales ranging from hundreds to thousands of kilometers; and (2) $PM_{2.5}$ levels are a concern in both summer and winter, with important differences between the meteorological and chemical dynamics determining the levels in the two seasons.

Figure ES-1 illustrates both urban versus rural differences and seasonal differences in the species contribution of $PM_{2.5}$. In general, $PM_{2.5}$ concentrations are lower at the rural monitor sites compared to the urban site. Further, sulfate comprises a greater percentage of the total speciated fine particles at the rural monitor site. The elemental and volatile carbon fractions are greater in the urban areas, likely due to diesel truck traffic and other local combustion sources.

Figure ES-1. $PM_{2.5}$ Species Contribution in the Urban New York Area -- NJ (Elizabeth, NJ) Compared to an Upwind Background Site -- BG (Chester, NJ)



On average, summertime concentrations of sulfate in the northeastern United States are more than twice that of the next most important fine particle constituent, organic carbon, and more than four times the combined concentration of nitrate and black carbon constituents. In the winter, sulfate levels in urban areas are higher than background sulfate levels across the eastern United States, suggesting that the local urban contribution to wintertime sulfate levels is significant relative to the regional sulfate contribution from long-range transport.

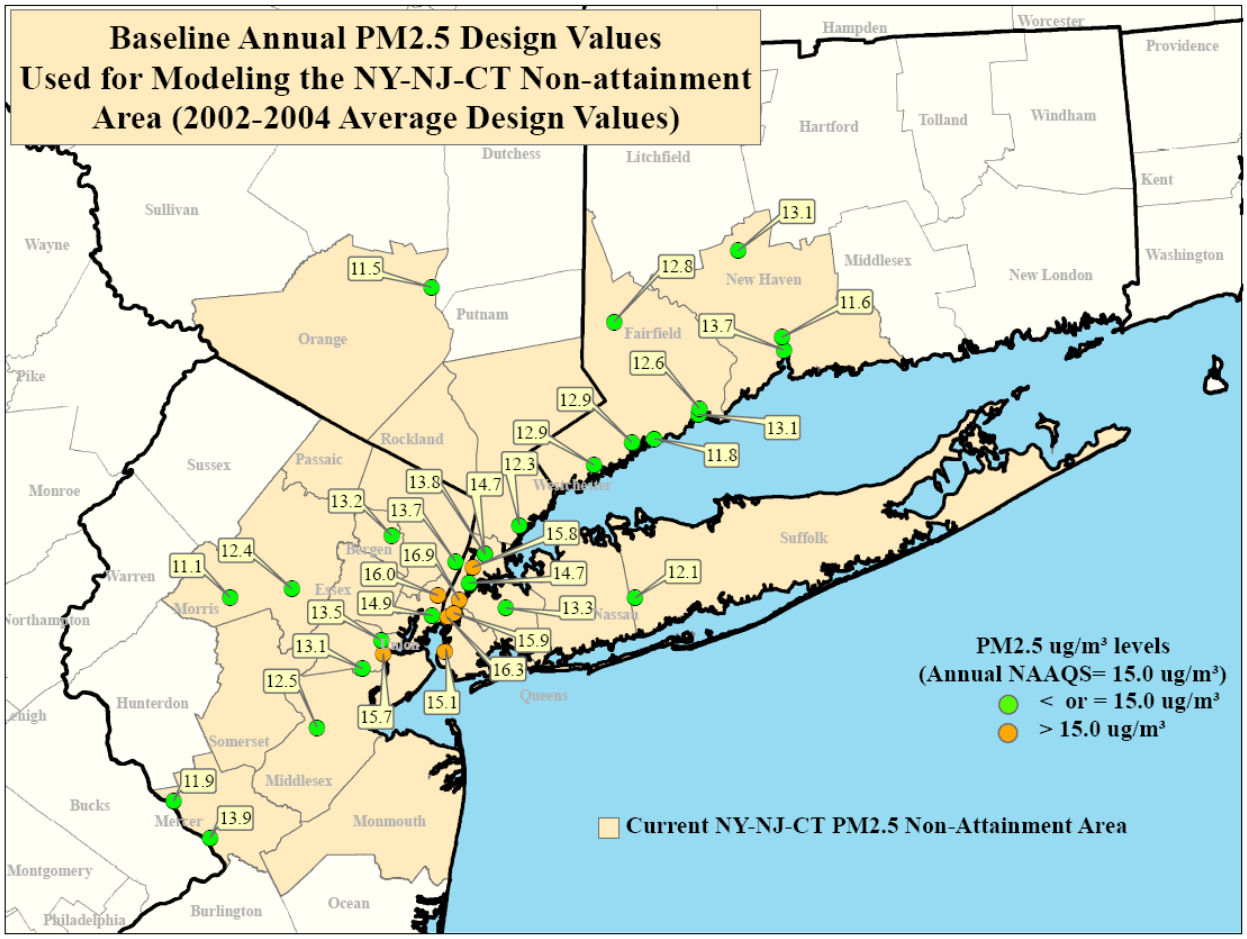
These concepts of speciation were used to identify patterns of $PM_{2.5}$ levels in Connecticut and to perform an analysis of highly time-resolved speciated data and meteorology for several high $PM_{2.5}$ events at Connecticut monitoring sites. The implications of this Connecticut analysis to national air quality regulation are two-fold: (1) control measures on electric generating units to the west of Connecticut are necessary to reduce sulfate levels sufficiently during the summer; and (2) control measures on motor vehicles are needed to reduce carbon and nitrate levels in both summer and winter.

[5] The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description; NESCAUM; November 2, 2006; See: http://www.nescaum.org/activities/major-reports.

Air Quality and Trends

CTDEP's monitoring network currently includes 12 federal reference method $PM_{2.5}$ monitors, nine of which are located at sites in the Connecticut portion of the NY-NJ-CT annual $PM_{2.5}$ nonattainment area. Figure ES-2 shows monitor locations throughout the NY-NJ-CT nonattainment area, along with corresponding baseline design values (representative of the 2000-2004 time period) used in the attainment modeling effort.[6] Baseline design values were less than the annual $PM_{2.5}$ NAAQS at all monitor locations in Connecticut. Several monitors in New York City and northern New Jersey recorded baseline design values exceeding the annual $PM_{2.5}$ NAAQS of 15 µg/m^3, with a maximum measured value of 16.9 µg/m^3 at a monitor located at the PS 59 site on Manhattan Island in New York City.

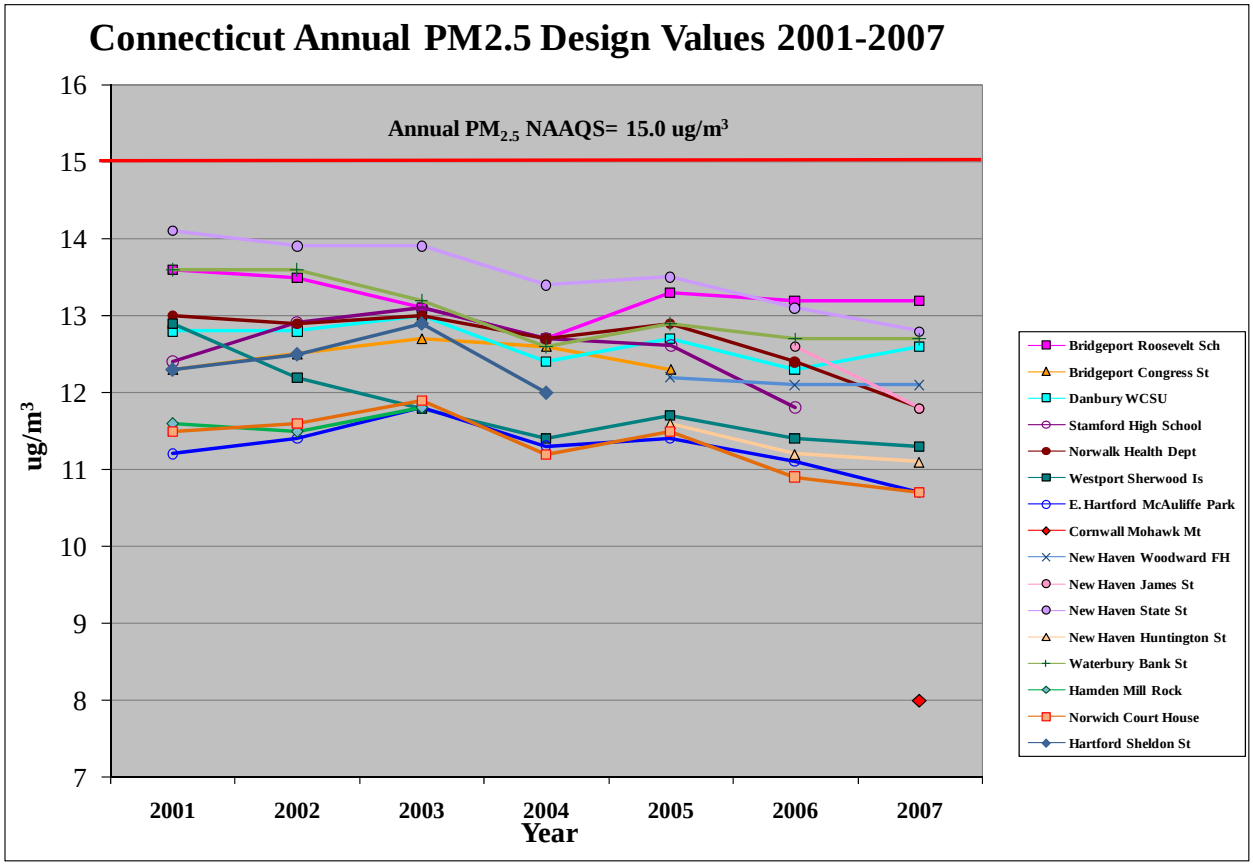
Figure ES-2. $PM_{2.5}$ Monitor Locations and Modeling Baseline Year Design Values



Design value trends are plotted for Connecticut monitors in Figure ES-3 for the period 2001 through 2007. Design values remained in compliance with the annual NAAQS throughout the period at all Connecticut sites, with a general downward trend in $PM_{2.5}$ levels.

[6] See Section 8.4.1 for an explanation of how baseline $PM_{2.5}$ design values were determined for use in the attainment demonstration modeling exercise.

Figure ES-3. Connecticut $PM_{2.5}$ Design Value Trend 2001-2007



Control Measures

Connecticut has a long history of implementing local and regional control measures to reduce NOx and VOC emissions to meet our 1-hour and 8-hour ozone attainment obligations. Similarly, Connecticut has a history of implementing local and statewide measures to reduce particulate and sulfur dioxide emissions to meet particulate matter obligations, including actions under a limited maintenance plan for New Haven. Emissions reductions from these measures, as well as reductions from federal emission control programs, achieved significant reductions in ambient $PM_{2.5}$ levels in Connecticut prior to the 2002 base year. Many of these measures continue to reduce emissions of direct $PM_{2.5}$ and its precursors.

Such previously implemented control measures form the foundation of Connecticut's $PM_{2.5}$ attainment planning and constitute a significant number of Connecticut's reasonably available control measures (RACM). Section 172(c)(1) of the Clean Air Act (CAA) requires states with nonattainment areas to implement all RACM, including those measures requiring the adoption of reasonably available control technology (RACT), as expeditiously as practicable. RACM refers to measures that may be applicable to a wide range of sources, including mobile and areas sources, whereas RACT is a type of RACM specifically designed for stationary sources. This demonstration addresses the requirements of CAA Section 172(c)(1), through (1) an analysis to demonstrate all RACM have been implemented; and (2) a catalogue of measures reducing emissions in Connecticut, RACM or not, that contribute to the predicted attainment in 2010 for the NY-NJ-CT area.

Given Connecticut's currently monitored attainment and the projected attainment of the NY-NJ-CT nonattainment area by 2010, CTDEP concludes its RACM analysis by finding that no new measures are

necessary as RACM. While no new RACM are identified as necessary for this demonstration, a number of measures adopted in the past have contributed to Connecticut's monitored attainment and are considered as RACM. Continuing reductions from such measures plus reductions from non-RACM measures will ensure continued compliance with the NAAQS in Connecticut and attainment in the NY-NJ-CT area.

Table ES-1 lists the pre-2002 control strategies that CTDEP considers RACT and RACM, which were implemented prior to the 2002 baseline year used for the $PM_{2.5}$ emissions inventory and modeling. Table ES-2 identifies the post-2002 control strategies that contribute to the modeled $PM_{2.5}$ attainment in 2009 and hence are considered RACM. The demonstration also identifies additional measures that produce directionally correct emissions reductions. While such measures are not RACM, as they are difficult to quantify, are not federally enforceable and may only slightly advance attainment, CTDEP pursues them as weight-of-evidence leading to the conclusion that attainment in 2010 has been demonstrated.

Table ES-1. Pre-2002 Control Strategies

	Pollutant Controlled			
Control Strategy	**PM**	**NO_X**	**SO_2**	**VOC**
Federal Tier 0 Motor Vehicle Controls		X		X
Federal Tier 1 Motor Vehicle Controls	X	X		X
Federal Low Emission Vehicle Program	X	X		
Federal On-board Refueling Vapor Recovery				X
Reformulated Gasoline – Phases I and II		X		X
Federal Non-Road Control Programs (See Table 4-2 for details of each strategy)	X	X		X
Title IV of the 1990 Amendments to the Clean Air Act (CAA) mandates requirements for the control of acid deposition		X	X	
EPA Wood Stove Certification Program	X			
Control of Open Burning (1983) CGS Sec. 22a-174 (f)	X	X		
Permit to Construct and Operate Stationary Sources RCSA Section 22a-174-3	X	X	X	X
Control of particulate matter and visible emissions RCSA Section 22a-174-18	X			
Control of sulfur compound emissions RCSA Section 22a-174-19			X	
Control of nitrogen oxides emissions RCSA Section 22a-174-22		X		
CT Enhanced I/M (ASM 2525 phase-in standards) RCSA 22a-174-27		X		X
Dispensing of Gasoline/Stage I and Stage II Vapor Recovery RCSA Section 22a-174-30				X
Low Emission Vehicles RCSA Section 22a-174-36		X		X
Standards for Municipal Waste Combustion (Phase 1) RCSA 22a-174-38	X	X	X	

Table ES-2. Post-2002 Control Strategies

Control Strategy	Pollutant Controlled			
	PM	NO_X	SO2	VOC
Federal Tier 2 Motor Vehicle Controls/Low Sulfur Gasoline	X	X	X	X
Federal On-board Refueling Vapor Recovery				X
Federal Heavy-Duty Diesel Vehicle Controls and Fuels	X	X	X	X
Federal 2007 Highway Rule	X	X	X	X
Federal Highway Motorcycle Exhaust Emission Standards	X	X		X
Federal Non-Road Control Programs (See Table 4-2 for details of each strategy)	X	X	X	X
Federal CAIR Requirements for SO_2 Sources*			X	
Outdoor Wood Burning Furnace Restrictions Section 22a-174k of the Connecticut General Statutes	X			
General Permit to Construct and/or Operate a New or Existing Distributed Generation Resource	X	X		
Permit to Construct and Operate Stationary Sources RCSA Section 22a-174-3a	X	X	X	X
Improvements in the Control of Particulate Matter and Visible Emissions RCSA Section 22a-174-18	X	X		
Control of Sulfur Dioxide and Nitrogen Oxide Emissions from Power Plants and Other Large Stationary Sources RCSA Sections 22a-174-19a and 22a-174-22(e)(3)		X	X	
Proposed Restrictions on Asphalt Paving Operations RCSA Section 22a-174-20(k)				X
Reduced Vapor Pressure Limitation for Solvent Cleaning RCSA Section 22a-174-20(l)				X
The Post-2002 Nitrogen Oxides (NOx) Budget Program RCSA Section 22a-174-22b		X		
CAIR NO_X Ozone Season Trading Program RCSA Section 22a-174-22c		X		
CT On-Board Diagnostic Inspection & Maintenance Program RCSA 22a-174-27	X	X		X
Pressure-Vacuum Gas Station Vent Valves and Increased Testing for Stage II Controls RCSA Section 22a-174-30				X
Heavy Duty Diesel Engines RCSA Section 22a-174-36a	X	X	X	
CT's California Low Emission Vehicle Phase 2 (CALEV2) RCSA Section 22a-174-36b	X	X		X
Standards for Municipal Waste Combustion (Phase 2) RCSA Section 22a-174-38		X		
VOC Content Limits for Consumer Products RCSA Section 22a-174-40				X
VOC Content Limits for Architectural and Industrial Maintenance (AIM) Coatings RCSA Section 22a-174-41				X
Design Improvements for Portable Fuel Containers RCSA Section 22a-174-43				X
Proposed Restrictions on the Manufacture and Use of Adhesives and Sealants RCSA Section 22a-174-44				X

*Although federal CAIR SO_2 requirements do not apply to Connecticut, significant emission reductions are anticipated from upwind sources in other states when Phase 1 annual SO_2 budgets take effect in 2010. Some non-modeled early reductions are expected by 2009, which should help the NY-NJ-CT area achieve timely attainment. Note that CTDEP does not necessarily concur with EPA's interpretation that compliance with CAIR satisfies the RACT requirement for all affected sources.

Base Year Emissions and Projections to 2009 and 2012

The baseline emissions inventories, developed from calendar year 2002 emissions, are the cornerstone of future year projections and the attainment demonstration. In light of the regional nature of ozone, $PM_{2.5}$ and visibility problems, states in the Northeast compiled comprehensive multi-pollutant inventories under the coordination of the Mid-Atlantic/Northeast Visibility Union (MANE-VU). Annual county-level inventories were developed for a number of pollutants, including primary $PM_{2.5}$ as well as its significant precursor pollutants, sulfur dioxide (SO_2) and oxides of nitrogen (NOx). The inventories include emissions from stationary, area and mobile sources.

Appropriate growth estimates and control factors, representing federal and state post-2002 emissions control programs (so-called "beyond-on-the-way", or BOTW controls), were applied to the baseline inventory to obtain projected emissions for 2009 and 2012. For mobile source emissions, the NONROAD and MOBILE6.2 (as embedded 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.

The resulting emission estimates for Connecticut for the years 2002, 2009 and 2012 are summarized in Figures ES-4 through ES-6 for $PM_{2.5}$, NOx and SO_2, respectively. For 2002, area sources contributed the largest fraction of primary $PM_{2.5}$ (78%), on-road mobile sources were the largest contributors of NOx emissions (57% of the total), with point and area sources contributing the largest fractions of SO_2 emissions (50% and 39%, respectively).

In the future years, primary $PM_{2.5}$ emissions are anticipated to decline slightly between 2002 and 2009 (by 4%), with an additional reduction of 3% by 2012. Projected increases of $PM_{2.5}$ emissions in the point source sector are more than offset by projected decreases in the area, non-road and on-road sectors. More significant changes are anticipated in precursor emissions. Total NOx emissions in Connecticut are projected to decrease from 2002 levels by 30% in 2009 and 41% in 2012. Significant decreases are expected from the on-road, non-road and point source sectors due to federal and state post-2002 control measures. 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.

In addition to the SIP control strategies included in the MANE-VU modeling inventories, several non-modeled state and federal control programs have or will be implemented that will serve to further reduce $PM_{2.5}$-related emissions by 2010 and beyond, such as: programs to reduce peak electricity demand and increase energy efficiency; diesel retrofit and anti-idling programs; transportation control measures; and certain federal non-road engine regulations.

Figure ES-4. MANE-VU $PM_{2.5}$ Emissions Projections for Connecticut (2002-2012)

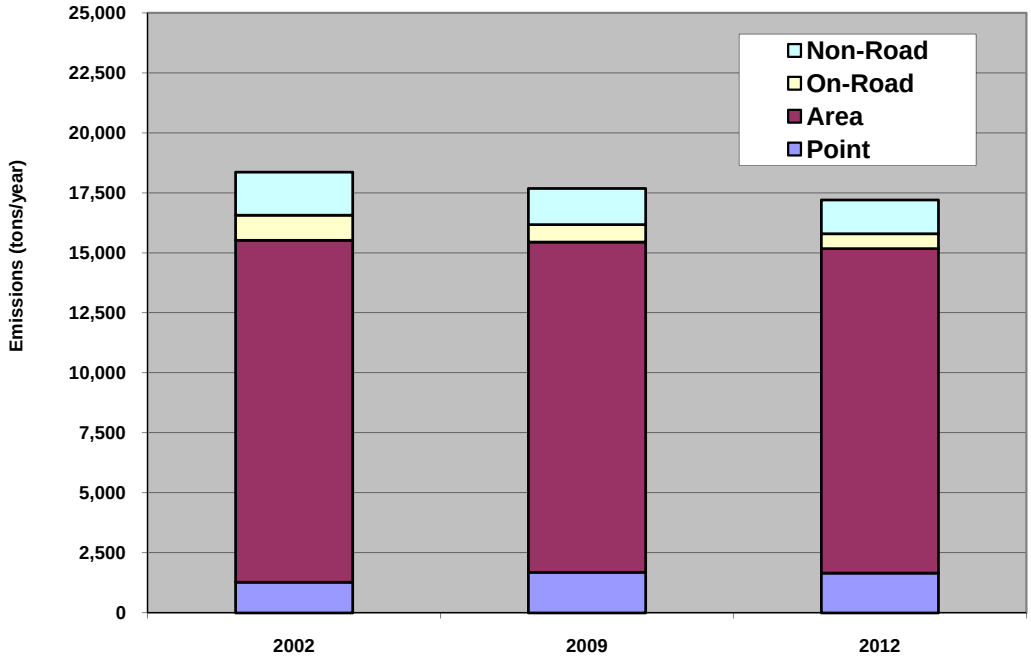


Figure ES-5. MANE-VU NOx Emission Estimates for Connecticut 2002-2012 Beyond-On-the-Way (BOTW) Controls

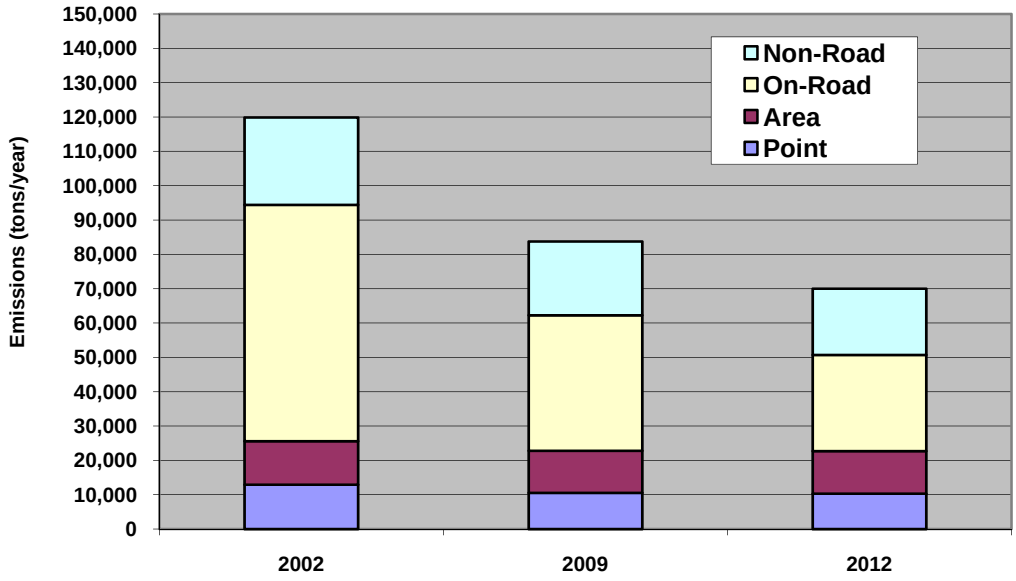
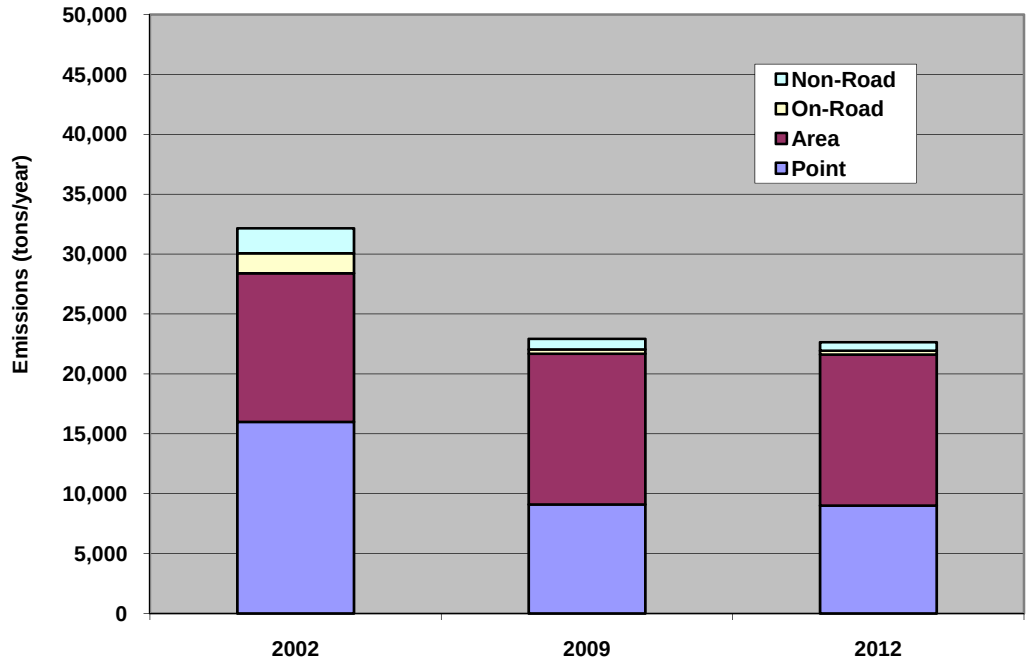


Figure ES-6. MANE-VU SO_2 Emission Estimates for Connecticut 2002-2012 Beyond-On-the-Way (BOTW) Controls



Transportation Conformity Process and Motor Vehicle Emission Budgets

Transportation conformity is a CAA requirement that serves as a bridge to connect air quality and transportation planning activities. Transportation conformity is required under the CAA to ensure that highway and transit project activities receiving federal funds are consistent with ("conform to") the purpose of the SIP. Conformity to a SIP is achieved if transportation programs or transit project activities do not cause or contribute to any new air quality violations, do not worsen existing violations, and do not delay timely attainment of the relevant NAAQS.

CTDEP proposed early $PM_{2.5}$ transportation conformity budgets in April 2007 that were determined by EPA in June 2007 to be adequate for transportation conformity purposes and subsequently approved by EPA in August 2007. Budgets were established for direct $PM_{2.5}$ emissions and for NOx, a $PM_{2.5}$ precursor pollutant, for the required attainment year of 2009. The 2009 budgets, which are summarized in Table ES-4, represent a cap on on-road emissions in the Connecticut portion of the NY-NJ-CT annual $PM_{2.5}$ nonattainment area (*i.e.*, Fairfield and New Haven Counties).

Table ES-4. 2009 Transportation Conformity Budgets for the Connecticut Portion of the NY-NJ-CT $PM_{2.5}$ Nonattainment Area

Annual Direct $PM_{2.5}$ Emissions (tons per year)	Annual NOx Emissions (tons per year)
360	18,279

CTDEP has determined that the previously approved early $PM_{2.5}$ budgets should be retained as part of the $PM_{2.5}$ attainment demonstration SIP, as these budgets account for the effects of the $PM_{2.5}$ mobile source control programs that are included in the attainment demonstration modeling.

Attainment Demonstration and Weight-of-Evidence

Photochemical grid modeling and weight-of-evidence (WOE) analyses, including monitored data trends, were used to assess the likelihood of achieving timely attainment of the $PM_{2.5}$ NAAQS in the NY-NJ-CT nonattainment area. The results of the photochemical modeling and WOE analyses lead CTDEP to two major conclusions:

- There is a high level of probability that the NY-NJ-CT area will achieve attainment of the 1997 annual $PM_{2.5}$ NAAQS by the required April 2010 attainment date; and
- Adopted emission control programs will result in continued reductions in $PM_{2.5}$ and precursor emissions through 2012 and beyond, providing confidence that compliance with the NAAQS will continue once attainment is achieved.

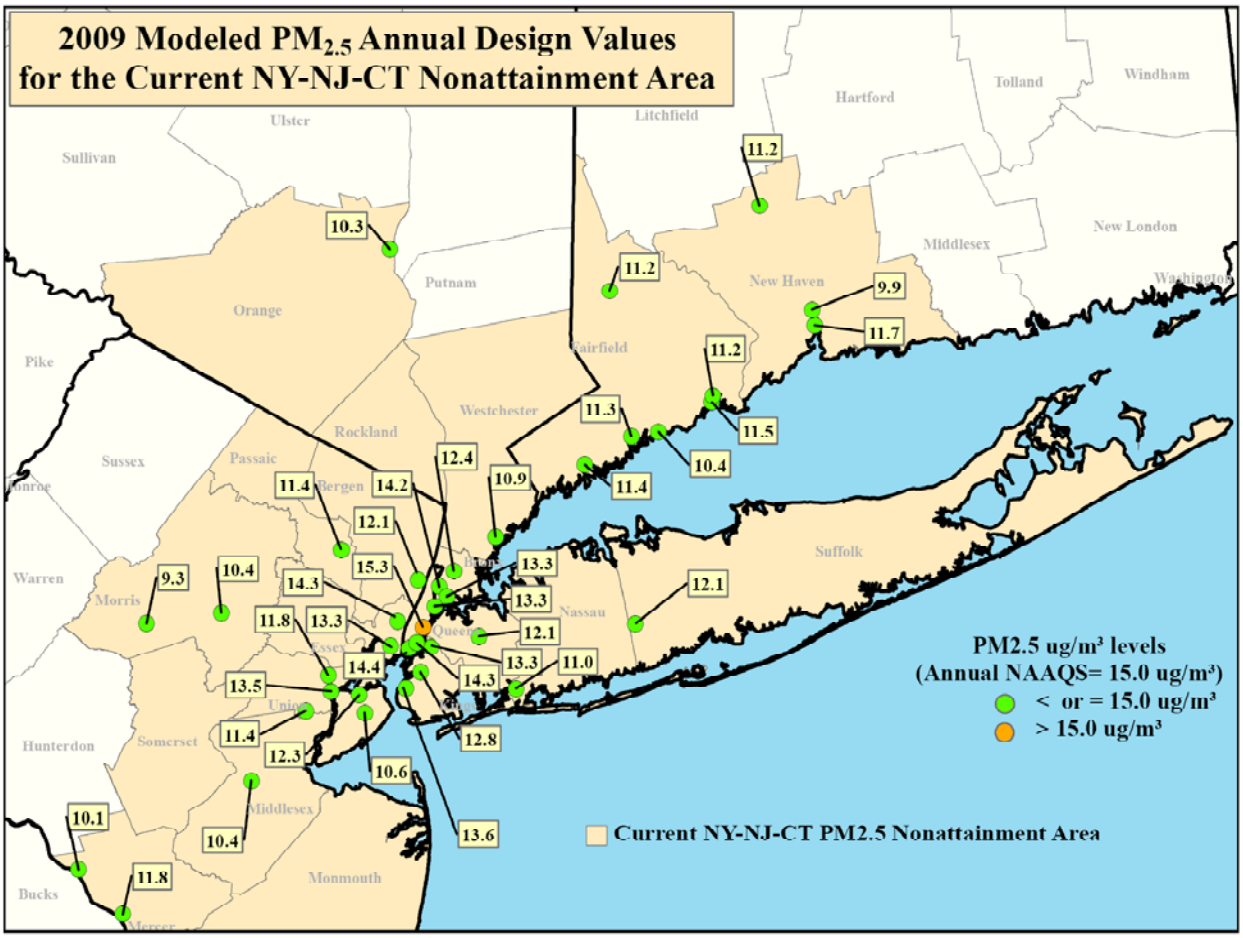
Modeled Design Values Generally Demonstrate Attainment

The photochemical model selected for the attainment modeling demonstration was the EPA's Models-3/Community Multi-scale Air Quality (CMAQ) modeling system. CMAQ was employed to simulate $PM_{2.5}$ for the calendar year 2002 and to develop projections of $PM_{2.5}$ design values for 2009, the last full calendar year before the April 2010 attainment date.

CMAQ modeling projects that all monitors in the NY-NJ-CT nonattainment area, except the PS 59 monitor in New York County (Manhattan), will have annual 2009 $PM_{2.5}$ design values below the modeling uncertainty range, negating the need for weight-of-evidence (WOE) analyses for attaining monitors. Figure ES-7 maps the modeled 2009 design values for monitor locations throughout the nonattainment area. The projected 2009 design value for the PS 59 site is 15.3 ug/m^3, a value within the WOE range of 14.5 ug/m^3 to 15.5 ug/m^3.[7] As a result, corroboratory WOE analyses are needed to demonstrate attainment at the PS 59 monitor. These WOE analyses, summarized below, support the conclusion that the entire NY-NJ-CT nonattainment area will attain the annual $PM_{2.5}$ NAAQS by the April 2010 deadline.

[7] "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze"; EPA-454/B-07-002; April 2007; Page 17; http://www.epa.gov/scram001/guidance/guide/final-03-pm-rh-guidance.pdf.

Figure ES-7. 2009 Modeled $PM_{2.5}$ Design Values for the NY-NJ-CT Nonattainment Area



Monitoring Data Show General Downward Trend Toward Timely Attainment

Monitored $PM_{2.5}$ and precursor emission data trends are one of two types of WOE analyses used to evaluate the certainty of attainment at the PS 59 site. Monitors throughout the NY-NJ-CT nonattainment area have recorded gradual improvements in annual average $PM_{2.5}$ levels over the last several years. As was shown previously in Figure ES-3, $PM_{2.5}$ levels at Connecticut monitors have consistently been less than the 15.0 µg/m^3 annual NAAQS, with a general downward trend during the period.

Similar downward trends in annual $PM_{2.5}$ levels have been recorded at monitoring sites in the New York and New Jersey portions of the nonattainment area over the 2000 to 2007 period, as displayed in Figures ES-8 and ES-9. Extrapolation of linear trend lines into the future indicates that all monitors in the nonattainment area are likely to achieve $PM_{2.5}$ levels lower than the annual $PM_{2.5}$ NAAQS prior to the attainment deadline. A continuation of the overall downward trend in annual $PM_{2.5}$ concentration levels is supported by emission projections. Significant additional reductions in $PM_{2.5}$ and precursor emissions are expected to occur in the nonattainment area through at least 2012. These results reinforce the conclusion that the NY-NJ-CT area will achieve attainment of the annual $PM_{2.5}$ NAAQS by the April 2010 deadline.

Figure ES-8. Trends in Annual $PM_{2.5}$ Levels in the New Jersey Portion of the NY-NJ-CT Nonattainment Area

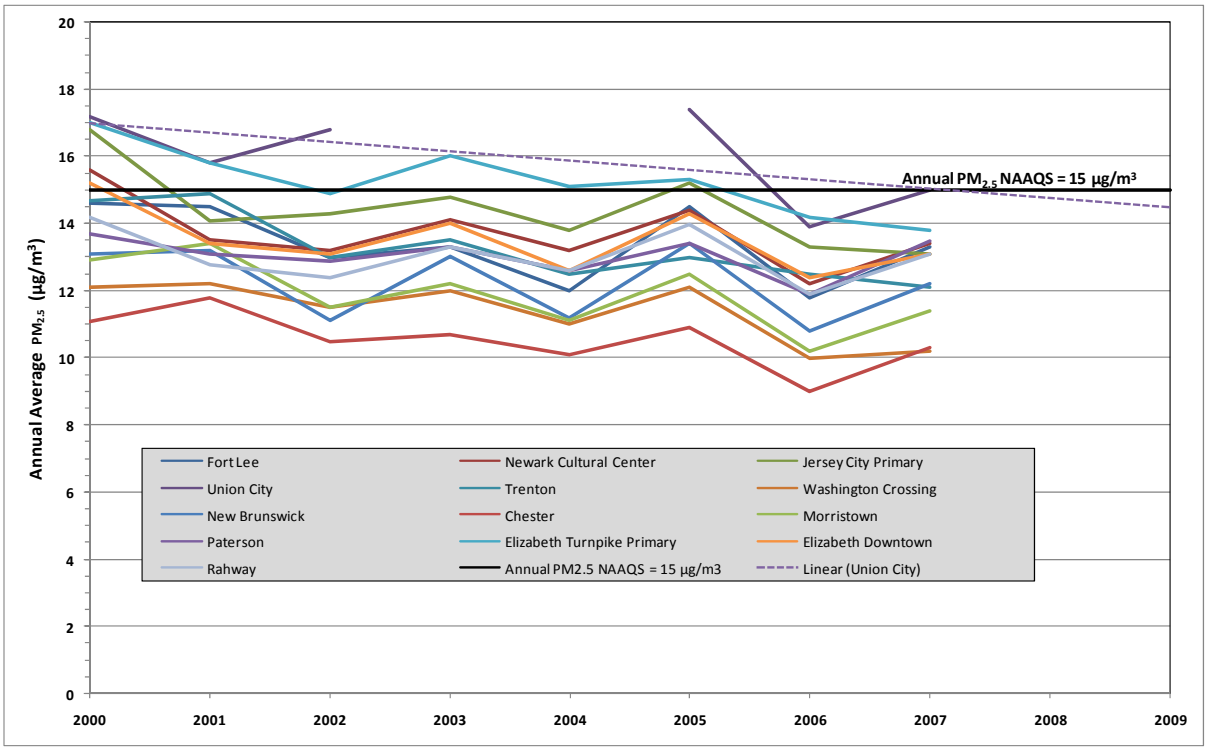
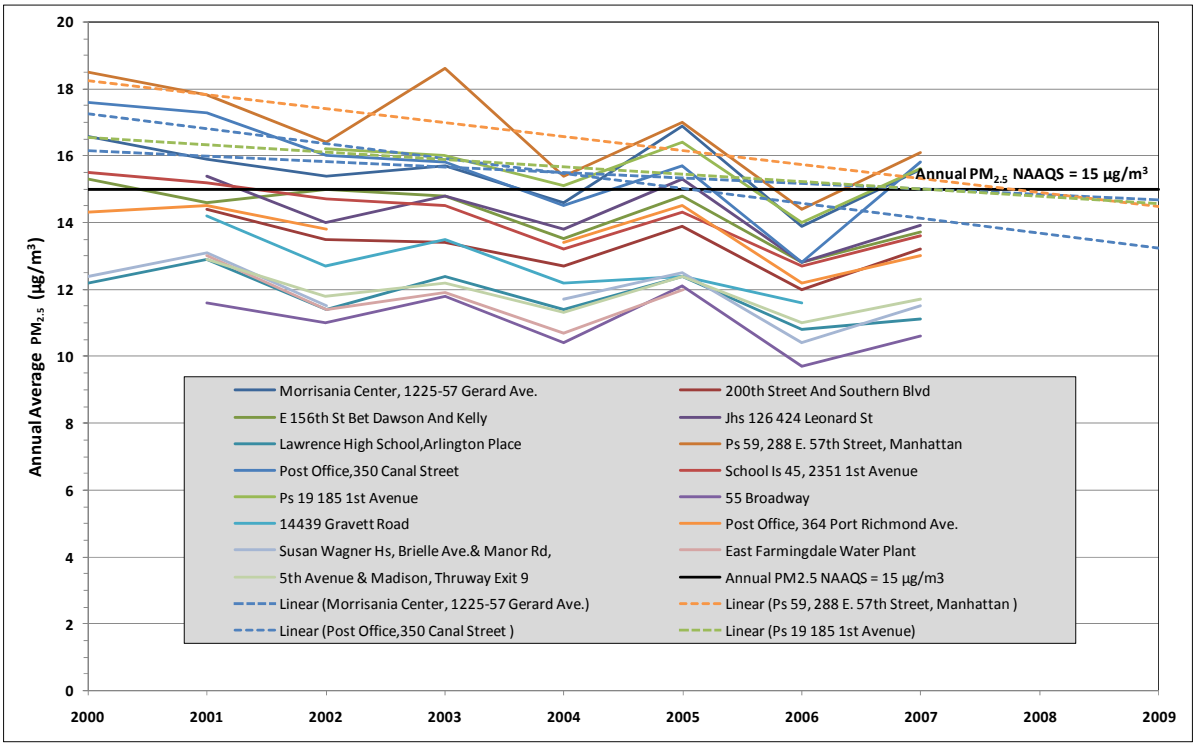


Figure ES-9. Trends in Annual $PM_{2.5}$ Levels in the New York Portion of the NY-NJ-CT Nonattainment Area



Additional Connecticut Control Measures Provide Further Reductions

Emissions reductions from numerous control programs that were not included in the CMAQ modeling or the 2009 MANE-VU emissions inventory are the second type of WOE supporting attainment by the 2010 attainment date. Such supplemental emissions reductions increase the level of confidence that attainment of the annual $PM_{2.5}$ NAAQS will occur by April 2010 throughout the nonattainment area and be maintained into the future. In Connecticut, such additional emissions control programs include energy efficiency measures; diesel retrofit and anti-idling strategies; and transportation control measures.

Other Components of the Demonstration

In addition to the elements summarized above, the attainment demonstration addresses the following information in satisfaction of the CAA and the $PM_{2.5}$ Implementation Rule:

- Reasonable further progress;
- Contingency measures; and
- Infrastructure requirements under CAA Section 110(a)(1) and (2).

Future Actions

As summarized here, attainment of the annual $PM_{2.5}$ NAAQS in the NY-NJ-CT nonattainment area is anticipated by April 2010. In the Connecticut portion of the nonattainment area, compliance with the NAAQS has been monitored continuously since at least 2001. Modeling and weight-of-evidence analyses indicate the remainder of the NY-NJ-CT nonattainment area will comply with the annual $PM_{2.5}$ NAAQS by the April 2010 deadline. Regardless of these small accomplishments for cleaner air, in recognition of the significant public impacts of $PM_{2.5}$, Connecticut is pursuing a range of actions to further limit emissions of direct $PM_{2.5}$ and its precursors and to address urban core issues, thereby allowing Connecticut's residents to breathe easier in years beyond the immediate attainment horizon for the annual $PM_{2.5}$ NAAQS. Connecticut acting alone, however, has limited authority and ability to effect changes in air quality, even within our own state borders. Only concerted efforts at all levels – national, regional and state – can achieve the best environmental future.

To this end, we encourage EPA to adopt additional national and regional emission control programs to ensure that equitable and cost effective progress is made to achieve the 2006 24-hour $PM_{2.5}$ NAAQS. Such programs might include the most stringent possible non-road and on-road emission standards for all mobile source categories; more stringent national limitations on the sulfur content in fuels, including home heating oil; federal or regional standards to address wood burning; and effective programs to further limit emissions from electric generation, including emissions from small and peaking generators operating on the highest electric demand days as well as emissions from large generators located to the west of Connecticut, all of which contribute to summer sulfate emissions.

1.0 Introduction and Background

1.1 Purpose of Document

This document presents the Connecticut Department of Environmental Protection's (CTDEP) air quality state implementation plan (SIP) revision for attaining the federal 1997 annual National Ambient Air Quality Standard (NAAQS) for fine particulate matter less than a nominal 2.5 micrometers in diameter ($PM_{2.5}$). The plan describes the national, regional and local control measures being implemented to reduce emissions in future years and employs air quality modeling and other analyses of air quality and meteorological data to assess the likelihood of reaching attainment throughout Connecticut by the mandated 2010 attainment deadline.

As described in detail in subsequent sections of this document, results of these analyses lead CTDEP to conclude that attainment in the New York-New Jersey-Connecticut (NY-NJ-CT) nonattainment area will be achieved by the April 2010 attainment date. Since before the effective date of $PM_{2.5}$ nonattainment designations, April 2005, monitors in Connecticut have not recorded an exceedance of the annual $PM_{2.5}$ NAAQS. Air quality modeling of future emissions, grown and controlled to 2009, and other weight-of-evidence indicate that the previously non-attaining air quality in New York City and northern New Jersey will achieve compliance by the April 2010 attainment date.

1.2 Particulate Matter Formation and Health Effects

Fine particles in the atmosphere are comprised of a complex mixture of components. Common constituents include: sulfate (SO_4); nitrate (NO_3); ammonium; elemental carbon; a great variety of organic compounds; and inorganic material (including metals, dust, sea salt, and other trace elements) generally referred to as 'crustal material. Primary particles are emitted directly into the air as a solid or liquid particle (e.g., elemental carbon from diesel engines or fire activities, or condensable organic particles from gasoline engines). Secondary particles form in the atmosphere over time as a result of various chemical reactions (e.g., gaseous sulfur dioxide and ammonia reacting to form ammonium sulfate particles). As a consequence, $PM_{2.5}$ experienced at one location can have origins both nearby and distant.

