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.

1997 $PM_{2.5}$ NAAQS

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]

[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

[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.