The annual average and 24-hour average $PM_{2.5}$ NAAQS were established by the United States Environmental Protection Agency (EPA) based on evidence from numerous health studies demonstrating that serious health effects are associated with exposure to elevated levels of $PM_{2.5}$. Epidemiological studies have shown statistically significant correlations between elevated $PM_{2.5}$ levels and premature mortality. Individuals particularly sensitive to $PM_{2.5}$ exposure include older adults, people with heart and lung disease, and children[1].

The health effects associated with exposure to fine particles are significant, mainly due to the fact that particles of this size can easily reach into the deepest regions of the lungs. Significant health effects associated with fine particle exposure include:

- premature mortality,
- aggravation of respiratory and cardiovascular disease (as evidenced by increased hospital admissions, emergency room visits, school/work absences, and restricted activity days),
- decreased lung function and difficulty breathing,

[1] 62 FR 38652-690 (July 18, 1997).

- asthma attacks, and
- certain cardiovascular problems such as heart attacks and cardiac arrhythmia.[2, 3]

The EPA has estimated that attainment of the 1997 annual and daily $PM_{2.5}$ standards nationally would prolong tens of thousands of lives and prevent tens of thousands of hospital admissions each year.[4] In addition, these standards would prevent hundreds of thousands of doctor visits, absences from work and school, and respiratory illnesses in children. The elderly have been shown to be particularly at risk for premature death from the effects of particulate matter. Health studies have shown that there is no clear threshold below which adverse effects are not experienced by at least certain segments of the population.

Although fine particulate matter generated from all sources can cause serious health impacts, particulate matter generated from diesel combustion is particularly troublesome. The concern over diesel particulate matter is two-fold. First, while diesel engines collectively are large sources of NO_x and direct fine particle emissions, they also emit significant amounts of toxic air pollutants.[5] Second, the size of diesel particulate matter may add to its health impacts. Almost all of the particles produced by diesel exhaust are fine particulate matter (below 2.5 micrometers in diameter), much in the ultra-fine range (that is, particles with an aerodynamic diameter of less than 0.1 micrometer). Since both fine and ultra-fine particles are respirable, many of these particles are not captured by the human respiratory system's defense mechanisms and enter deeply into the lung. Studies have shown that ultra-fine particles are so small that they are capable of penetrating all the way to the cellular level, where they may induce structural damage in the body's core building blocks.

1.3 Particulate Matter NAAQS History

The 1970 Clean Air Act (CAA) amendments established health and welfare protective limits, or national ambient air quality standards (NAAQS), for a number of air pollutants, including particulate matter. EPA first issued standards for total suspended particulate matter in 1971 and revised the standards for PM_{10} in 1987 and $PM_{2.5}$ 1997. In September 2006, the Agency revised the 1997 standards.

<u>1997 $PM_{2.5}$ NAAQS</u>

On July 18, 1997, the EPA established two new primary NAAQS for fine particles:

- an annual $PM_{2.5}$ health-based standard of 15 micrograms per cubic meter ($\mu g/m^3$) (annual arithmetic mean not to be exceeded over a three year average) and
- a daily (24-hour) $PM_{2.5}$ health-based standard of 65 $\mu g/m^3$ (the three year average of 98th percentile days not to be exceeded).[6,7]

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[2] 72 FR 20586, April 25, 2007.

[3] EPA. Air Quality Criteria for Particulate Matter. United States Environmental Protection Agency, Research Triangle Park, North Carolina: National Center for Environmental Assessment—RTP, Office of Research and Development; report no. EPA/600/P–99/002aF and EPA/600/P–99/002bF. October 2004.

[4] 62 FR 38652-690, July 18, 1997.

[5] EPA. Health Assessment Document for Diesel Engine Exhaust. United States Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Washington, DC, EPA/600/8-90/057F, May 1, 2002.

[6] 62 FR 38652-760, July 18, 1997.

Simultaneously, the EPA established secondary (welfare-based) $PM_{2.5}$ standards identical to the primary standards. These standards are hereafter referred to as the 1997 $PM_{2.5}$ standards. The EPA set the $PM_{2.5}$ standards with 24-hour and annual averaging times to protect against effects from short- and long-term exposure identified by a number of published epidemiological studies.

A number of events delayed implementation of the 1997 $PM_{2.5}$ standard.[8] Specifically, the EPA's 1997 standards were challenged by the American Trucking Association, the U.S. Chamber of Commerce, and other state and business groups. The Transportation Equity Act for the Twenty-first Century (TEA-21) revised the deadline to publish nonattainment designations in order to provide additional time to collect three years of air quality monitoring data. In February 2001, the Supreme Court upheld the EPA's authority under the Clean Air Act to set NAAQS that protect the American public from the harmful effects of air pollution. The Supreme Court also sent the case back to the D.C. Circuit Court of Appeals to resolve several additional issues. In March 2002, the D.C. Circuit Court rejected all remaining legal challenges to the EPA's 1997 ambient air quality standards for $PM_{2.5}$.

Clear of all legal challenges, on December 17, 2004, the EPA finalized attainment/ nonattainment designations for the 1997 $PM_{2.5}$ standards, which became effective on April 5, 2005.[9] EPA determined that air quality in Connecticut was in compliance with the 1997 24-hour $PM_{2.5}$ NAAQS, but that emissions from Fairfield and New Haven Counties contributed to measured violations of the annual $PM_{2.5}$ NAAQS in New York City. As a result, EPA included those two Connecticut counties in a multi-state nonattainment area also comprised of the New York and New Jersey counties that make up the New York City Metropolitan Area. The multi-state NY-NJ-CT nonattainment area is depicted in Figure 1-1. The three affected states are responsible for developing and coordinating revisions to their respective air quality State Implementation Plans (SIPs) to provide for attainment of the 1997 annual $PM_{2.5}$ NAAQS by the 2010 attainment deadline.

2006 $PM_{2.5}$ Standards

Meanwhile, as required by Clean Air Act (CAA) section 109(d)(1) and governed by a March 2003 consent decree reached with national environmental organizations, EPA conducted a review of more recent health effects studies to assess the adequacy of the 1997 $PM_{2.5}$ NAAQS. As result of that review, EPA promulgated[10] revised NAAQS for $PM_{2.5}$. The EPA retained the annual $PM_{2.5}$ standard of 15 $\mu g/m^3$ and revised the 24-hour $PM_{2.5}$ standard, changing it from 65 $\mu g/m^3$ to 35 $\mu g/m^3$. The effective date for the new 24-hour $PM_{2.5}$ standard became December 18, 2006. In December 2007, Connecticut submitted a recommendation that New Haven and Fairfield Counties be designated nonattainment for the $PM_{2.5}$ 24-hour NAAQS based on an analysis of monitored data. EPA is currently reviewing this submittal and is expected to issue

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[7] The EPA also revised the PM_{10} NAAQS by revising the 24-hour form of the PM_{10} standard to the 99th percentile averaged over 3 years but retaining the 24-hour PM_{10} level (i.e., 150 mg/m^3) (62 FR 38652 (July 18, 1997)). In 2006, the EPA revoked the annual PM_{10} standard (71 FR 61144 (October 17, 2006)). Connecticut was not designated in nonattainment of the PM_{10} NAAQS and continues to meet the revised PM_{10} standards.

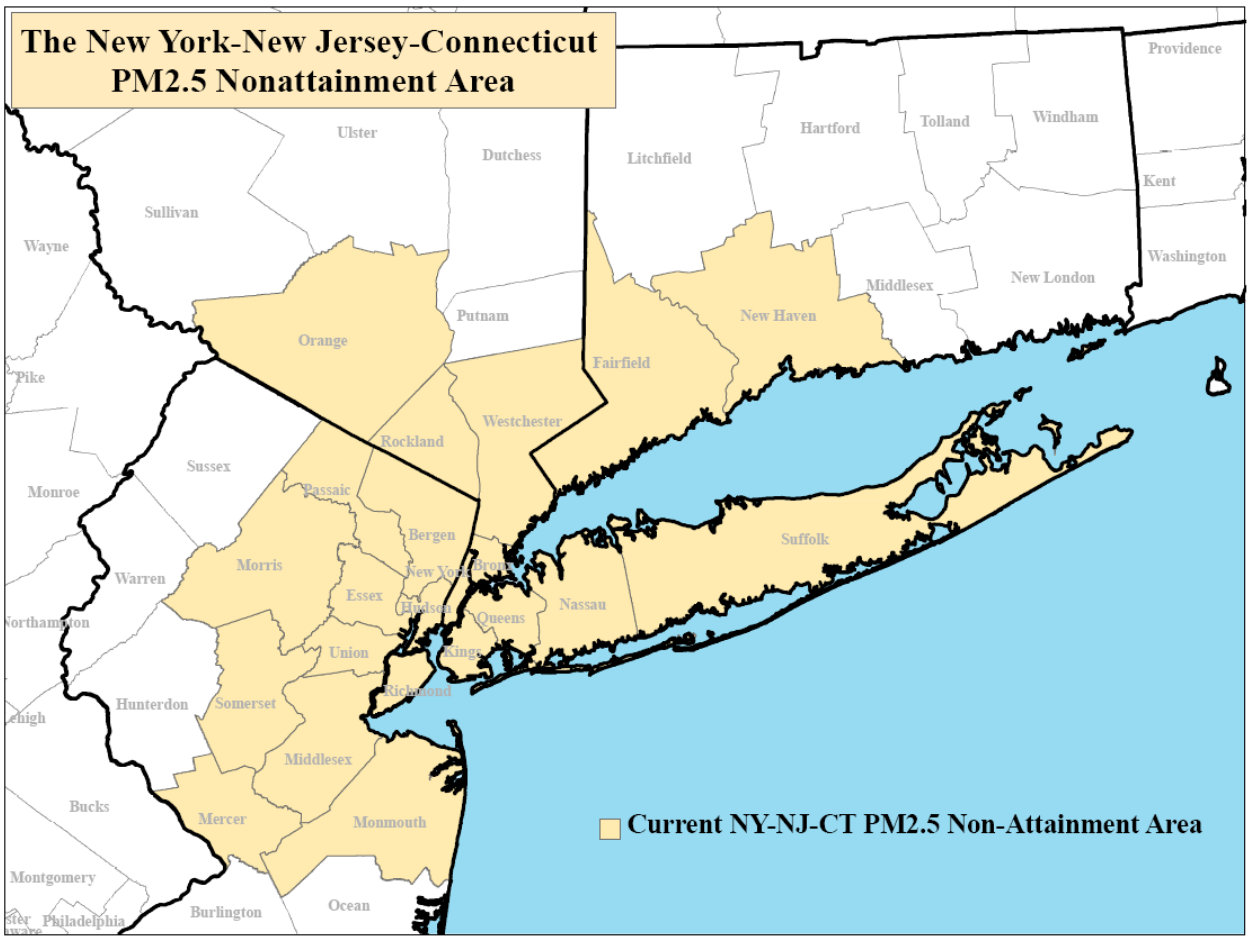
[8] EPA. Fact Sheet: Areas Designated Nonattainment for the Fine Particle National Air Quality Standards. United States Environmental Protection Agency, December 17, 2004, http://www.epa.gov/pmdesignations/documents/final/factsheet.htm, accessed June 28, 2007.

[9] 72 FR 20586-667, April 25, 2007.

[10] 71 FR 61144, October 17, 2006.

final designations for the 2006 standard in December 2008. States will then be required to submit attainment SIPs for the 2006 24-hour $PM_{2.5}$ NAAQS three years after designations become final.

Figure 1-1. The New York-New Jersey-Connecticut Annual $PM_{2.5}$ Nonattainment Area



1.4 Requirements for this SIP Revision

On April 25, 2007, subsequent to the finalization of nonattainment designations for the annual $PM_{2.5}$ NAAQS, EPA published the Clean Air Fine Particle Implementation Rule[11] (Implementation Rule) which prescribes the requirements that must be met by $PM_{2.5}$ attainment demonstration SIPs. The SIP must identify and evaluate sources of both $PM_{2.5}$ direct emissions and precursors. States must also address:

- Sulfur dioxide as a $PM_{2.5}$ precursor, including an evaluation of control measures for sources of SO_2 emissions,
- NO_x as a $PM_{2.5}$ attainment precursor, including an evaluation of control measures for sources of NO_x emissions unless the State or EPA provide a technical demonstration that NO_x emissions in the state do not significantly contribute to elevated $PM_{2.5}$ levels in the nonattainment area.

[11] 72 FR 20586, April 25, 2007; See: http://edocket.access.gpo.gov/2007/pdf/E7-6347.pdf.

States are not required to address VOC or ammonia in the $PM_{2.5}$ attainment plan or evaluate relevant sources for potential reductions unless a technical demonstration shows that either/both of those pollutants significantly contribute to elevated $PM_{2.5}$ levels in the nonattainment area. As required in section 172(a)(2)(A) of the Act, the required attainment date for a nonattainment area is the date by which attainment can be achieved as expeditiously as practicable, but no more than five years from the date of designation (e.g., by April 2010 for the NY-NJ-CT annual $PM_{2.5}$ nonattainment area). The Administrator may extend the attainment date to the extent deemed appropriate, for a period no greater than 10 years from the date of designation, considering the severity of nonattainment and the availability and feasibility of pollution control measures.

For areas designated as nonattainment for the $PM_{2.5}$ NAAQS, an attainment demonstration must be completed showing that the area will attain the standards as expeditiously as practicable. The demonstration must include emission inventory estimates, emission reduction analyses and modeling results for which the State has based its projected attainment date. For each nonattainment area, the SIP must include all control measures needed to reach attainment as expeditiously as practicable, but no later than the beginning of the year prior to the attainment date. As specified in Section 51.1010 of the Implementation Rule, SIP control measures must include all reasonably available control measures (RACM), including reasonably available control technology (RACT) for stationary sources, which serve to advance the attainment date by at least one year.

An emission inventory must also be submitted for direct $PM_{2.5}$ emissions and emissions of $PM_{2.5}$ precursors, along with any additional emission-related inventory information needed to support the attainment demonstration and reasonable further progress (RFP) plan. The baseline emission inventory must represent the most recent calendar year for which a complete inventory was required to be submitted to EPA. In this case, the baseline emission inventory for 2002 is used for the attainment demonstration and RFP plans.

Section 172(c)(2) of the CAA and Section 51.1009 of EPAs Implementation Rule requires SIPs to include control measures sufficient to meet applicable RFP milestones. For SIPs demonstrating attainment within five years of the date of designation (i.e., by April 2010), a separate RFP plan is not required because EPA considers the emission reduction measures in the attainment demonstration to be sufficient to meet the CAA's RFP requirement. This is the case with the present submission since compliance is projected in 2009.

Finally, consistent with CAA Section 172(c)(9) and Section 51.1012 of the Implementation Rule, attainment SIPs must specify contingency measures that will be implemented if the area fails to achieve RFP or attain the $PM_{2.5}$ NAAQS by the required attainment date. Contingency measures must take effect without significant further action by the state or EPA. The requirement for contingency measures can also be satisfied if the SIP provides for additional emission reductions beyond those shown to be necessary to achieve attainment.

1.5 Contents of this SIP Revision Document

This document contains the required elements of a SIP as prescribed under CAA 172(c) and the Implementation Rule. In addition to the Executive Summary and this Introduction, the contents of each section are described briefly below.

- Section 2 - Conceptual Model of the $PM_{2.5}$ Problem: Section 2 analyzes available air quality, meteorological and emissions information to develop a description of the characteristics, chemistry and likely causes of elevated $PM_{2.5}$ in the Northeast and in Connecticut.
- Section 3 - $PM_{2.5}$ Air Quality Levels in Connecticut and Recent Trends: Section 3 presents monitored levels of $PM_{2.5}$ mass, including design values, trends and contributing species.
- Section 4 – Control Measures: Section 4 presents federal and state control measures implemented before and after the 2002 baseline year, describes the determination of reasonably available control measures (RACM), and discusses non-modeled control measures that provide additional emission reductions that will assist with achieving attainment.
- Section 5 - Base and Future Year Emission Estimates: Section 5 presents emission estimates for the baseline (2002) and future (2009 and 2012) years used in the dispersion modeling exercise.
- Section 6 - Reasonable Further Progress (RFP): Section 6 discusses the requirements for RFP in the NY-NJ-CT nonattainment area.
- Section 7 - Transportation Conformity Process and Motor Vehicle Emission Budgets: Section 7 discusses the requirements for transportation conformity and presents motor vehicle emission budgets that are consistent with the attainment plan for the Connecticut portion of the nonattainment area.
- Section 8 - Attainment Demonstration and Weight-of-Evidence: Section 8 describes the modeling platform used for the attainment demonstration, presents the findings of a model performance evaluation, documents the results of the attainment demonstration modeling and provides additional weight-of-evidence supporting the conclusion that the NY-NJ-CT nonattainment area will comply with the annual $PM_{2.5}$ NAAQS by the April 2010 deadline.
- Section 9 – Contingency Measures: Section 9 quantifies the level of emission reductions required to meet CAA contingency measure requirements and describes the measures and triggers included in Connecticut's contingency measure plan.
- Section 10 - Adequacy Determination for CAA Section 110(a)(1) and (2) Program Infrastructure: Section 10 documents how Connecticut's air quality program infrastructure meets (or will be amended to meet) the requirements of CAA Sections 110(a)(1) and (2).
- Section 11 - Commitments and Requests for EPA Actions: Section 11 documents Connecticut's commitment to adopt and implement modeled control measures, maintain an adequate $PM_{2.5}$ monitoring network, and provide for timely implementation of EPA's $PM_{2.5}$ new source review requirements. It also stresses the importance that EPA must:
  1. ensure upwind states implement control measures sufficient to address their significant impact on Connecticut and the remainder of the NY-NJ-CT nonattainment area, and
  2. adopt additional national and regional emission control programs to provide for timely attainment of the newly revised (2006) 24-hour $PM_{2.5}$ NAAQS.

2.0 Conceptual Model of the $PM_{2.5}$ Problem

The Northeast States for Coordinated Air Use Management (NESCAUM) is the regional association of air pollution control agencies representing Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. NESCAUM assists the states in developing technical support materials for regional planning efforts, such as for the particulate matter and regional haze state implementation plans. The regional planning organization coordinating regional haze programs in the Northeast is known as MANE-VU, the Mid-Atlantic and Northeast Visibility Union, which includes the NESCAUM states plus the states of Pennsylvania, Delaware and Maryland and the District of Columbia. In November 2006 NESCAUM prepared a report titled "The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description." The executive summary of the NESCAUM report is reproduced below (with supplemental figures and text from the main body of the report) to provide the reader with an overview of the $PM_{2.5}$ problem in Connecticut and the Northeast. The full version of the NESCAUM report is provided in Appendix 2A.

2.1 Executive Summary from NESCAUM's Conceptual Description

A large body of scientific evidence has established a solid link between cardiac and respiratory health risks and transient exposure to ambient fine particle pollution. The same fine particles that are capable of penetrating deep into the lungs are also in the size range that is most efficient at absorbing and scattering visible light, thus impairing visibility. The emission sources, atmospheric chemistry, and meteorological phenomena that influence ambient concentrations of fine particle pollution can act on scales that range from hundreds to thousands of kilometers. Fine particles are not exclusively a secondary pollutant; primary fine particle pollution from local sources can have a significant effect on ambient concentrations in some locations. Fine particles are also not exclusively a summertime pollutant. There are important differences between the meteorological and chemical dynamics that are responsible for high fine particle levels during summer and winter.

In 1997, EPA issued national ambient air quality standards (NAAQS) for fine particles with an aerodynamic diameter of 2.5 micrometers or less. The annual NAAQS was set at 15 $\mu g/m^3$. To meet this standard, the 3-year average of a site's annual mean concentration (i.e., the design value) must not be greater than this level. The daily NAAQS was set at 65 $\mu g/m^3$ at the 98^{th} percentile level. To meet this standard, the 98^{th} percentile value (of daily measurements recorded at a site) must not be greater than this level, when averaged over three years. No counties in MANE-VU have been designated nonattainment for the daily standard, however, in 2006 EPA revised the NAAQS with respect to the 24-hr average concentrations and states will have to comply with the new standard (35 $\mu g/m^3$ at the 98^{th} percentile level) within five years of designations (expected in 2009). Fine particle data from EPA's Air Quality System (AQS) database for years 2002 through 2004 were used to determine the attainment status (with respect to the 1997 NAAQS) for monitoring sites in MANE-VU.

Table 2-1 shows a summary of areas found to exceed the annual standard (no areas exceed the 1997 24-hr standard) and the associated design values. As tabulated, 12 areas

in the Northeast fail to achieve the annual standard, with design values ranging from 15.1 to 20.4 μg/m^3. The nonattainment areas are concentrated in Pennsylvania and the coastal urban corridor. Sulfates and organic carbon represent the largest contributors to these high fine particle levels.

Table 2-1. 2004 $PM_{2.5}$ Design Values (μg/m^3) for Nonattainment Areas in MANE-VU

State(s)	Nonattainment Area	2004 Annual Design Value
MD	Baltimore	16.3
PA	Harrisburg-Lebanon-Carlisle	15.4
PA	Johnstown	15.3
PA	Lancaster	16.8
PA	Liberty-Clairton	20.4
MD	Martinsburg, WV-Hagerstown	16.1
NY-NJ-CT	New York-New Jersey-Connecticut	16.8
PA-NJ-DE	Philadelphia-Wilmington	15.4
PA	Pittsburgh-Beaver Valley	16.5
PA	Reading	16.1
DC-MD-VA	Washington, DC	15.1
PA	York	16.9

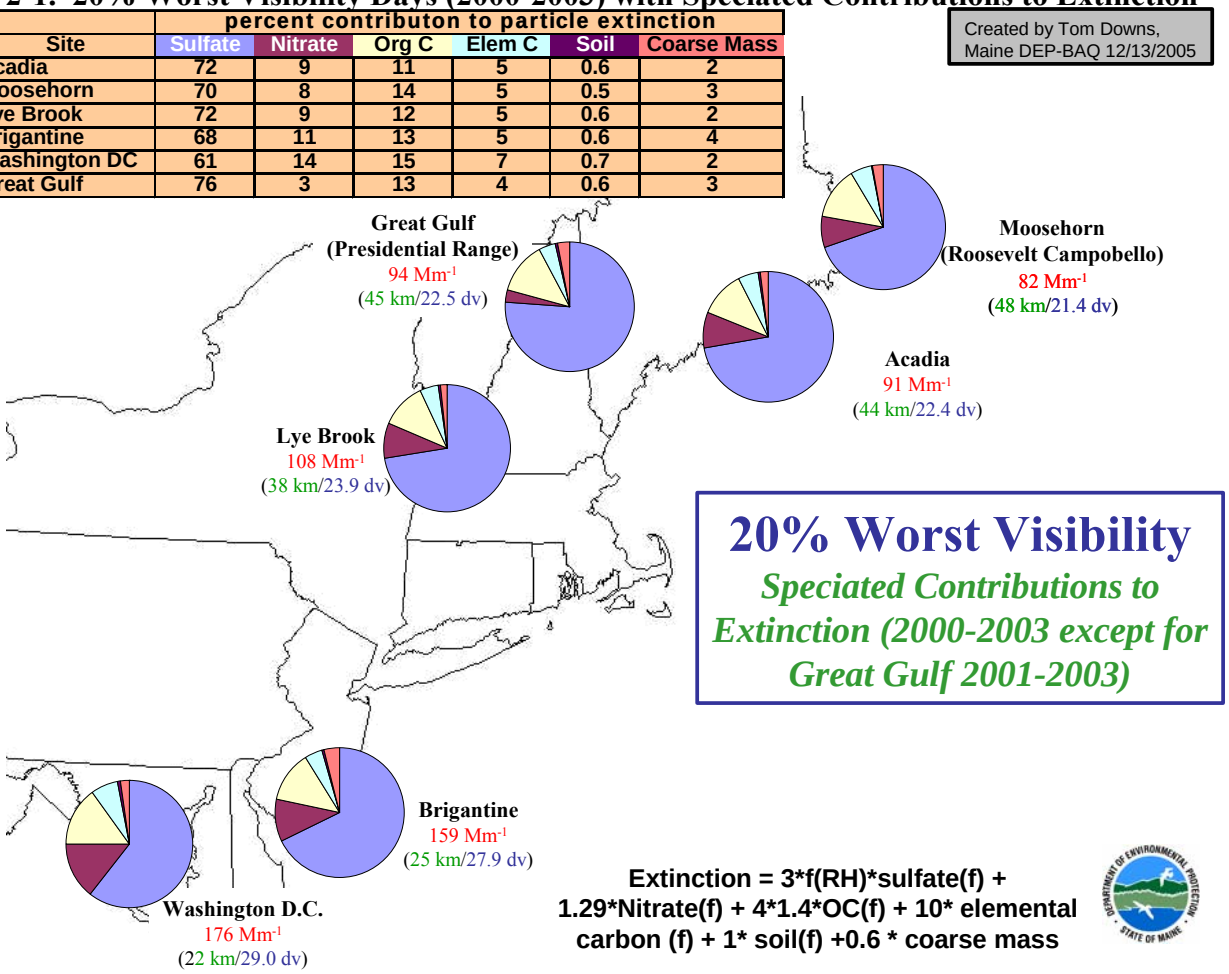
In 1999, EPA followed up with the Regional Haze Rule that enforces a national visibility goal laid out in the CAA. This will ultimately restore natural visibility to 156 national parks and wilderness areas across the country (called "Class I" areas). To address these CAA requirements, states will have to develop State Implementation Plans (SIPs) detailing their approaches for reducing fine particle pollution to meet the health-based fine particle NAAQS. They also must develop plans that address the degradation of visibility that exists in Class I areas of the MANE-VU region. As part of this process, EPA urges states to include in their SIPs a conceptual description of the pollution problem in their nonattainment and Class I areas. The full NESCAUM document, as presented in Appendix 2A, provides the conceptual description of the fine particle and regional haze problems in the MANE-VU states, consistent with EPA's guidance.

Scientific studies of the regional fine particle problem have uncovered a rich complexity in the interaction of meteorology and topography with fine particle formation and transport. Large scale high pressure systems covering hundreds of thousands of square miles are the source of classic severe fine particle episodes in the eastern United States, particularly in summer. These large, synoptic scale systems create particularly favorable conditions for the oxidation of sulfur dioxide (SO_2) emissions to various forms of sulfate which, in turn, serve to form – or are incorporated into – fine particles that are subsequently transported over large distances. These synoptic scale systems move from west to east across the United States, bringing air pollution emitted by large coal-fired

power plants and other sources located outside MANE-VU into the region. This then adds to the pollution burden within MANE-VU on days when MANE-VU's own air pollution sources are themselves contributing to poor air quality. The worst regional haze events typically occur under these conditions as well (see Figure 2-1). At times, the high-pressure systems may stall over the East for days, creating particularly intense fine particle episodes.

Figure 2-1. 20% Worst Visibility Days (2000-2003) with Speciated Contributions to Extinction

Site	percent contributon to particle extinction					
	Sulfate	Nitrate	Org C	Elem C	Soil	Coarse Mass
Acadia	72	9	11	5	0.6	2
Moosehorn	70	8	14	5	0.5	3
Lye Brook	72	9	12	5	0.6	2
Brigantine	68	11	13	5	0.6	4
Washington DC	61	14	15	7	0.7	2
Great Gulf	76	3	13	4	0.6	3



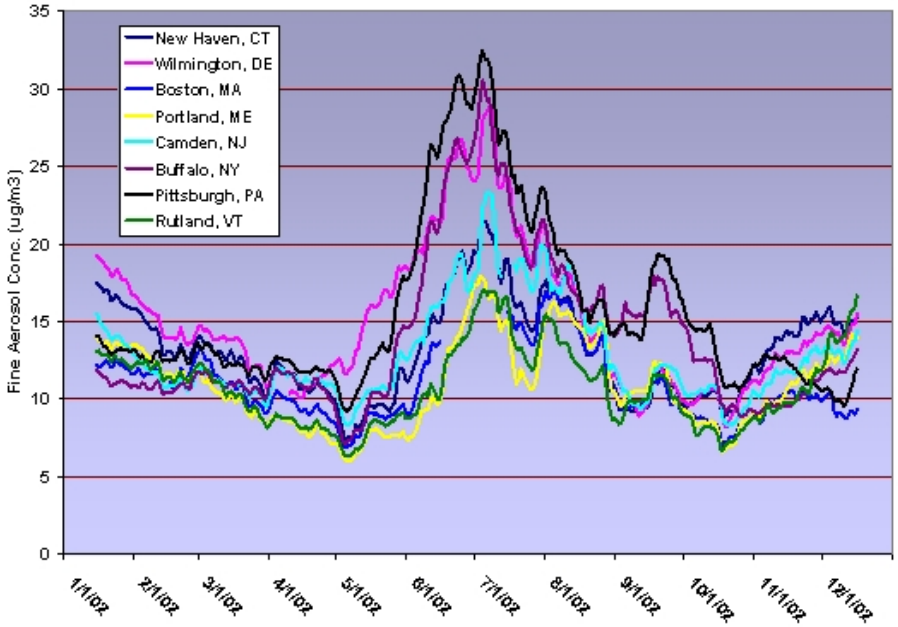
In the winter, temperature inversions occur that are effective at concentrating local primary particle emissions at the surface overnight and during early morning hours. This pollution can then be mixed into regionally transported particle pollution (aloft) later in the morning when convection is restored. Additionally, the lower temperature in the winter can shift the chemical equilibrium in the atmosphere slightly toward the production of nitrate particle pollution relative to sulfate formation. As a result, nitrate can become a significant fraction of measured fine particle mass in parts of the eastern U.S. during winter months.

Primary and secondary emissions of carbon-containing compounds (e.g., diesel exhaust, biogenic organic carbon emissions, and anthropogenic volatile organic compound

emissions) all contribute to a significant presence of carbonaceous aerosol across the MANE-VU region, which can vary from urban to rural locations and on a seasonal basis. In addition, short range pollution transport exists, with primary and precursor particle pollutants pushed by land, sea, mountain, and valley breezes that can selectively affect relatively local areas. With the knowledge of the different emission sources, transport scales, and seasonal meteorology in various locations adjacent to and within MANE-VU, a conceptual picture of fine particle pollution and its impacts emerges. The seasonal variations in $PM_{2.5}$ levels across the MANE-VU region are shown in Figure 2-2.

The conceptual description that explains elevated regional $PM_{2.5}$ peak concentrations in the summer differs significantly from that which explains the largely urban peaks

Figure 2-2.
The 30-day Average $PM_{2.5}$ Concentrations from 8 Northeastern Cities During 2002



observed during winter. On average, summertime concentrations of sulfate in the northeastern United States are more than twice that of the next most important fine particle constituent, organic carbon (OC), and more than four times the combined concentration of nitrate and black carbon (BC) constituents. Episodes of high summertime sulfate concentrations are consistent with stagnant meteorological flow conditions upwind of the MANE-VU region and the accumulation of airborne sulfate (via atmospheric oxidation of SO_2) followed by long-range transport of sulfur emissions from industrialized areas within and outside the region.

National assessments have shown that in the winter, sulfate levels in urban areas are higher than background sulfate levels across the eastern U.S., suggesting that the local urban contribution to wintertime sulfate levels is significant relative to the regional sulfate contribution from long-range transport. A network analysis for the winter of 2002 suggests that the local enhancement of sulfate in urban areas of the MANE-VU region ranges from 25 to 40% and that the long-range transport component of $PM_{2.5}$ sulfate is still the dominant contributor in most eastern cities.

In the winter, urban OC and sulfate each account for about a third of the overall $PM_{2.5}$ mass concentration observed in Philadelphia and New York City (see Figures 2-3, 2-4 and 2-5). Nitrate also makes a significant contribution to urban $PM_{2.5}$ levels observed in the northeastern United States during the winter months. Wintertime concentrations of OC and nitrate in urban areas can be twice the average regional concentrations of these pollutants, indicating the importance of local source contributions. This is likely because winter conditions are more conducive to the formation of local inversion layers, which prevent vertical mixing. Under these conditions, emissions from tailpipe, industrial and other local sources become concentrated near the Earth's surface, adding to background pollution levels associated with regionally transported emissions.

From this conceptual description of fine particle pollution formation and transport into and within MANE-VU, air quality planners need to develop an understanding of what it will take to clean the air in the MANE-VU region. Every air pollution episode is unique in its specific details. The relative influences of the transport pathways and local emissions vary by hour, day, and season. The smaller scale weather patterns that affect pollution accumulation and its transport underscore the importance of local (in-state) controls for SO_2, nitrogen oxides (NO_X) and volatile organic compound (VOC) emissions. Larger synoptic scale weather patterns, and pollution patterns associated with them, support the need for SO_2 and NO_X controls across the broader eastern United States. Studies and characterizations of nocturnal low level jets also support the need for local and regional controls on SO_2 and NO_X sources as locally generated and transported pollution can both be entrained in low level jets formed during nighttime hours. The presence of land, sea, mountain, and valley breezes indicate that there are unique aspects of pollution accumulation and transport that are area-specific and will warrant policy responses at the local and regional levels beyond a one-size-fits-all approach.

The mix of emission controls is also important. Regional fine particle formation is primarily due to SO_2, but NO_X is also important because of its influence on the chemical equilibrium between sulfate and nitrate pollution during winter. While the effect of reductions in anthropogenic VOCs is less well characterized at this time, secondary organic aerosol (SOA) is a major component of fine particles in the region and reductions in anthropogenic sources of OC may have a significant effect on fine particle levels in urban nonattainment areas. Therefore, a combination of localized NO_X and VOC reductions in urban centers with additional SO_2 and NO_X reductions from across a larger region will help to reduce $PM_{2.5}$ and precursor pollutants in nonattainment areas as well improve visibility across the entire MANE-VU region.

Figure 2-3. 2002 Seasonal Average SO_4 Based on IMPROVE and STN Data

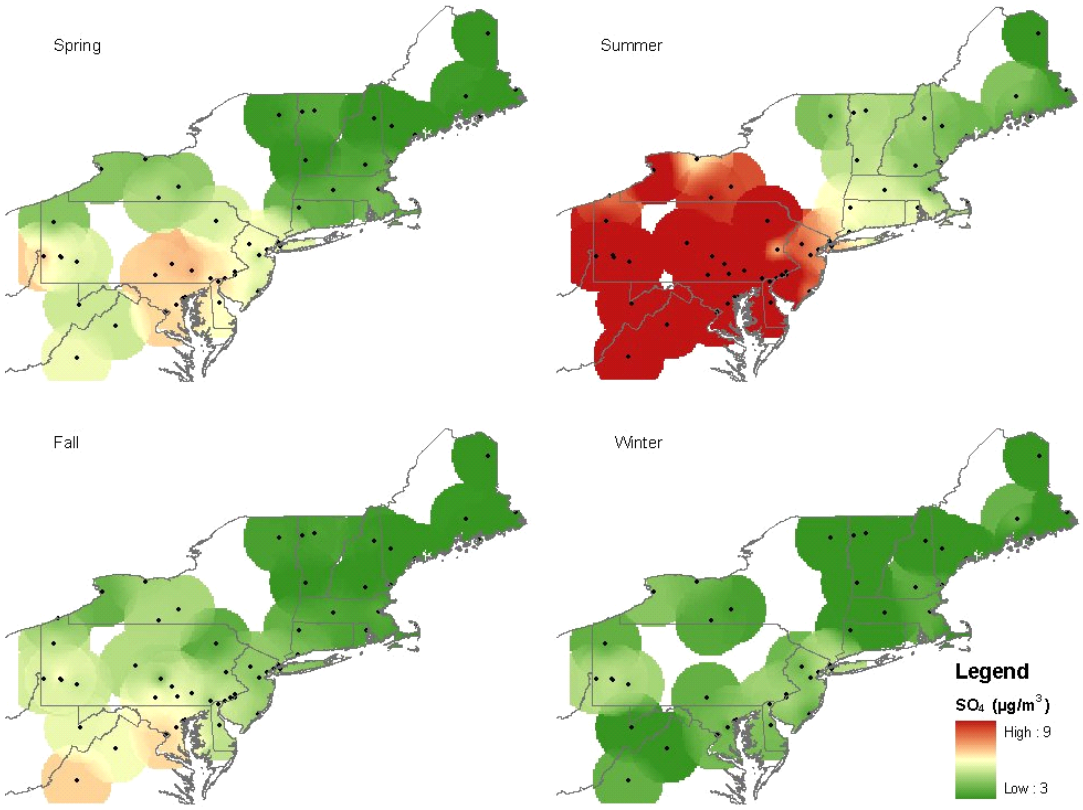


Figure 2-4. 2002 Annual Average $PM_{2.5}$, Sulfate, Nitrate and Total Carbon for MANE-VU Based on IMPROVE (I) and STN (S) Data. $PM_{2.5}$ Mass Data are Supplemented by Measurements from the FRM Network (•).

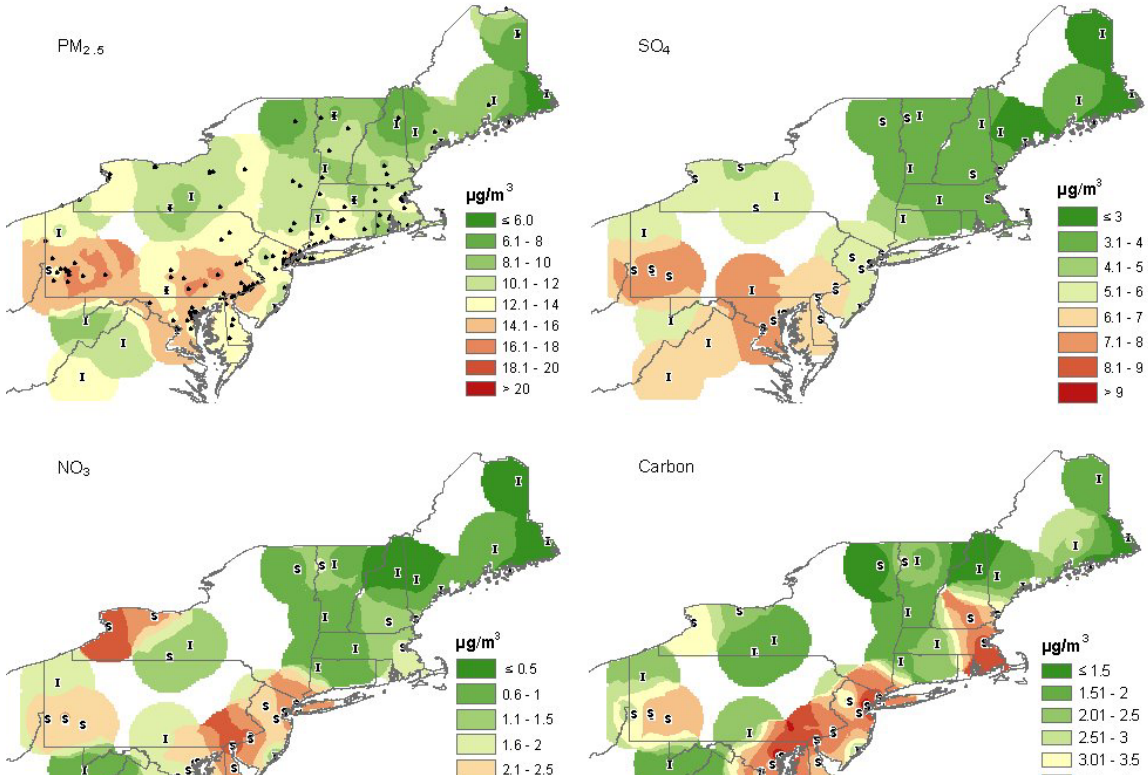
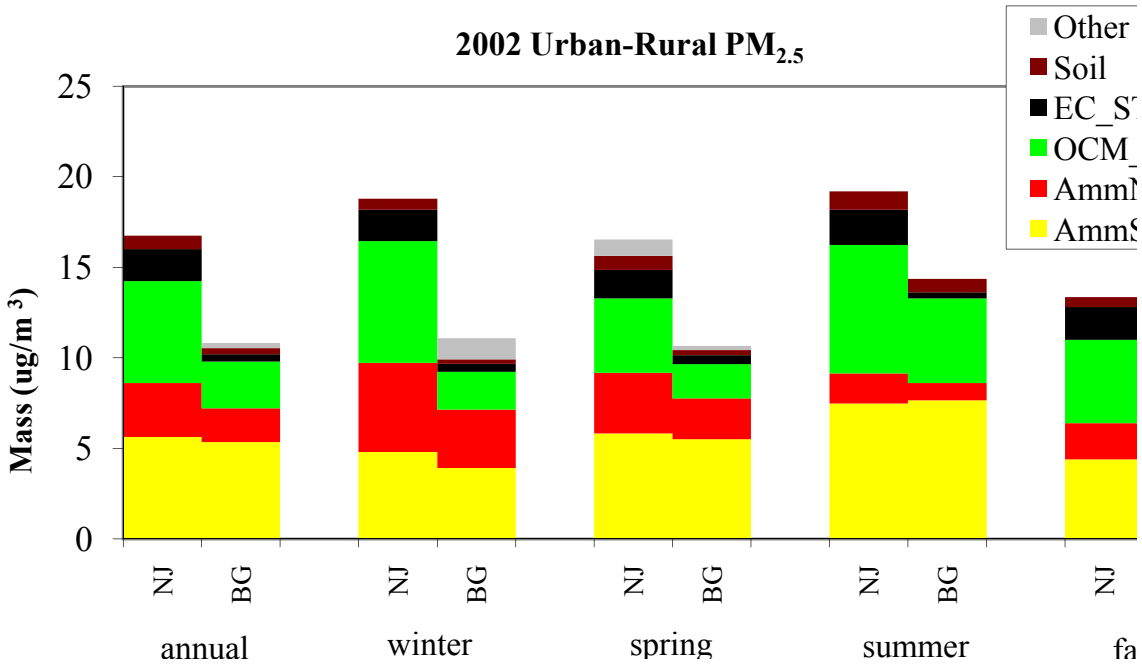


Figure 2-5. $PM_{2.5}$ Species Contribution in the Urban New York Nonattainment Area, NJ (Elizabeth, NJ), Compared to an Upwind Background Site, BG (Chester, NJ).



2.2 Conceptual Model for Elevated $PM_{2.5}$ in Connecticut

Elevated $PM_{2.5}$ levels in Connecticut can occur in either winter or summer and follow similar patterns to those described above for the MANE-VU region. Appendix 2B contains CTDEP's analysis of speciated $PM_{2.5}$ data, meteorological data, and receptor modeling to characterize both winter and summer events. Conclusions from that analysis are summarized below.

2.2.1 Summary of the Seasonal Characteristics of Elevated $PM_{2.5}$

$PM_{2.5}$ events in Connecticut can be categorized as winter or summer time events.

Winter events can be characterized as having:

1. 98^{th} percentile 24-hour value > 32 µg/m^3;
2. Low mixing heights (250m) and E/F Pasquill stability class (shallow, little mixing) for an extended period of time;
3. Warm fronts or overrunning warm air forcing low mixing heights with non-stagnant wind conditions;
4. Low level winds from the southwest (following the urban northeast corridor);
5. Extended periods of high values, not just short duration diurnal rush hour peaks;
6. The primary PM source is motor vehicle (MV) (fresh and aged) and secondary aerosol (volatile species). Lesser contributions come from oil combustion aerosol and wood smoke;
7. Constituent aerosol is primarily carbon (organic and elemental) and;
8. Wintertime sulfate aerosol is less than summertime sulfate aerosol. This can be attributed to cold temperature affinity of ammonium to nitrate over sulfate, the shallow mixing prohibiting deep mixing of Midwest aerosol downward, and reduced EGU emissions during the cold months (no air conditioning).

Summertime events can be characterized as having:

1. 98th percentile 24-hour value > 40 μg/m^3;
2. High mixing heights 600-1200m coast, >1500m inland;
3. Bermuda high weather conditions lasting over several days;
4. Low-level winds from the SSW-SW (NYC CMSA), midlevel winds from the SW and WSW enhanced by the nocturnal low-level jet (LLJ) (following urban NE corridor;)
5. Extended periods of high values, not just short duration diurnal rush hour peaks;
6. The primary $PM_{2.5}$ source is coal burning EGUs, followed by carbon from mobile sources;
7. Constituent aerosol is primarily ammonium sulfate, followed by organic carbon and;
8. Summertime sulfate aerosol is greater than wintertime sulfate aerosol. This can be attributed to warm temperature affinity of ammonium to sulfate over nitrate, the deep mixing of western aerosol downward, and increased EGU emissions during the warm months (air conditioning).

2.2.2 Seasonal Speciation of $PM_{2.5}$

Figures 2-6 and 2-7 illustrate the difference between summer and winter $PM_{2.5}$ composition during typical high events. Motor vehicle (MV) and other fossil fuel combustion sources dominate in the winter at the New Haven site, as depicted by the levels of ammonium nitrate (ammnit) and organic carbon (oc). Ammonium sulfate (ammsul) contributions are somewhat smaller during the winter, but still important. During a typical summer high $PM_{2.5}$ event at the Cornwall site, over 75% of the speciation occurs as ammonium sulfate. This is indicative of long-range transport from the west and southwest.

Figures 2-8 and 2-9 show typical meteorological patterns during high $PM_{2.5}$ events in the winter and summer, respectively. Wintertime events are often associated with the passage of warm fronts and may or may not be long in duration, and high pressure stagnation events. Summertime patterns events are often associated with broad Bermuda high type air masses that may persist for several days.

The implications of this analysis to national air quality regulation are two-fold:

- Control measures on electric generating units to the west of Connecticut are necessary to reduce sulfate sufficiently during the summer;
- Control measures on motor vehicles are needed to reduce nitrate in winter and carbon in both summer and winter.

Figure 2-6. Typical High $PM_{2.5}$ Winter Speciation at New Haven, CT (Criscuolo)

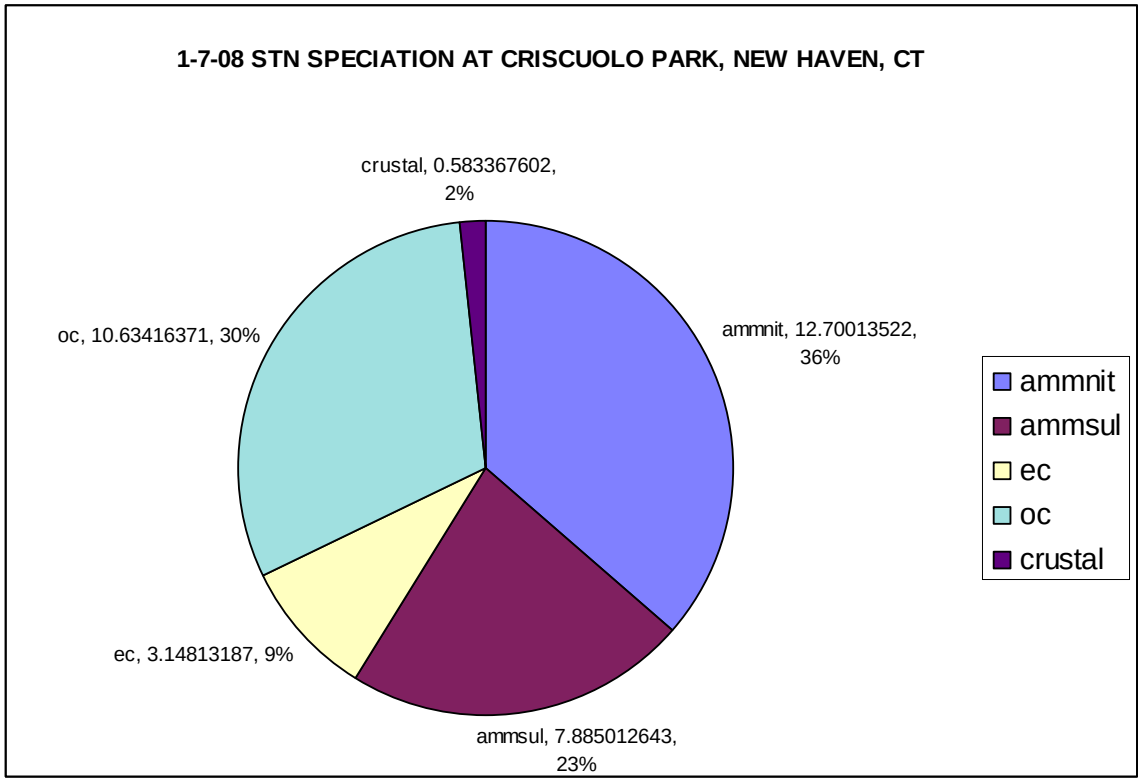


Figure 2-7. Typical High $PM_{2.5}$ Summer Speciation at Cornwall, CT (Mohawk)

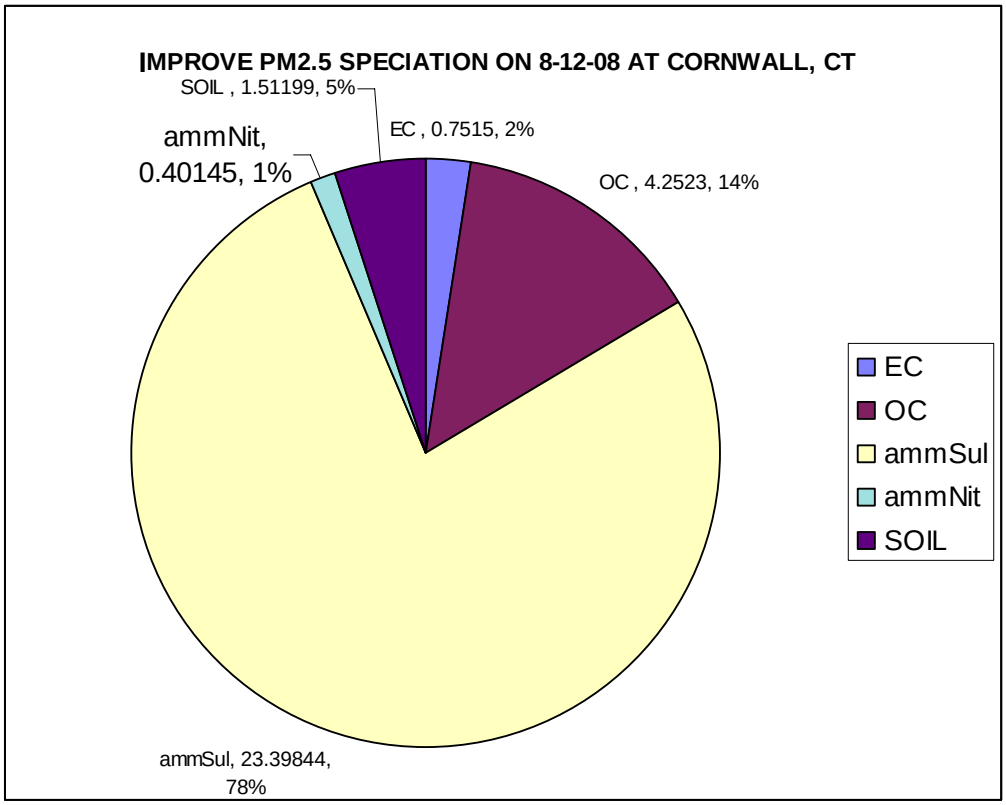


Figure 2-8. Surface Analysis for 3/14/07 12Z (Winter)

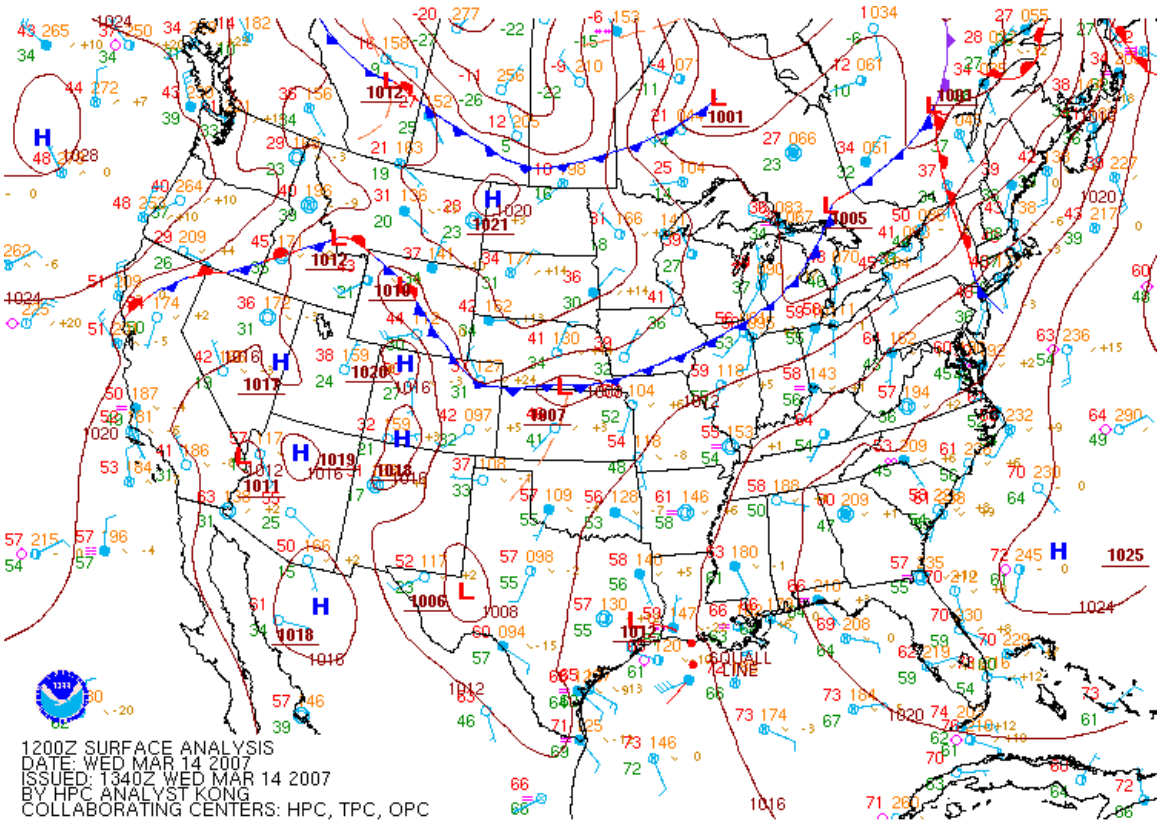
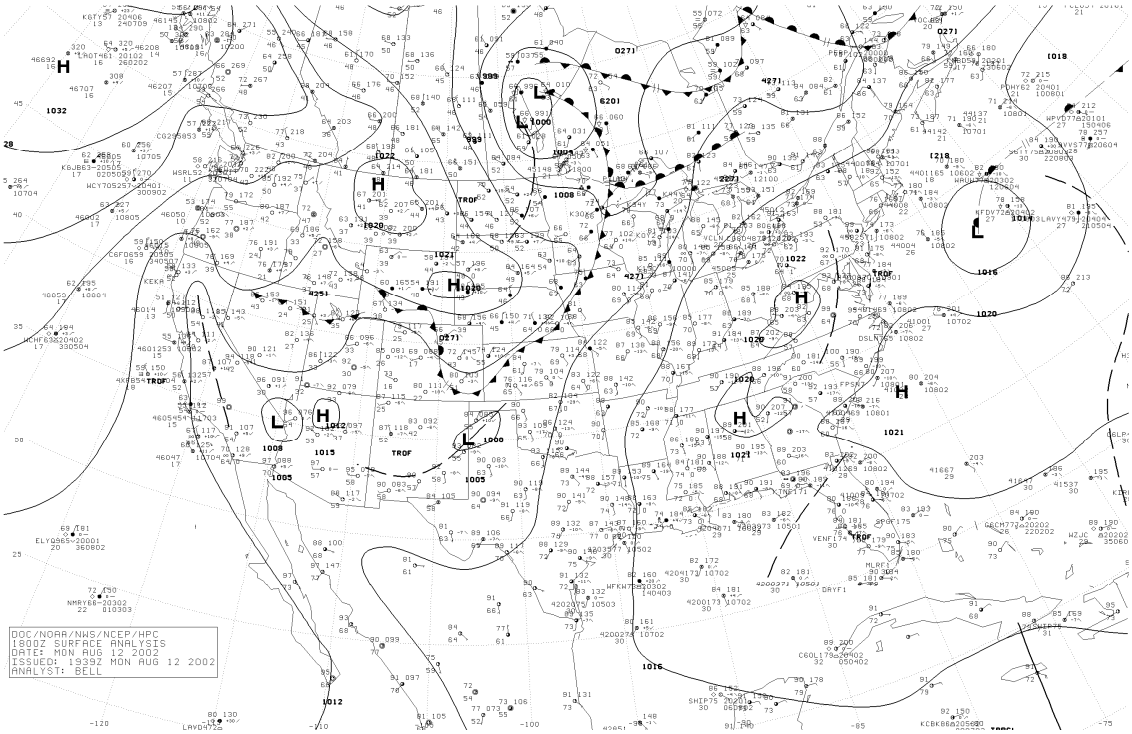


Figure 2-9. Surface Analysis for 8/12/02, 18Z (Summer)



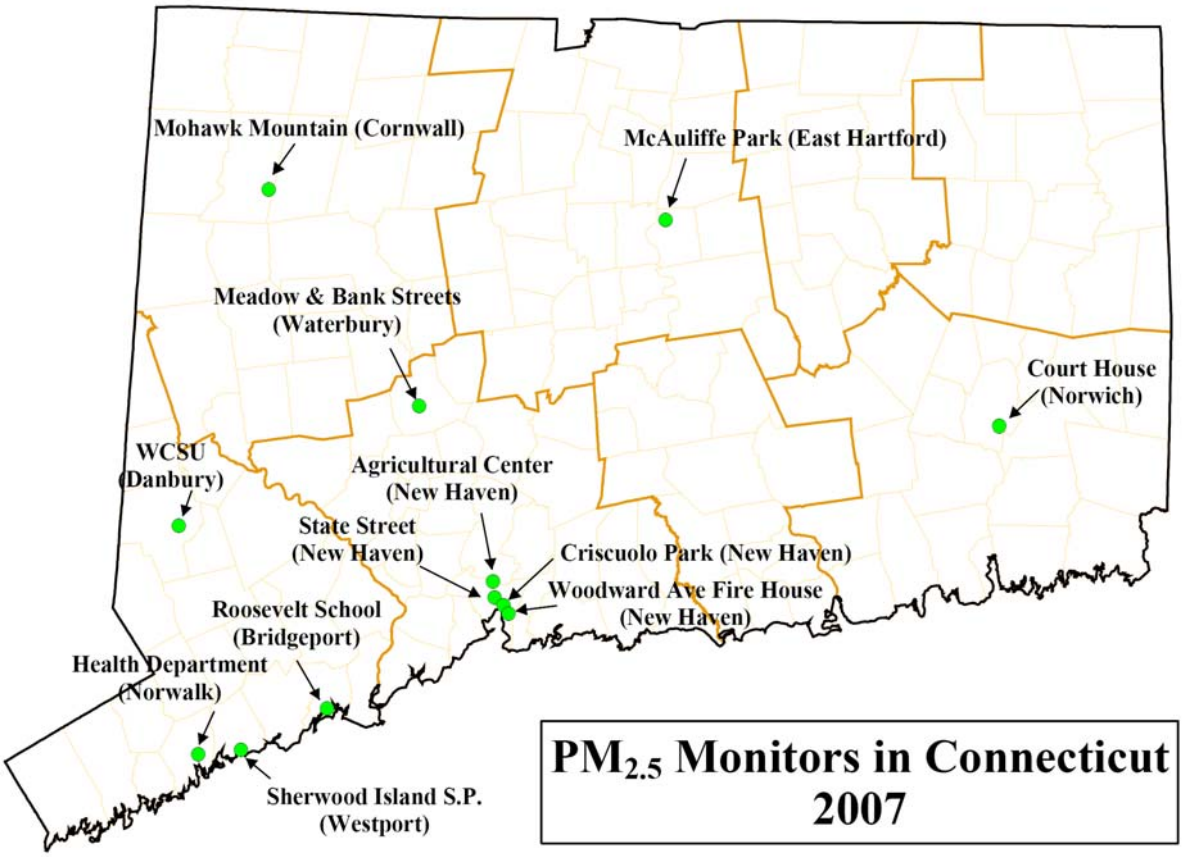
3.0 Observed $PM_{2.5}$ Air Quality Trends and Levels

This section shows the locations as well as the historical and current $PM_{2.5}$ monitoring data at Connecticut monitoring sites. Annual $PM_{2.5}$ concentrations since 1999 have been below the NAAQS of 15.0 µg/m^3 at all monitors; and trends at most sites have been downward. Annual design values (three year running averages) for the sites have all been below the standard in Connecticut; however monitors in New York and New Jersey continue to measure annual design values above the annual NAAQS of 15.0 µg/m^3. It is because of these sites in New York and New Jersey that the multi-state area was designated as nonattainment for the 1997 annual $PM_{2.5}$ NAAQS. All sites in Connecticut, as well as the entire nonattainment area are in attainment for the 1997 24-hour $PM_{2.5}$ NAAQS.

3.1 $PM_{2.5}$ Monitoring Sites in Connecticut

The CTDEP's $PM_{2.5}$ federal reference method (FRM) monitoring network for year 2007 included 12 monitor sites. Four of the sites, Criscuolo Park in New Haven, East Hartford, Westport and Norwich operated on an everyday sample schedule while all other sites operated on a 1-in-3 day sample schedule. Two sites, Waterbury and Criscuolo Park in New Haven, operated collocated $PM_{2.5}$ FRM samplers on a 1-in-6 day sample schedule. A thirteenth $PM_{2.5}$ FRM monitor is scheduled to be installed in 2008 at the Fort Griswold site in Groton. These monitor locations are plotted in Figure 3-1.

Figure 3-1. $PM_{2.5}$ Monitoring Sites in Connecticut in 2007



3.2 Annual Average $PM_{2.5}$ Data[1]

The annual average concentration is calculated from the four calendar quarterly averages at each monitoring site. The annual average is the basic statistic used in determining trends and compliance with the annual average NAAQS. Completeness criteria of 75 percent valid daily values of the expected number of samples in each quarter must be satisfied for a valid annual average. Exceptional/natural event data are excluded when calculating the averages. For sites with collocated monitors, collocated values are substituted for any missing primary values.

Annual Averages. Table 3-1 shows the annual average $PM_{2.5}$ concentration at each CTDEP monitoring site currently in operation. Figure 3-2 is a graph of these data which shows trends over the eight years of monitoring that have been conducted. The black trend line for the Bridgeport Roosevelt School site indicates a downward trend in the annual concentrations since 1999.

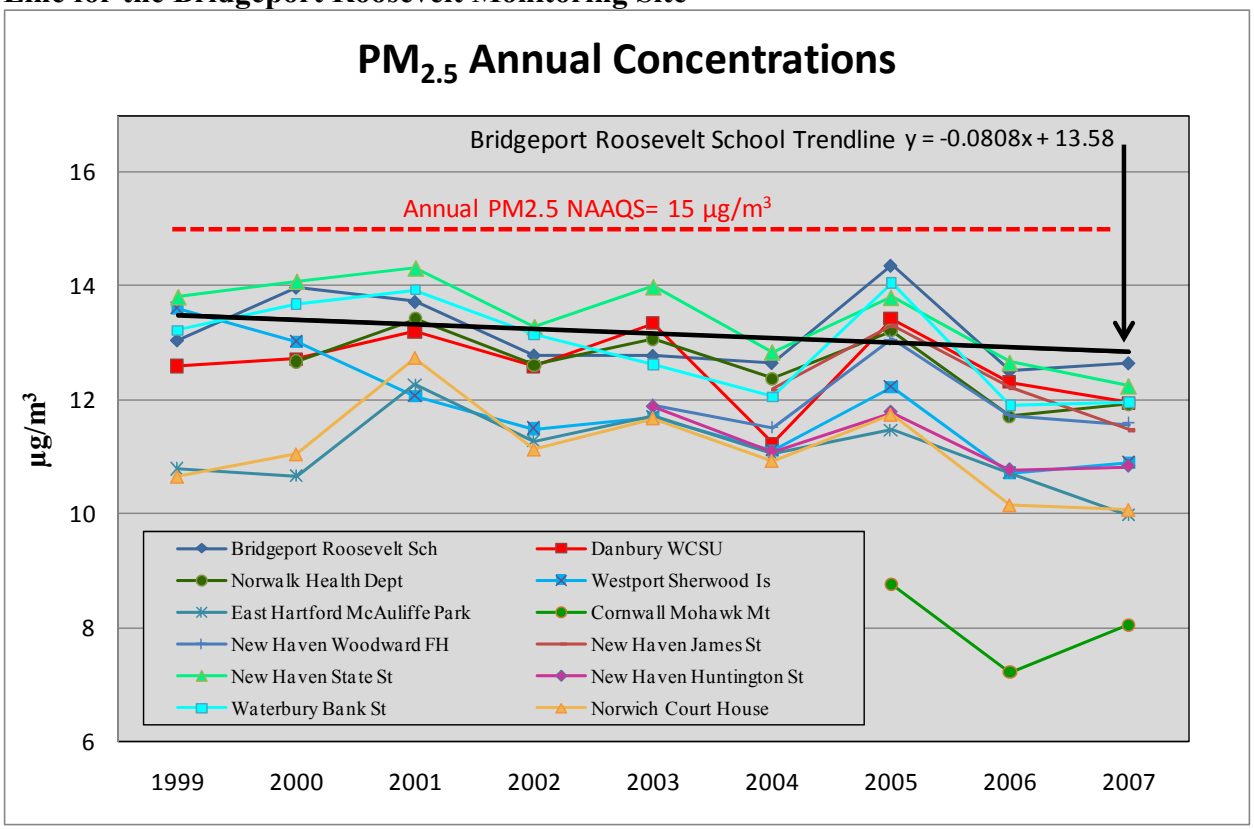
Table 3-1. Annual Average $PM_{2.5}$ Concentrations from 1999-2007

		Annual Averages µg/m^3								
Town	**Site Description**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Bridgeport	Roosevelt Sch	13.1	14.0	13.7	12.8	12.8	12.7	14.4	12.5	12.7
Danbury	WCSU	12.6	12.7	13.2	12.6	13.3	11.2	13.4	12.3	12.0
Norwalk	Health Dept		12.7	13.4	12.6	13.1	12.4	13.2	11.7	11.9
Westport	Sherwood Is	13.6	13.0	12.1	11.5	11.7	11.1	12.2	10.7	10.9
East Hartford	McAuliffe Park	10.8	10.7	12.3	11.3	11.7	11.1	11.5	10.7	10.0
Thomaston	WWTP								8.7	10.2
Cornwall	Mohawk Mt							8.8	7.2	8.1
New Haven	Woodward FH					11.9	11.5	13.1	11.7	11.6
New Haven	James St						12.2	13.3	12.2	11.5
New Haven	State St	13.8	14.1	14.3	13.3	14.0	12.8	13.8	12.7	12.3
New Haven	Huntington St					11.9	11.1	11.8	10.8	10.8
Waterbury	Bank St	13.2	13.7	13.9	13.1	12.6	12.1	14.1	11.9	12.0
Norwich	Court House	10.7	11.0	12.7	11.1	11.7	10.9	11.7	10.2	10.1

Annual value does not meet completeness criteria (75% valid data in each quarter)
Value is N/A for inclusion in DV because a quarter had less than 11 samples

[1] In addition to the $PM_{2.5}$ monitoring locations described in this section, CTDEP operated a "special purpose" monitor in New Haven at the Stiles Street I-95 on-ramp until 2006. In December 2004, upon CTDEP's request, EPA concluded that this monitor, located in an industrial section of the city near a steep on-ramp to Interstate-95, was representative of a microscale "hot spot" that did not represent population exposure in the New Haven area. The site was found to be overly influenced by microscale phenomena, including heavy duty truck exhaust from trucks leaving the New Haven Terminal area and accelerating uphill on the Interstate-95 on-ramp. The monitor was less than twenty feet from the traffic lane. Following a special, multi-site monitoring study conducted by CTDEP, the Stiles Street monitor was deemed unrepresentative of population exposure in the City of New Haven. As a result, data from this site cannot be used to make attainment or nonattainment determinations. In 2006, the Stiles Street site was shut down as part of the Interstate-95 New Haven Harbor Crossing Corridor Improvement Program.

Figure 3-2. Graph of Annual Average $PM_{2.5}$ Concentrations from 2000-2007; and Trend Line for the Bridgeport Roosevelt Monitoring Site



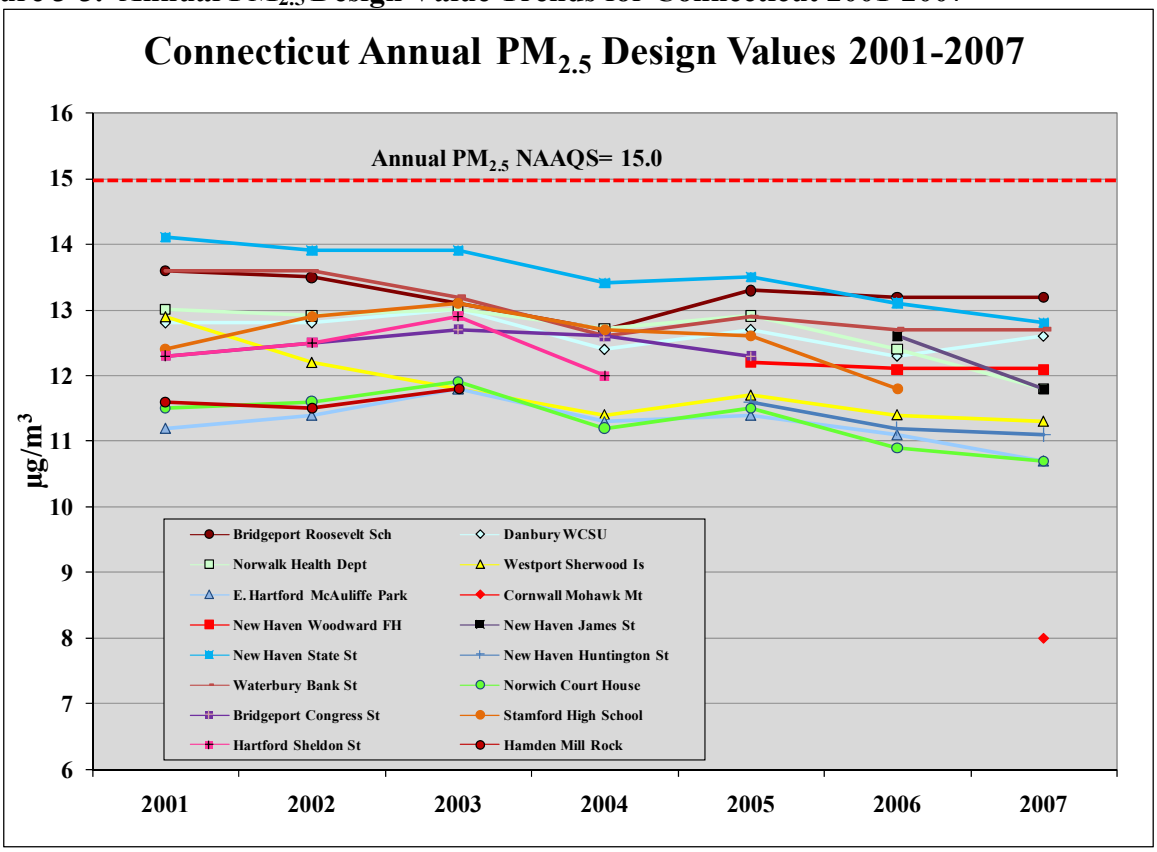
Annual $PM_{2.5}$ Design Values. The annual design value (DV) is derived by averaging three consecutive weighted annual averages, in accordance with 40 CFR Part 50 Appendix N. The annual DVs are calculated based on the 3-year arithmetic average of all valid annual values, with the exception that annual averages are included if the annual average exceeds the standard, or if inclusion of the average results in the DV exceeding the standard. Table 3-2 shows the annual $PM_{2.5}$ design values from 2001-2007 for sites currently operated by CTDEP.

Table 3-2. Annual $PM_{2.5}$ Design Values from 2001-2007

		Annual Design Values µg/m^3						
Town	**Site Description**	2001	2002	2003	2004	2005	2006	2007
Bridgeport	Roosevelt School	13.6	13.5	13.1	12.7	13.3	13.2	13.2
Danbury	WCSU	12.8	12.8	13.0	12.4	12.7	12.3	12.6
Norwalk	Health Dept	13.0	12.9	13.0	12.7	12.9	12.4	12.3
Westport	Sherwood Is	12.9	12.2	11.8	11.4	11.7	11.4	11.3
East Hartford	McAuliffe Park	11.2	11.4	11.8	11.3	11.4	11.1	10.7
Thomaston	WWTP						8.7	9.5
Cornwall	Mohawk Mt					8.8	8.0	8.0
New Haven	Woodward FH			11.9	11.7	12.2	12.1	12.1
New Haven	James St				12.2	12.8	12.6	12.3
New Haven	State St	14.1	13.9	13.9	13.4	13.5	13.1	12.8
New Haven	Huntington St			11.9	11.5	11.6	11.2	11.1
Waterbury	Bank St	13.6	13.6	13.2	12.6	12.9	12.7	12.6
Norwich	Court House	11.5	11.6	11.9	11.2	11.5	10.9	10.7
	DV is N/A due to lack of 3 years of monitoring							

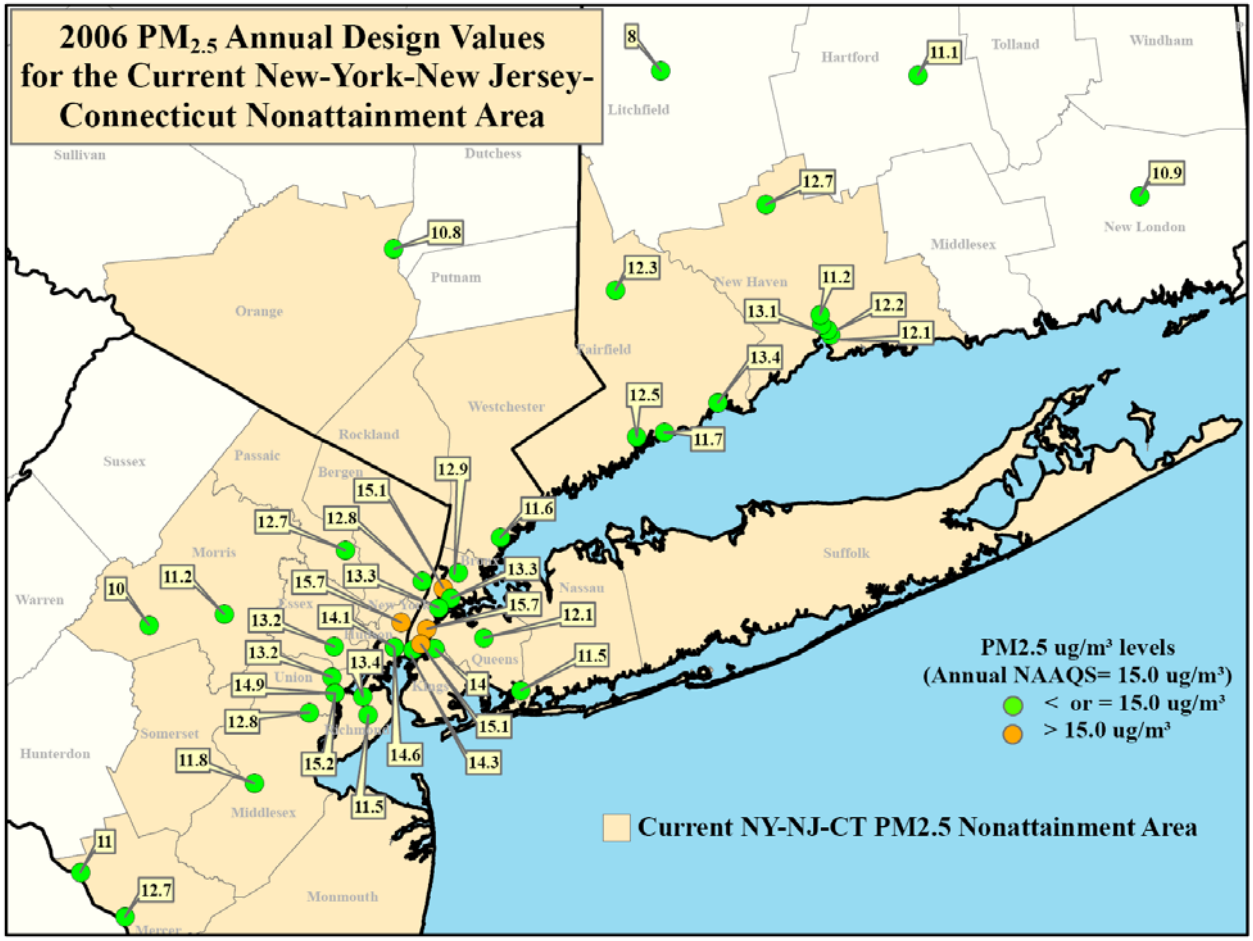
$PM_{2.5}$ Annual Design Value Trends. Annual $PM_{2.5}$ design values for Connecticut monitoring sites have remained under the annual NAAQS of 15.0 µg/m^3 since 2001. Figure 3-3 graphs the design values for these sites from 2001-2007. Trends appear to be downward at most sites.

Figure 3-3. Annual $PM_{2.5}$ Design Value Trends for Connecticut 2001-2007



Nonattainment Area Design Values. Although annual $PM_{2.5}$ design values have remained below 15 µg/m^3 in Connecticut since 2001, annual design values have exceeded this value at monitors in New Jersey and New York. The current $PM_{2.5}$ nonattainment area designation was based on 2003 design values and although Connecticut had no monitors exceeding the annual standard during that year, Fairfield and New Haven Counties were included in the greater New York City nonattainment area. Figure 3-4 shows a map of the nonattainment area with the latest available (2006) annual $PM_{2.5}$ design values. Both New Jersey and New York had a monitoring site with a peak design value of 15.7 µg/m^3 for the three year period ending 2006, while the peak Connecticut monitored level was 13.4 µg/m^3.

Figure 3-4. Map of 2006 Annual Design values for the NY-NJ-CT Nonattainment Area

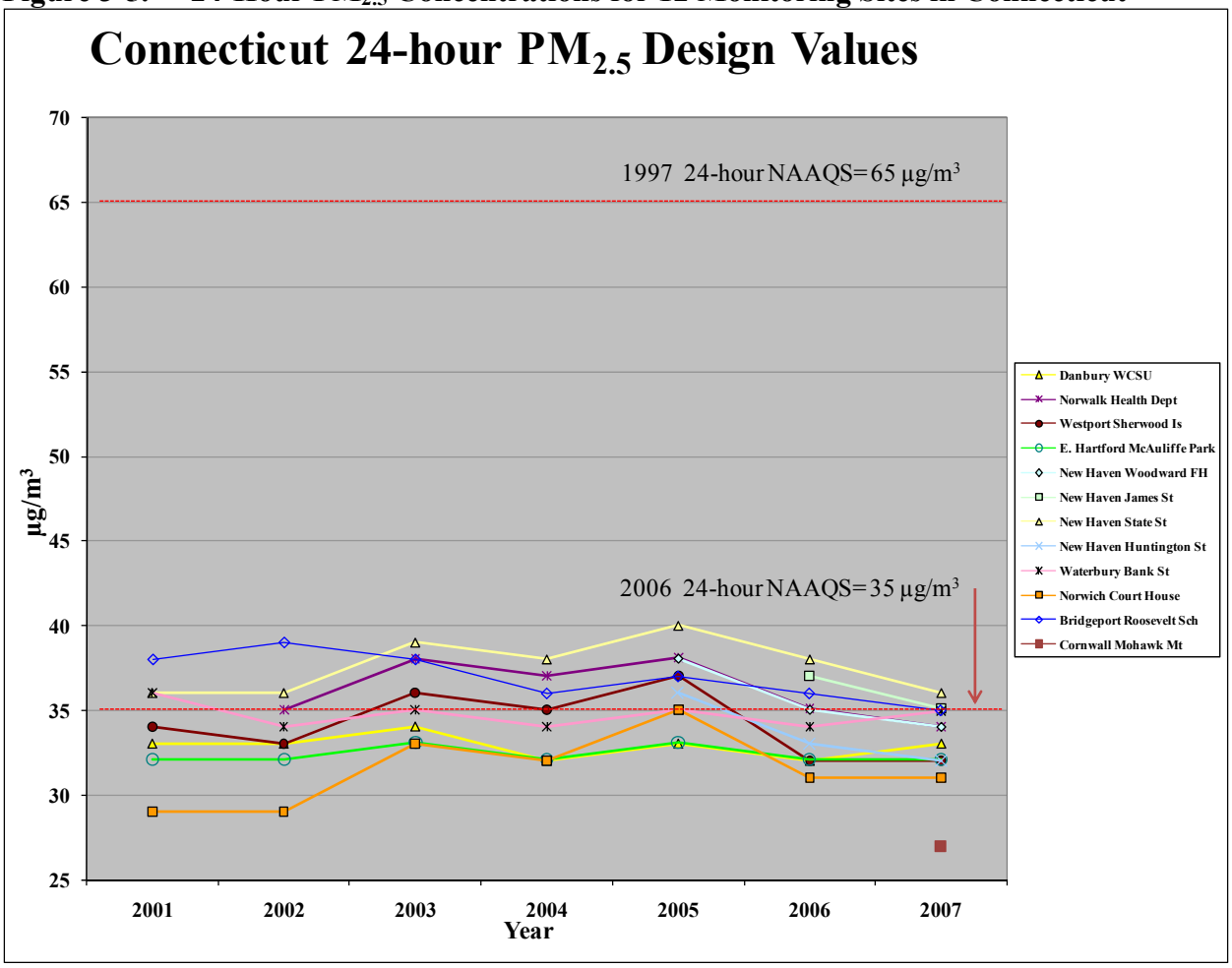


3.3 Daily (24-hour) $PM_{2.5}$ Design Values

The 24-hour design value is defined as the 3-year average of valid yearly 98th percentile $PM_{2.5}$ values, calculated in accordance with 40 CFR Part 50 Appendix N. Missing data are augmented with valid collocated values, if available, and concurred natural/exceptional events are excluded. As with the annual design values, yearly 98th percentile values not meeting completeness requirements are only included in the 3-year average if they exceed the level of the standard, or if the inclusion of the yearly 98th percentile $PM_{2.5}$ value would result in the design value exceeding the standard.

As shown in Figure 3-5, all 24-hour design values in Connecticut are well below the 1997 $PM_{2.5}$ NAAQS of 65 µg/m^3. Note, however, that the $PM_{2.5}$ NAAQS for the 24-hour standard was revised downward in December 2006 to 35 µg/m^3. Although this SIP does not apply to the 2006 NAAQS, it is worth noting that only 1 site in Connecticut registered a design value exceeding the new daily NAAQS in 2007.

Figure 3-5. 24-Hour $PM_{2.5}$ Concentrations for 12 Monitoring Sites in Connecticut



3.4 Monitor Speciation: Urban/Rural Speciation Characterization

Over the past several years the CTDEP has collected speciated $PM_{2.5}$ data from several monitor locations. Monitoring equipment was moved sequentially from site to site for three coastal sites, and from May 2002 to December 2003 was located at the Westport site. The sites were operated using the Speciation Trends Network (STN)[2] protocol. The monitoring sites were designed to characterize air quality influenced by local urban sources, primarily motor vehicles, as they are close to urban centers and interstate highways (I-95 and I-91). Additionally, their close proximity to Long Island Sound (LIS) allowed them to measure $PM_{2.5}$ transport on days with southwest winds. Transported pollution on these days is coming from out-of-state areas: not just the NYC Metropolitan Area but also from other states south and west of Connecticut.

CTDEP also operated a rural monitor located on Mohawk Mountain in Cornwall using the IMPROVE[3] (Interagency Monitoring of Protected Visual Environments) protocol for speciated $PM_{2.5}$. It is located at an elevation of 1683 feet above sea level and is designed to capture upwind transported air pollution.

Table 3-3 lists the speciation monitors and protocols used for this analysis.

Table 3-3. IMPROVE and STN Monitors in Connecticut Used for Speciation Analysis

Monitor Location	Protocol Method	Period of Operation/record
Westport (Fairfield Co)	STN	May 2002-December 2003
Cornwall (Litchfield Co)	IMPROVE	September 2001- December 2004

Six major species are analyzed for the $PM_{2.5}$ data: sulfate, nitrate, elemental carbon, organic carbon, crustal material and ammonium. Figure 3-6 shows the speciation breakdown for the Westport STN site over the 17 month period of operation. Organic carbon and sulfates are the predominant species. Figure 3-7 shows the data categorized by calendar quarter for Westport. The data clearly shows that, while sulfates and organic carbon predominate in all seasons, nitrate levels are higher in the cooler seasons. Figure 3-8 shows the speciation data from the Cornwall IMPROVE site over a 40 month period. For this elevated, rural site, sulfate is the predominant species over the entire period.

Sulfate, or SO_4, is a secondary pollutant, being transformed from gaseous SO_2 to particle form in the presence of water vapor in the atmosphere. Ammonium sulfate is the most prevalent form of sulfate that is created in the atmosphere. Sulfate particles also compete with nitrate for ammonium, with the most efficient conversion to ammonium sulfate occurring in summer. The primary source of SO_2 is coal combustion. Most of the coal burned in the Northeast is by electricity generating units in the states of Pennsylvania, West Virginia and Ohio, states that are located to the south and west of Connecticut. Therefore much of the sulfate measured in Connecticut most likely originates in these states.

[2] http://www.epa.gov/airtrends/aqtrnd03/pdfs/2_chemspecofpm25.pdf
[3] http://vista.cira.colostate.edu/improve/

Figure 3-6. Pie Chart of $PM_{2.5}$ Speciated Data for Westport Connecticut

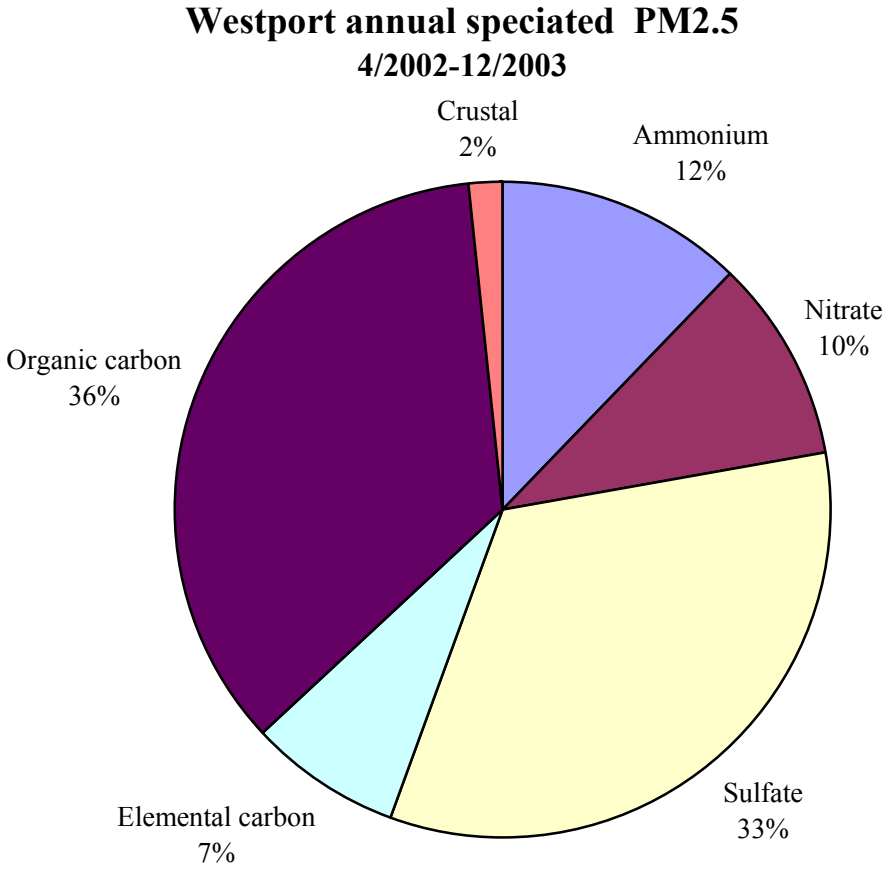


Figure 3-7. Pie Charts of Quarterly $PM_{2.5}$ Speciated Data for Westport Connecticut

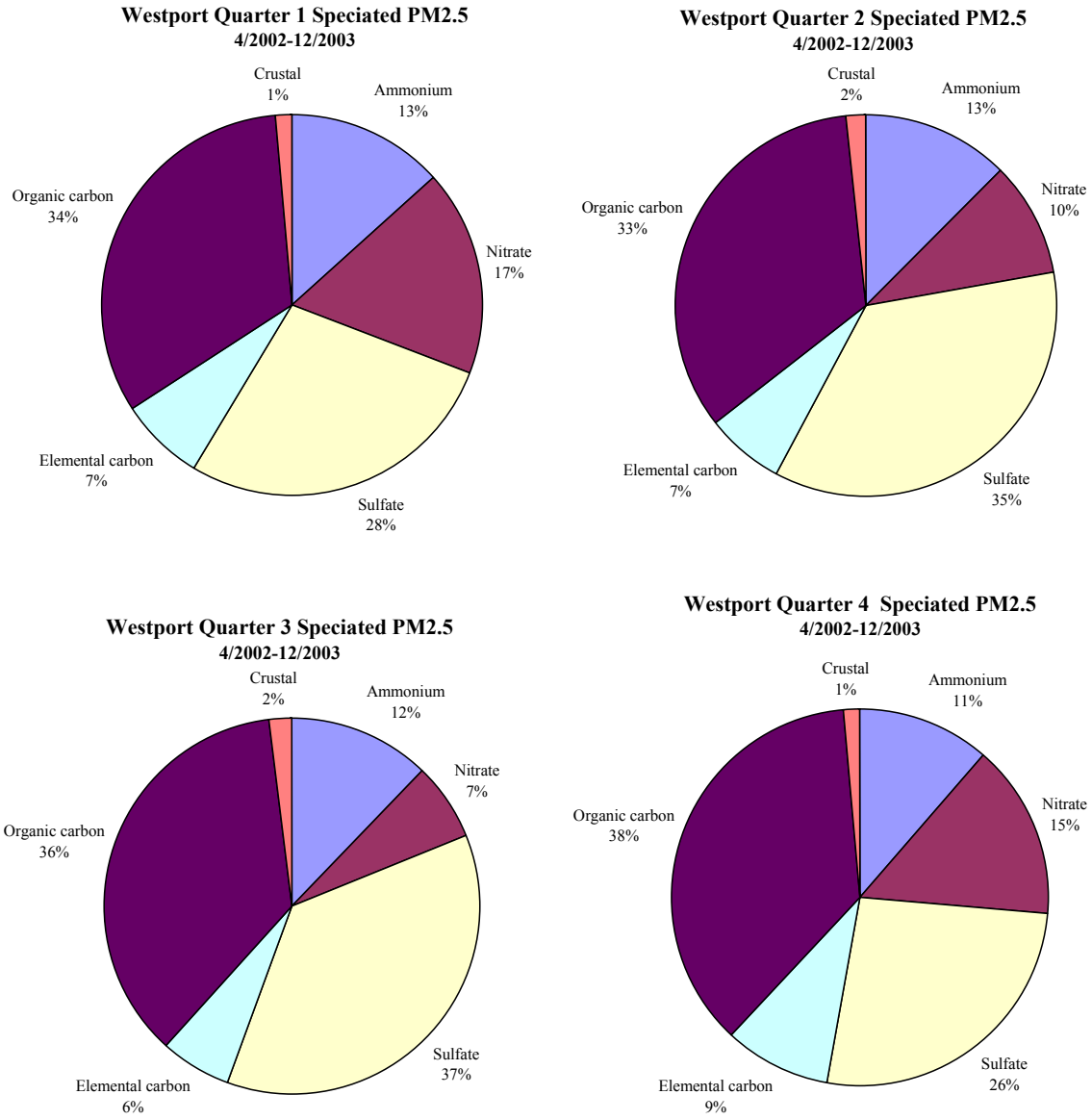
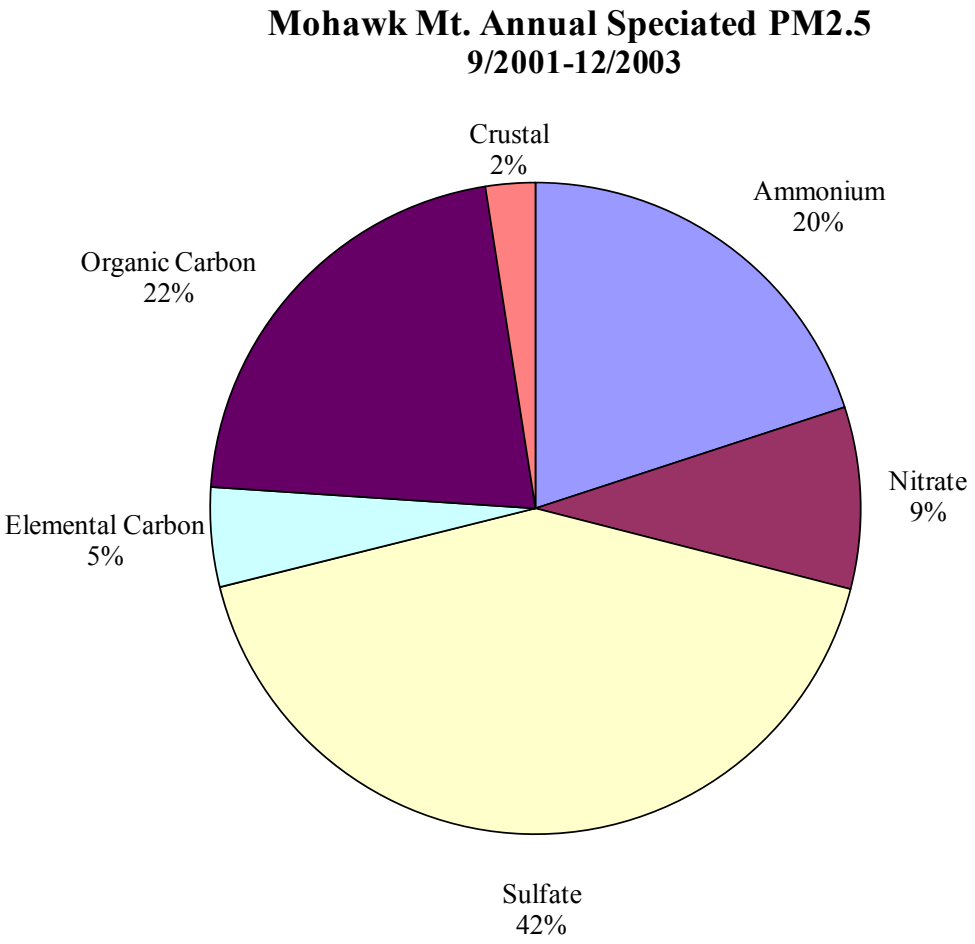


Figure 3-8. Pie Chart of $PM_{2.5}$ Speciated Data for Cornwall Connecticut



The sources of nitrate are high temperature fuel combustion and agricultural operations that first create nitrogen oxides. Gaseous nitrogen oxides are eventually converted in the presence of water vapor in the atmosphere to ammonium nitrate. The largest source sectors emitting nitrogen oxides are mobile sources, coal fired power plants, industrial boilers and residential furnaces. The atmospheric and chemical conversion to ammonium nitrate can occur relatively quickly, but preferentially in the winter. Hence ammonium nitrate concentrations are highest in the winter but are present all year.

Elemental carbon, (EC is also known as black carbon or soot) is the product of incomplete fuel combustion. Sources can include diesel trucks or wood fires, residential fires or wild fires. Summertime presence of high EC can sometimes be attributed to wildfires, especially when accompanied with high concentrations of potassium. Wintertime EC can also be attributed to residential wood combustion.

Organic carbon can originate from fuel or solvent evaporation and fuel combustion. The highest density of these sources typically occurs in urban areas, i.e., motor vehicles, home heating, fuel handling, commercial businesses and industrial operations (factories, dry cleaners, bakeries, etc.). Natural sources (vegetation) emit gaseous volatile organic compounds that also contribute to secondary organic carbon particles in the atmosphere.

Crustal material is defined here as the sum of elemental Al, Ca, Fe, Si, and Ti. Crustal material can be measured in clean air masses (though concentrations are low) and also in dust kicked up by road traffic.

Although the speciation analysis does not explicitly pinpoint the source of the pollutants, it does show a pattern consistent with other monitors in the eastern United States. Overall $PM_{2.5}$ concentrations are lower at the rural Cornwall site, compared to the urban Westport site and sulfate concentrations are a greater percentage of the total at the Cornwall site. Also the elemental and volatile carbon fractions are greater in the urban areas, likely due to the diesel traffic and other combustion sources. Unlike annual $PM_{2.5}$ concentrations, for which the urban excess is more easily quantifiable, daily $PM_{2.5}$ concentrations above 35 $\mu g/m^3$ are mostly due to regional transport of $PM_{2.5}$ and its precursors, as illustrated in trajectory diagrams provided in Figures 3-9 and 3-10.

Figure 3-9. 72-hour back Trajectories from State Street, New Haven, CT 2000-2004 Days when $PM_{2.5}$ > 35µg/m^3 (1 in 3 day sampling)

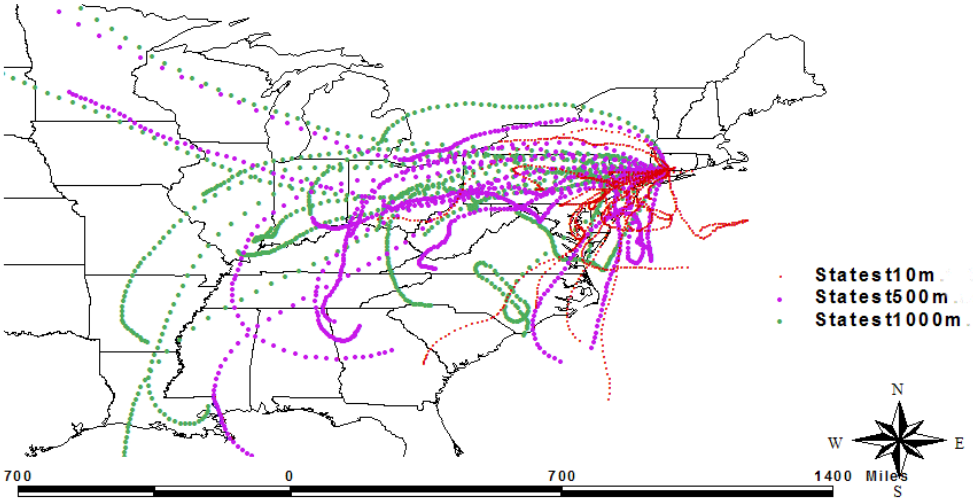
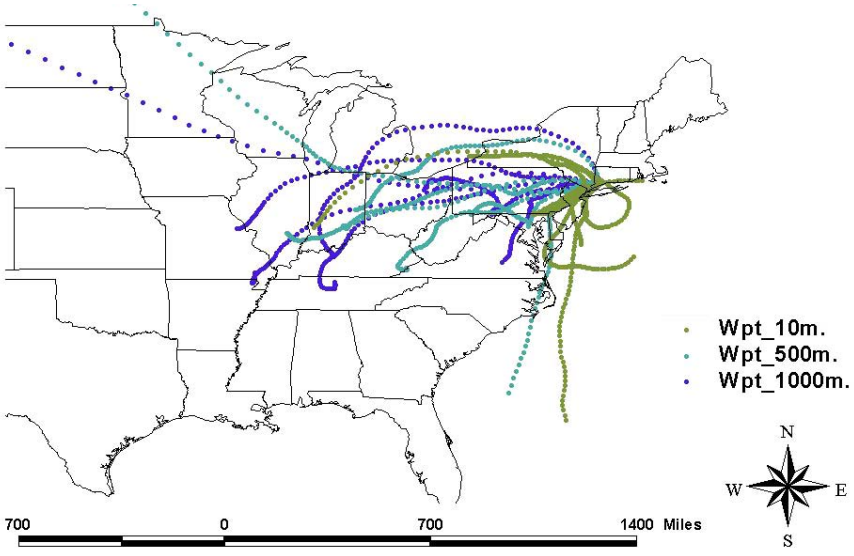


Figure 3-10. 72-hour back Trajectories from Westport, CT 2000-2004 Days when $PM_{2.5}$ > 35µg/m^3 (1 in 3 day sampling)



4.0 Control Measures

Connecticut has a long history of implementing local and regional control measures to reduce NOx and VOC emissions to meet our 1-hour and 8-hour ozone attainment obligations. Similarly, Connecticut has a history of implementing local and statewide measures to reduce particulate and sulfur dioxide emissions to meet particulate matter obligations, including actions under a limited maintenance plan for New Haven. Emissions reductions from these measures, as well as reductions from federal emission control programs, achieved significant reductions in ambient $PM_{2.5}$ levels in Connecticut prior to the 2002 base year. Many of these measures continue to reduce emissions of direct $PM_{2.5}$ and its precursors.

Such previously implemented control measures form the foundation of Connecticut's $PM_{2.5}$ attainment planning and constitute a significant number of Connecticut's reasonably available control measures (RACM). This section of this demonstration addresses the two requirements of CAA Section 172(c)(1) for this plan to include all RACM and to provide for attainment of the annual $PM_{2.5}$ NAAQS through (1) an analysis to demonstrate all RACM have been implemented (Section 4.1); and (2) a catalogue of measures reducing emissions in Connecticut, RACM or not, that contribute to the predicted attainment in 2010 for the NY-NJ-CT area (Sections 4.2 through 4.4). Some of the control measures identified in this section are discussed in Sections 5 and 8 with respect to their use in modeling future year emissions or as weight-of-evidence in support of a conclusion that timely attainment will be achieved in the area.[1]

4.1 RACM Analysis

Although Connecticut has no violating monitors for the annual $PM_{2.5}$ NAAQS and is expected to continue to monitor attainment through 2010, Connecticut is part of the NY-NJ-CT $PM_{2.5}$ nonattainment area and thus a RACM analysis is required. RACM refers to measures that may be applicable to a wide range of sources, including mobile and areas sources, whereas RACT is a type of RACM specifically designed for stationary sources. RACM and RACT measures are considered together, consistent with the $PM_{2.5}$ Implementation Rule, where both RACT and RACM include measures that are economically feasible, technically feasible and contribute to the advancement of the attainment date. The $PM_{2.5}$ Implementation Rule requires measures that reduce three pollutants (directly emitted fine particulate matter ($PM_{2.5}$), nitrogen oxides (NOx) and sulfur dioxide (SO_2)) to be analyzed as potential RACM.[2]

Given Connecticut's currently monitored attainment and the projected attainment of the NY-NJ-CT nonattainment area by 2010, CTDEP concludes that no new measures are necessary as RACM. To reach this conclusion, CTDEP underwent the practical exercise of identifying and evaluating control measures with the potential to create reductions in NOx, SO_2 and direct $PM_{2.5}$. Such measures that were reviewed and rejected as RACM are listed in Appendix 4A. These potential control measures were gathered from a number of sources including EPA's recommendations in the $PM_{2.5}$ Implementation Rule, measures currently planned in other states

[1] Both SIP and non-SIP measures are identified in this section. CTDEP's inclusion of the measures for discussion here is independent of the SIP status and does not indicate a request for approval as such.

[2] 72 FR 20629, April 25, 2007. Although CTDEP has made no finding of significant contribution for emissions of VOC, recently adopted and in-process measures that reduce VOC are discussed as further measures to reduce $PM_{2.5}$ concentrations, by reducing secondary organic aerosols.

in the region, and emission control initiatives in California and other states.[3] A cursory evaluation of the broad list on the basis of technical and economic feasibility significantly reduced the number of potential measures. Based on projected timely attainment in the area, CTDEP could readily determine, without modeling or further analysis, that no new measure alone or in conjunction with other measures will advance the attainment date by one year for the annual $PM_{2.5}$ NAAQS.

While no new RACM are identified as necessary for this demonstration, a number of measures adopted in the past have contributed to Connecticut's monitored attainment and are considered as RACM. Continuing reductions from such measures plus reductions from non-RACM measures will ensure continued compliance with the NAAQS in Connecticut and attainment in the NY-NJ-CT area. Section 4.2 discusses the pre-2002 control strategies that CTDEP considers RACT and RACM, which were implemented prior to the 2002 baseline year used for the $PM_{2.5}$ emissions inventory and modeling. Section 4.3 discusses the post-2002 control strategies that contribute to the modeled $PM_{2.5}$ concentrations to advance the attainment date to 2009 and hence are considered RACM. Section 4.4 identifies additional measures that produce directionally correct emissions reductions. While such measures are not RACM as they are difficult to quantify, are not federally enforceable and may not advance attainment, CTDEP pursues them as weight-of-evidence.

Thus, the remainder of this section identifies all measures that reduce in-state emissions of $PM_{2.5}$ or its precursors, regardless whether or not a measure is considered RACM; whether or not a measure is submitted to the SIP; or whether the emission reductions produced by a measure are included in projecting $PM_{2.5}$ levels in the future. Sections 5 and 8 of this demonstration identify measures with regard to their use in modeling future year emissions or as weight-of-evidence.

4.2 Pre-2002 Control Measures

The pre-2002 control measures that have made contributions to lowering $PM_{2.5}$ concentrations are listed in Table 4-1. These measures include both state and federal requirements that control at least one of the major PM creating pollutants (direct $PM_{2.5}$, NO_x, SO_2) or produce VOC emissions reductions.[4] These measures are considered RACM *in toto* as past implementation is evidence that each measure was economically and technically feasible, and, as a group, the measures reduced emissions to contribute to the advancement of the attainment date.

[3] A precedent to CTDEP's $PM_{2.5}$ RACM review was a regional examination of control measures as RACM for the purposes of demonstrating attainment of the 8-hour ozone NAAQS. CTDEP participated in this regional exercise organized through the Ozone Transport Commission (OTC). The process the OTC used to evaluate and select candidate control measures is summarized in the Technical Support Document that is Appendix 4B to this demonstration. CTDEP had adopted, or is in the process of adopting, several of the candidate control measures chosen in the OTC process; those control measures are discussed in CTDEP's 8-Hour Ozone Attainment Demonstration, which was submitted to EPA on February 1, 2008. Some of those measures are also identified in this section as contributing to $PM_{2.5}$ NAAQS attainment.

[4] Although CTDEP has made no finding of significant contribution for emissions of VOC, recently adopted and in process measures that reduce VOC are discussed as further measures to reduce $PM_{2.5}$ concentrations, by reducing secondary organic aerosols.

Table 4-1. Pre-2002 Control Measures

Control Measure	Pollutant Controlled			
	PM	NO_X	SO_2	VOC
Federal Motor Vehicle Control Program (Tier 0)		X		X
Federal Tier 1 Motor Vehicle Controls	X	X		X
Federal Low Emission Vehicle Program	X	X		
Federal On-board Refueling Vapor Recovery				X
Reformulated Gasoline – Phases I and II		X		X
Federal Non-Road Control Programs	X	X		X
CAA Title IV Acid Rain Program (requirements for the control of acid deposition)		X	X	
EPA Wood Stove Certification Program	X			
Control of Open Burning CGS Section 22a-174(f)	X	X		
New Source Review Permit to Construct and Operate Stationary Sources RCSA Section 22a-174-3	X	X	X	X
Control of Particulate Matter and Visible Emissions RCSA Section 22a-174-18	X			
Control of Sulfur Compound Emissions from Fuel Burning Equipment RCSA Section 22a-174-19			X	
Control of Nitrogen Oxides Emissions from Fuel Burning Equipment RCSA Section 22a-174-22		X		
Connecticut's Enhanced Inspection & Maintenance Program RCSA 22a-174-27		X		X
Dispensing of Gasoline/Stage I and Stage II Vapor Recovery RCSA Section 22a-174-30				X
Low Emission Vehicles RCSA Section 22a-174-36		X		X
Standards for Municipal Waste Combustors (Phase 1) RCSA 22a-174-38	X	X	X	

4.2.1 Federal Control Measures

Federal Tier 0 and Tier 1 Motor Vehicle Controls

Federal emission standards for on-road vehicles have become increasingly more stringent since the CAA was amended in 1990. In June 1991, EPA published a final rule establishing "Tier 1" emission standards to supplement previous federal standards (i.e., "Tier 0" standards established prior to the 1990 CAA Amendments) for light-duty vehicles and trucks.[5] The final rule implemented the mandates of CAA sections 202(g) and 202(h), setting both certification and useful life standards for emissions of NO_X, VOC and PM (as well as carbon monoxide), phased-in over model years from 1994 through 1996.[6]

National Low Emission Vehicle (NLEV) Program

Light-duty vehicle emission standards were reduced from the analogous Tier 0 and Tier 1 standards in 1998 through the National Low Emission Vehicle (NLEV) Program, a voluntary agreement reached among 23 vehicle manufacturers and nine northeastern states, including Connecticut.[7] The NLEV Program required the phase-in of lower emitting vehicles, beginning with model year 1999 in the Northeast, and with model year 2001 throughout the remainder of the country.

Federal On-Board Refueling Vapor Recovery (ORVR)

Pursuant to CAA Section 202(a)(6), EPA promulgated regulations that require passenger car and light truck manufacturers to meet refueling emission standards. For passenger cars, the onboard control requirements were phased-in over three model years with 40 percent, 80 percent and 100 percent of new car production being required to meet the standard in model years 1998, 1999 and 2000, respectively. The regulations establish a refueling emission standard of 0.20 grams VOC per gallon of dispensed fuel, which will yield a 95 percent emission reduction over uncontrolled levels. After phase-in, EPA estimates the ORVR requirements result in capture of 95 percent of refueling emissions, thereby reducing VOC and toxic emissions from vehicle refueling by 300,000 to 400,000 tons nationwide.[8]

Reformulated Gasoline - Phase II

The federal reformulated gasoline (RFG) program is a two-phased program designed to provide reductions of both VOC and NOx emissions. Phase I was implemented in 1995 and Phase II went into effect in 2000. Phase II RFG performance standards require a minimum emission reduction of 27% for VOC and 7% for NOx from baseline levels. Reformulated gasoline is sold statewide in Connecticut.

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[5] 56 FR 25724, June 5, 1991.

[6] *See* http://www.epa.gov/otaq/stds-ld.htm.

[7] 40 CFR Part 86 Subpart R; See http://www.epa.gov/oms/regs/ld-hwy/lev-nlev/subpt-r.pdf.

[8] With adoption by EPA of the onboard rule, moderate ozone nonattainment areas are relieved of the CAA requirement to implement Stage II, but many of these areas continue to implement Stage II to satisfy other air quality requirements. Connecticut continues to implement its Stage II program, in part due to uncertainty about the lifespan of ORVR canisters and in recognition that only light-duty vehicles have ORVR systems.

CAA Title IV – Acid Rain Program

The Acid Rain Program was established to achieve significant environmental and public health benefits through reductions in emissions of SO_2 and NO_x, the primary causes of acid rain. The Program required a two-phase tightening of the restrictions placed on fossil fuel-fired power plants. Phase I began in 1995 and affected 263 units at 110 mostly coal-burning electric utility plants located in 21 eastern and Midwestern states. An additional 182 units joined Phase I of the program as substitution or compensating units, bringing the total of Phase I affected units to 445. Emissions data indicate that 1995 SO_2 emissions at these units nationwide were reduced by almost 40 percent below their required level. Phase II, which began in the year 2000, tightened the annual emissions limits imposed on large, higher emitting plants and also set restrictions on smaller, cleaner plants, to regulate over 2,000 units in all. By 2002, the Program achieved significant reductions in SO_2 and NO_x emissions. Over 40 Acid Rain Program Units in Connecticut follow the national trend in reducing SO_2 and NO_x emissions.

Wood Stove Certification Program

Since 1988, EPA has required manufacturers of wood stoves to certify that each model line of wood stoves offered for sale in the United States comply with the EPA particulate emissions limits specified in the new source performance standard for residential wood heaters. EPA-certified wood stoves are cleaner and more efficient than a wood stove manufactured before 1988. As part of the certification process, each wood stove model line is required to undergo emissions testing in accordance with EPA Reference Method 28 and sampling methods 5G or 5H by an EPA-accredited laboratory.

Federal Non-Road Control Programs

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 regulated emissions from a number of categories of new non-road engines.[9] As listed in Table 4-2[10] and described below, non-road mobile source controls contained in this attainment demonstration include the adoption of a number of different standards for compression-ignition engines, spark-ignition engines, marine diesel engines, locomotives and aircraft; as well as relevant changes to fuels used to power engines in the non-road source category.

[9] *See* http://www.epa.gov/nonroad/index.htm.

[10] Table 4-2 lists both pre-and post-2002 federal non-road control programs. The discussion addresses each measure since these programs create reductions for years after implementation as older engines are replaced.

Table 4-2. Non-Road Mobile Sources Control Measures

Non-Road Engine Category	Date of Final Rule	*NOx*	$PM_{2.5}$	SO_2	VOC	Implementation Phase-In Period
Compression Ignition (diesel) Engines						
Tier 1: Land-Based Diesel Engines > 50 hp	06/17/1994 (59 FR 31306)		●			1996-2000
Tier 1: Small Diesel Engines < 50 hp	10/23/1998 (63 FR 56968)	●	●		●	1999-2000
Tier 2: Diesel Engines (all sizes)	10/23/1998 (63 FR 56968)	●	●		●	2001-2006
Tier 3: Diesel Engines 50 - 750 hp	10/23/1998 (63 FR 56968)	●	●		●	2006-2008
Tier 4: All Diesel Engines (Except locomotive and marine vessels)	06/29/2004 (69 FR 38958)	●	●		●	2008-2015
Spark-Ignition (e.g., gasoline) Engines						
Phase 1: SI Engines < 25 hp (except marine & recreational)	07/03/1995 (60 FR 34581)		●		●	1997
Phase 2: Non-Handheld SI Engines < 25 hp	03/30/1999 (64 FR 15208)		●		●	2001-2007
Phase 2: Handheld SI < 25 hp	04/25/2000 (65 FR 24268)		●		●	2002-2007
Gasoline SI Marine Engines (outboard & personal watercraft)	10/04/1996 (61 FR 52088)				●	1998-2000
Large Spark-Ignition Engines >19 kW (or >25 hp)	11/08/2002 (67 FR 68242)		●		●	2004/2007
Recreational Land-Based Spark-Ignition Engines	11/08/2002 (67 FR 68242)		●		●	2006-2012
Marine Diesel Engines **MARPOL: New/Old Engines on Vessels Constructed Starting 1/1/2000**	09/27/1997 MARPOL (Annex VI of International Convention on Prevention of Pollution from Ships)	●	●		●	2000
Commercial Marine Diesel Engines[1] (US-flagged vessels)	12/29/1999 (64 FR 73300)	●	●		●	2004/2007
Recreational Marine Diesel Engines >37 kW (or >50 hp)	11/08/2002 (67 FR 68242)	●	●		●	2006-2009
Marine Diesel Engines (US-flagged vessels) >30 liters/cylinder	02/28/2003 (68 FR 9746)	●	●		●	2004
Locomotives **New & Remanufactured Locomotives and Locomotive Engines[2]**	04/16/1998 (63 FR 18978)	●	●		●	(see note 2) Tier 0: 1973-2001 Tier 1: 2002-2004 Tier 2: 2005 +
Non-Road Diesel Fuel **(phased into all non-road sectors by 2012)**	06/29/2004 (69 FR 38958)	●	●	●		2007/2010/2012
Aircrafts **Control of Air Pollution From Aircraft and Aircraft Engines 1** **Control of Air Pollution From Aircraft and Aircraft Engines 2**	 05/08/1997 (62 FR 25356) 11/17/2005 (70 FR 69664)		●			 1997 2005
Future Control Measures **Final Locomotive & Marine Diesel Rule** **Proposed Spark-Ignition Engines, Equipment, and Vessels Rule**	 03/14/2008[3] (signed) 05/18/2007[4] (72 FR 28098)	●	●		●	 2008-2015 2009, 2011-2012

[1] Only applies to commercial marine diesel engines with displacements under 30 liters per cylinder.

[2] EPA established three sets of locomotive standards, applied based on the date of first manufacture (i.e. during the Tier 0, Tier 1, or Tier 2 periods). The standards take effect when the locomotive or locomotive engine is first manufactured and continue to apply at each periodic remanufacture.

[3] This rule, finalized March 2008, will start achieving reductions from remanufactured engines in 2008, with phase-in for new engines from 2009-2015. See: http://www.epa.gov/otaq/regs/nonroad/420f08004.htm. Emissions calculations in this SIP do not account for reductions from this measure.

[4] This is a proposed rule, not yet finalized. Emissions calculations in this SIP do not account for reductions from this measure.

- *Non-Road Compression Ignition (Diesel) Engines*

EPA rules have established four tiers of emission standards for new non-road diesel engines. EPA's first non-road regulations were finalized in 1994,[11] when Tier 1 emission standards were issued for most large, greater than 50 horsepower (hp), land-based non-road compression-ignition (CI, or diesel) engines used in applications such as agricultural and construction equipment. These standards were phased in between 1996 and 2000.

In 1998, EPA subsequently promulgated Tier 1 standards for smaller (< 50 hp) diesel engines, including marine propulsion and auxiliary engines, which required phase-in between 1999 and 2000.[12] At the same time, EPA also issued more stringent Tier 2 emission standards for all non-road diesel engine sizes to be phased in from 2001 to 2006 and Tier 3 standards requiring additional reductions from new diesel engines between 50 and 750 hp to be phased in from 2006 to 2008.

EPA's Clean Air Non-Road Diesel Rule was published in 2004. The rule integrates new diesel engine emission standards (Tier 4 standards) with fuel requirements that will decrease the allowable levels of sulfur in non-road diesel fuel.[13] This rule establishes a comprehensive national program that regulates nonroad diesel engines and diesel fuel as a system.

The Clean Air Non-Road Diesel Tier 4 Final Rule sets new emission standards for diesel engines used in most construction, agricultural, industrial and airport equipment, beginning with new 2008 engines and phasing-in fully by 2014. Larger engines (greater than 750 hp) have one year of additional flexibility to meet the Tier 4 emission standards. These emission standards do not apply to diesel engines used in locomotives and marine vessels, although low-sulfur fuel requirements do apply to such engines. However, fuel requirements for these categories are covered in this rule.

Decreasing the sulfur levels in non-road diesel fuel will prevent damage to emission-control systems used to meet the new Tier 4 engine exhaust emission standards. The Non-Road Diesel Rule will reduce current sulfur levels in two steps. First, current sulfur levels of about 3,000 ppm were limited to a maximum of 500 ppm in 2007. This limit also covers fuels used in locomotive and marine applications (though not to the marine residual fuel used by very large engines on ocean-going vessels). The second step consists of reducing fuel sulfur levels in non-road diesel fuel to 15 ppm in 2010 (except for locomotive and marine diesel fuel which will be reduced to 15 ppm in 2012).

- *Non-Road Spark Ignition Engines*

Non-road spark ignition engines, which usually burn gasoline, are used primarily in lawn and garden equipment. EPA rules regulate small (less than 25 hp) non-road spark-ignition (SI) engines (except marine and recreational engines) in two phases. EPA's Phase 1 standards for

[11] 59 FR.31306 (1994).

[12] 63 FR 56968 October 23, 1998.

[13] 69 FR 38958, June 29, 2004.

new small (< 25 hp) non-road spark-ignited (SI) engines were issued in 1995.[14] The Phase 1 standards apply to model year 1997 and newer engines.

EPA subsequently issued more stringent Phase 2 emission standards for both small non-handheld engines (e.g., lawn mowers, generator sets, air compressors) and small handheld engines (e.g., leaf blowers, chain saws, augers) in 1999[15] and 2000,[16] respectively. Phase 2 standards were phased-in from 2001 to 2007 for non-handheld engines and from 2002 to 2007 for handheld engines.

EPA finalized emission standards for new gasoline spark-ignition marine engines in 1996[17] which were phased-in between 1998 and 2000. These engines, typically based on simple two-stroke technology, are used for outboard engines, personal watercraft, and jet boats.

On November 8, 2002, EPA published a final rule which includes new engine emission standards for large spark-ignition engines rated over 19 kilowatts (kW), or >25 hp.[18] Large spark-ignition engines are used in a variety of commercial and industrial applications, including forklifts, electric generators, airport baggage transport vehicles, and a variety of farm and construction applications, as well as in non-road recreational vehicles. Most large spark-ignition engines are fueled with liquefied petroleum gas, with others operating on gasoline or natural gas. The standards were implemented in two tiers: Tier 1 standards started in 2004 and Tier 2 standards in 2007. Tier 2 engines must also have engine diagnostic capabilities that alert the operator to malfunctions in the engine's emission-control system, ensuring that engine emissions are controlled during normal operating conditions.

EPA's 2002 rulemaking also includes exhaust emission standards for non-road recreational spark-ignition engines and vehicles.[19] These recreational land-based engines are found in snowmobiles, off-highway motorcycles, and all-terrain-vehicles (ATVs). These standards were phased-in between 2006 and 2007, except for snowmobiles, which have until 2009 to be fully phased-in. In addition, snowmobiles will have to meet more stringent standards that will be in effect in 2010 and 2012. Beginning in 2008, plastic fuel tanks and rubber hoses available on recreational vehicles will also be regulated for permeation, to minimize the fuel lost through the component walls.

- *Marine Diesel Engines*

Marine diesel engines include small auxiliary and propulsion engines, medium-sized propulsion engines on coastal and harbor vessels and very large propulsion engines on ocean-going vessels. Both new and modified marine diesel engines rated above 175 hp must adhere to international standards (i.e., MARPOL convention) if vessel construction or engine

[14] 60 FR 34581 (1995).
[15] 64 FR 15208, March 30, 1999.
[16] 65 FR 24268, April 25, 2000.
[17] 61 FR 52088 (1996).
[18] 67 FR 68242, November 8, 2002.
[19] Ibid.

modification commences on or after January 1, 2000. Furthermore, U.S.-flagged commercial vessels with new marine diesel engines rated over 37 kW (or >50 hp, with displacements up to 30 liters per cylinder) produced after 2003 (after 2006 for very large engines) must comply with EPA standards issued in 1999.[20]

EPA published a final rule in 2002 that includes new engine emission standards for recreational marine diesel engines.[21] These are marine diesel engines rated over 37 kW, or >50 hp, which are used in yachts, cruisers, and other types of pleasure craft. The standards are phased-in, beginning in 2006, depending on the size of the engine. By 2009, emission standards will be in effect on all recreational, marine diesel engines.

On February 28, 2003, EPA finalized emission standards for exhaust emission from U.S.-flagged vessels with new marine diesel engines rated over 37 kW with displacements over 30 liters per cylinder (also known as Category 3 Marine Diesel Engines).[22] This marks the first time that emissions from very large marine diesel engines have been regulated. These diesel engines are used primarily for propulsion power on ocean-going vessels such as container ships, tankers, bulk carriers, and cruise ships. Most Category 3 marine diesel engines are used for propulsion on vessels engaged in international trade. The standards were implemented in two tiers: Tier 1 standards, which match internationally negotiated standards, took effect in 2004; and Tier 2 standards will be established in a future rulemaking.

- *Locomotives*

EPA's final rule establishing emission standards for new and remanufactured locomotives and locomotive engines was published in 1998.[23] Three sets of standards were adopted, with applicability of the standards tied to the date a locomotive is first manufactured (i.e., 1973 through 2001, 2002 to 2004, and 2005 and later).

- *Aircraft*

Control of air pollution from aircraft and aircraft engines was covered in a final rule published by EPA in 1997.[24] The 1997 rule adopts the international aircraft emissions standards of the United Nations International Civil Aviation Organization (ICAO), which had been in place since 1986 and amended in 1993. This rule brings the U.S. aircraft standards into alignment with the international standards and applies to newly manufactured and newly certified commercial aircraft gas turbine engines with rated thrust greater than 26.7 kilonewtons. ICAO adopted revised standards in 1999 for implementation beginning in 2004. In November of 2005, EPA finalized the adoption of the revised ICAO standards, to once again bring U.S. aircraft standards into alignment with international standards.[25]

[20] 64 FR 73300, December 29, 1999.
[21] 67 FR 68242, November 8, 2002.
[22] 68 FR 9746, February 28, 2003.
[23] 63 FR 18978, April 16, 1998.
[24] 62 FR 25356, May 8, 1997.
[25] 70 FR 69664, November 11, 2005.

4.2.2 State of Connecticut Control Measures

Control of Open Burning

Since 1976, Connecticut has had in place statutory restrictions on open burning. The statute, Section 22a-174(f) of the Connecticut General Statutes (CGS) applies to open burning on residential property as well as municipal landfills and other municipal facilities. Notable provisions of the statute include an obligation on a private property owner to obtain a permit from a local municipal official before conducting open burning; prohibitions on open burning on forecasted NAAQS exceedance days, when an air pollution advisory is in effect, and when the forest fire danger is extreme; and restrictions on the burning of leaves and demolition waste in municipal landfills. Such restrictions work to reduce particulate matter emissions from open burning.

Pre-2002 New Source Review (NSR) Construction and Operation Permit Program

RCSA section 22a-174-3, in effect from 1972 through March 15, 2002, implemented the federal prevention of significant deterioration (PSD),[26] federal nonattainment NSR and the state NSR programs by requiring the owners and operators of stationary sources in Connecticut to obtain a permit to construct and operate the source. The program includes best available control technology (BACT) and lowest achievable emission rate (LAER) requirements that apply to sources with potential emissions of at least 5 tons per year or maximum uncontrolled emissions of at least 100 tons per year or emissions of NOx greater than 25 tons per year, SO_2 greater than 40 tons per year, particulate matter greater than 25 tons per year or VOC greater than 25 tons per year; and offset requirements for new sources in ozone nonattainment areas.

Control of Particulate Matter and Visible Emissions

Beginning in 1972, CTDEP has restricted emissions of particulate from stationary and mobile sources through visible emissions standards. The pertinent regulation, RCSA section 22a-174-18, achieves this purpose through a number of provisions including work practices to control fugitive emissions from construction, demolition and transportation activities and a three-minute restriction on mobile source idling.

TSP RACT requirements were added to the regulation in 1981 for fuel-burning equipment and process sources including hot mix asphalt plants, iron foundry cupolas, foundry sand operations and concrete batching operations.

Control of Sulfur Compound Emissions from Fuel-Burning Equipment

Since 1972, CTDEP has regulated sulfur compound emissions from fuel burning via the requirements of RCSA section 22a-174-19 (Section 19). Section 19 includes a general restriction on the use of fuel with a sulfur content greater than one percent (1.0%), except in specified situations. Section 19 also includes corresponding sales restrictions on fuels.

Control of Nitrogen Oxides Emissions from Fuel-Burning Equipment

Since May 1995, RCSA section 22a-174-22 has required a variety of fuel-burning sources to limit NOx emissions by meeting NOx emissions limits.. The regulation includes ozone season

[26] The Connecticut program did not address Prevention of Significant Deterioration requirements to EPA's satisfaction until 1979 (47 FR 762).

requirements for fuel-burning equipment locating in a nonattainment area, if the equipment exceeds certain daily NOx emission thresholds.

Enhanced I/M Program

Connecticut implemented a motor vehicle I/M program in 1983. When the CAA was amended in 1990, section 182(c)(3) required Connecticut to adopt an enhanced vehicle emission inspection and maintenance (I/M) program throughout most of the state. In response to this requirement, CTDEP, in cooperation with the Connecticut Department of Motor Vehicles, revised the statewide testing program in January 1998, subjecting most vehicles to Acceleration Simulation Mode (ASM 2525) testing, a tailpipe emission test conducted on a treadmill simulating travel at 25 miles per hour at a 25% load factor. This program enhancement was incorporated into RCSA section 22a-174-27, which had specified the requirements for Connecticut's original motor vehicle I/M program.

Dispensing of Gasoline/Stage I and Stage II Vapor Recovery

Effective in 1993, CTDEP adopted Stage I and II vapor recovery requirements to control VOC emissions from gasoline tanks and stations.

Low Emission Vehicles

CTDEP adopted California's Low Emission Vehicle (LEV) Program in RCSA section 22a-174-36 (Section 36) in 1994. Section 36 applies to all 1998 and subsequent model year passenger cars and light duty trucks sold, leased, offered for sale or lease, imported, delivered, purchased, rented, acquired or received, in Connecticut and required that such vehicles be manufactured to meet exhaust emissions standards for a number of pollutants, including NOx.

Beginning with 1999 model year motor vehicles, Section 36 provided for manufacturers to comply with the requirements of the National LEV Program as an alternative to California LEV. The National LEV Program required compliant vehicles to meet exhaust emissions standards, which EPA estimated would reduce overall light-duty vehicle emissions by 70%.

Standards for Municipal Waste Combustors

Connecticut has six facilities that burn municipal waste to create electricity. These six facilities account for approximately thirty percent of the actual annual NO_X emissions from the major NO_X emitters in the state and are regulated by RCSA section 22a-174-38 (Section 38). Section 38 became effective on June 28, 1999 and included NO_X emission limits equivalent to the emission limits established in the federal emissions guidelines and NSPS for MWCs. Section 38 also requires each municipal waste combustor unit to limit emissions of opacity, particulate matter and sulfur dioxide, at levels established in the federal emissions guidelines and NSPS.

4.3 Post-2002 Control Measures

The control measures discussed in this section and listed in Table 4-3 are federal and state programs that reduce emissions of $PM_{2.5}$ or its precursors after January 1, 2002. These measures can be considered RACT or RACM *in toto* since, as a group, the measures may have lowered ambient $PM_{2.5}$ concentrations enough to advance the attainment date.

Table 4-3. Post-2002 Control Measures

Control Measure	Pollutant Controlled			
	PM	NO_X	SO_2	VOC
Federal Tier 2 Motor Vehicle Controls/Low Sulfur Gasoline	X	X	X	X
Federal On-board Refueling Vapor Recovery				X
Federal Heavy-Duty Diesel Vehicle Controls and Fuels	X	X	X	X
Federal 2007 Highway Rule	X	X	X	X
Federal Highway Motorcycle Exhaust Emission Standards	X	X		X
Federal Non-Road Control Programs (see: http://www.epa.gov/nonroad-diesel/regulations.htm)	X	X	X	X
Federal CAIR Requirements for SO_2 Sources*			X	
Outdoor Wood Burning Furnace Restrictions Section 22a-174k of the Connecticut General Statutes	X			
General Permit to Construct and/or Operate a New or Existing Distributed Generation Resource	X	X		
NSR Permit to Construct and Operate Stationary Sources RCSA Section 22a-174-3a	X	X	X	X
Improvements in the Control of Particulate Matter and Visible Emissions RCSA Section 22a-174-18	X	X		
Control of Sulfur Dioxide and Nitrogen Oxide Emissions from Power Plants and Other Large Stationary Sources RCSA Sections 22a-174-19a and 22a-174-22(e)(3)		X	X	
Proposed Restrictions on Asphalt Paving Operations RCSA Section 22a-174-20(k)				X
VOC Reductions from Metal Cleaning RCSA Section 22a-174-20(l)				X
The Post-2002 Nitrogen Oxides (NOx) Budget Program RCSA Section 22a-174-22b		X		
CAIR NO_X Ozone Season Trading Program* RCSA Section 22a-174-22c		X		
Connecticut Enhanced Inspection and Maintenance Program (ASM 2525 final standards and OBD II program) RCSA Section 22a-174-27		X		X
Pressure-Vacuum Gas Station Vent Valves and Increased Testing for Stage II Controls RCSA Section 22a-174-30				X
Heavy-Duty Diesel Engines RCSA Section 22a-174-36a	X	X	X	
CT's California Low Emission Vehicle Phase 2 (CALEV2) RCSA Section 22a-174-36b	X	X		X
Reductions in NOx emissions from Municipal Waste Combustors (Phase 2) RCSA Section 22a-174-38		X		
VOC Reductions from Consumer Products RCSA Section 22a-174-40				X
VOC Reductions from Architectural and Industrial Maintenance (AIM) Coatings RCSA Section 22a-174-41				X
VOC Reductions from Portable Fuel Container Spillage Control RCSA Section 22a-174-43				X
Proposed VOC Reductions from the Manufacture and Use of Adhesives and Sealants RCSA Section 22a-174-44				X

*CTDEP assumes SO_2 and NOx reductions equivalent to the CAIR program will occur in the 2009 to 2010 timeframe, either through resolution of the pending CAIR vacatur by the courts, Congressional action, or action by EPA or affected states to implement a regional program. Although federal CAIR SO_2 requirements do not apply to Connecticut, significant emission reductions are anticipated from upwind sources in other states when Phase 1 annual SO_2 budgets take effect in 2010. Some non-modeled early reductions are expected by 2009, which should help the NY-NJ-CT area achieve timely attainment. Note that CTDEP does not necessarily concur with EPA's interpretation that compliance with CAIR satisfies the RACT requirement for all affected sources.

4.3.1 Federal Control Measures

Federal Tier 2 Motor Vehicle Controls/Low Sulfur Gasoline

EPA adopted final rules requiring more protective emission standards for all new passenger vehicles, including cars, sport utility vehicles (SUVs), minivans, vans, and pick-up trucks. These "Tier 2" standards, published on February 10, 2000,[27] marked the first time that the largest passenger vehicles were subject to the same emission standards as cars. Manufacturers of new vehicles weighing less than 6000 pounds have a phase-in period between 2004 and 2007. Manufacturers of heavier passenger vehicles are provided a longer phase-in period, from 2004 through 2009. EPA's regulatory impact analysis (RIA) for the Tier 2 program[28] estimated reductions in the NY-NJ-CT nonattainment area of 7% VOC, 23% NOx, 78% SOx and 27% $PM_{2.5}$ compared to what light duty vehicle (LDV) emission levels would have been in 2007 under the NLEV program. By 2030, EPA projects Tier 2 will provide LDV emission reductions of 28% VOC, 79% NOx, 78% SOx and 29% $PM_{2.5}$ compared to NLEV.

Federal On-Board Refueling Vapor Recovery

On-board Refueling Vapor Recovery (ORVR) began to be phased in on light-duty cars in model year 1998 (cars on the road in calendar year 1997). By 2005, all 2006 model year light-duty cars and trucks up to 8,500 pounds (lbs) gross vehicle weight rating (GVWR) were equipped with ORVR systems.

Federal Heavy-Duty Diesel Vehicle Engines and Fuels

In October of 2000, EPA published final rules affirming more stringent NO_X and hydrocarbon (HC) emission standards for heavy-duty diesel engines and vehicles (starting with vehicle model year 2004) and establishing tighter NO_X and HC standards for heavy-duty gasoline engines and vehicles (starting with vehicle model year 2005). The October 2000 final rule also requires that heavy-duty vehicles (HDVs), up to 10,000 lbs GVWR, be equipped with ORVR systems. The ORVR systems for HDVs began to be equipped on model year 2004 vehicles and were fully phased-in on HDVs by model year 2006.

On January 18, 2001, EPA published a final rule, referred to as the "2007 Heavy-Duty Highway Rule."[29] The 2007 Heavy-Duty Highway Rule serves as a second phase to the heavy-duty motor vehicle emission standards implemented for heavy-duty vehicles starting with model year 2004. The 2007 Highway Rule required additional, significant reductions of NO_X, PM and HC emissions from heavy-duty engines and vehicles, beginning with vehicle model year 2007. This rule also reduced the sulfur content of diesel fuel to 15 ppm from previous levels of 500 ppm, beginning in 2006. In addition to allowing proper operation of engine pollution control equipment, the cleaner fuel reduces sulfur-related (e.g., SOx, sulfate) emissions from the heavy duty fleet.

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[27] 65 FR 6698, February 10, 2000; see also http://www.epa.gov/otaq/regs/ld-hwy/tier-2/index.htm.

[28] "Regulatory Impact Analysis - Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements"; EPA420-R-99-023; December 1999; See Appendix A to EPA's RIA at: http://www.epa.gov/tier2/frm/ria/r99023.pdf.

[29] 66 FR 5001, January 18, 2001, *see* EPA summary at http://www.epa.gov/otaq/highway-diesel/index.htm.

Federal 2007 Highway Rule

On January 18, 2001 EPA published a final rule, referred to as the "2007 Heavy-Duty Highway Rule."[30] The 2007 Heavy-Duty Highway Rule serves as a second phase to the heavy-duty motor vehicle emission standards implemented for heavy-duty vehicles starting with model year 2004. The 2007 Highway Rule required additional, significant reductions of NO_X, PM and VOC emissions from heavy-duty engines and vehicles, beginning with vehicle model year 2007.

Federal Highway Motorcycle Exhaust Emission Standards

In 2004, EPA published a final rule to implement improved exhaust emission standards on new highway motorcycles.[31] The new exhaust emission standards apply to all 2006 model year and newer motorcycles. Motorcycles with the largest engines, 280 cubic centimeters (cc) displacement and above, will be subject to more stringent HC and NO_X emission standards beginning with model year 2010, in addition to the emission standards that were required in model year 2006. Prior to this final rule, the exhaust emission standards that applied to motorcycles had not been updated in over 20 years. Thus, a model year 2005 motorcycle produces more harmful emissions per mile than even the largest of passenger cars of the same age. This rule marks the first time that exhaust emissions from motorcycles with engines of less than 50cc displacement (scooters and mopeds) are regulated.

Federal Non-Road Control Programs

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. Many of the measures listed in Table 4-2 and discussed in Section 4.2.1 include requirements that became effective in 2002 or later or that continue to produce new emissions reductions in 2002 and beyond. A corollary to the non-road programs are non-road diesel fuel requirements, which are phased-in for all non-road sectors by 2012.[32] In particular, non-road diesel fuel requirements and certain marine diesel engine, locomotive engine and large spark-ignition engine requirements begin to produce reductions after 2002. Such requirements can be identified by the implementation date in Table 4-2. Future non-road control measures, not included in emissions modeling for this demonstration, are discussed in Section 4.4.2.

Federal CAIR Requirements for SO_2 Sources

The $PM_{2.5}$ Demonstration air quality modeling analyses relied in part on the Clean Air Interstate Rule (CAIR) to achieve reductions in emissions of sulfur dioxide (SO_2) and nitrogen oxides (NOx) from upwind sources to help the NY-NJ-CT area achieve timely attainment. On July 11, 2008, the U.S. Court of Appeals for the D.C. Circuit vacated CAIR in its entirety. On September 24, 2008, EPA filed a petition for rehearing, on which a decision is pending. CTDEP assumes that, whether through legislative or judicial action, a federal program will be implemented to provide emission reductions in the 2009-2010 timeframe comparable to those that were anticipated from the CAIR program. In any case, CTDEP encourages EPA to focus on ensuring that all upwind states' SIPs address their obligations to reduce transported pollution under the CAA section 110(a)(2)(D).

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[30] 66 FR 5001, January 18, 2001, see EPA summary at http://www.epa.gov/otaq/highway-diesel/index.htm.

[31] 69 FR 2398, January 15, 2004.

[32] 69 FR 38958, June 29, 2004.

Although federal CAIR SO_2 requirements do not apply to Connecticut, significant emission reductions are anticipated from upwind sources in other states when Phase 1 annual SO_2 budgets take effect in 2010. Some non-modeled early reductions are expected by 2009,[33] which should help the NY-NJ-CT area to achieve timely attainment. Note that CTDEP does not necessarily concur with EPA's interpretation that compliance with CAIR satisfies the RACT requirement for all affected sources.

4.3.2 State of Connecticut Control Measures

Outdoor Wood Burning Furnace (OWBF) Restrictions

CGS Section 22a-174k prohibits the construction and use of an OWBF unless the OWBF is located more than 200 feet from any residence, meets certain stack height criteria and the owner complies with certain operating practices, including a requirement to burn only clean wood. These requirements are an initial step to ensure proper oversight of the siting and operation of these units in a manner that will work to limit particulate matter emissions.

General Permit to Construct and/or Operate a New or Existing Distributed Generation Resource

CTDEP developed the General Permit to Construct and/or Operate a New or Existing Distributed Generation Resource (General Permit) in response to Public Act 07-242, *An Act Concerning Electricity and Energy Efficiency*. The General Permit covers the construction and operation of new or existing diesel powered emergency engines and distributed generation resources of up to two megawatts for purposes of participation in a pilot program developed by the Connecticut Department of Public Utility Control. The owner of any source operating under the general permit must install and operate selective catalytic reduction or equivalent controls to reduce NOx by 90%, and must meet a particulate matter standard of 0.01 gr/bhp-hr or install a diesel particulate filter, or equivalent particulate matter control, to achieve a design control efficiency of at least 85%. Sources operating under the general permit must use fuel with a sulfur content less than or equal to 15 ppm.

Post-2002 New Source Review (NSR) Permit Program

Effective March 15, 2002,[34] CTDEP made significant revisions to its NSR program, which was initiated in part to address requirements of CAA section 112(g) concerning the pre-construction review of new or reconstructed sources of federally listed hazardous air pollutants (HAPs). The program revision was incorporated into the air quality regulations as a new section, RCSA section 22a-174-3a, and RCSA section 22a-174-3 was repealed.

In addition to establishment of a program pursuant to section 112(g) of the CAA, RCSA section 22a-174-3a reconciles certain applicability provisions under which some sources are required to

[33] For a discussion regarding early CAIR emission reductions, see Section XIII of EPA's "Corrected Response to Significant Public Comments on the Proposed Clean Air Interstate Rule"; Corrected April 2005; See: http://epa.gov/oar/interstateairquality/pdfs/cair-rtc.pdf.

[34] *See* 68 FR 9009 (February 27, 2003) for federal approval as a SIP revision.

apply for, but not obtain, an air pollution control permit. The revised NSR program provides the requirements for permit applications, standards for granting permits and permit modifications, and establishes the threshold for which a state-specific air pollution control permit is required at a level of 15 tons per year of potential emissions. Because the state permit threshold is more stringent than the federal program, this amendment also provides for an exemption from the requirement to obtain a new source review permit when a source operates in a manner that restricts actual emissions below the applicability thresholds.

BACT and LAER requirements continue to apply to new sources. CTDEP commits in Section 11 of this demonstration to implement the 40 CFR 51 Appendix S for $PM_{2.5}$ in Fairfield and New Haven counties, as specified in the May 16, 2008 final rule for implementation of the NSR program for the annual $PM_{2.5}$ NAAQS. CTDEP will also: address condensable emissions during the transition period before EPA finalizes Method 202, as provided in the implementation rule; implement the major source thresholds, significant emission rate thresholds and offset ratios as required in the implementation rule; and seek to prepare and submit a revised PSD and non-attainment area NSR SIP, which takes into account $PM_{2.5}$ within Connecticut's air quality regulations, by May 16, 2011.

Improvements in the Control of Particulate Matter and Visible Emissions

RCSA section 22a-174-18 was revised in 2004 to (1) improve the enforceability of the opacity requirements by specifying the form and averaging time of the existing opacity standards for stationary sources and including provisions specific to sources with continuous emissions monitors; (2) add particulate matter standards appropriate to fuel-burning equipment using certain fossil fuels; and (3) add particulate matter emissions standards and requirements for stationary reciprocating internal combustion engines.

Control of SO_2 and NOx Emissions from Power Plants and Other Large Stationary Sources

CTDEP was required by an executive order of the Governor to adopt regulations to reduce emissions of SO_2 and NOx from major stationary sources including power plants. In response, in December 2000, CTDEP adopted RCSA section 22a-174-19a and amended section 22a-174-22, with the requirements taking effect in 2003. The requirements apply in general to the Acid Rain program sources and NOx Budget sources.

The SO_2 emissions reduction requirements include low sulfur fuel requirements (0.5% or 0.3%) and quarterly average emissions limits. The revision with regard to NOx was the addition of a non-ozone season NOx limit of 0.15 pounds per MMBtu, which applied to the owners of all sources subject to the NOx Budget Program of RCSA section 22a-174-22b.

Restrictions on Asphalt in Paving Operations

CTDEP is seeking to amend RCSA section 22a-174-20(k) to further limit VOC emissions from cutback and emulsified asphalt used to pave roads. Adoption of this amendment will allow Connecticut to make a significant stride towards compliance with national health-based standards for ozone.

Beginning in 2009, the amendment reduces emissions of VOC from road paving and maintenance activities during the months from May through September, when the use of cutback asphalt is banned and the VOC content of emulsified asphalt is limited.

CTDEP anticipates adoption of the amendment in fourth quarter 2008.

VOC Reductions from Metal Cleaning

Effective May 1, 2008, CTDEP revised RCSA section 22a-174-20(*l*) to adopt a limitation on the vapor pressure of solvents used in cold cleaning and tightened work practices to further limit VOC emissions from metal cleaning. The limitation and other requirements are consistent with the Ozone Transport Commission's Model Rule for Solvent Cleaning, and the resulting VOC emissions reductions were submitted to EPA for 8-hour ozone NAAQS attainment.

The Post-2002 Nitrogen Oxides (NO_x) Budget Program

Connecticut's NOx Budget Program, implemented through RCSA section 22a-174-22b, was approved by EPA as a SIP strengthening measure on December 27, 2000.[35] RCSA section 22a-174-22b establishes a statewide NOx budget and NOx allowance trading program for large electric generators and other industrial sources beginning with the 2003 ozone season. The budget cap is consistent with EPA's NOx SIP Call and the September 1994 OTC Memorandum of Understanding establishing the OTC NOx Budget Program (NBP). In Connecticut, the OTC program was conducted pursuant to RCSA section 22a-174-22a. As a result of the OTC NBP, the Acid Rain program and other CAA requirements, by 2000 the OTC states had already reduced NOx emissions by approximately 55% from 1990 levels, thereby reducing the level of reductions necessary to meet the federal NBP targets. With the further implementation of the federal NBP in 2003, the OTC states' ozone season NOx emissions from subject sources were reduced 30% from 2002 levels and were 18% less than the number of NBP allowances allocated in 2003. In addition, NOx highest daily emissions and average daily emissions in the OTC states have decreased approximately 25% and 35%, respectively, from 1997 to 2003.[36]

The Clean Air Interstate Rule (CAIR) Nitrogen Oxides (NO_x) Ozone Season Trading Program

As described above, CTDEP assumes that, whether through legislative or judicial action, a federal program will be implemented to provide emission reductions in the 2009-2010 timeframe comparable to those that were anticipated from the CAIR program. The following discussion presumes that such a resolution will allow Connecticut to move forward with its recently adopted CAIR regulation.

Connecticut will comply with CAIR by participating in the federal CAIR ozone-season NOx trading program, and a regulation establishing the program, RCSA section 22a-174-22c, was adopted September 4, 2007 and approved by EPA on January 24, 2008 [73 FR 4105]. Shortly after May 1, 2009, the effective date for the CAIR trading program, the current NOx budget program implemented under RCSA section 22a-174-22b will be repealed. All the sources that

[35] 65 FR 81743, December 27, 2000.

[36] 1997 and 1998 data from the Acid Rain Program; 1999-2002 data from the OTC trading program; 2003 data from the NBP.

now participate in the RCSA section 22a-174-22b NOx budget program will be subject to Connecticut's CAIR ozone season NOx trading program, albeit subject to a reduced statewide ozone season budget and a revised allocation system.

With the transition to the CAIR program, the ozone season budget will be reduced from 4,466 tons in 2008 to 2,691 tons beginning in 2009. As a result of the decreased ozone season budgets in Connecticut and in states throughout the region, NOx emissions levels are expected to continue to decline beyond the emissions reductions achieved in the NOx SIP Call trading program.

Connecticut Enhanced I/M (ASM 2525 final standards) and OBD-II Enhanced I/M

In August 2004, CTDEP updated the motor vehicle emissions testing program standards implemented by the Connecticut Commissioner of Motor Vehicles to conform to revisions to the underlying federal program standards. Specifically, the revisions to RCSA section 22a-174-27: (1) defined new on-board diagnostic test requirements; (2) added new emissions standards for vehicles subject to a pre-conditioned two speed idle exhaust emissions test procedure; (3) required ASM 2525 exhaust emission standards consistent with federal guidance but for which the federal government has not adopted analogous standards; and (4) added new emissions standards for diesel vehicles subject to a modified snap acceleration smoke opacity test.

In 2003, Connecticut began operating a decentralized I/M testing infrastructure through a new I/M contractor. The revised I/M program requires the use of the on-board diagnostics II (OBDII) test, the ASM 2525 test, the pre-conditioned two-speed idle (PCTSI) test, or one of two types of opacity testing, depending on the age, weight and fuel type of each vehicle. Virtually all vehicles that weigh less than 10,000 pounds (gross vehicle weight rating) and that are between 4 and 25 years of age are subject to the program. The CTDEP filed a SIP revision with EPA on December 20, 2007 to incorporate these changes to the I/M program. Emission estimates in this attainment demonstration account for Connecticut's I/M program.

Pressure Vent Caps and Increased Testing for Stage II Controls

In May 2004, Connecticut amended RCSA section 22a-174-30 to reduce emissions of VOCs by requiring the use of "pressure-vacuum vent caps" on gasoline pumps that are subject to the Stage II vapor control regulation. The amendment also requires the use of a two-point closed system for the transfer of gasoline from a gasoline tanker truck to an underground storage tank; improves Stage II system maintenance; clarifies testing requirements and increases testing frequency. EPA approved that amendment as a 1-hour ozone additional control measure.[37]

Heavy-Duty Diesel Engines

RCSA section 22a-174-36a restricts the sale in Connecticut of all heavy-duty diesel engines produced for the model year 2006 and subsequent model years and to new heavy-duty motor vehicles containing such engines. Any such engines or vehicles sold must meet exhaust emissions limits and other certification requirements of the California Air Resources Board.

[37] 71 FR 51761, August 31, 2006.

This regulation is expected to produce significant reductions in diesel emissions from heavy-duty diesel engines as the fleet is turned over.

California Low Emission Vehicle Phase 2 (CALEV2)

The State of Connecticut will be implementing the light-duty motor vehicle emission standards of the State of California applicable to motor vehicles of model year 2008 and later. California's revision of their Low Emission Vehicle (LEV) standards also includes adoption of green house gas emission standards for passenger cars, light-duty trucks and medium duty passenger vehicles commencing with 2009 and subsequent model year vehicles. The program is implemented through RCSA section 22a-174-36b, which was adopted in Connecticut in December 2005.

Reducing NOx Emissions from Municipal Waste Combustors

Connecticut's regulation to limit air pollutant emissions from the state's municipal waste combustor (MWC) units is described in the previous section. An October 26, 2000 amendment to RCSA section 22a-174-38 reduced the NOx emission limits below the 1999 levels beginning May 1, 2003. EPA approved the amended regulation and associated emissions reductions for 1-hour ozone NAAQS attainment on December 6, 2001.[38]

VOC Reductions from Consumer Products

Most states in the OTR have adopted regulations based on a 2001 OTC Model Rule for Consumer Products. That OTC Model Rule was, in turn, based on consumer product requirements in California. Connecticut opted not to adopt a regulation for 1-hour ozone NAAQS attainment purposes based on that initial OTC model rule.

The OTC states were prompted to revisit the 2001 OTC model rule for consumer products in 2005 when California amended its consumer products program to create additional VOC reductions by reducing the VOC content limits for certain products and specifying new VOC content limits for additional products. This led to the creation of a 2006 OTC model rule for consumer products.

CTDEP has adopted regulation, RCSA section 22a-174-40, consistent with the 2006 OTC model rule for consumer products. The new Connecticut regulation will apply to anyone who sells, supplies, offers for sale or manufactures for sale regulated products sold on or after January 1, 2009.

VOC Reductions from Architectural and Industrial Maintenance Coatings

New RCSA section 22a-174-41 (Section 41) will limit VOC emissions from AIM coatings through VOC content limits developed in 2001 by the OTC as part of a model rule. Section 41 will apply to anyone who sells, supplies, offers for sale or manufactures for sale in the State of Connecticut any AIM coating for use in the State of Connecticut and to any person who applies or solicits the application of any AIM coating within the State of Connecticut on or after the implementation date of May 1, 2008.

[38] 66 FR 63311, December 6, 2001.

VOC Reductions from Portable Fuel Container Spillage Control

RCSA section 22a-174-43, which was adopted on May 10, 2004, reduces emissions of VOCs by requiring the sale of portable fuel containers (PFCs) designed to minimize spillage and fugitive evaporative emissions. This regulation is based on an OTC model rule that requires manufacturers of particular PFCs to reformulate to meet VOC limits. The 2004 regulation and the associated emissions reductions were approved for 1-hour ozone NAAQS attainment on August 31, 2006.[39]

VOC Reductions from Adhesives and Sealants

New RCSA section 22a-174-44 will reduce emissions of VOCs from adhesives, sealants and primers. This section achieves VOC reductions through two basic components: sale and manufacture restrictions that limit the VOC content of specified adhesives, sealants and primers sold in the state; and use restrictions that, in general, apply to commercial/industrial operations. By reducing the availability of higher VOC content adhesives and sealants within the state, the sales prohibition is also intended to address adhesive and sealant usage at area sources. In addition to the VOC content limits and use requirements, this section includes requirements for cleanup and preparation solvents and a compliance alternative in the form of add-on air pollution control equipment.

The associated emissions reductions, which are estimated to be nearly 4 tons per summer day, will support attainment of the 1997 and 2008 national ambient air quality standards for ozone.

RCSA section 22a-174-44 is not yet adopted in the state, and CTDEP anticipates adoption in September 2008. The sales restrictions apply to adhesives and sealants manufactured after January 1, 2009.

4.4 Other Control Measures Producing Directionally Correct Emissions

There are a number of Connecticut control measures that apply to stationary and mobile sources that are not considered RACM as they are not federally enforceable or are difficult to quantify, yet these measures produce directionally correct reductions in $PM_{2.5}$ and precursor emissions. These non-SIP measures are considered as further "weight-of-evidence" that emissions will be declining enough for the nonattainment area to achieve attainment by April 2010. Such state and federal measures are described here and discussed in Section 8 as weight-of-evidence.

4.4.1 Connecticut Control Measures

Efforts to Reduce Peak Electricity Demand

In September of 2006, Connecticut Governor M. Jodi Rell addressed the peak demand issue in her "Energy Vision" for the state,[40] setting a goal of achieving a 20% reduction in electric-peak consumption by 2020. Public Act 07-242, An Act Concerning Electricity and Energy Efficiency (Energy Act),[41] codified three significant peak reduction measures, consistent with the Governor's goals. On the supply side, the Energy Act calls for mandatory decoupling of utility

[39] 71 FR 51761, August 31, 2006.

[40] "Connecticut's Energy Vision for a Cleaner, Greener State," September 18, 2006, available at http://www.ct.gov/governorrell/lib/governorrell/ctenergyvisionsept19.pdf .

[41] Public Act 07-242, available at http://www.cga.ct.gov/2007/ACT/PA/2007PA-00242-R00HB-07432-PA.htm.

revenue from the sales of each electric and gas company in the next rate proceeding, thereby ending the incentive for electric utilities to sell more energy to increase profits. On the demand side, the Energy Act calls for the development of plans to implement time-of-use pricing with appropriate metering and network support ("smart meters") to provide incentives for consumers to reduce electricity use at times of peak demand. Third, the Energy Act will also reduce peak demand by providing rebates for the replacement of inefficient home air conditioning units with units that meet the federal Energy Star standard.

Reductions in energy demand mean fewer hours of operation for less-efficient "peaking" electric generators that are brought online to meet peak demand. Fewer operating hours means fewer emissions of air pollutants, including SO_2 and NOx.

Energy Efficiency Measures

In Connecticut, the Energy Conservation Management Board (ECMB) advises and assists Connecticut's electric distribution companies in the development and implementation of comprehensive and cost-effective energy conservation and market transformation plans. ECMB utilizes the Connecticut Energy Efficiency Fund (CEEF) to provide financial support to homeowners and renters, small and large businesses, and state and local governments for projects to improve efficient energy use and reduce electric demand. Measures include reducing lighting loads, installing more efficient air conditioning and cooling systems, improving insulation and replacing older motors and pumps with state-of-the-art high efficiency units. Energy demand reductions mean fewer hours of operation for less-efficient power plants that are brought online to meet peak loads. Fewer hours of operation means fewer emissions of air pollutants, including SO_2 and NOx. The magnitude of the emissions reductions produced are discussed in detail in Section 8.

Several specific provisions of the Energy Act, when fully implemented, will result in additional emission reductions supplemental to those from ongoing ECMB programs. Some of these provisions include:

- A requirement that energy capacity needs must first be met through all available energy efficiency and demand-side resources that are cost effective, reliable and feasible;
- All state building projects over $5 million must meet Leadership in Environmental Design Silver (LEEDS Silver) standards or better;
- The creation of the first home heating oil conservation and efficiency program;
- The adoption of appliance efficiency standards for nine additional products; and
- The continued ramp-up of renewable energy portfolio requirements under which 20% of Connecticut's energy shall be derived from renewable resources by the year 2020.

Even without this legislative driver to reduce energy costs, per capita energy use in Connecticut, which has been relatively constant at 250 million BTUs (75 MWh), is significantly lower than the average US consumption rate of 340 million BTUs (100 MWh). Only California and New York City have lower per capita consumption, both estimated at 225 million BTUs (65 MWh).[42] Connecticut's low rate was achieved by commitment to demand-side management.

[42] The Connecticut Academy of Science and Engineering, "Energy Alternatives and Conservation," December 2006.

Product Efficiency Standards

Public Act 04-85 establishes energy efficiency standards for a variety of heating, cooling, lighting and other products. The legislation mandates that products that do not meet Connecticut standards cannot be sold, offered for sale or installed in Connecticut on or after the effective date of the standard. Since the legislation was passed, federal energy standards have pre-empted states from establishing standards for certain products. For Connecticut, standards for the three products identified in Table 4-4 are in effect or will soon become effective until they become pre-empted by the federal standards.

Table 4-4. Products Currently Subject to Connecticut Efficiency Standards Until Pre-empted by Federal Standards

Product	Effective date of CT Standards	Date Federal Standards Pre-empt CT standards
Unit heaters	07/01/06	08/01/08
Commercial refrigerators and freezers	07/01/08	01/01/10
Large packaged air conditioning equipment	07/01/09	01/01/10

Public Act 07-242 adds a number of new product categories that are required to meet energy efficiency standards. For these product categories, there are currently no similar federal standards. These categories include: residential furnaces and boilers (only those purchased by state government), residential pool pumps, metal halide lamp fixtures, single voltage external AC to DC power supplies, state regulated incandescent reflector lamps, bottle-type water dispensers, commercial hot food holding cabinets, portable electric spas, walk-in refrigerators and freezers and pool heaters. The Office of Policy and Management is currently developing standards for the additional product categories.

Connecticut's OneThing™ Campaign

A key part of the Governor's Energy Vision is a plan to promote energy efficient behavior among all residents and businesses. This effort is being carried out through the Governor's OneThing™ campaign, a movement designed to capture the state's collective imagination, encourage widespread participation and facilitate real changes in behavior as they relate to energy consumption and environmental attitudes.

The OneThing™ campaign is being implemented through an 18-month intensive television, radio, print and internet (see http://onethingct.com) communications effort that encourages individuals to commit to doing at least "one thing" to reduce their energy use or environmental impact, so that collectively the State of Connecticut can have a positive impact.

Integrated Resource Planning for Energy Solutions

The Connecticut Energy Advisory Board (CEAB) is a statutory entity responsible for representing the state in regional energy planning, participating in the state's annual load forecast proceedings and reviewing procurement plans submitted by electric distribution companies. In collaboration with the state's electric utilities and stakeholders, CEAB identifies key issues

(procurement, demand management, renewable energy, environmental compliance, generation, and transmission) and develops processes to improve future energy planning cycles. Such improved planning will promote efficiency in energy procurement, generation and distribution, and thereby work to limit increases in emissions from electric generation that might otherwise occur.

Diesel Retrofit Program

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 of direct-$PM_{2.5}$ emissions, primarily in urban areas and locations with sensitive receptor populations such as schools. These retrofit projects implement the recommendations of Connecticut's Clean Diesel Plan, which was finalized in 2006 in response to a mandate of the Connecticut General Assembly.

Table 4-5. Diesel Retrofit Projects.

Project	City	Vehicles	Type of Technology	# of Retrofits or Vehicles Affected	Fuel Type	Status
Bridgeport Public Schools	Bridgeport	School Buses	DOC / DPF	112	ULSD	Complete
Hartford Public Schools	Hartford	School Buses	TBD	70	ULSD	Ongoing
New Haven School Department	New Haven	School Buses	DOC	181	ULSD	Complete
Newington Public Schools	Newington	School Buses	DPF	15	ULSD	Complete
Stamford Public Schools	Stamford	School Buses	DOC	53		Complete
Norwich Public Schools	Norwich	School Buses	DOC / DPF	42	ULSD	Complete
Fairfield Public Schools	Fairfield	School Buses	DOC	50	ULSD	Ongoing
Hamden Public Schools	Hamden	School Buses		25	ULSD	Complete
Hamden Public Schools	Hamden	School Buses		85	ULSD	
Regional School District 18	Lyme/Old Lyme	School Buses	DPF/DOC	20	ULSD	Ongoing
Mansfield Public Schools	Mansfield	School Buses		22		Grant expected 2008
Newtown Public Schools	Newtown	School Buses		60		Grant expected 2008
I-95 New Haven Harbor Q-Bridge Construction Initiative	New Haven	Construction Equipment	DOC	104	Highway diesel	Ongoing
I-95 New Haven Harbor Q-Bridge Construction Initiative	New Haven	Construction Equipment (Pilot Project)	DPF	2+2 (separate contracts)	ULSD	Ongoing
Yale University	New Haven	Shuttle Buses	N/A		electric/ULSD	Complete
Connecticut Transit - Stamford	Stamford	Transit Buses	DPF	31	ULSD	Complete
Connecticut Transit - Hartford	Hartford	Transit Buses	DPF	191	ULSD	May 2009 Completion
Connecticut Transit - New Haven Division	New Haven	Transit Buses	DPF	84	ULSD	May 2009 Completion
Electrified Truck Stop	North Stonington	Truck stops	Electrification technology	116 spaces		Completed 2007
Landfill Retrofits	Hartford	Recycling Trucks, Off-road equipment	TBD	27 Trucks 17 Off-Road Vehicles	TBD	Agreement signed February 2007
Expand Fueling Station	Fairfield	Cars, School Buses, Heavy Duty Vehicles	N/A		CNG	
CNG Trash Trucks	Trumbull	Trash Trucks	N/A	3	CNG	Complete

DOC: diesel oxidation catalyst; DPF: diesel particulate filter; ULSD: ultra-low sulfur diesel; CNG: compressed natural gas; TBD: to be determined.

School Bus Anti-Idling Program

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.

Transportation Control Measures

This section reviews transportation control measures (TCMs) in terms of their contribution to producing reductions in emissions of NOx, SOx and $PM_{2.5}$. This information was developed by the Connecticut Department of Transportation (CTDOT), which produces annual updates to the Statewide Transportation Improvement Program (STIP), documenting projects to be funded under federal transportation programs for a three-year period. Some examples of programs eligible for federal transportation funding include:

- Public transit improvements;
- Restriction of certain roads or lanes to, or construction of such roads or lanes for use by, passenger buses or high-occupancy vehicles (HOV);
- Employer-based transportation management plans, including incentives;
- Traffic flow improvements that reduce air emissions;
- Fringe and transportation corridor parking facilities serving multiple-occupancy vehicle programs or transit service;
- Increased high-occupancy, shared-ride services;
- Motor vehicle-free areas and times in metropolitan areas;
- Secure bicycle storage facilities and other facilities, including bicycle lanes; and
- Employer-sponsored flexible work schedules.

While none of the projects and activities identified here constitute RACM, as in the case of the stationary/area measures described in the previous section, these activities support Connecticut's conclusion that attainment of the annual $PM_{2.5}$ NAAQS will be maintained through the attainment deadline and beyond.

Significant TCMs completed in 2007 are identified in Table 4-6, and projects completed in years 2002 through 2006 are listed in Table 4-7. Both Tables 4-6 and 4-7 provide estimated emissions reductions for NOx and $PM_{2.5}$ [43] and total emissions reductions across projects (tons/day). In addition to all the projects included in Tables 4-6 and 4-7, there are numerous other TCMs that receive federal funding that will result in emission reductions but have yet to be quantified.

Reducing New Haven-New York City Traffic on the I-95 Corridor

The Connecticut Transportation Strategy Board (TSB) is charged with developing strategies to create a balanced, intermodal transportation system to provide for the efficient, cost effective movement of people and goods. Taking into account the goals of the Climate Change Action Plan, the Governor's Energy Vision and the Connecticut Clean Diesel Plan, the TSB has identified key transportation initiatives that integrate Connecticut air quality goals. One such

[43] VOC emissions reductions are provided for information only as CTDEP has not made a finding that VOC makes a significant contribution to ambient $PM_{2.5}$ in Connecticut.

Table 4-6. 2007 Emission Summary Report for Significant TCMs Completed*

State Project Number	Project Description	Geographic Area	Total Emission Benefit (kg/d)		
			VOC	NO_X	$PM_{2.5}$
TRANSIT					
Bus Improvements					
0170-T763	Purchase 7 diesel/electric hybrid buses. Assumption that 3 hybrids will operate in the NY/NJ/CT $PM_{2.5}$ non-attainment area is reflected in $PM_{2.5}$ benefit calculations.	Statewide	0.22	2.00	0.04
0171-0305	New Britain-Hartford busway that will serve 8 other towns: Berlin, Bristol, Farmington, Newington, Plainville, Southington, West Hartford, and Wethersfield. Project to be complete in 2011.	District 1	9.40	19.90	n/a
0301-0060	**New railroad station in Fairfield, potential access from I-95 and Route 1.**	Fairfield	7.69	6.95	0.21
Railroad Station Improvements					
0138-0226	Expand current railroad parking capacity by 400 additional spaces.	Stratford	8.38	7.57	0.23
0161-0136	Expand parking capacity.	Wilton	1.95	1.74	0.10
0310-0039	Construct station parking lot, 141 spaces.	Guilford	3.07	2.91	0.09
SHARED RIDE					
Main Regional Rideshare Program					
Various Projects	Programs to encourage van or carpooling. Projects include: 0170-2709, 0170-T714, 0170-2706, 0170-2708, 0170-TX15, 0170-2711, 0170-2707, and 0170-2710.	Statewide	897.39	737.22	7.34
TRAFFIC FLOW IMPROVEMENTS					
Signal System Upgrades					
0155-0160 0155-0161	Traffic signal adjustments and additions.	Statewide	2.73	2.73	n/a
Incident Management System Design & Construction					
0063-0563	Improve the Travel Information Gateway for managing traffic congestion on I-84.	Hartford	30.70	15.05	n/a
DEMAND MANAGEMENT					
Various Projects	Employee Commute Option program to include Telecommuting, Transportation Days and Travel Demand Management Offices (to promote carpooling, vanpooling and public transportation). Projects include: 0170-2713, 0170-2712, 0063-0634, 0092-0600, 0135-0296, 0015-0325, 0034-0326, 0094-0221, and 0151-0306.	Statewide	192.10	386.01	5.47
EXPERIMENTAL PILOT PROJECTS					
Alternate Fuel Vehicles					
0170-2734 0170-2735	Purchase of four alternate fuel vehicles.	Statewide	1.35	7.63	n/a
	TOTAL of all projects		**1154.98**	**1189.71**	**13.48**
	TOTAL (tons/day)		**1.24**	**1.31**	**0.01**

*** Summary table provided by CTDOT.**

Table 4-7. 2002 – 2006 Emission Summary Report for Significant TCMs Completed*

State Project Number	Project Description	Geographic Area	Total Emission Benefit (kg/d)			CMAQ Report Year
			VOC	NO_X	$PM_{2.5}$	
TRANSIT						
Rail Freight Facilities						
0092-0586	Advancement of the railroad track installation on Waterfront Street and associated utility relocations.	New Haven	0.46	18.44	0.16	2005-09
TRAFFIC FLOW IMPROVEMENTS						
Signal System Upgrades						
Various Projects	Upgrade signal control equipment to a closed loop system. Projects include: 0046-0120, 0048-0180, 0048-0181, 0063-0567, and 0128-0141	Statewide	4.58	4.58	n/a	2005-09
Various Projects	Upgrade signal control equipment to a closed loop system. Projects include: 0007-0178, 0033-0122, 0051-0255, 0051-0256, 0155-0153, 0155-0154, and 0155-0155		16.85	0.85	n/a	2002
Incident Management System Design & Construction						
0014-0170	Construct incident management system on I-95 from exit 56 vicinity to exit 64 vicinity.	Branford	6.11	3.00	0.00	2005-09
0131-0184	Construct incident management system on I-84 in Central Connecticut Region.	Southington	3.91	1.92	n/a	2005-09
0151-0278	Construct incident management system on I-84 in the Waterbury area.	Waterbury	1.03	0.50	0.001	2005-09
0151-0286	Construct incident management system on CT 8.	Waterbury	2.19	1.08	0.002	2005-09
0034-H044	Construct incident management system on I-84 in the Danbury area.	Danbury	6.00	0.18	n/a	2002
0092-0524	Construct incident management system on I-91 in New Haven from I-95 interchange to exit 8.	New Haven	1.70	0.05	n/a	2002
	TOTAL of all projects		**42.83**	**30.60**	**0.17**	
	TOTAL (tons/day)		**0.0472**	**0.0337**	**0.0002**	

*** Summary table provided by CTDOT.**

initiative focuses on reducing vehicle miles traveled between New Haven and New York City on Interstate 95 (I-95). A specific strategy TSB has developed is a Bridgeport to New York feeder barge service that would transport trucks and buses across the Long Island Sound, removing them from this congested section of I-95. More information is available in TSB's 2007 report and recommendations, entitled "Moving Forward: Connecticut's Transportation Strategy"

4.4.2 Federal Control Measures

Locomotives and Marine Diesel Engines

Effective July 7, 2008, EPA promulgated more stringent emission standards for locomotives and marine diesel engines.[44] This proposed rule will reduce emissions from these engines through a three-part program. The first part involves tightening emission standards for existing locomotives when they are remanufactured. These standards are effective as soon as certified remanufacture systems are available (as early as 2008). The new remanufacturing standards would not apply to the existing fleets of locomotives owned by very small railroads, such as those that comprise the bulk of the fleet in Connecticut

The second part includes setting near term engine-out (Tier 3) emission standards for new locomotives and marine diesel engines to be phased-in starting in 2009. The third part of the program entails setting longer-term (Tier 4) emission standards for newly built locomotives and marine diesel engines that reflect the application of high-efficiency emission control technology.

The Tier 4 emission standards would begin to be phased-in starting in 2014 for marine diesel engines and 2015 for locomotives (these standards are enabled due to the availability of diesel fuel capped at 15 ppm sulfur content in 2012). All new marine diesel engines with displacements less than 30 liters per cylinder (Category 1 and Category 2 engines greater than 50 hp) installed on U.S.-flagged vessels are covered in this rulemaking. This proposal also includes provisions to eliminate emissions from unnecessary locomotive idling as well as requesting comments to reduce emissions from existing marine diesel engines when they are remanufactured.

Spark-Ignition Engines

On May 18, 2007, EPA published a rule proposing exhaust emission standards for marine spark-ignition engines (more stringent than those finalized on October 4, 1996)[45] and small land-based non-road spark-ignition engines.[46] The proposed rule also includes new evaporative emission standards for equipment and vessels using these engines. The marine spark-ignition engines and vessels affected by these standards (effective starting with the 2009 model year) include outboard engines and personal watercraft, as well as sterndrive and inboard engines, which are being regulated for the first time.

The small non-road spark-ignition engines and equipment affected by these standards (effective starting with the 2011 and 2012 model years) are those rated below 25 hp (19 kW) used in

[44] 73 FR 37095, June 30, 2008.
[45] 61 FR 52088, October 4, 1996.
[46] 72 FR 28098, May 18, 2007.

household and commercial applications, including lawn and garden equipment, utility vehicles, generators, and a variety of other construction, farm, and industrial equipment.

4.5 Conclusion

Connecticut has implemented all emission control programs mandated by the 1990 CAA, many of which are RACM, and, which, in conjunction with federal requirements now in effect, provide emissions reductions that ensure continuous improvement in ambient $PM_{2.5}$ levels and expeditious attainment in the NY-NJ-CT area. As $PM_{2.5}$ NAAQS violations are not occurring in Connecticut's ambient air and as attainment is projected by 2010 for the NY-NJ-CT area, no additional RACM are available or necessary that will advance attainment in the area by one year.

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.

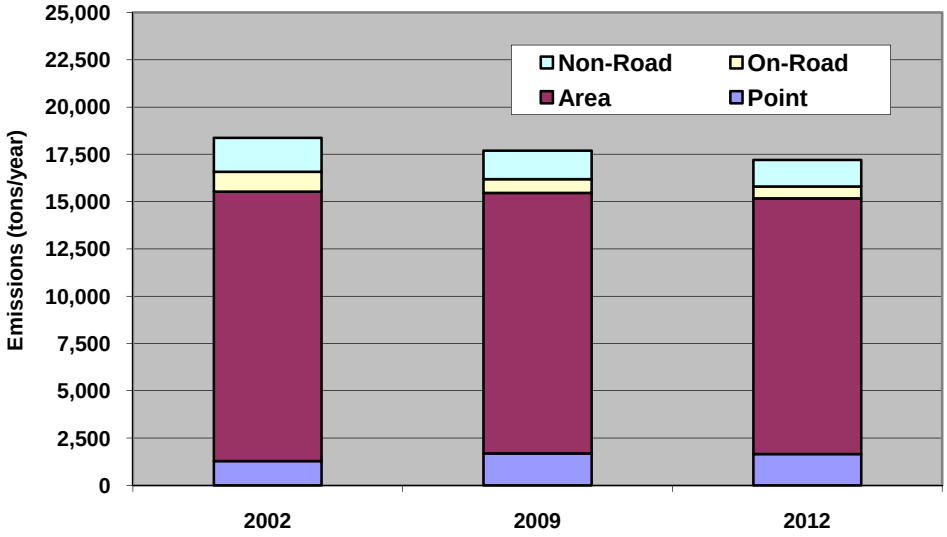
MOBILE6.2 (as imbedded in the SMOKE software) models were used to develop non-road and highway emission estimates, respectively, using state-specific input data representative of the future year. Appropriate temporal, spatial and speciation allocation profiles were applied to the resulting MANE-VU annual 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)



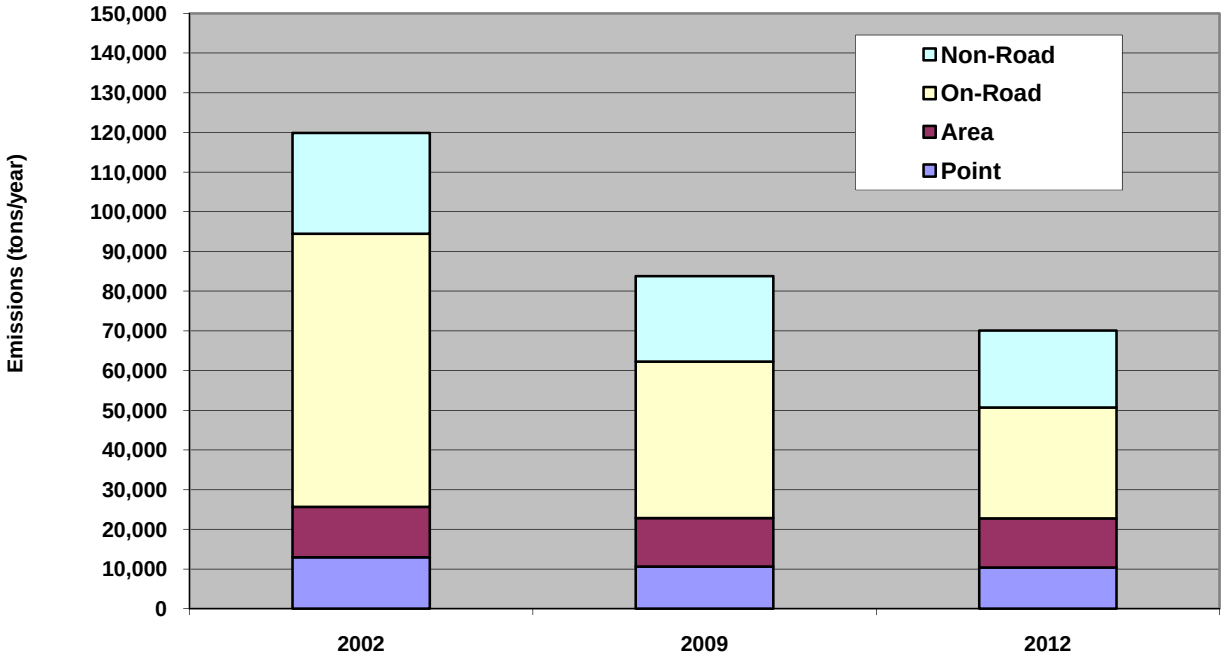
[6] Additional information regarding the MANE-VU future year inventories can be accessed at: http://www.marama.org/visibility/Inventory%20Summary/FutureEmissionsInventory.htm.

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

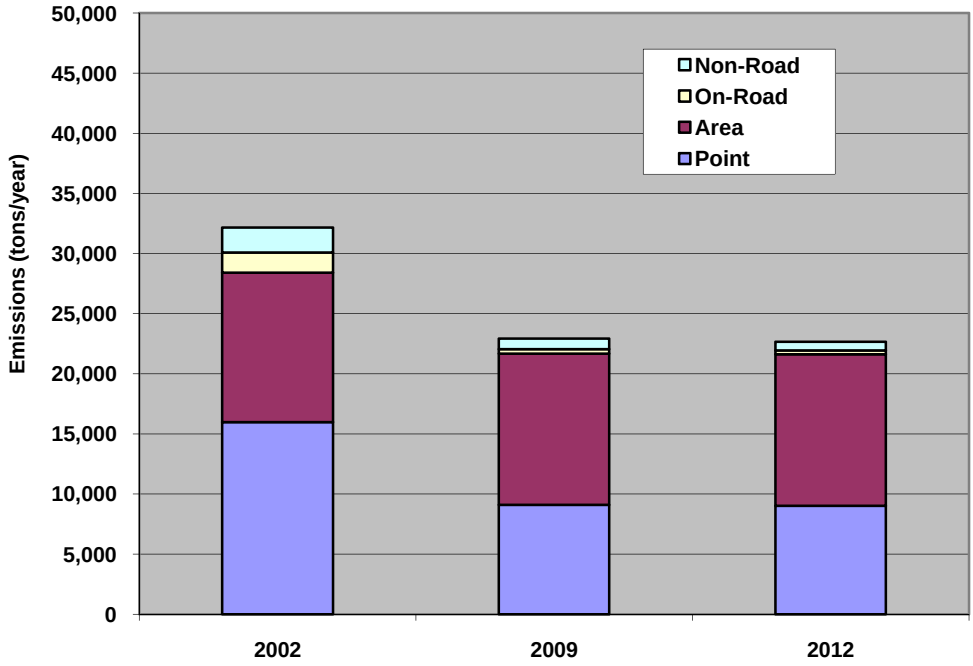


Total SO_2 emissions in Connecticut are projected to decrease by 29% between 2002 and 2009. Reductions are due to low sulfur fuels mandated for on-road vehicles and non-road equipment, as well as new sulfur emission limits for large industrial and electric generating facilities, as described in Section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

6.0 Reasonable Further Progress (RFP)

Section 172(c)(2) of the CAA and Section 51.1009 of the Implementation Rule requires SIPs to include control measures sufficient to meet applicable reasonable further progress (RFP) milestones. For $PM_{2.5}$ SIPs that demonstrate attainment will be achieved within five years of the date of designation (i.e., by April 2010), a separate RFP plan is not required because EPA considers the emission reduction measures in the attainment demonstration to be sufficient to meet the RFP requirement.[1] As shown in Chapter 8 of this document, CTDEP projects attainment will occur in the NY-NJ-CT area by the April 2010 deadline; therefore, RFP requirements have been satisfied.

[1] 72 Fed. Reg. 20633 (April 25, 2007).

7.0 Transportation Conformity Process and Motor Vehicle Emission Budgets

Transportation conformity is a CAA requirement that serves as a bridge to connect air quality and transportation planning activities. Transportation conformity is required under the CAA to ensure that highway and transit project activities receiving federal funds are consistent with ("conform to") the purpose of the SIP. Conformity to a SIP is achieved if transportation programs or transit project activities do not cause or contribute to any new air quality violations, do not worsen existing violations, and do not delay timely attainment of the relevant NAAQS.

Transportation conformity currently applies to areas that are designated nonattainment for the following transportation-related criteria pollutants: ozone, particulate matter ($PM_{2.5}$ and PM_{10}), carbon monoxide (CO), and nitrogen oxides (NO_X). Transportation conformity also applies to "maintenance areas," *i.e.*, areas that have been redesignated to attainment after 1990. Figure 7.1 is a flowchart depicting the transportation conformity process and how the elements of a conformity determination interact.

7.1 Overview of Transportation Conformity

Transportation conformity addresses air pollution from on-road mobile sources such as cars, trucks, motorcycles, and buses. There are also significant emissions from off-road mobile sources, area sources, and stationary sources that are not addressed by transportation conformity. Transportation conformity budgets are developed by the lead air quality agency (e.g., CTDEP) as part of the attainment planning process, with a goal of ensuring that emissions from the transportation sector are balanced with those from the other source sectors such that NAAQS attainment and maintenance requirements are met in a timely fashion.

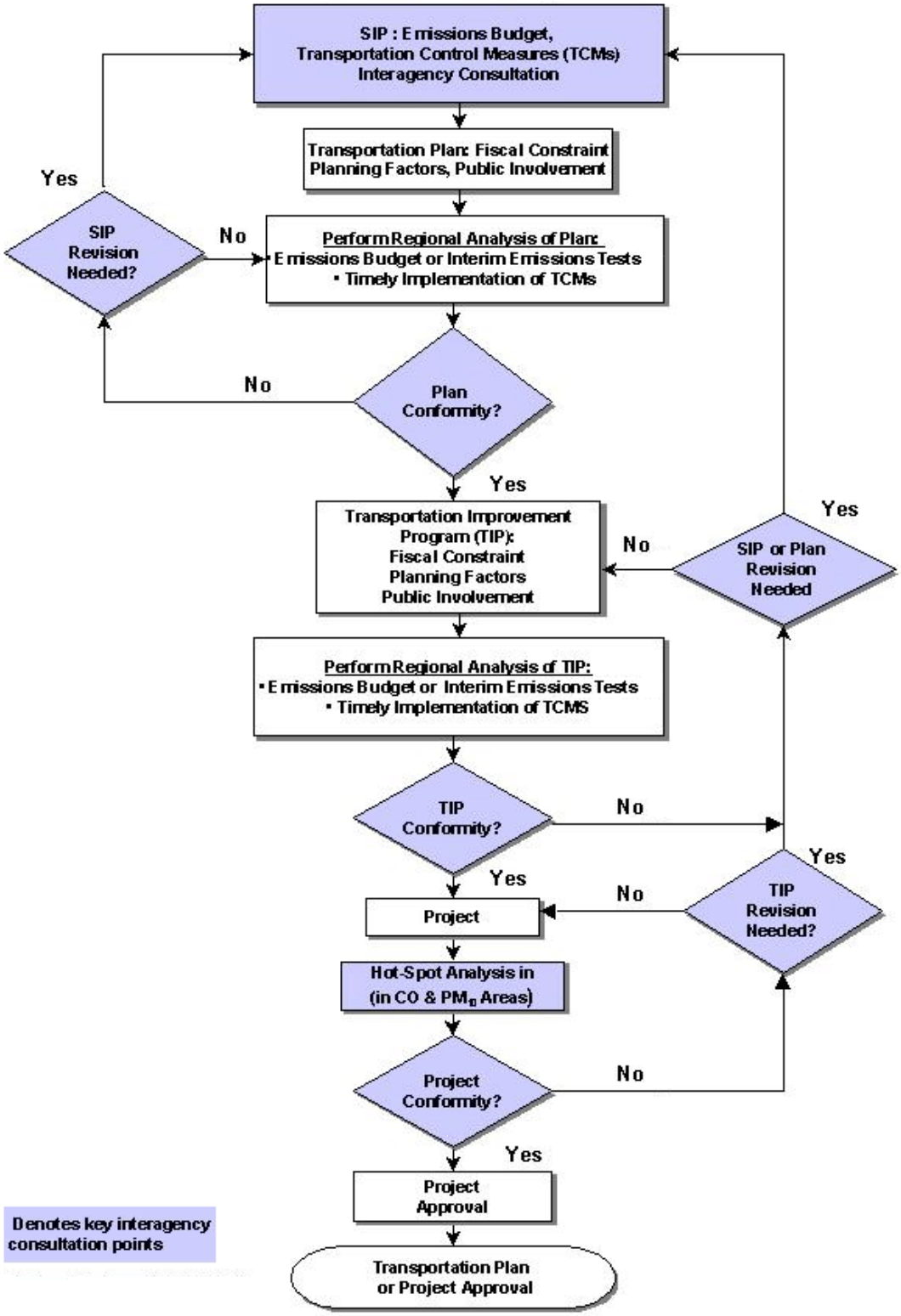
The State of Connecticut Department of Transportation (CTDOT) and the metropolitan planning organizations (MPOs) in Connecticut must demonstrate conformity with transportation conformity budgets for all transportation plans and transportation improvement programs (TIPs), including any federally supported highway and transit projects.

Conformity determinations are developed by CTDOT and the MPOs in consultation with CTDEP and EPA. The Federal Transit Administration (FTA) and the Federal Highway Administration (FHWA) agencies of the United States Department of Transportation (US DOT) review the CTDOT/MPOs submittals and make a conformity determination. It is customary that EPA's regional office provides US DOT with a letter of comment regarding the Connecticut air quality conformity report submittal.

Conformity determinations consist of the following components:

- Regional emissions analysis;
- Transportation modeling requirements;
- Latest planning assumptions and emissions model;
- Timely implementation of transportation control measures (TCMs);
- Interagency consultation;
- Public participation (consistent with US DOT regulations); and
- Fiscal constraint (consistent with US DOT regulations).

Figure 7-1. Transportation Conformity Process[1]



[1] Source: Federal Highway Administration, http://www.fhwa.dot.gov/environment/conformity/ref_guid/sectiona.htm

The regional emissions analysis is the primary component, which incorporates either a "budget" test for areas or states with approved SIP budgets, or an interim emissions test for areas with no adequate or approved SIP budgets. Budgets are developed using various transportation and emissions models. Local modeling inputs are cooperatively developed by CTDEP and CTDOT, using EPA recommended methods where applicable. Generally, CTDOT's estimated air emissions from transportation plans and TIPs must not exceed transportation conformity budgets established by the CTDEP's Bureau of Air Management as part of the SIP development process.

7.2 Requirements

The federal CAA and federal transportation reauthorization legislation passed in the 1990s established an interrelationship of clean air and transportation planning. In order to receive federal transportation funds, CTDOT and the MPOs in Connecticut must cooperatively work to develop and endorse an Air Quality Conformity Statement, which certifies to the federal government that the Statewide Transportation Improvement Program (STIP), which incorporates all TIPs, conforms to the requirements of the CAA.

On August 15, 1997, EPA published the Final Conformity Rule.[2] Subsequently, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)[3] revised the CAA conformity SIP requirements in order to use state and local resources more efficiently.

CTDOT regularly updates the STIP in accordance with the terms and provisions of SAFETEA-LU and the CAA and all regulations[4] issued pursuant thereto. As part of the STIP development process, CTDOT and the MPO's conduct air quality assessments and prepare conformity reports. EPA, CTDEP, and other stakeholders have the opportunity to evaluate the STIP and conformity report prior to the determination of conformity by the US DOT.

7.3 Initial $PM_{2.5}$ Conformity Determinations

$PM_{2.5}$ nonattainment areas were required to initially address transportation conformity requirements by April 2006. In accordance with the conformity regulations[5] and guidance, nonattainment areas were provided a choice of interim tests that could be used to demonstrate conformity of transportation plans during the period prior to the establishment of transportation conformity budgets that are required as part of the $PM_{2.5}$ attainment demonstration. Alternative interim tests include:

(1) Demonstrating that planned build scenarios for key years of transportation plans do not result in increased emissions when compared to the corresponding no-build scenario for each year;
(2) Comparing area wide on-road emission estimates for key years in transportation plans to the 2002 base year emission levels to ensure transportation plans do not increase emissions; or

[2] 62 FR 43780.
[3] PL 109-59, August 10, 2005; (Section 6011).
[4] 70 FR 71950, Nov. 30, 2005.
[5] 69 FR 40028; July 1, 2004.

(3) Establishing state and/or local "early" conformity budgets at a level consistent with progress toward attainment and demonstrating that transportation plans do not exceed those budgets.

In April 2006, affected transportation and air quality agencies in the NY-NJ-CT $PM_{2.5}$ nonattainment area met the initial one year deadline for demonstrating conformity through a complex multi-state interagency consultation process that showed future year transportation-related emissions throughout the area would not exceed base year emission levels from 2002 using the second alternative interim test. The States of New Jersey and Connecticut subsequently proposed local early conformity budgets that were approved by EPA in July 2006 and August 2007,[6] respectively, for use in each state's future conformity determinations. The early budgets, set at emission levels below those of the base year (i.e., 2002), provide assurance of continued progress toward attainment during the period when the $PM_{2.5}$ attainment demonstration is being developed and undergoing review by EPA.

7.4. Transportation Conformity Budgets

As noted above, CTDEP proposed early $PM_{2.5}$ transportation conformity budgets in April 2007 that were determined by EPA in June 2007 to be adequate for transportation conformity purposes and fully approved by EPA in August 2007. Budgets were established for direct $PM_{2.5}$ emissions and for NOx, a $PM_{2.5}$ precursor pollutant, for the required attainment year of 2009. The 2009 budgets, which are summarized in Table 7-1, represent on-road emissions in the Connecticut portion of the NY-NJ-CT $PM_{2.5}$ nonattainment area (i.e., Fairfield and New Haven Counties).

Table 7-1. 2009 Transportation Conformity Budgets for the Connecticut Portion of the NY-NJ-CT $PM_{2.5}$ Nonattainment Area[7]

Annual Direct $PM_{2.5}$ Emissions (tons per year)	Annual NOx Emissions (tons per year)
360	18,279

The 2009 budgets were determined using EPA's MOBILE6.2 emissions model, as documented in a technical support document (TSD) included with the April 2007 early budget SIP submittal. The early budget TSD is included here as Appendix 7A. Vehicle activity levels (e.g., speed, vehicle miles traveled) are based on CTDOT's Series 28 travel model runs.

The early $PM_{2.5}$ budgets account for the effects of the $PM_{2.5}$ mobile source control programs that were discussed previously in Section 5.2.1 and are included in the attainment demonstration modeling. Based on analyses of precursor emissions and $PM_{2.5}$ speciation data (see Section 3 and 5), CTDEP has concluded that NOx is the only precursor species from on-road motor vehicles that warrants consideration as a potential significant contributor to peak $PM_{2.5}$ levels in the nonattainment area. Re-entrained road dust and highway/transit construction dust in Connecticut are judged to be insignificant contributors, especially since violating levels of annual $PM_{2.5}$ in the nonattainment area have only been measured in New York City and northern

[6] The August 30, 2007 Federal Register (72 FR 50059) included EPA's direct final approval of Connecticut's early conformity budgets. The rulemaking became effective on October 29, 2007.
[7] Connecticut's portion of the nonattainment area is comprised of Fairfield and New Haven Counties.

New Jersey. As a result, CTDEP has determined that the previously approved early $PM_{2.5}$ budgets, which include all of the mobile source control strategies incorporated into the CMAQ modeling exercise, should be retained as part of the $PM_{2.5}$ attainment demonstration SIP.

8.0 Attainment Demonstration and Weight of Evidence

The southwestern Connecticut counties of Fairfield and Middlesex are included by the EPA in a $PM_{2.5}$ nonattainment area encompassing the New York City metropolitan area, which also comprises 10 downstate New York counties and 10 northern New Jersey counties. This multi-state area is classified by EPA as nonattainment for the 1997 annual $PM_{2.5}$ NAAQS based on measured violations in the New York and New Jersey portions of the nonattainment area. All Connecticut monitors are in compliance with the annual $PM_{2.5}$ NAAQS.

States with nonattainment areas are required to submit a SIP revision demonstrating that adopted control programs are sufficient to achieve attainment no later than April 2010. EPA modeling guidance[1] suggests the use of a photochemical grid model and appropriate weight-of-evidence (WOE) analyses to demonstrate attainment of the $PM_{2.5}$ NAAQS.

Sections 8.1 through 8.5 of this document describe the procedures, inputs and results of the regional photochemical grid modeling exercise. Section 8.6 describes various WOE analyses used as supplements to the modeling results to assess the likelihood of achieving timely attainment of the $PM_{2.5}$ NAAQS in the multi-state nonattainment area.

CTDEP's primary conclusions based on the results of the photochemical modeling and WOE analyses are:

1) There is a high level of probability that the New York-New Jersey-Connecticut area will achieve attainment of the 1997 annual $PM_{2.5}$ NAAQS by the end of the 2009; and
2) Adopted emission control programs will result in continued reductions in emissions of $PM_{2.5}$-contributing pollutants through 2012 and beyond, providing confidence that compliance with the annual NAAQS will continue once attainment is achieved.

8.1 Objective and Background of the Photochemical Modeling

The objective of the regional photochemical modeling study is to enable states to analyze the efficacy of various control strategies, and to demonstrate that the measures adopted as part of the SIP will result in attainment of the annual $PM_{2.5}$ standard by the April 2010 deadline. As described below, the modeling exercise provided estimates of the relative improvements in air quality anticipated between 2002 and 2009, based on hourly simulations of meteorology, emissions, atmospheric chemistry and transformations, while accounting for the effects of expected growth in source activity and new emission controls implemented between the two years.

The photochemical model selected for the attainment modeling demonstration was the EPA's Models-3/Community Multi-scale Air Quality (CMAQ) modeling system. The CMAQ modeling system was selected for the attainment demonstration primarily because it is a photochemical grid model capable of modeling a variety of pollutants over a range of time and space scales, i.e. a "one-atmosphere" photochemical grid model. Not only was CMAQ used to model the components (i.e., primary and secondary) that make up particles with an aerodynamic

[1] Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Analysis Division, Air Quality Modeling Group, Research Triangle Park, NC, EPA-454/B-07-002, April 2007.

diameter less than or equal to a nominal 2.5 micrometers ($PM_{2.5}$), but it also was used to model ozone formation and regional haze in the northeast states. All of the regional modeling was conducted in accordance with the EPA's modeling guidance.[2]

Under the direction of the Ozone Transport Commission's (OTC) Modeling Committee, several states and modeling centers performed the regional modeling runs and/or contributed to the preparation of technical information for the regional modeling effort. Those organizations included the:

1) New York State Department of Environmental Conservation (NYSDEC),
2) Ozone Research Center at University of Medicine & Dentistry of NJ/Rutgers University (UMDNJ/ORC),
3) University of Maryland (UMD),
4) Virginia Department of Environmental Quality,
5) Northeast States for Coordinated Air Use Management (NESCAUM)
6) Maryland Department of the Environment,
7) New Hampshire Department of Environmental Services, and
8) Mid-Atlantic Regional Air Management Agency (MARAMA).

The lead agency for coordinating the running of the CMAQ model and performing the modeling runs for the OTC was the NYSDEC. The NYSDEC ran the CMAQ model (using the protocol in Appendix 8A) for the May 1 through September 30 ozone season, which was supplemented by modeling runs performed by the UMDNJ/ORC (March and April), NESCAUM (October, November, December), and the University of Maryland (January, February) for the purposes of determining $PM_{2.5}$ attainment. The four regional modeling centers were, therefore, able to model an entire year of meteorology and emissions. The NYSDEC was responsible for post-processing the results for the NY-NJ-CT nonattainment area, including calculating the projected $PM_{2.5}$ concentrations using the relative response factor (RRF) method specified in the EPA's modeling guidance.[3]

The CMAQ modeling system was installed at all participating modeling centers and diagnostic tests were run to insure that the model was operating as designed. In addition, the CMAQ model was benchmarked against other modeling platforms to ensure similar results. The OTC modeling committee oversaw the modeling effort and reported to the OTC Oversight Committee. The CTDEP participated as a member of the various OTC committees.

8.2 Modeling Platform and Configuration

As described above, the CMAQ modeling platform was selected for use in the attainment demonstration. The CMAQ modeling system requires user specifications regarding the modeling platform, as well as meteorological, air quality and emissions input information. The CMAQ system configuration is documented in Appendix 8B, and described below. Additional documentation regarding modeling procedures are provided in Appendix 8D (TSD-2c).

[2] Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Analysis Division, Air Quality Modeling Group, Research Triangle Park, NC, EPA-454/B-07-002, April 2007.

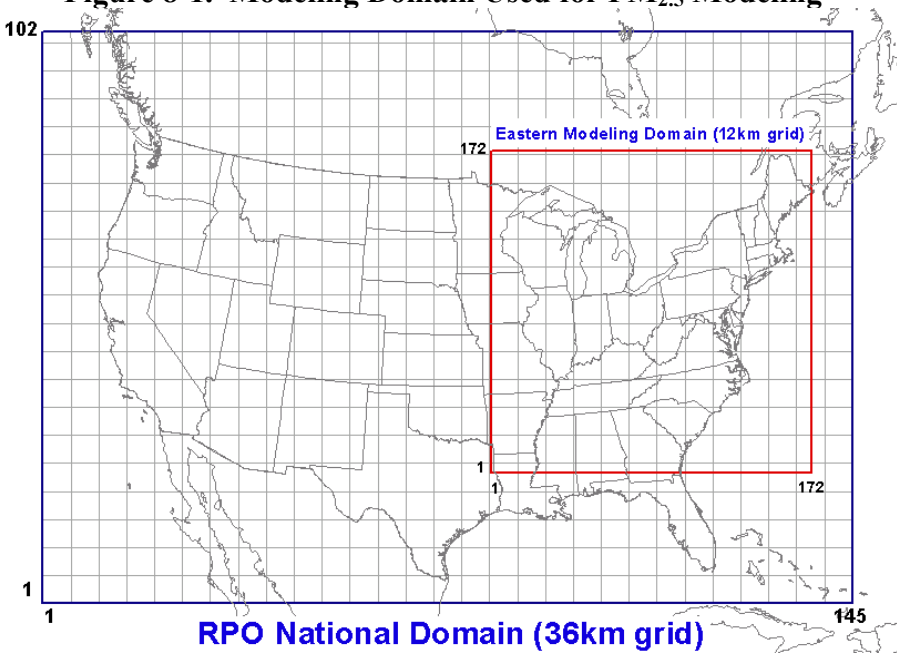
[3] Ibid.

8.2.1 Modeling Domain

When defining the modeling domain, the following parameters should all be considered: location of local urban areas; downwind extent of elevated ozone levels; location of large emission sources; availability of meteorological and air quality data; and available computer resources. In addition to the nonattainment areas of concern, the modeling domain should encompass enough of the surrounding area such that major upwind sources fall within the domain and emissions produced in the nonattainment areas remain within the domain throughout the day.

The areal extent of the OTR modeling domain (see Figure 8-1) is identical to the national grid adopted by the regional haze Regional Planning Organizations (RPOs), with a more refined "eastern modeling domain" focused on the eastern US and southeastern Canada. The placement of the eastern modeling domain was selected such that the northeastern areas of Maine are included. Based upon the existing computer resources, the southern and western boundaries of the imbedded region were limited to the area shown in Figure 8-1.

Figure 8-1. Modeling Domain Used for $PM_{2.5}$ Modeling



8.2.2 Meteorological Model Selection and Configuration

As explained in EPA's Emission Inventory Guidance,[4] 2002 was designated as the base year for 8-hour ozone SIPs, $PM_{2.5}$ SIPs, and regional haze plans; therefore, 2002 was used for baseline modeling for the $PM_{2.5}$ standard. The Pennsylvania State University/National Center for Atmospheric Research Mesoscale Meteorological Model (MM5) version 3.6 was used to generate the annual 2002 meteorology for the modeling analysis. MM5 is a non-hydrostatic,

[4] USEPA. Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations. United States Environmental Protection Agency, Emissions Inventory Group, Emissions, Monitoring, and Analysis Division, Office of Air Quality Planning and Standards, Research Triangle Park, NC, EPA-454/R-05-001, August 2005, updated November 2005.

prognostic meteorological model routinely used for urban-scale and regional-scale photochemical regulatory modeling studies. Based on model validation and sensitivity testing, the MM5 configurations provided in Appendix 8C were selected. Descriptions of the MM5 modeling process and the results of the model performance evaluation are provided in Appendix 8D (TSD-1).

8.2.3 Horizontal Grid Size

The basic CMAQ modeling platform utilized a two-way nested domain consisting of a coarse 36-km horizontal grid resolution for the continental United States domain and a fine 12-km grid over the eastern United States. A slightly larger domain was selected for the MM5 meteorological model simulations to provide a buffer of several grid cells around each boundary of the CMAQ 36-km domain. This was designed to minimize any errors in the meteorology from boundary effects. A 12-km inner domain was selected to better characterize air quality in the Ozone Transport Region and surrounding Regional Planning Organization regions. The horizontal grid definitions for the CMAQ and MM5 modeling domains are contained in Appendix 8E.

8.2.4 Vertical Resolution

The vertical structure of the air quality model is primarily defined by the vertical grid used in the meteorological modeling, which used a terrain-following coordinate system defined by pressure to create a total of 29 layers. The layer-averaging scheme adopted for the air quality modeling is designed to reduce the computational cost of the simulations, resulting in incorporation of 22 layers in the vertical, of which the lower 16 layers (approximately 3 km) coincide with those of the meteorological model. This ensures that the near-surface processes that affect air pollution the most are represented realistically in CMAQ, while the meteorological systems that are driven by upper level winds are allowed to develop properly in the MM5 model. Layer averaging has a relatively minor effect on the model performance metrics when compared to ambient monitoring data. Appendix 8E contains the vertical layer definitions for the meteorological and air quality modeling domains.

8.2.5 Initial and Boundary Conditions

The objective of a photochemical grid model is to estimate the air quality given a set of meteorological and emissions conditions. When initializing a modeling simulation, the exact concentration fields are unknown in every grid cell for the start time. Therefore, photochemical grid models are typically started with clean conditions within the domain and allowed to stabilize before the period of interest is simulated. In practice this is accomplished by starting the model several days prior to the period of interest; this is called ramp-up time.

The winds move pollutants into, within, and out of the domain. Although the model handles the movement of pollutants within the domain and out of the domain, estimates of the quantity of pollutants moving into the domain is needed. These are called boundary conditions. To estimate the boundary conditions for the modeling study, boundary conditions for the outer 36-km domain were derived from an annual model run performed by researchers at Harvard University using the GEOS-Chem global chemistry transport model.[5,6]

[5] Moo, N. and Byun, D. A Simple User's Guide For "geos2cmaq" Code: Linking CMAQ with GEOS-CHEM. Version 1.0. Institute for Multidimensional Air Quality Studies (IMAQS). University of Houston, 2004.

The influence of initial conditions was minimized by using a 15-day ramp-up period, which is sufficient to establish pollutant levels typically encountered in the eastern United States. Additionally, the predominant winds flow is from west to east; thus Connecticut is not influenced by nearby boundary conditions because the upwind boundary of the modeling domain is west of the Mississippi River.

8.2.6 Episode Selection

The entire 2002 base case and 2009 future case years were simulated with 2002 meteorological conditions for $PM_{2.5}$ modeling. This complete year of modeling provides a more robust analysis of the seasonal variations in $PM_{2.5}$ levels due to secondary aerosol formation, an important pathway to understanding the transport of particulate matter from out-of-state sources.

8.2.7 Emissions Inventory Development and Processing

Significant regional coordination was required to assemble the emission inventories needed to produce the emission data fields required for the modeling analysis. Recognizing the need for developing multipollutant inventories across many states to support fine-particulate, ozone and regional haze SIP modeling requirements, the Northeast and Mid-Atlantic states agreed to combine efforts under the MANE-VU RPO umbrella to compile base year and future year emission estimates for all required pollutants into a common format. MARAMA, OTC and NESCAUM joined the states in the inventory development effort.

Modeling inventories for the MANE-VU region were prepared, with the assistance of contractors, for the 2002 base year and the projection years of 2009, 2012 and 2018. The base year inventory was compiled using 2002 inventory estimates provided by the states. Projection year inventories account for any expected changes in economic activity as well the implementation of control strategies occurring after 2002. Inventories for adjacent areas outside the MANE-VU region were obtained from the corresponding RPOs.

Section 5 provides information regarding the development of the MANE-VU inventories. Included are tables and figures summarizing annual emission estimates of $PM_{2.5}$-contributing pollutants from Connecticut sources for 2002, 2009 and 2012. Section 4 and Section 5 provide descriptions of control strategies simulated in the CMAQ modeling effort. More detailed descriptions of the inventory development process are provided in Appendices 5A through 5D, and Appendix 8D (TSD-4).

Version 2.1 of the Sparse Matrix Operator Kernel Emissions (SMOKE) Processing System was selected to convert MANE-VU annual county emission estimates for each year into CMAQ-ready modeling inputs. The SMOKE model contains routines that apply pollutant speciation profiles and allocate annual county-level emissions from the regional inventory to CMAQ model grid cells on an hourly basis. The MANE-VU inventories were processed by the NYSDEC, Virginia Department of Environmental Quality and NESCAUM. Descriptions of the SMOKE processing are included in Appendices 8D (TSD-2a and 2b), 8F and 8G.

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[6] Baker, K. Model Performance for Ozone in the Upper Midwest over 3 Summers. Presentation given at the Lake Michigan Air Directors Consortium, 2005 AWMA Annual Conference, Minneapolis, MN, June 24, 2005.

8.2.8 Quality Assurance

All air quality, emissions, and meteorological data for the MANE-VU region were reviewed to ensure completeness, accuracy, and consistency before proceeding with modeling. Any errors, missing data or inconsistencies were addressed using appropriate methods that are consistent with standard practices. All modeling was benchmarked at each of the OTC modeling centers through the duplication of a set of standard modeling results.

Quality assurance activities were carried out for the various emissions, meteorological, and photochemical modeling components of the modeling study. Emissions inventories obtained from the RPOs were examined to check for errors in the emissions estimates. When such errors were discovered, the problems in the input data files were corrected.

The MM5 meteorological and CMAQ air quality model inputs and outputs were plotted and examined to ensure sufficiently accurate representation of the observed data in the model-ready fields, and temporal and spatial consistency and reasonableness. Both MM5 and CMAQ underwent operational and scientific evaluations in order to facilitate the quality assurance review of the meteorological and air quality modeling procedures.

8.3 Model Performance Evaluation[7]

An important first step in the modeling process is to verify the model's performance in terms of its ability to predict $PM_{2.5}$ and its individual components (i.e., sulfate, nitrate, ammonium, organic carbon, elemental carbon and other constituents) in the right locations and concentrations. To do this, model predictions for the base year simulation are compared to corresponding measured ambient data. This verification is accomplished through a combination of statistical and graphical evaluations. If the model appears to be producing $PM_{2.5}$ in the right locations for the right reasons, then the model can be used with greater confidence as a predictive tool to evaluate various control strategies and their effects on future $PM_{2.5}$ levels. The following subsections describe a performance evaluation conducted for the CMAQ modeling system used to project future $PM_{2.5}$ levels in the Northeast.

8.3.1 Overview

The results of a model performance evaluation were examined prior to commencing modeling in support of the attainment demonstration. EPA has included general recommendations for conducting model performance evaluations in recent modeling guidance.[8] The NYSDEC, Division of Air Resources, conducted a performance evaluation of the 2002 base case CMAQ simulation on behalf of the Ozone Transport Region member States. The performance of CMAQ was evaluated using both operational and diagnostic methods. Operational evaluation refers to the model's ability to replicate observed concentrations of particulate matter and/or its precursors (surface and aloft), whereas diagnostic evaluation assesses the model's accuracy with respect to characterizing the sensitivity of particulate formation to changes in emissions (i.e.,

[7] The following CMAQ model performance discussion is paraphrased from the draft Maryland $PM_{2.5}$ SIP, as posted at http://www.mde.state.md.us/assets/document/Air/BNAA_3-24-08/BNAA_PM_SIP.pdf (Section 9.3).

[8] "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze"; EPA-454/B-07-002; April 2007; http://www.epa.gov/scram001/guidance/guide/final-03-pm-rh-guidance.pdf.

relative response factors). Appendix 8-H provides comprehensive operational and diagnostic evaluation results. Highlights of this evaluation are provided in Section 8.3.2.

8.3.2 Diagnostic and Operational Evaluation

The issue of model performance goals for $PM_{2.5}$ is an area of ongoing research and debate. To evaluate model performance, EPA recommends that several statistical metrics be developed for air quality modeling. Performance goals refer to targets that a good performing model should achieve, whereas performance benchmarks are based on historical model performance measures for the best performing simulations. Performance goals are necessary in order to provide consistency in model applications and expectations across the country and to provide standardization in how much weight may be accorded to modeling study results in the decision-making process.

When EPA's guidance was first developed nearly four (4) years ago, an interim set of fine particulate modeling performance goals were suggested for aggregated mean normalized gross error (MNGE) and mean normalized bias (MNB) as defined in Table 8-1. The MNGE parameter provides an overall assessment of model performance and can be interpreted as precision. The MNB parameter measures a model's ability to reproduce observed spatial and temporal patterns and can be interpreted as accuracy.

Table 8-1. Interim EPA $PM_{2.5}$ Modeling Performance Goals

Pollutant	Gross Error	Normalized Bias
$PM_{2.5}$	~ +30 - +50%	~ +10%
Sulfate	~ +30 - +50%	~ -20 - -30%
Nitrate	~ +20 - +70%	~ -15 - +50%
EC	~ +15 - +60%	NA
OC	~ -40 - +50%	~ +38%

Because regional-scale $PM_{2.5}$ modeling is an evolving science, and considerable practical application and performance testing has transpired in the intervening years since these goals were postulated, they are considered as general guidelines.

It may also be possible to adopt levels of model performance goals for mean fractional bias (MFB) and mean fractional gross error (MFGE) as listed in Table 8-2 (developed by the VISTAS RPO) to help evaluate model performance.[9]

[9] For an explanation of these statistical parameters, see Section 18.4.2 of "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze"; EPA-454/B-07-002; April 2007; http://www.epa.gov/scram001/guidance/guide/final-03-pm-rh-guidance.pdf.

Table 8-2. VISTAS RPO $PM_{2.5}$ Modeling Performance Goals

Fractional Error	Fractional Bias	Comment
≤35%	≤±15%	Ozone model performance goal for which $PM_{2.5}$ model performance would be considered good.
≤50%	≤±30%	A level of model performance that we would hope each $PM_{2.5}$ species could meet.
≤75%	≤±60%	At or above this level of performance indicates fundamental problems with the modeling system.

The above performance goals are considered to be reasonable methods for assessing model performance; therefore, they are being used to frame and put the $PM_{2.5}$ model performance into context and to facilitate model performance across episodes, species, models and sensitivity tests.

As noted in EPA's $PM_{2.5}$ modeling guidance,[10] less abundant $PM_{2.5}$ species should have less stringent performance goals. Accordingly, performance goals that are a continuous function of average observed concentrations, such as those proposed by Dr. James Boylan at the Georgia Department of Natural Resources, may be appropriate:

- Asymptotically approaching proposed performance goals or criteria when the mean of the observed concentrations are greater than 2.5 ug/m^3.
- Approaching 200% error and ±200% bias when the mean of the observed concentrations are extremely small.

The preceding goals and criteria are not regarded as a pass/fail test, but rather as a basis of inter-comparing model performance across studies, sensitivity tests and models.

The OTC model performance evaluation was initially conducted by NYSDEC using the 2002 summer ozone season data only. The Virginia Department of Environmental Quality extended the evaluation to include observations from the entire year of 2002. Four statistical parameters, two suggested by EPA (Table 8-1) and two adopted by the VISTAS RPO (Table 8-2), were computed for FRM $PM_{2.5}$ mass and for individual species of SO_4, NO_3, NH_4, EC, OM (1.8* blank-corrected OC), soil or crustal material (sum of oxides of Ca, Fe, Si, and Ti). The statistics were organized into two categories: a) by date and b) by site.

For statistics by date, the parameters were calculated on a given day for any valid pairs of observed/predicted data across all FRM and speciation monitors that fall within the OTR modeling domain plus all Virginia monitors (referred to as OTR+). Data collected from three different monitoring networks, FRM, STN, and IMPROVE, were used in the statistics. Note that predicted data used for the model performance evaluation were extracted from CMAQ outputs at the exact grid cells where monitors are located. This is in contrast to the modeled design value calculations where predictions are based on the average of the surrounding nine grid cells.

[10] Ibid.

For statistics by site, parameters were computed at a given FRM, STN, or IMPROVE monitor for any valid pairs of observed/predicted data over a period of the entire 2002 calendar year, except for the dates between July 6 and July 9 due to the exceptional event caused by the Quebec forest fires.

Figure 8-2 depicts the location of the FRM, STN and IMPROVE monitor locations used for the model evaluation across the OTR+ region.

A composite FRM time series across the OTR+ region (264 monitors) is provided in Figure 8-3. This figure indicates that there is an overall mean bias of approximately 4 $\mu g/m^3$. There is a general over-prediction during the winter months and an under-prediction during the summer months. There is excellent agreement during a mid-August poor air quality episode.

Figure 8-2. Locations Used for the Model Evaluation Across the OTR+ Region FRM (●, 264 sites), STN (■, 50 sites), AND IMPROVE (▲, 21 sites)

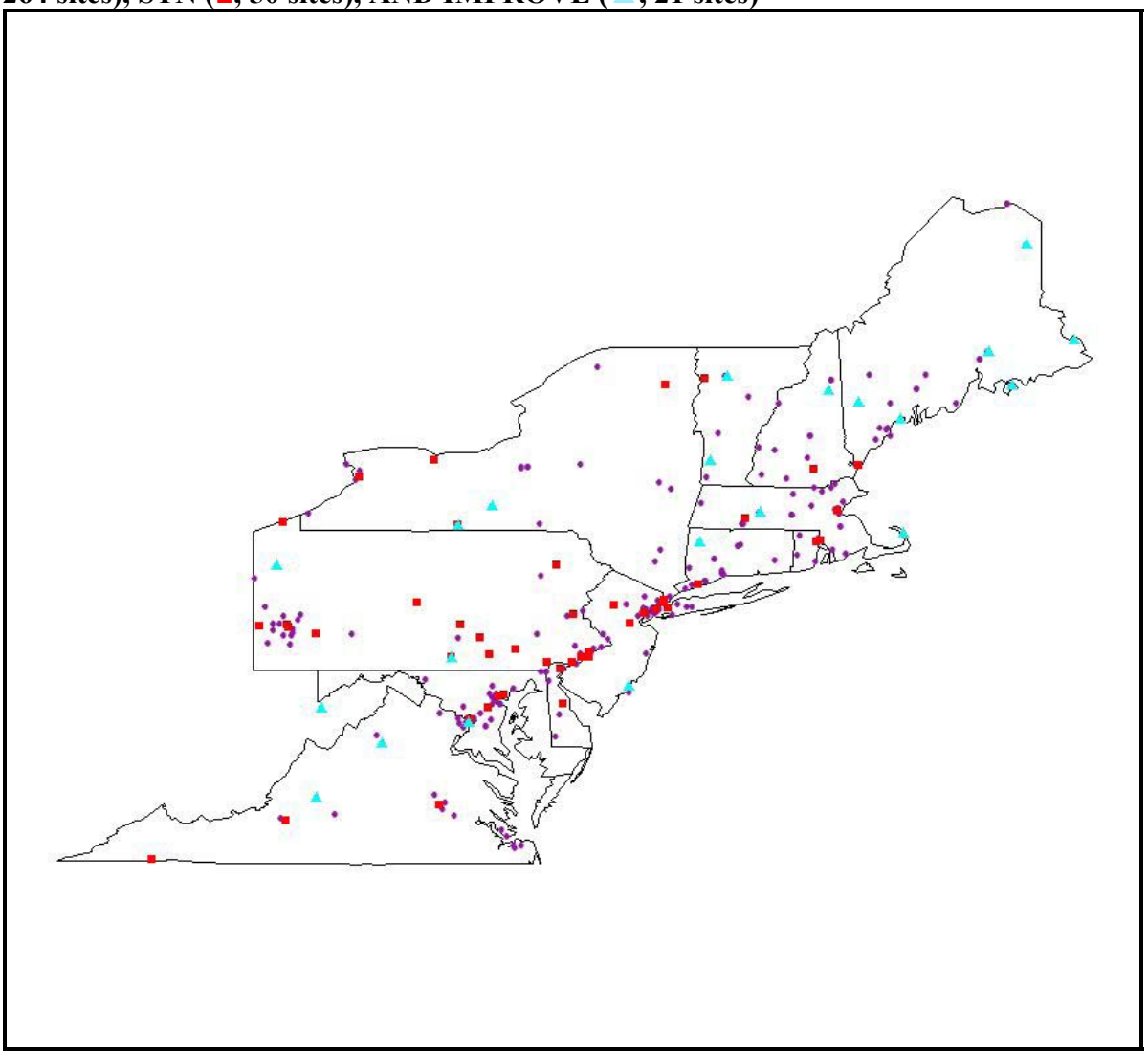


Figure 8-3. Composite FRM Time Series Across the OTR+ Region (264 Monitors)

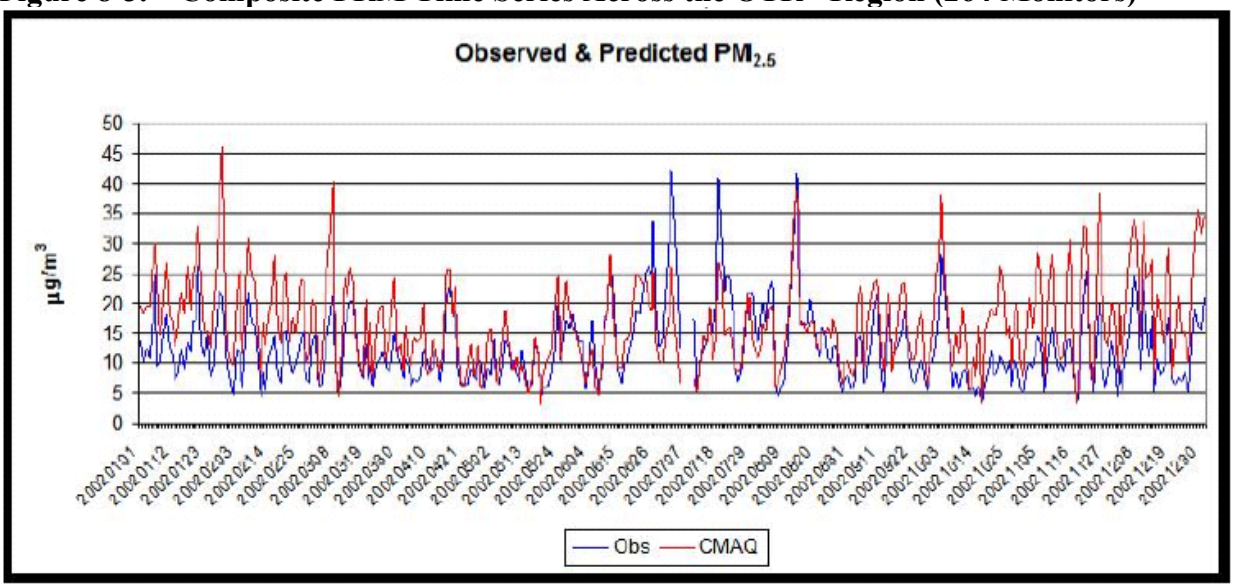
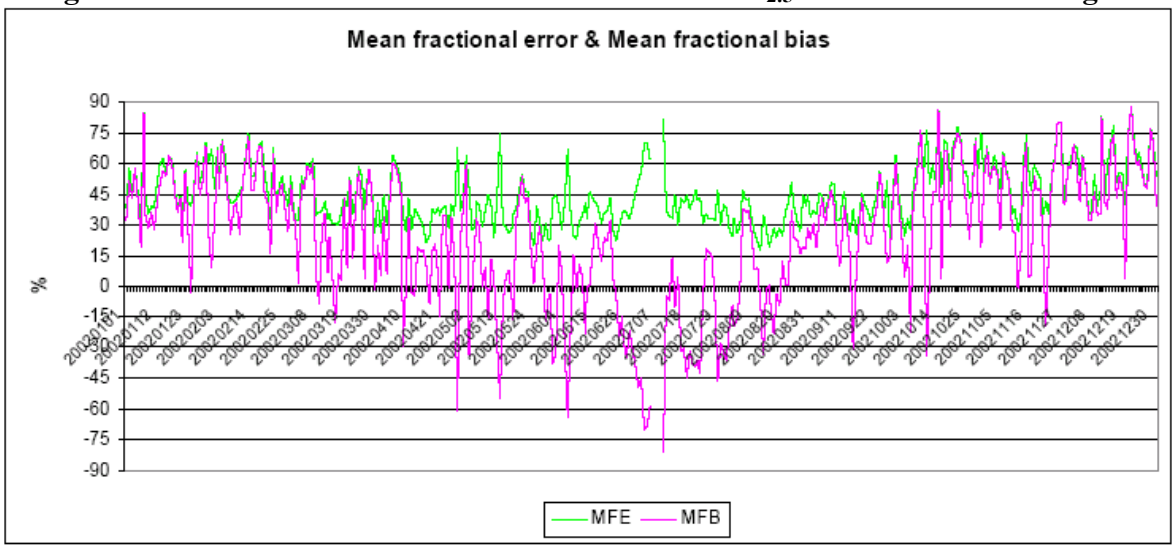


Figure 8-4 is a plot of both MFE and MFB for FRM sites across the OTR+ region. The MFE ranges from 17% to 88% with an average of approximately 45%. The MFB ranges from -82% to +88% with an average of approximately +24%. These values are generally consistent with similar studies listed in the EPA's modeling guidance.[11]

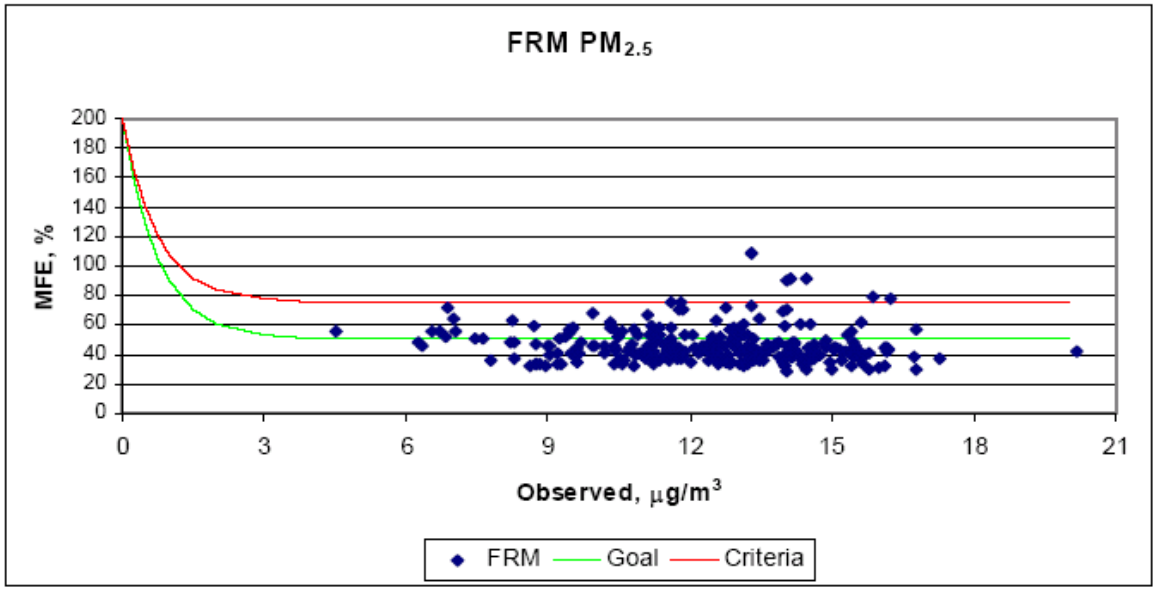
Figure 8-4. MFE and MFB Time Series for FRM $PM_{2.5}$ Across the OTR+ Region



[11] "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze"; EPA-454/B-07-002; April 2007; http://www.epa.gov/scram001/guidance/guide/final-03-pm-rh-guidance.pdf.

An MFE "bugle" plot for FRM $PM_{2.5}$ across OTR+ region is provided in Figure 8-5. "Goal" curves are the best a model can be expected to achieve while the "criteria" curves are considered acceptable for model performance. The "criteria restriction" is satisfied at 258 of 264 sites on an annual average basis.

Figure 8-5. MFE Bugle Plot for FRM $PM_{2.5}$ Across the OTR+ Region



MFE bugle plots were also generated for SO_4, NO_3, and NH_4, EC, OM, and soil/crustal across OTR+ region and are provided in Figures 8-6 through 8-11. As can be seen from the results, the performance for individual species is generally consistent with the criteria necessary for acceptable model performance.

Figure 8-6. MFE Bugle Plot for SO_4 Across the OTR+ Region

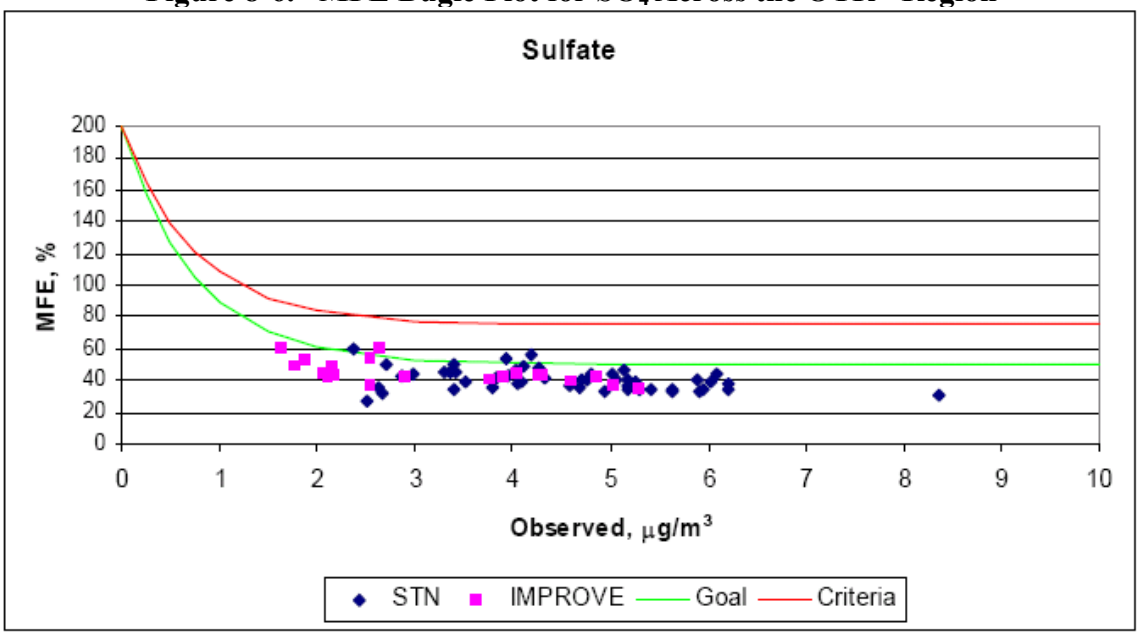


Figure 8-7. MFE Bugle Plot for NO_3 Across the OTR+ Region

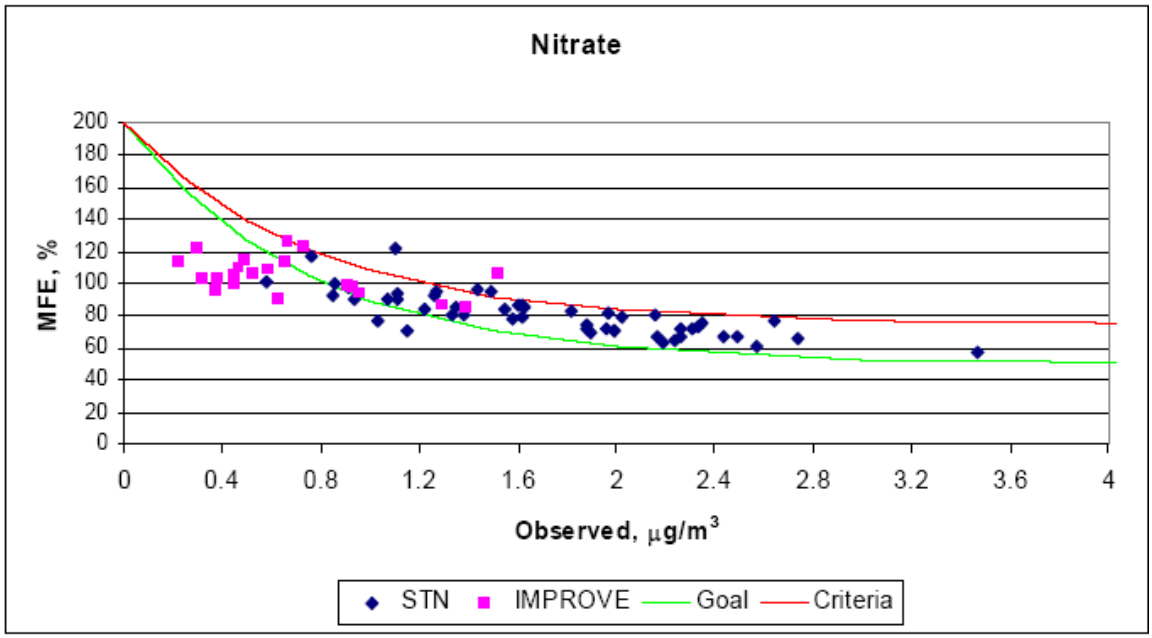


Figure 8-8. MFE Bugle Plot for NH_4 Across the OTR+ Region

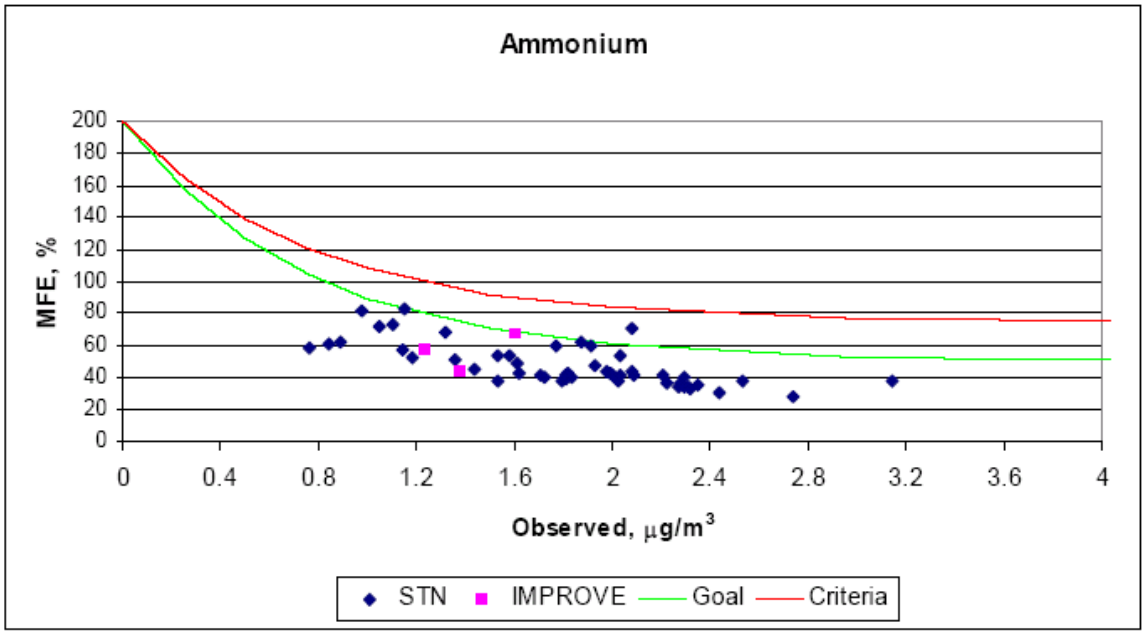


Figure 8-9. MFE Bugle Plot for EC Across the OTR+ Region

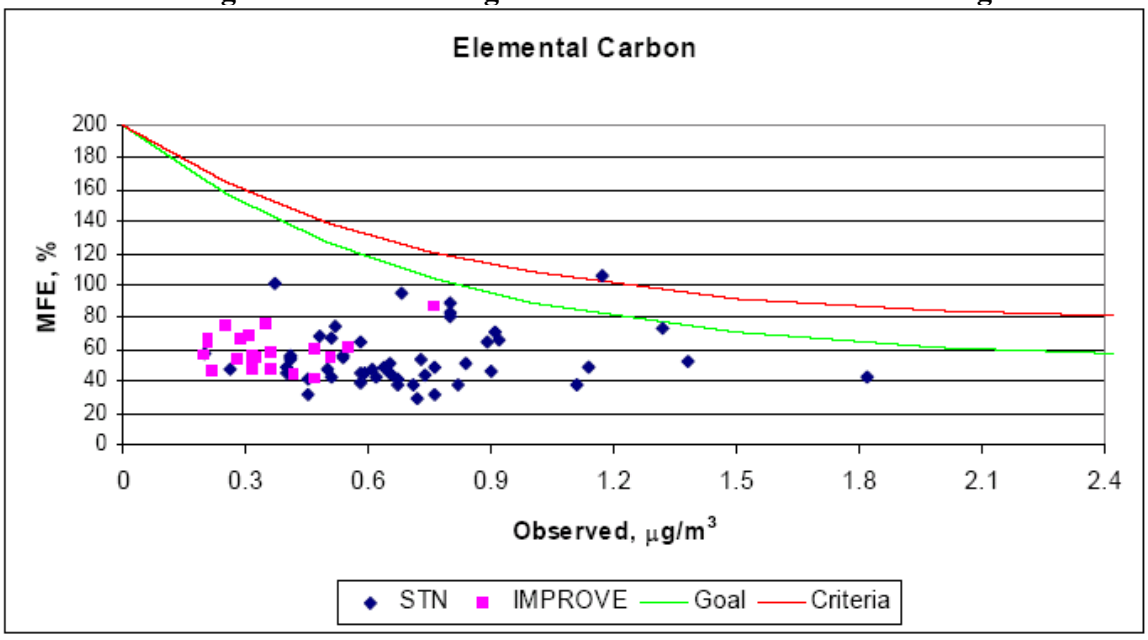


Figure 8-10. MFE Bugle Plot for OM Across the OTR+ Region

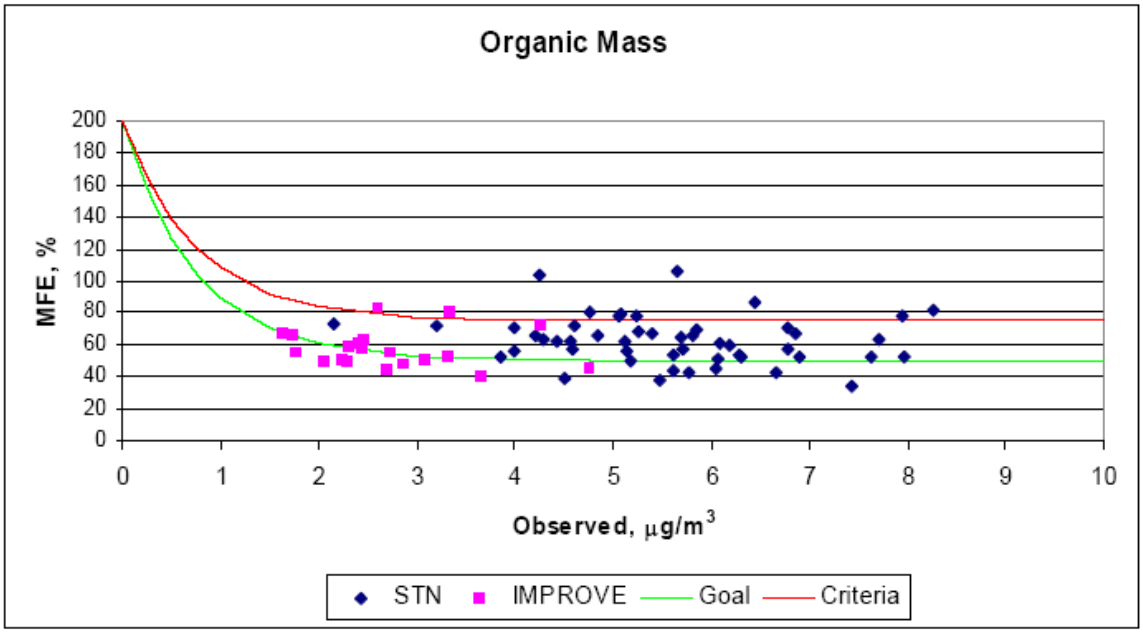
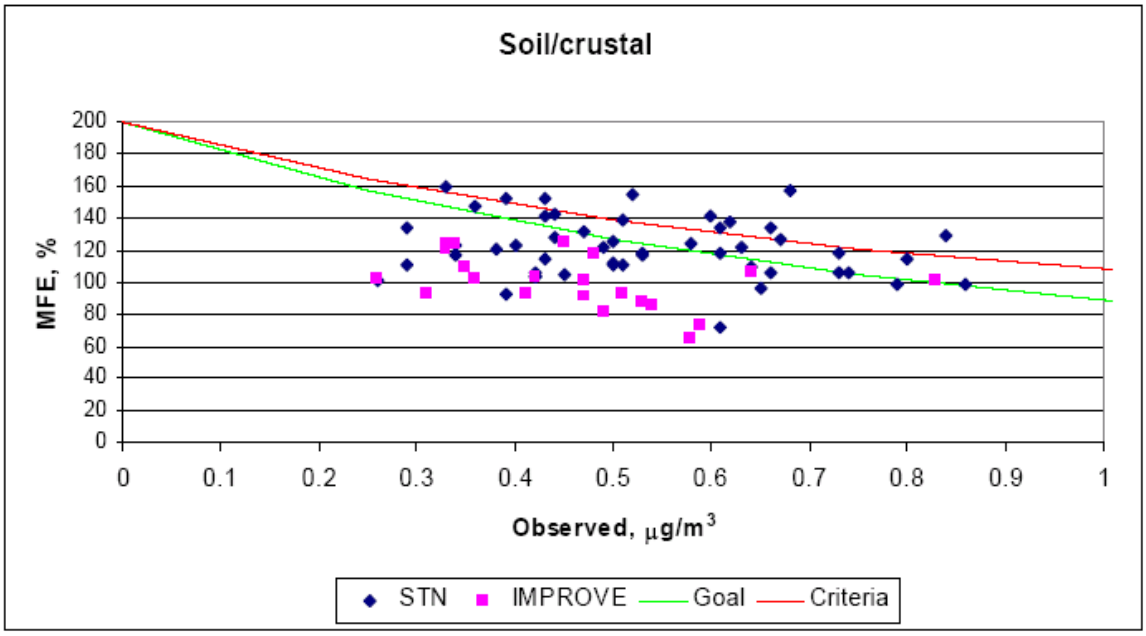


Figure 8-11. MFE Bugle Plot for Soil/Crustal Across the OTR+ Region



The plots show that concentration-dependent performance goals for sulfate, ammonium, and elemental carbon are easily met. Concentration-dependent performance criteria for nitrate, organic mass, and soil/crustal material are met at nearly all IMPROVE sites and most STN sites.

8.3.3 Summary of Model Performance

CMAQ was employed to simulate $PM_{2.5}$ for the calendar year 2002. A review of $PM_{2.5}$ and its individual species was conducted for the study domain.

The CMAQ model performance for surface $PM_{2.5}$ is good with acceptable bias and error. Several observations can be made with respect to model performance, including the following:

1. Organic matter (OM) is comprised of primary and secondary components. Approximately 80-90% of CMAQ calculated OM consists of primary OM. Observed OM has a distinct maximum during the summer when secondary formation is highest; CMAQ exhibits substantial under-prediction of secondary organic aerosol (SOA) formation.
2. CMAQ captures seasonal variation in SO_4 well.
3. CMAQ appears to overestimate primary $PM_{2.5}$ components (EC, soil, primary OM), especially during colder months.
4. CMAQ appears to underestimate secondary OM during the summer.

Seasonal biases in the CMAQ calculated $PM_{2.5}$ component concentrations are not of great regulatory concern since attainment tests are based on the application of relative response factors to observed concentrations. As described in Section 8.4, the largest overall changes in any $PM_{2.5}$ species between 2002 and 2009 are projected to occur in sulfate, the species for which CMAQ performs at its best. Most other species show relatively more modest improvements in fine particle concentrations between 2002 and 2009. CMAQ's performance is poorest for soil/crustal material and organic matter. The poor performance for soil/crustal material is only a minor concern since soil/crustal material comprises on the order of 5% of total $PM_{2.5}$ mass measured in the Northeast region.

The underestimation of summertime organic matter concentrations by CMAQ is of more concern since organic matter is an important part of the $PM_{2.5}$ budget at some Northeast locations. Much of the bias is likely due to an underestimation of secondary organic aerosols, most of which have a biogenic source. Since changes in biogenic emissions are expected to be small over the next decade, CMAQ-calculated relative response factors for organic matter are not crucial. In addition, following EPA guidance, the impact of this bias is minimized by normalizing model predicted changes in organic matter by observed $PM_{2.5}$ partitioning.

While there are some differences between the spatial data between sub-regions, there is nothing to suggest a tendency for the model to respond in a systematically different manner between regions. Examination of the statistical metrics by sub-region confirms the absence of significant performance problems arising in one area but not in another, building confidence that the CMAQ modeling system is operating consistently across the full OTC domain.

In summary, CMAQ's $PM_{2.5}$ model performance is determined to be acceptable for this modeling demonstration. Biases in CMAQ and the inventories used in the model are such that the calculated future design values are likely to be somewhat higher than they would be in reality, providing additional confidence in conclusions of the attainment demonstration.

8.4 Attainment Demonstration Modeling

The CMAQ regional photochemical modeling system was used to develop projections of $PM_{2.5}$ design values for 2009, the last full calendar year before the required April 2010 attainment deadline. The EPA recommends[12] using regional photochemical model estimates in a "relative" rather than "absolute" sense, with a goal of minimizing uncertainties and biases in the modeling system. This was accomplished by running CMAQ for baseline year (i.e., 2002) and future year (i.e., 2009) emission scenarios, both using 2002 meteorology data. The "absolute" modeled results from each of these runs were then used to develop ratios, or "relative response factors" (RRF), for each monitor location, representing the "relative" improvement expected near[13] each monitor between 2002 and 2009 due to implemented control programs. Finally, the RRF's developed for each monitor were multiplied by representative baseline period design values to calculate projected 2009 $PM_{2.5}$ design values for comparison to the NAAQS.[14] These steps are described in more detail below.

8.4.1 Baseline $PM_{2.5}$ Design Values

In accordance with EPA's guidance,[15] the baseline design values used in the modeling application were calculated differently than the measured design values used for NAAQS designation purposes, although both are based on monitored quarterly averages of ambient air quality data. Design values used for $PM_{2.5}$ NAAQS designations were calculated using the average of the three annual average $PM_{2.5}$ values recorded over the 2002 through 2004 period at each monitor. For modeling purposes, the baseline design value is calculated by averaging three, three-year annual average design values, centered on the baseline inventory year of 2002. In other words, the modeling baseline design value for each monitor was calculated using the average of the 2000-2002, 2001-2003, and 2002-2004 annual average design values. Therefore, the baseline design value used in the modeling is actually a five-year weighted average, with the greatest weight given to the baseline inventory year of 2002.

Table 8-3 lists the baseline design values used for the modeling, developed from quarterly averages at each FRM site across the NY-NJ-CT annual $PM_{2.5}$ nonattainment.[16] Baseline values exceeded the annual PM $_{2.5}$ NAAQS at seven sites in the nonattainment area, five in New York and two in New Jersey. Baseline values for all Connecticut monitors comply with the annual $PM_{2.5}$ NAAQS. Further explanation of how these values were calculated is provided in Appendix 8D (TSD-5).

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[12] "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze"; EPA-454/B-07-002; April 2007; http://www.epa.gov/scram001/guidance/guide/final-03-pm-rh-guidance.pdf.

[13] "Near" was determined by using an average of the concentration predicted within a 3x3 array of grid cells surrounding each monitor, as recommended by the USEPA for 12-km grid resolution modeling.

[14] Note that this process was actually carried out separately for each $PM_{2.5}$ species, then summed to determine total $PM_{2.5}$ mass. See the remainder of Section 8.4 for details.

[15] See footnote 12, above.

[16] Note that one monitor – PS 59 (360610056) in Manhattan – recorded an anomalously high average concentration of 25.2 $\mu g/m^3$ during the third quarter of 2003. Examination of the data by the NYSDEC revealed that there were only five valid data points recorded at the beginning of the quarter, with the monitor subsequently shut down because of construction activity at the site. Because the limited data are not representative of air quality over the entire quarter, data for the 3rd quarter of 2003 was treated as missing when calculating the baseline design value for this site in Table 8-3. Appendix 8D (see Attachment 1 of TSD-5) provides a more detailed analysis of this particular issue.

Table 8-3. NY-NJ-CT Nonattainment Area Baseline Annual $PM_{2.5}$ Design Values Used for Modeling Purposes and the Nearest STN Monitor to Each FRM Monitor

FRM Site ID	FRM Monitoring Site Name	State	Baseline Design Value (DV_B) ($\mu g/m^3$)	Nearest STN Monitor
90010010	Bridgeport - Roosevelt School	CT	13.1	090019003
90010113	Bridgeport - Congress Street	CT	12.6	090019003
90011123	Danbury	CT	12.8	090019003
90012124	Stamford	CT	12.9	090019003
90013005	Norwalk	CT	12.9	090019003
90019003	Westport	CT	11.8	090019003
90091123	New Haven- 715 State St	CT	13.7	090091123
90092123	Waterbury	CT	13.1	090091123
90099005	Hamden	CT	11.6	090091123
340030003	Fort Lee Library	NJ	13.7	360050110
340171003	Jersey City Primary	NJ	14.9	360610062
340172002	Union City	NJ	**16.0**	360610062
340210008	Trenton	NJ	13.9	340230006
340218001	Washington Crossing	NJ	11.9	340230006
340230006	New Brunswick	NJ	12.5	340230006
340270004	Morristown	NJ	12.4	340273001
340273001	Chester	NJ	11.1	340273001
340310005	Paterson	NJ	13.2	360050083
340390004	Elizabeth	NJ	**15.7**	340390004
340390006	Elizabeth Downtown	NJ	13.5	340390004
340392003	Rahway	NJ	13.1	340390004
360050080	Morrisania Center -Gerard Ave.	NY	**15.8**	360050110
360050083	Botanical Gardens	NY	13.8	360050083
360050110	IS 52 East 156 Street	NY	14.7	360050110
360470052	PS 314-60th St and GawanusExp.	NY	**15.1**	360610062
360470076	PS 321- 180 7th Ave.	NY	14.2	360610062
360470122	JHS 126 424 Leonard St	NY	14.8	360610062
360590008	Hempstead, Nassau County	NY	12.2	360810124
360610056	PS 59, 288 E. 57th St., Manhattan	NY	**16.9**	360610062
360610062	Post Office, 350 Canal St.	NY	**16.3**	360610062
360610079	School IS 45, 2351 1st Ave.	NY	14.7	360050110
360610128	PS 19, 185 1st Avenue	NY	**15.9**	360610062
360710002	NYC- 55 Broadway	NY	11.5	090019003
360810124	NYC- 14439 Gravett Road	NY	13.3	360810124
360850055	Post Office, 364 Port Richmond	NY	14.0	340390004
360850067	Susan Wagner	NY	12.1	340390004
361030001	East Farmingdale Water Plant	NY	12.1	360810124
361191002	5th Avenue & Madison, Thruway Exit 9	NY	12.3	360050083

Note: Baseline values greater than the annual average NAAQS of 15.0 $\mu g/m^3$ are in **bold**.

8.4.2 Baseline Species Concentrations

The next step in the modeled attainment test is to determine the baseline species composition at each FRM monitor, based on measured species data. The $PM_{2.5}$ species composition is highly complex, but if the goal of air quality management decisions is to reduce $PM_{2.5}$, it is necessary to know the dominant chemical species. Nine of the FRM monitor sites in the NY-NJ-CT nonattainment area are collocated with Speciation Trends Network (STN) monitors that collect major ions, including sulfate (SO_4), nitrate (NO_3), and ammonium (NH_4); carbon species, including elemental carbon (EC) and organic carbon (OC); and about 50 trace elements. Four of the STN sites are located in the New York portion of the nonattainment area, three in the New Jersey portion and two in the Connecticut portion.

At sites where both STN and FRM data are available, total FRM mass can be directly related to the mass of individual species, as measured at the corresponding STN site. At those FRM sites that do not have a collocated STN monitor, it can reasonably be assumed that the speciation data from the nearest STN monitor is sufficient to characterize the FRM site. Table 8-3 lists the nearest STN site that was associated with the FTM site for computing baseline species concentrations.

It is known that FRM monitor filters do not retain semi-volatile species such as ammonium nitrate and some organics with high efficiency, especially during the warmer months. Hence, one cannot simply add up the major species from the STN monitor and expect to relate this identically to the total mass from the FRM monitor. It is necessary to adjust some of the STN data to estimate the species composition of mass measured by the FRM monitor. According to the modeling guidance[17] the mass from the FRM monitor can be expressed as:

$PM_{2.5}$ = "retained nitrate mass" + "ammoniated sulfate mass" + "ammonium associated with sulfate and retained nitrate" + "particle-bound water" + "other primary $PM_{2.5}$" + "blank mass" + "carbonaceous mass" [Eq. 1]

where $PM_{2.5}$ refers to the total mass measured at each FRM site; "retained nitrate mass" and "ammonium associated with sulfate and retained nitrate" refer only to the fractions of NO_3 and NH_4, respectively, that are not volatilized; "ammoniated sulfate mass" refers to the SO_4 that is measured by the STN; "particle-bound water" refers to water that is associated with the hygroscopic ammonium sulfate and nitrate, and can be estimated as a polynomial function of retained ammonium, sulfate, and nitrate; "other primary $PM_{2.5}$" refers to unspeciated, inert $PM_{2.5}$ such as soil/crustal elements (here assumed to be the sum of major crustal oxides – Si, Ca, Fe, and Ti); "blank mass" refers to passively collected contamination, assumed to be 0.5 $\mu g/m^3$; and "carbonaceous mass" refers to elemental carbon (EC) and an estimate of retained organic carbon (OC). Because of uncertainties in the measured OC, the modeling guidance suggests that organic mass be computed as the difference between the measured FRM mass and the sum of the other species listed above.

[17] "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze"; EPA-454/B-07-002; April 2007; http://www.epa.gov/scram001/guidance/guide/final-03-pm-rh-guidance.pdf.

NYSDEC used EPA's official Air Quality System (AQS) database of STN data to compute the baseline species concentrations at each FRM site in the NY-NJ-CT nonattainment area for the period 2002-2004. This database also includes the adjusted speciation data needed to compute the various retained species. A separate calculation of the quantity of the component species was performed for each of the $PM_{2.5}$ components listed in Equation #1 (except blank mass) for each FRM monitoring site. This calculation applied the same ratio of each species collected from the "nearest" STN site, to the total $PM_{2.5}$ mass measured at the FRM site. Each of these site-specific ratios is called a "component-specific design value". EPA modeling guidance procedures[18] were used to carry out the calculations, including procedures for estimating retained NH_4, particle-bound water and other primary $PM_{2.5}$.

8.4.3 Relative Response Factors

As stated in the introduction to Section 8.4, EPA recommends that air quality modeling results be used in a relative sense to compute future $PM_{2.5}$ design values. This is accomplished by applying what EPA's guidance calls the "speciated modeled attainment test" (SMAT), as described below.

For each species *i*, the future concentration of each species (DV_{Fi}) was calculated as the product of the baseline concentration (DV_{Bi}) and the corresponding RRF_i:

$$DV_{Fi} = DV_{Bi} \times RRF_i \qquad \text{[Eq. 2]}$$

For each quarter and species, the quarterly average concentration for the base and future year simulations was computed. The RRF is the ratio of the quarterly average future-to-base year modeled values for the species of interest. For each FRM site, the concentrations of the nine grid cells surrounding the FRM site were averaged.

RRF values were based on the application of the CMAQ model for 2002 and 2009. Future $PM_{2.5}$ design values were estimated at each existing FRM monitoring site by multiplying the component-specific modeled RRF "near" each monitor times the observed component-specific design value. EPA procedures[19] were used for calculations, including the assumption that the blank concentration of 0.5 $\mu g/m^3$ remains constant in the future year. Future total $PM_{2.5}$ design values at a site were then estimated by summing the future year design values of the seven $PM_{2.5}$ components.

8.4.4 Future $PM_{2.5}$ Design Values

Table 8-4 summarizes the results of applying the SMAT at each FRM site in the NY-NJ-CT nonattainment area, listing both the measured baseline and modeled future (i.e., 2009) design values for each FRM site. Figure 8-12 shows a mapped representation of the 2009 modeled design values.

[18] "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze"; EPA-454/B-07-002; April 2007; http://www.epa.gov/scram001/guidance/guide/final-03-pm-rh-guidance.pdf.
[19] Ibid.

Table 8-4. Baseline and Modeled Future (2009) Annual $PM_{2.5}$ Design Values for the NY-NJ-CT Nonattainment Area

FRM Site ID	FRM Monitoring Site Name	State	Baseline Design Value (DV_B) ($\mu g/m^3$)	2009 Modeled Design Value (DV_F) ($\mu g/m^3$)
90010010	Bridgeport - Roosevelt School	CT	13.1	11.5
90010113	Bridgeport - Congress Street	CT	12.6	11.2
90011123	Danbury	CT	12.8	11.2
90012124	Stamford	CT	12.9	11.4
90013005	Norwalk	CT	12.9	11.3
90019003	Westport	CT	11.8	10.4
90091123	New Haven- 715 State St	CT	13.7	11.7
90092123	Waterbury	CT	13.1	11.2
90099005	Hamden	CT	11.6	9.9
340030003	Fort Lee Library	NJ	13.7	12.1
340171003	Jersey City Primary	NJ	14.9	13.3
340172002	Union City	NJ	**16.0**	14.3
340210008	Trenton	NJ	13.9	11.8
340218001	Washington Crossing	NJ	11.9	10.1
340230006	New Brunswick	NJ	12.5	10.4
340270004	Morristown	NJ	12.4	10.4
340273001	Chester	NJ	11.1	9.3
340310005	Paterson	NJ	13.2	11.4
340390004	Elizabeth	NJ	**15.7**	13.5
340390006	Elizabeth Downtown	NJ	13.5	11.8
340392003	Rahway	NJ	13.1	11.4
360050080	Morrisania Center -Gerard Ave.	NY	**15.8**	14.2
360050083	Botanical Gardens	NY	13.8	12.4
360050110	IS 52 East 156 Street	NY	14.7	13.3
360470052	PS 314-60th St and GawanusExp.	NY	**15.1**	13.6
360470076	PS 321- 180 7th Ave.	NY	14.2	12.8
360470122	JHS 126 424 Leonard St	NY	14.8	13.3
360590008	Hempstead, Nassau County	NY	12.2	11.0
360610056	PS 59, 288 E. 57th St., Manhattan	NY	**16.9**	**15.3**
360610062	Post Office, 350 Canal St.	NY	**16.3**	14.4
360610079	School IS 45, 2351 1st Ave.	NY	14.7	13.3
360610128	PS 19, 185 1st Avenue	NY	**15.9**	14.3
360710002	NYC- 55 Broadway	NY	11.5	10.3
360810124	NYC- 14439 Gravett Road	NY	13.3	12.1
360850055	Post Office, 364 Port Richmond	NY	14.0	12.3
360850067	Susan Wagner	NY	12.1	10.6
361030001	East Farmingdale Water Plant	NY	12.1	10.7
361191002	5th Avenue & Madison, Thruway Exit 9	NY	12.3	10.9

Note: Values greater than the annual average NAAQS of 15.0 $\mu g/m^3$ are in **bold**.

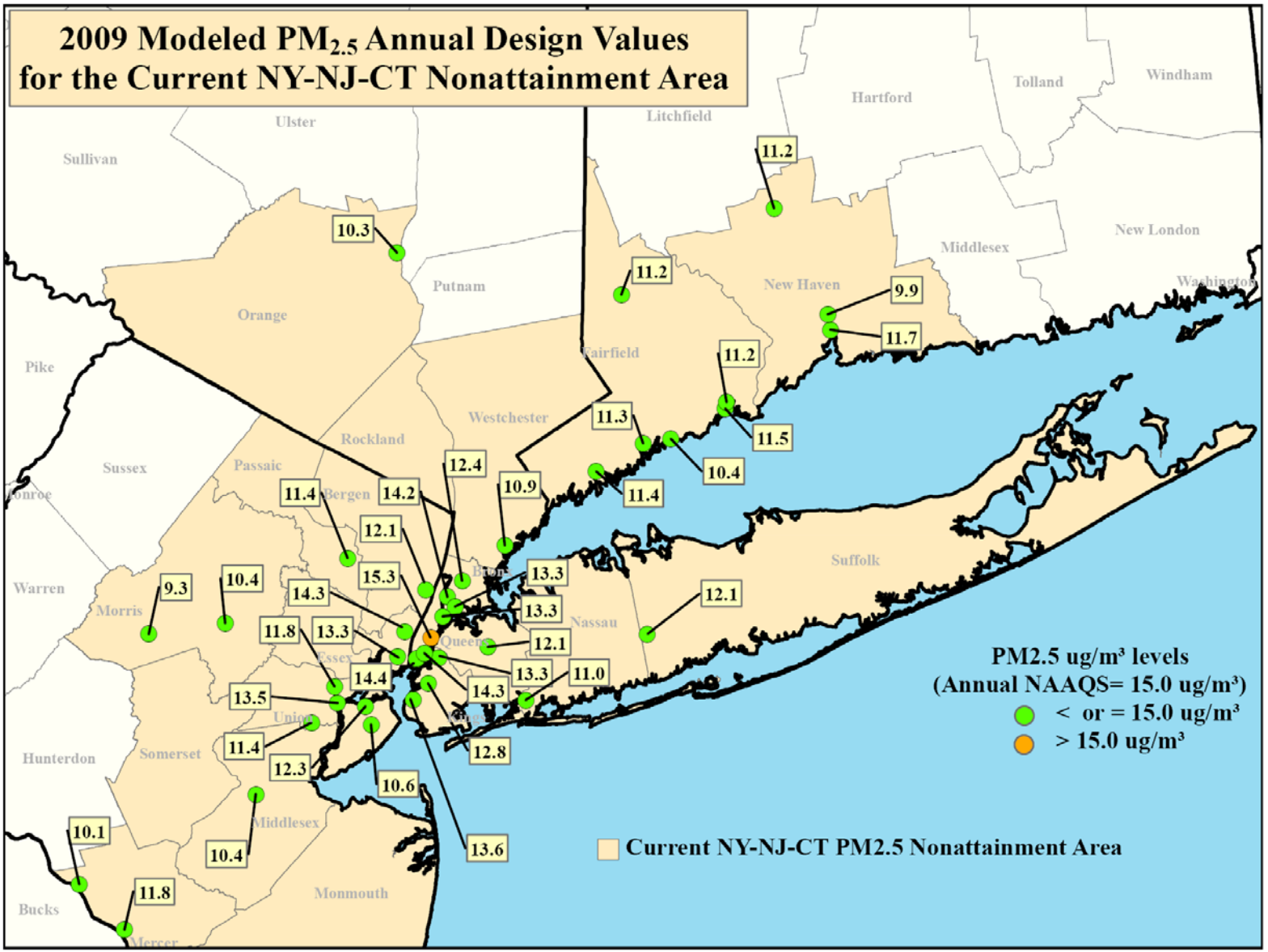


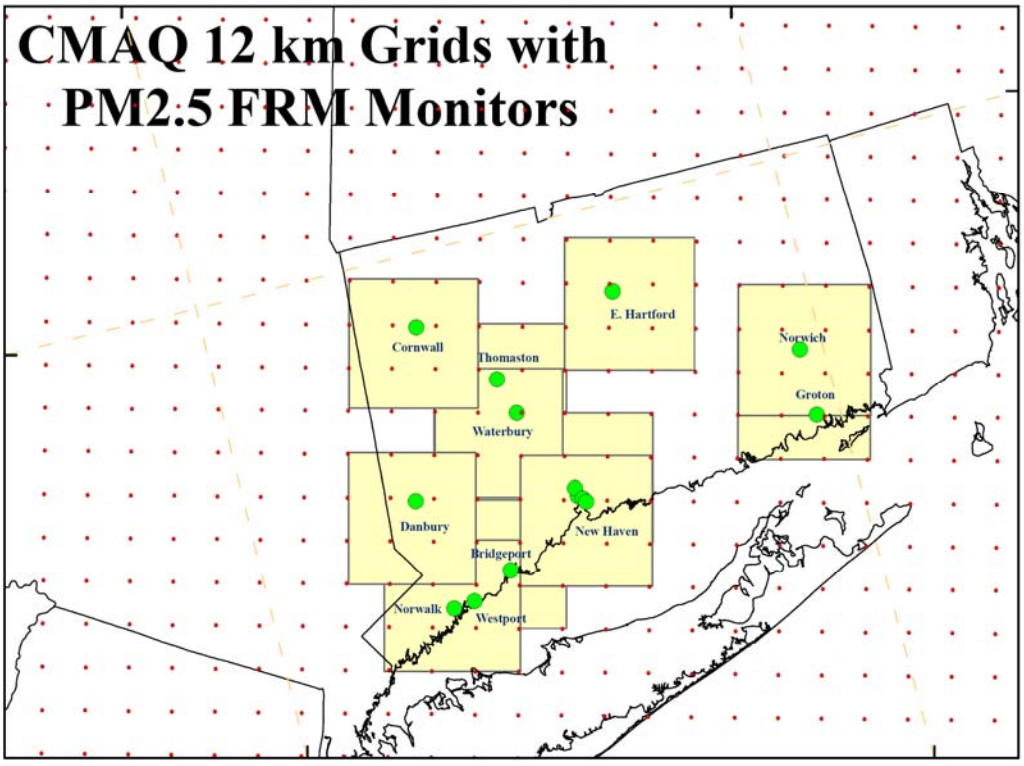
Figure 8-12. Modeled 2009 $PM_{2.5}$ Design Values for the New York- New Jersey- Connecticut Nonattainment Area

As can be seen in the table and figure, the only site with a projected 2009 future design value greater than the annual $PM_{2.5}$ NAAQS of 15.0 ug/m^3 is the PS 59 site located in Manhattan, New York City. The projected 2009 value for the PS 59 site is 15.3 ug/m^3, which is within the weight-of-evidence (WOE) range of 14.5 ug/m^3 to 15.5 ug/m^3, as defined in EPA's $PM_{2.5}$ modeling guidance.[20] All other sites are projected to be in compliance with the NAAQS and below the WOE range of values. As a result, corroboratory WOE analyses are needed to demonstrate attainment at the PS 59 monitor. These WOE analyses, which are provided in Section 8.6**,** support the conclusion that the entire NY-NJ-CT nonattainment area will attain the annual $PM_{2.5}$ NAAQS by the April 2010 deadline.

8.5 Unmonitored Area Analysis

The EPA modeling guidance requires an evaluation to ensure that the modeling effort provides adequate areal coverage such that areas of maximum concentrations are identified. The CTDEP's monitoring network, laid over the 12 kilometer CMAQ modeling grid, is depicted in Figure 8-13. This network of monitors covers the majority of the State when the nine CMAQ modeling grid squares encompassing each of the monitors are considered. More importantly, the densest portion of the network covers virtually all of southwest Connecticut, which is included in the NY-NJ-CT nonattainment area. Thus, the existing monitoring network is adequate to detect high $PM_{2.5}$ levels and further analysis of unmonitored areas is unnecessary.

Figure 8-13. CMAQ Grid Cells Associated With Connecticut's $PM_{2.5}$ Monitors



[20] "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze"; EPA-454/B-07-002; April 2007; Page 17; http://www.epa.gov/scram001/guidance/guide/final-03-pm-rh-guidance.pdf.

8.6 Weight-of-Evidence Analyses

By definition, models are simplistic approximations of complex phenomena. It is generally recognized that there is significant uncertainty associated with the results of photochemical grid modeling. In addition to the uncertainties associated with the dispersion and chemical response mechanisms built into the air quality model, the required meteorological, baseline and projected emissions, and air quality input data sets also contain their own levels of uncertainty that can affect the performance of the modeling system. These uncertain aspects of the modeling analyses can sometimes prevent definitive assessments of future attainment status, especially when projected pollutant levels are at levels close to air quality standards.

Due to these uncertainties, modeling results should not be used in a strictly deterministic fashion to determine "bright-line" compliance by comparing projected air quality levels directly with the ozone NAAQS. Modeling is more appropriately used as a probabilistic tool, along with other available assessment techniques, to assess the likelihood of complying with the NAAQS by a certain deadline. Of course, a properly performing model which projects air quality in an area to be well above, or well below, the level of the NAAQS may warrant greater consideration among the mix of available other assessments when determining the likelihood of compliance.

EPA addresses the modeling uncertainty issue in its modeling guidance,[21] recommending that weight-of-evidence (WOE) analyses be performed to better determine the likelihood of NAAQS compliance when the model attainment test results are "inconclusive". For annual $PM_{2.5}$ modeling results, EPA's guidance defines an uncertainty range of 14.5 $\mu g/m^3$ to 15.5 $\mu g/m^3$, with WOE analyses required for any location where future year model projections fall within that range.

As described in Section 8.4 (see Table 8-4), CMAQ modeling projects that all monitors in the NY-NJ-CT nonattainment area, except the PS 59 monitor in New York County (Manhattan), will have annual 2009 $PM_{2.5}$ design values below the modeling uncertainty range; therefore not requiring WOE analysis. For the PS 59 monitor, CMAQ modeling projects a 2009 annual average design value of 15.3 $\mu g/m^3$, which is within the uncertainty range requiring WOE analysis. The remainder of this section presents WOE analyses of monitoring data and describes additional control programs not included in the CMAQ modeling to provide further evidence that the NY-NJ-CT area will achieve attainment of the annual $PM_{2.5}$ NAAQS by the April 2010 deadline. Additional discussions of monitored $PM_{2.5}$ data and trends are provided in Appendix 8D (TSD-3a, TSD-3b and TSD-5).

[21] Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze; EPA OAQPS; EPA-454/B-07-002; April 2007; See page 98 of: http://www.epa.gov/scram001/guidance/guide/final-03-pm-rh-guidance.pdf.

8.6.1 Monitoring Data Show General Downward Trend Towards Timely Attainment

Monitors throughout the NY-NJ-CT nonattainment area have recorded gradual improvements in annual average $PM_{2.5}$ levels over the last several years. Figure 8-14 displays annual $PM_{2.5}$ levels for monitors located in the Connecticut portion of the nonattainment area during the period from 2000 through 2007. $PM_{2.5}$ levels at all relevant sites have consistently been less than the 15.0 $\mu g/m^3$ annual NAAQS, with a general downward trend during the period.

Similar downward trends were recorded at monitoring sites in the New York portion of the nonattainment area over the 2000 to 2007 period, as displayed in Figure 8-15. Five of eight sites recorded $PM_{2.5}$ levels above the annual NAAQS in 2000, with four of twelve sites exceeding the standard in 2007. When simple linear extrapolation of trend lines are applied to the data (see the dashed lines in Figure 8-14), each of the four exceeding monitors are projected to achieve annual average $PM_{2.5}$ levels below the NAAQS by 2008, prior to the required April 2010 attainment date. Note that the PS 59 monitor in Manhattan is one of these sites.

Downward trends in annual average $PM_{2.5}$ levels have also been measured in the New Jersey portion of the nonattainment area over the 2000 to 2007 period, as shown in Figure 8-16. In 2000, five of thirteen monitors recorded annual levels exceeding the $PM_{2.5}$ NAAQS. By 2007, twelve monitors recorded annual values less than the NAAQS, with the other monitor (Union City) recording a value equal to the annual NAAQS of 15.0 $\mu g/m^3$. Linear extrapolation of the Union City trend line (the dashed line in Figure 8-15) projects continued improvement in $PM_{2.5}$ concentrations at that site[22] to levels below the NAAQS.

A continuation of the overall downward trend in annual $PM_{2.5}$ concentration levels is supported by emission projections. As was discussed earlier in Sections 5.3 and 5.4, significant additional reductions in $PM_{2.5}$ and precursor emissions are expected to occur in the nonattainment area through at least 2012. These results reinforce the conclusion that the NY-NJ-CT area will achieve attainment of the annual $PM_{2.5}$ NAAQS by the April 2010 deadline.

8.6.2 NYDEC's WOE Demonstration Suggests Timely Attainment at the PS 59 Site

As described in Section 8.4, the CMAQ modeling results project one monitor in the NY-NJ-CT nonattainment area to exceed the annual $PM_{2.5}$ NAAQS of 15.0 $\mu g/m^3$ in 2009. The PS 59 monitor, located in Manhattan, is projected to have an annual design value of 15.3 $\mu g/m^3$, within the weight-of-evidence range specified by EPA.

The NYDEC has prepared a WOE demonstration[23] for the PS 59 monitor describing factors to be considered when determining whether the site will attain the annual $PM_{2.5}$ NAAQS by the April 2010 deadline. NYDEC's full WOE demonstration is included in Appendix 8D (see Attachments 1 and 2 of TSD-5). A summary of key findings is provided as follows:

[22] Note that the Union City monitor was not in full operation during 2003 and 2004, so the extrapolated trend line in Figure 8-15 is based on the remaining annual average values recorded during the 2000-2007 time period.
[23] The NYDEC WOE demonstration described here is in draft form, subject to change prior to submission by NYDEC to EPA.

Figure 8-14. Trends in Annual $PM_{2.5}$ Levels in the Connecticut Portion of the NY-NJ-CT Nonattainment Area

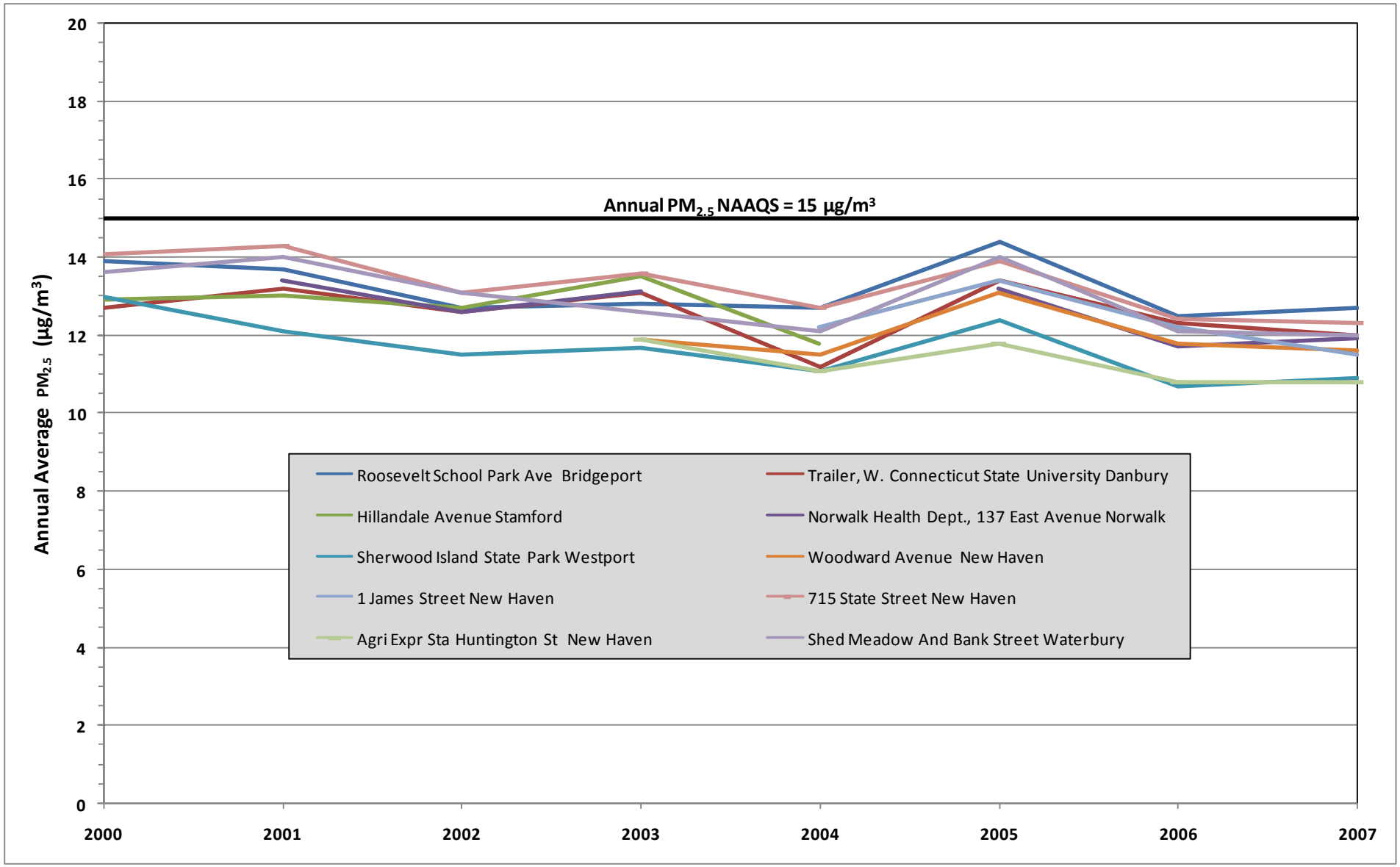


Figure 8-15. Trends in Annual $PM_{2.5}$ Levels in the New York Portion of the NY-NJ-CT Nonattainment Area

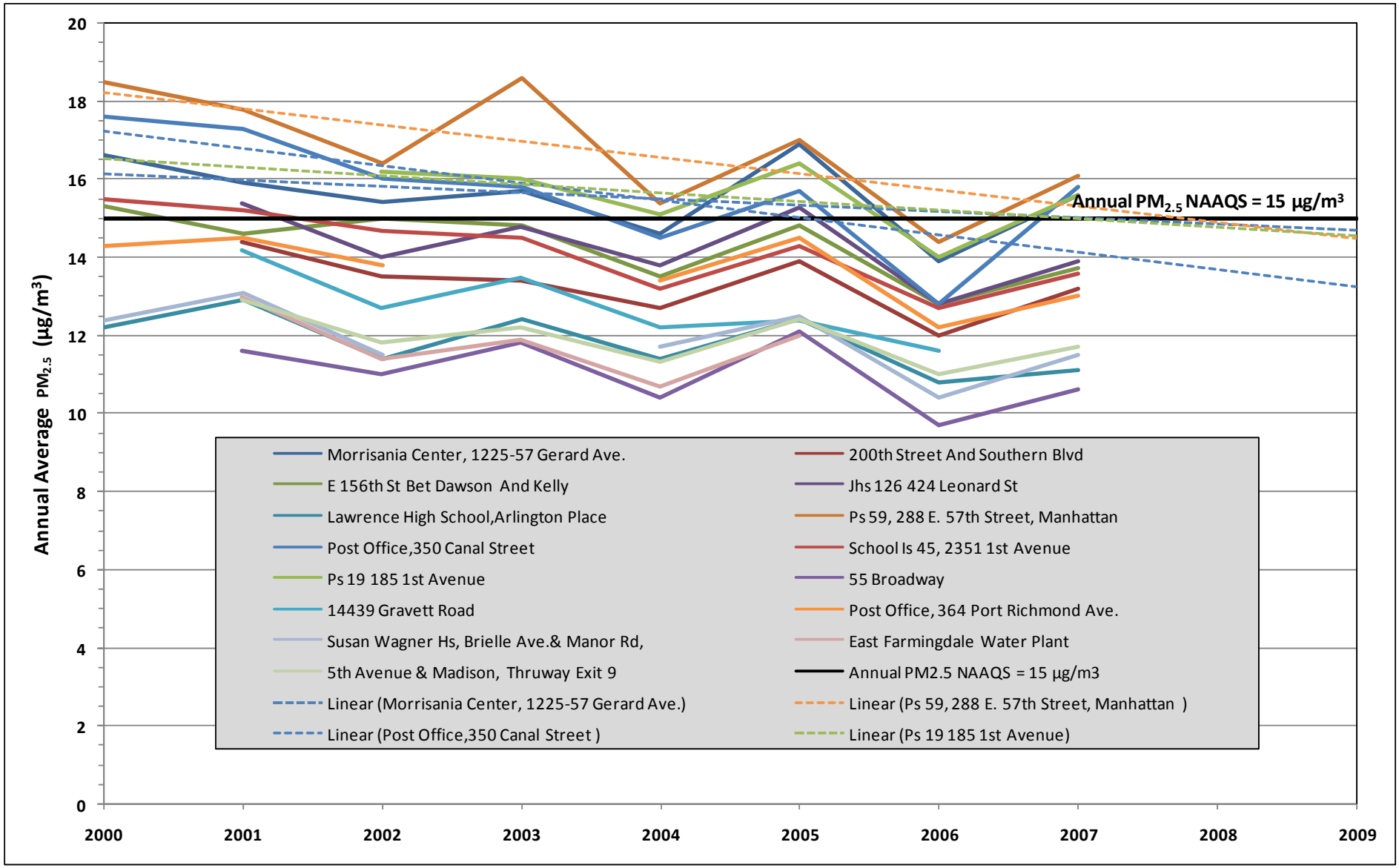
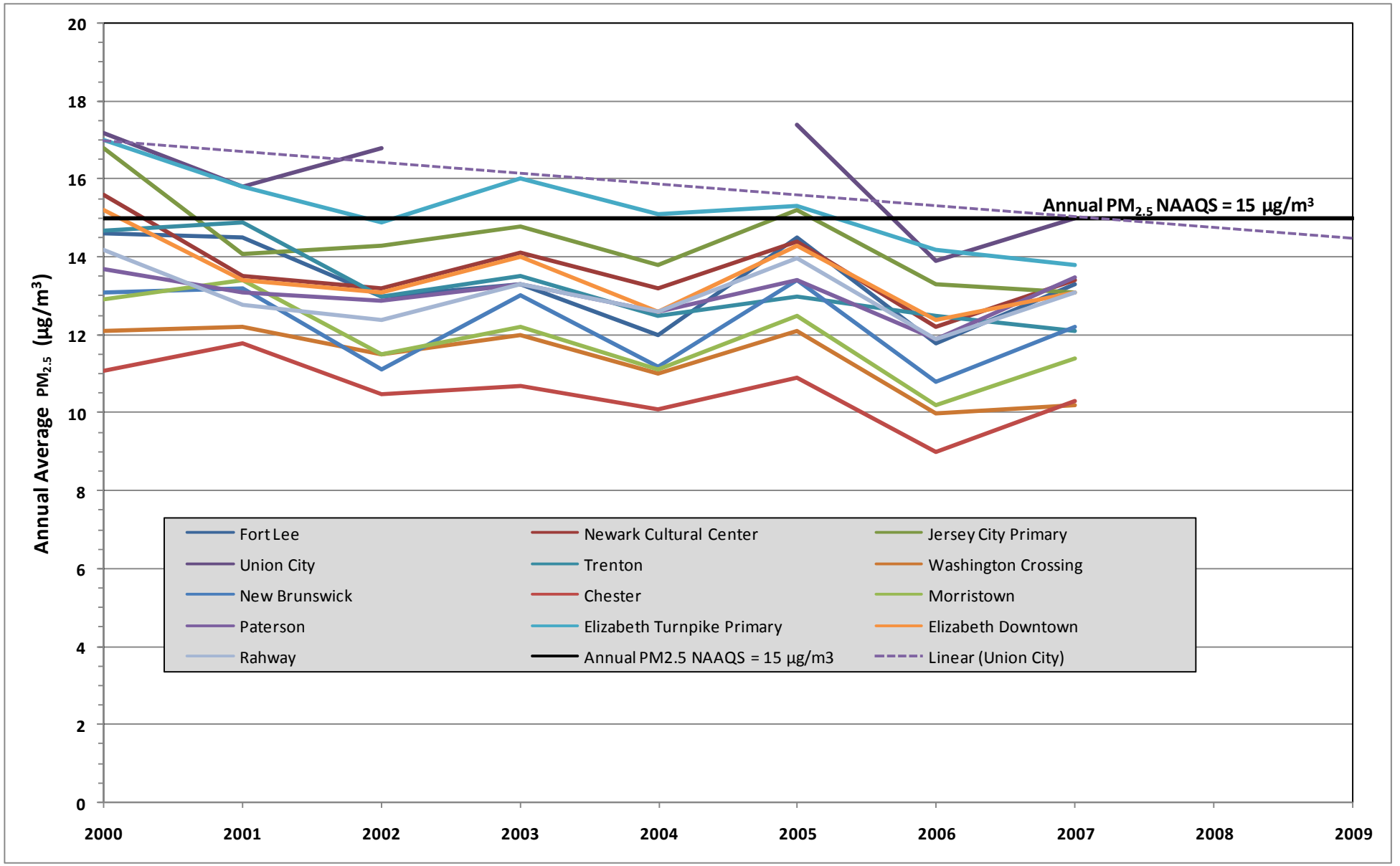


Figure 8-16. Trends in Annual $PM_{2.5}$ Levels in the New Jersey Portion of the NY-NJ-CT Nonattainment Area



1. The PS 59 data set lacks complete information for the third quarter of 2003. Construction work occurring at the site location during that quarter likely influenced a number of samples, biasing the collected fine particulate levels on the high side. NYDEC applied substitution procedures using contemporaneous data from PS 59 and other nearby sites to appropriately adjust the data set.
2. The lack of a collocated speciation monitor at the PS 59 site required the use of speciation data from the nearest neighborhood monitor. Analysis suggests that differences between the sites may have contributed to overestimates of 2009 modeled $PM_{2.5}$ levels at the PS 59 site. Calculations based on the only other site with similar $PM_{2.5}$ concentration levels suggest PS 59 would achieve attainment by 2009.
3. A significant portion of $PM_{2.5}$ mass in New York City has been attributed to secondary species from upwind emission sources. Analysis of $PM_{2.5}$ and precursor data reveals a downward trend at the PS 59 site. Additional upwind reductions expected from CAIR, mobile source and other programs should continue the downward trend, increasing the potential for timely attainment of the annual $PM_{2.5}$ NAAQS.

8.6.3 Other Data Analysis Conducted for New York City Indicate Timely Attainment

A recent study[24] suggests that the sum of sulfate and nitrate comprise about 40% or more of the $PM_{2.5}$ mass in the New York City metropolitan area, and that 70% or more of the measured $PM_{2.5}$ results from transport into the region. Based on results from source apportionment modeling using Positive Matrix Factorization (PMF), the authors determined that the largest single source factor affecting NYC is "secondary sulfate" associated with SO_2 emissions from upwind regions. It is clear that emission reductions in upwind states will be needed to further reduce $PM_{2.5}$ in the NY-NJ-CT nonattainment area.

As previously shown in Figures 8-13 through 8-15, $PM_{2.5}$ levels are generally improving across the NY-NJ-CT nonattainment area. Although the data records for $PM_{2.5}$ are somewhat short, $PM_{2.5}$ mass appears to be decreasing by about 0.1-0.5 $\mu g/m^3$ per year, depending on the monitoring location. At the PS 59 site, annual $PM_{2.5}$ levels improved, based on the linear trend line, by more than 0.4 $\mu g/m^3$ per year during the 2000-2007 period. In addition to $PM_{2.5}$ mass, several criteria pollutants are also measured at the PS 59 site. Examination by NYDEC of the trends in SO_2 and NO_2 from 1993 to 2006 using the seasonal Kendall test revealed that ambient levels are declining at rates of 3.4% per year and 1.7% per year, respectively. This strengthens the argument that this area will achieve timely attainment of the NAAQS, given that there are various measures scheduled to be implemented aimed at decreasing the emissions of these $PM_{2.5}$ precursors (e.g., the CAIR program).

8.6.4 New York City's PlaNYC Will Provide Additional Local Emission Reductions

In December of 2006, New York City announced the intent to develop a strategy to deal with growth, infrastructure, sustainability and the need for environmental improvement. The resulting plan, known as PlaNYC, contains measures that New York City has, or plans to, institute or promote to address these issues between now and 2030. Many of these will become effective in the near term.

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[24] Qin, Y., Kim., E., Hopke, P. K., 2006. The concentrations and sources of $PM_{2.5}$ in metropolitan New York City. Atmospheric Environment 40, S312-S332.

The portion of PlaNYC that concerns air quality encompasses a comprehensive program for addressing pollution that originates from residential units, motor vehicles, buses, truck and other diesel equipment, as well as utility operations throughout New York City. Many of these program elements will result in a reduction of particulate matter and its precursors. Table 8-5 provides a conceptual description of these air quality related elements, which were not included in the CMAQ modeling exercise. Details on PlaNYC, and the progress achieved towards implementing its goals, are provided in Appendices 8H and 8I.

Table 8-5. Air Quality Goals of New York City's PlaNYC

Reduce road vehicle emissions
1. Capture the air quality benefits of the NYC transportation plan 2. Improve fuel efficiency of private cars 3. Reduce emissions from taxis, black cars, and for-hire vehicles 4. Replace, retrofit, and refuel diesel trucks 5. Reduce school bus emissions
Reduce other transportation emissions
6. Retrofit ferries, promote use of cleaner fuels, and engine replacements 7. Work with Port Authority to reduce emissions from vehicles, vessels and facilities 8. Reduce emissions from construction vehicles
Reduce emissions from buildings and power plants
9. Capture the air quality benefits of the NYC energy plan 10. Promote the use of cleaner burning heating fuels
Pursue natural solutions to improve air quality
11. Capture the benefits of the NYC open space plan 12. Reforest targeted areas of the City's parkland 13. Reduce heating effect of asphalt parking lots with increased tree plantings
Understand the scope of the challenge
14. Launch collaborative local air quality study to track local pollution

New York City's efforts to implement these PlaNYC measures have not been considered in the attainment modeling and are not considered to be a SIP commitment. Nevertheless, PlaNYC and other non-SIP measures being pursued in New York (see Appendix 8H) should provide improvements in $PM_{2.5}$ levels beyond those predicted by the modeling, helping to ensure compliance with the annual standard by 2010 and continued maintenance of the NAAQS in subsequent years. In addition, emission reductions resulting from PlaNYC will be crucial to achieving compliance with the revised 24-hour $PM_{2.5}$ NAAQS, which was promulgated by EPA in 2006.

8.6.5 Early SO_2 Emission Reductions are Anticipated from the CAIR Program

Phase 1 SO_2 reductions mandated by EPA's CAIR program are not required until 2010. As a result, the CMAQ modeling projections for 2009 included in this attainment demonstration do not reflect any SO_2-related reductions from the CAIR program. However, EPA anticipates[25] that CAIR incentives will lead to early reductions in SO_2 emissions prior to the April 2010 attainment deadline. Therefore, any early SO_2 reductions from upwind CAIR sources should provide pre-2010 improvements in measured $PM_{2.5}$ concentrations that are not reflected in the 2009 CAIR modeling results. In addition, CAIR program emission reductions will serve as a starting point for securing emission reductions from electricity generating units that will be necessary to reach attainment of the 2006 24-hour $PM_{2.5}$ NAAQS.

8.6.6 Additional Connecticut Non-SIP Control Measures Provide Further Reductions

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. These initiatives will also play an important role in achieving attainment of the 2006 24-hour $PM_{2.5}$ NAAQS. These initiatives are described in detail in Section 4.4.1. Such Connecticut programs, by reducing electricity demand and use; reducing vehicle emissions; or by reducing vehicle miles travelled, create directionally correct reductions in $PM_{2.5}$ and precursor emissions.

None of the programs described in Section 4.4.1 produce emissions reductions that are quantified or are not quantifiable in a manner typical of attainment planning efforts. However, in the case of the energy efficiency (EE) programs administered by the Energy Conservation and Management Board, there are estimates of NOx and SOx emissions reductions in 2007 associated with projects funded through the ECMB (*see* Table 8-6). These estimates, combined with the legislated growth in Connecticut's energy efficiency and conservation efforts in future years, convey a compelling argument that Connecticut's EE programs are doing much to limit the growth of electricity demand and the otherwise high NOx and SOx emissions associated with such growth. The efforts Connecticut has made to reduce peak demand and encourage EE (through ECMB programs, product efficiency standards exceeding federal requirements, the OneThing campaign and integrated planning) provide further weight-of-evidence that Connecticut will continue to reduce emissions of $PM_{2.5}$ precursors through 2010 and beyond.

[25] For a discussion regarding early CAIR emission reductions, see Section XIII of EPA's "Corrected Response to Significant Public Comments on the Proposed Clean Air Interstate Rule"; Corrected April 2005; See: http://epa.gov/oar/interstateairquality/pdfs/cair-rtc.pdf.

Table 8-6. Pollutant Reductions from Conservation and Load Management Program Activities (Tons)[26]

	2007 Annual Actual	2007 Lifetime Actual	2008 Annual Plan	2008 Lifetime Plan
SOx	336	4,076	236	2,801
NOx	104	1,258	73	864

Section 4.4.1 also identifies several Connecticut mobile source programs that produce directionally correct emissions reductions. While the emissions reductions are not easily quantified, such as in the case of the legislated school bus anti-idling program, CTDEP has provided emissions estimates associated with the TCMs implemented in 2002 through 2007. Although the estimated emission reductions from the TCMs are relatively small, many are focused on urban areas where ambient $PM_{2.5}$ levels are typically highest.

8.6.7 Additional Federal Non-Road Engine Control Measures Result in Continued Emission Reductions

The federal locomotive and marine diesel engine and spark-ignition rules described in Section 4.4.2 will have a positive, albeit minimal, impact on complying with the April 2010 attainment date because they only begin to take effect in 2008. Emission reductions from these measures are not accounted for in this SIP. However, the new regulations will help to ensure that emissions continue to decrease through 2012 and beyond

8.7 Attainment Demonstration Conclusions

Monitored air quality data demonstrate that Connecticut monitors remain in attainment of the annual $PM_{2.5}$ NAAQS. CMAQ modeled results for 2009 verify continued attainment at all Connecticut monitors, with design values at all sites projected to be less than the EPA-defined lower threshold of model uncertainty (i.e.,14.5 ug/m^3). Furthermore, the CMAQ modeling projects that all but one monitor in the NY-NJ-CT nonattainment areas will be in compliance with the annual $PM_{2.5}$ NAAQS by 2009 and below the model uncertainty threshold, thus not requiring WOE analyses.

The only site with a projected 2009 design value greater than the annual NAAQS is the PS 59 site located in Manhattan, New York City. The 2009 CMAQ projection for that site is 15.3 ug/m^3, slightly above the $PM_{2.5}$ NAAQS of 15.0 ug/m^3, but within the range of values (i.e., 14.5 ug/m^3 – 15.5 ug/m^3) for which EPA recommends that supplemental WOE analyses be used to demonstrate attainment.[27]

Two types of WOE analyses support the conclusion that the PS 59 monitor, and all of the NY-NJ-CT area, will come into compliance with the annual $PM_{2.5}$ NAAQS by the April 2010 attainment date. Analysis of $PM_{2.5}$ and precursor emission and monitored data trends indicate

[26] Benefits are calculated for the lifetime of funded measures. From *Report of the Energy Conservation and Management Board Year 2007 Programs and Operation*s. Available at: http://www.ctsavesenergy.org/files/ECMB%202007%20FINAL%2002.20.08.pdf.

[27] Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze, USEPA, EPA-454/B-07-002, April, 2007, p. 105.

that timely attainment is likely to be achieved. In addition, numerous control programs that were not included in the CMAQ modeling exercise will provide supplemental emission reductions through 2009 and beyond, increasing the level of confidence that attainment of the annual $PM_{2.5}$ NAAQS will occur by April 2010, and be maintained into the future.

The continued downward trend in emissions also serves as the initial step towards reaching attainment of the recently revised 2006 24-hour $PM_{2.5}$ NAAQS. However, significant additional emission controls will be needed on a national, regional and local level to ensure timely attainment of that NAAQS.

9.0 Contingency Measures

This chapter describes the Clean Air Act's contingency measures requirement and demonstrates that Connecticut's contingency plan provides sufficient emission reductions to comply with the requirement.

9.1 Contingency Plan Requirements

All $PM_{2.5}$ nonattainment area SIPs must include contingency measures consistent with CAA Section 172(c)(9). Contingency measures are additional control measures to be implemented in the event that an area fails to either meet reasonable further progress[1] (RFP) requirements or attain the standards by the required attainment date.

Contingency measures must be fully adopted rules or control measures that are ready to be implemented quickly upon failure to meet RFP or failure of the area to meet the standard by its attainment date. The SIP should contain trigger mechanisms and a schedule for contingency measure implementation, as well as indicate that implementation will not rely on any further action by the State or EPA. States may also use as contingency measures one or more Federal or local measures that are already in place and provide reductions that are in excess of the reductions required by the attainment demonstration or RFP plan.

The $PM_{2.5}$ Implementation Rule also specifies that a contingency plan should "provide for emission reductions equivalent to about one year of reductions needed for RFP, based on the overall level of reductions needed to demonstrate attainment divided by the number of years from the 2002 base year to the attainment year." [2]

Section 179(c)(1) of the CAA requires the EPA Administrator to determine, within six months of the required attainment date, whether each nonattainment area has attained the NAAQS by the attainment deadline. Such determination must be published in the Federal Register. CAA Section 179(d)(1) specifies that those areas found not to attain by the required attainment date be provided one year from the Federal Register notice to submit a revised SIP describing how and when the area will achieve attainment.

As the required attainment date for the NY-NJ-CT $PM_{2.5}$ nonattainment area is April 5, 2010, the EPA Administrator has until October 5, 2010 to analyze air quality data and determine whether the area attained the $PM_{2.5}$ NAAQS; such a finding is published in the Federal Register. Assuming EPA adheres to this schedule, areas identified as not attaining the NAAQS will be required to begin implementation of their contingency measure plans upon EPA's publication of a Federal Register notice in October 2010. The emission reductions realized by the contingency plan will ensure continued progress toward attainment during the one-year period (i.e., until October 2011) in which the CAA allows states to prepare revised SIPs providing for expeditious attainment.

[1] 72 FR 20633 (April 25, 2007). Nonattainment areas that demonstrate attainment by 2010 will be considered to have satisfied the RFP requirement.
[2] 72 FR 20643.

9.2 Connecticut's Contingency Measures Plan

The purpose of a contingency plan is to ensure that continued progress toward attainment occurs during the period when affected states would be required to revise their air quality plans in the event that EPA makes a finding that an area failed to comply with an air quality standard by the required attainment date. To accomplish this goal, EPA's $PM_{2.5}$ Implementation Rule indicates that contingency plans should provide emission reductions equivalent to one year's worth of the reductions required for attainment. EPA specifies a procedure that uses total $PM_{2.5}$ and precursor emissions in the base year and required attainment year to calculate the required contingency plan emission reduction. Although this procedure may be an appropriate method for ensuring continued progress in most cases, CTDEP has concluded that strict application of EPA's procedure is not appropriate for Connecticut's situation. The rationale for this conclusion is summarized below. An alternate procedure is also described that makes more sense for Connecticut's situation and will therefore be used to develop Connecticut's contingency plan. CTDEP's rationale is as follows:

- All Connecticut $PM_{2.5}$ monitors remain in compliance with the annual $PM_{2.5}$ NAAQS.
- All violating monitors in the NY-NJ-CT nonattainment area are located in New York City and nearby New Jersey urban areas. The violating areas in New York and New Jersey are located upwind of Connecticut during periods when high $PM_{2.5}$ levels most frequently occur. This observation is corroborated by EPA's CAIR modeling analysis,[3] which concluded that SO_2 and NOx emissions from sources located *within* Connecticut's borders do not significantly impact violating $PM_{2.5}$ monitors in New York and New Jersey.
- Based on the above, it follows that a contingency plan that provides additional emission reductions from sources *within* Connecticut's borders will not result in significantly improved air quality at any monitors in New York or New Jersey that might remain in non-compliance of the annual $PM_{2.5}$ NAAQS after the required 2010 attainment date.
- A primary reason EPA decided to include portions of Connecticut in the multi-state NY-NJ-CT nonattainment area was due to a concern that Connecticut motor vehicles traveling into New York City might have a direct local contribution to violating monitors.[4] Presuming that assertion to be true, it follows that Connecticut's contingency plan should be structured to focus on Connecticut's on-road motor vehicle fleet to ensure that emissions from that source sector continue to decline in the 2009 to 2012 timeframe, the period when EPA will determine if air quality plans must be updated due to a failure to reach timely attainment.

Based on the discussion above, Connecticut's revised contingency plan is comprised of the federal control measures required for new gasoline and diesel powered automobiles and trucks. These control programs, which are described in Chapter 4.3.1 and Table 4-3 of this attainment demonstration, will continue to provide significant emission reductions in the post-2009 period.

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[3] See Section VII of EPA's "Technical Support Document for the Final Clean Air Interstate Rule: Air Quality Modeling; March 2005; See: http://www.epa.gov/cair/pdfs/finaltech02.pdf.

[4] Letter from EPA Administrator Stephen L. Johnson to CTDEP Commissioner Gina McCarthy; December 5, 2005; available at: http://www.ct.gov/dep/lib/dep/air/particulate_matter/pm25planning/epapm25reconsiderdesignationresponseletter.PDF.

Projected emissions for Connecticut's on-road motor vehicle fleet are summarized in Table 9-1. Projected emissions are shown for primary $PM_{2.5}$ and NOx for the years 2002, 2009 and 2012. The required contingency plan reduction targets are also listed, calculated as the average yearly reduction in on-road motor vehicle emissions projected to occur between the base year and attainment year inventories (i.e., $1/7^{th}$ of the reduction between 2002 and 2009 emission levels). Actual emission reductions expected from the contingency plan are listed in the last column of Table 9-1, representing the emission reductions expected from the on-road motor vehicle fleet between 2009 and 2011, determined assuming linear decreases in emissions between 2009 and 2012. Note that sulfate impacts from Connecticut vehicles traveling near New York City monitors are considered to be insignificant due to Federal fuel sulfur limits that were implemented during the 2002 to 2009 planning period, resulting in sulfur reductions of 90% for gasoline and 97% for diesel fuel from previous levels.

Table 9-1. Analysis of Emissions from Connecticut's Motor Vehicle Fleet

Pollutant[3]	2002 Emissions (tons)	2009 Emissions (tons)	2012 Emissions (tons)	Contingency Reduction Targets[1] (tons)	Contingency Plan Reductions[2] (tons)
Primary $PM_{2.5}$	1,042	723	620	46	69
NOx	68,816	39,468	28,010	4193	7639

[1] Contingency reduction targets represent the average yearly emission reduction expected between the base year and attainment year inventories (i.e., $1/7^{th}$ of the reduction between 2002 and 2009).

[2] The contingency plan reductions represent the level of emission reductions expected between 2009 and 2011 from the on-road motor vehicle fleet, assuming emissions decline linearly between 2009 and 2012.

[3] Sulfate impacts from Connecticut vehicles traveling near New York City monitors are considered to be insignificant due to Federal fuel sulfur limits that were implemented during the 2002 to 2009 planning period, resulting in sulfur reductions of 90% for gasoline and 97% for diesel fuel from previous levels.

As shown in Table 9-1, emission reductions provided by Connecticut's contingency plan (i.e., 69 tons of primary $PM_{2.5}$ and 7639 tons of NOx) exceed the required emission reduction targets (i.e., 46 tons of primary $PM_{2.5}$ and 4193 tons of NOx), thereby satisfying contingency plan requirements. As a result, CTDEP concludes that any localized impacts caused by emissions from Connecticut vehicles at any remaining violating monitors in New York or New Jersey will continue to decline in the post-2009 period.

9.3 Contingency Measure Weight of Evidence Analysis

The CAA requirement to implement contingency measures in areas that fail to achieve timely attainment is intended to ensure continued $PM_{2.5}$ air quality improvements during the period that SIPs are being updated. EPA's $PM_{2.5}$ Implementation Rule attempts to accomplish that goal by requiring states to develop contingency plans based solely on emission reductions from local sources, as was done for Connecticut in the above calculations. However, as more fully discussed in the $PM_{2.5}$ conceptual description in Chapter 2 of this attainment demonstration, elevated levels of $PM_{2.5}$ in the Northeast are caused by varying combinations of both local and regionally transported emissions. In summer, regional levels of sulfate often contribute 50% or

more of total $PM_{2.5}$ concentrations during peak periods. Although peak periods of $PM_{2.5}$ in winter typically have a larger local emissions component than in summer, regionally transported contributions are still significant. Therefore, in addition to the benefits of local emission reductions, continued improvements in $PM_{2.5}$ air quality can be achieved through reductions in transported emissions from upwind areas.

As noted above, sulfates are the single greatest contributor to the regionally transported component of measured $PM_{2.5}$ concentrations. Power plants are the major emitters of SO_2 emissions, much of which is converted in the atmosphere to sulfates, especially during summer episodes when sulfates can make up the majority of measured $PM_{2.5}$ mass.

EPA's CAIR program is designed to reduce the level of transported sulfates caused by power plants, with Phase 1 of the program due to be implemented in 2010. EPA's CAIR modeling demonstrated that Connecticut is not a significant contributor to the sulfate component of $PM_{2.5}$ levels in any nonattainment state; therefore, Connecticut is not subject to the SO_2 provisions of CAIR. However, New York, New Jersey, Pennsylvania and 22 other states in the eastern U.S. are required to implement the CAIR program for SO_2, which EPA estimates will provide a 44% reduction in power plant SO_2 emissions between 2003 and 2010 in covered states. When the CAIR reductions are considered in conjunction with the mounting reductions due to the federal on-road and non-road engine standards and fuel requirements, significant improvements in transported levels of $PM_{2.5}$ can be expected between 2009 and 2011 and beyond. For example, discussions with New Jersey regarding their draft $PM_{2.5}$ SIP indicate that these measures will produce more than 6,600 tons/year of NOx reductions and 16,600 tons of SO_2 reductions in 2010, representing a 15% reduction compared to the total of NOx and SO_2 emissions in New Jersey in the attainment year of 2009. Similar levels of post-2009 reductions can be expected in other states upwind of Connecticut due to the CAIR and federal mobile source measures. As a result, significant improvements in transported levels of $PM_{2.5}$ can be anticipated after 2009 in Connecticut and throughout the Northeast, thus reinforcing the satisfaction of Connecticut's contingency requirements.

10.0 Adequacy Determination for CAA Section 110(a)(1) and (2) Program Infrastructure

Pursuant to CAA Section 110(a)(l) and (2), all States are required to submit plans to implement, maintain and enforce the 1997 $PM_{2.5}$, including such basic SIP requirements as emissions inventories, monitoring and modeling to assure attainment and maintenance of the standards. On August 15, 2006, the EPA issued guidance to States about compliance with CAA Section 110(a)(2)(D)(i). CTDEP addressed the interstate transport requirements of CAA Section 110(a)(2)(D)(i) for the $PM_{2.5}$ NAAQS.[1] On October 2, 2007, EPA issued guidance on compliance with the remaining non-transport-related requirements of CAA Section 110(a)(2). This explanation addresses such non-transport-related requirements for the $PM_{2.5}$ NAAQS.

CTDEP submitted a $PM_{2.5}$ NAAQS infrastructure adequacy determination to EPA on September 4, 2008[2]. That determination states that Connecticut's SIP will fully satisfy the infrastructure requirements of CAA section 110(a)(1) and (2) for the $PM_{2.5}$ NAAQS with the submission of this final $PM_{2.5}$ attainment demonstration SIP and a required May 2011 SIP revision pertaining to elements of the new source review (NSR) and Prevention of Significant Deterioration (PSD) programs. EPA approved the September 4, 2008 submission as complete on October 22, 2008.[3]

On July 11, 2008, the U.S. Court of Appeals (D.C. Circuit) vacated the Clean Air Interstate Rule (CAIR). The D.C. Circuit is currently considering requests for rehearing of that decision, making the future of the CAIR program and the anticipated emissions reductions uncertain. CTDEP was subject to CAIR only for the ozone season nitrogen oxides program, and the vacatur is unlikely to have an impact on CTDEP's satisfaction of its interstate transport requirements for $PM_{2.5}$.[4] However, should the vacatur stand, CTDEP notes that upwind states will need to evaluate reductions in sulfur dioxide and nitrogen oxide emissions to be certain that those states satisfy their interstate transport obligations.

[1] *See* 73 FR 25516 (May 7, 2008).
[2] *See* http://www.ct.gov/dep/cwp/view.asp?a=2684&q=331234&depNav_GID=1619.
[3] *See* 73 FR 62902.
[4] EPA's CAIR modeling determined that Connecticut emissions do not exceed the 0.2 microgram per cubic meter average annual threshold by which EPA established a significant $PM_{2.5}$ impact on another state in the projection year 2010. From this, EPA determined that Connecticut emissions do not contribute significantly to downwind nonattainment of the 1997 $PM_{2.5}$ NAAQS. In addition, air quality modeling conducted by CTDEP also concluded that emissions of $PM_{2.5}$do not significantly contribute to downwind $PM_{2.5}$ nonattainment. See 72 FR 62420 (November 5, 2007).

11.0 Commitments and Requests for EPA Actions

As Connecticut has no violating monitors for the annual $PM_{2.5}$ NAAQS, and as attainment in the NY-NJ-CT nonattainment area is anticipated by April 2010, CTDEP's commitments largely focus on existing state and federal control measures, which are identified in detail in Sections 4 and 5. CTDEP acting alone, however, has limited authority and ability to effect changes in air quality, even within our own state borders. The ultimate success of this attainment demonstration, and of Connecticut's broader efforts to address ozone and daily $PM_{2.5}$ levels, eliminate Connecticut's contributions to regional haze in Class I areas and reduce air toxic emissions will depend upon actions in other states and EPA to adopt, implement and enforce a wide array of $PM_{2.5}$ and $PM_{2.5}$-precursor control measures and to comply with relevant CAA requirements. To that end, CTDEP makes the following commitments to and requests of EPA:

11.1 Full Implementation and Enforcement of Modeled Control Measures

Connecticut has already adopted and implemented pre- and post-2002 control strategies that will reduce emissions and allow for attainment of the annual $PM_{2.5}$ NAAQS in the NY-NJ-CT nonattainment area. Connecticut commits to maintaining, as necessary and appropriate, the implementation and enforcement of those State programs and control measures identified in Tables 4-1 and 4-3, for as long as the underlying enforceable mechanism is valid.

11.2 Completion of the Adoption of Certain Control Measures

In Connecticut's 8-Hour Ozone Attainment Demonstration (February 1, 2008), CTDEP committed to the adoption of a number of control measures intended to reduce ozone precursor emissions in the state. While most of those control measures have been successfully adopted (e.g., architectural and industrial maintenance coating VOC reductions, VOC reductions from consumer products, a CAIR NOx ozone season trading program), CTDEP continues to work to achieve emission reductions consistent with the 8-Hour Ozone Attainment Demonstration.

11.3 Maintenance of Monitoring Network

CTDEP maintains an extensive network for monitoring ambient $PM_{2.5}$ concentrations. As depicted previously in Figure 3-1, CTDEP operated 12 $PM_{2.5}$ monitors in 2007. A full description of Connecticut's air monitoring program is included in the current version of the CTDEP's annual monitoring plan.[1] Connecticut commits to maintaining an adequate $PM_{2.5}$ network, subject to a joint annual review process by CTDEP and EPA.

11.4 Implementation of New Source Review in a $PM_{2.5}$ Nonattainment Area

On May 16, 2008 EPA published the final rule for implementation of the new source review (NSR) program for the annual $PM_{2.5}$ NAAQS. As required by the May 16, 2008 implementation rule, as of July 15, 2008, Connecticut commits to implement the provisions of 40 CFR 51 Appendix S for $PM_{2.5}$ in Fairfield and New Haven counties. CTDEP will also: address condensable emissions during the transition period before EPA finalizes Method 202, as provided in the implementation rule; implement the major source thresholds, significant emission rate thresholds and offset ratios as required in the implementation rule; and seek to prepare and submit a revised PSD and non-attainment area NSR SIP, which takes into account $PM_{2.5}$ within Connecticut's air quality regulations, by May 16, 2011.

[1] A draft of CTDEP's 2007 monitoring plan, "Connecticut 2007 Annual Monitoring Network Plan" is available at: http://www.ct.gov/dep/lib/dep/air/siprac/2007/2007networkplan.pdf.

11.5 Address Transport

Connecticut's recently submitted Section 110(a)(2)(D) SIP revision[2] includes a discussion of EPA's CAIR modeling analysis,[3] which identifies eight upwind states that contribute significantly to 8-hour ozone NAAQS nonattainment in Connecticut (i.e., New York, Pennsylvania, New Jersey, Ohio, Virginia, Maryland, West Virginia, Massachusetts, District of Columbia). The analysis showed that Connecticut is the only state subject to transport exceeding 90% of projected 2010 ozone levels, illustrating the unique and overwhelming influence upwind emissions have on Connecticut's prospects for achieving timely attainment. EPA's modeling also predicts that CAIR will provide minimal relief to Connecticut, reducing by less than one percent the ozone transport affecting the state on high ozone days.

EPA's CAIR modeling highlights the importance of securing sufficient upwind reductions to enable Connecticut to ensure attainment and maintenance of the 8-hour ozone NAAQS in a timely manner. Most, if not all of the same transport mechanisms would also apply in the case of $PM_{2.5}$. As described in Section 8, the modeling used in this attainment demonstration is based on the OTC's "beyond-on-the-way" suite of control measures. CTDEP is pursuing adoption of these measures; achievement of the anticipated emissions reductions in Connecticut and the region is dependent on upwind states doing the same.

Although the weight-of-evidence analyses included in Section 8 support CTDEP's conclusion that $PM_{2.5}$ attainment has already occurred throughout Connecticut and may credibly be achieved in all of the nonattainment area by 2010, the probability of attainment will be enhanced if additional non-modeled upwind reductions are secured. CTDEP requests that EPA, when reviewing $PM_{2.5}$ attainment demonstrations and other related SIP revisions, ensures that adequate emission controls are adopted and implemented by upwind states such that no other state continues to make significant contributions to $PM_{2.5}$ nonattainment in New York, New Jersey or Connecticut.

11.6 Adopt New Federal Programs

CTDEP also requests that EPA adopt additional, national and regional emission control programs to ensure that equitable and cost-effective progress is made to achieve the 2006 24-hour $PM_{2.5}$ NAAQS. At a minimum, EPA should move forward with the adoption of the most stringent possible non-road and on-road emission standards for all mobile source categories. Also, consistent with EPA's reductions in the sulfur content of mobile source fuels, national fuel sulfur content limits for home heating oil would go far to reduce $PM_{2.5}$ levels, particularly in the Northeast.[4] We also urge EPA to work with states to address emissions from electric generation on high electric demand days, as such emissions typically occur on the hottest summer days and exacerbate ozone air quality problems.

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[2] "Revision to Connecticut's State Implementation Plan: Meeting the Interstate Air Pollution Transport Requirements of Clean Air Act Section 110(a)(2)(D)(i)"; Submitted to EPA on March 13, 2007; See: http://www.ct.gov/dep/lib/dep/air/regulations/proposed_and_reports/revsipsec110appendix.pdf.

[3] "Technical Support Document for the Final Clean Air Interstate Rule: Air Quality Modeling"; US EPA OAQPS; March 2005; See: http://www.epa.gov/cleanairinterstaterule/pdfs/finaltech02.pdf.

[4] CGS section 16a-21a allows for Connecticut to limit the sulfur content of home heating oil to as low as 500 ppm, but only if the surrounding states of New York, Massachusetts and Rhode Island first adopt such a requirement. Regional or federal regulation of the sulfur content of home heating oil would facilitate actions necessary to trigger CGS section 16a-21a.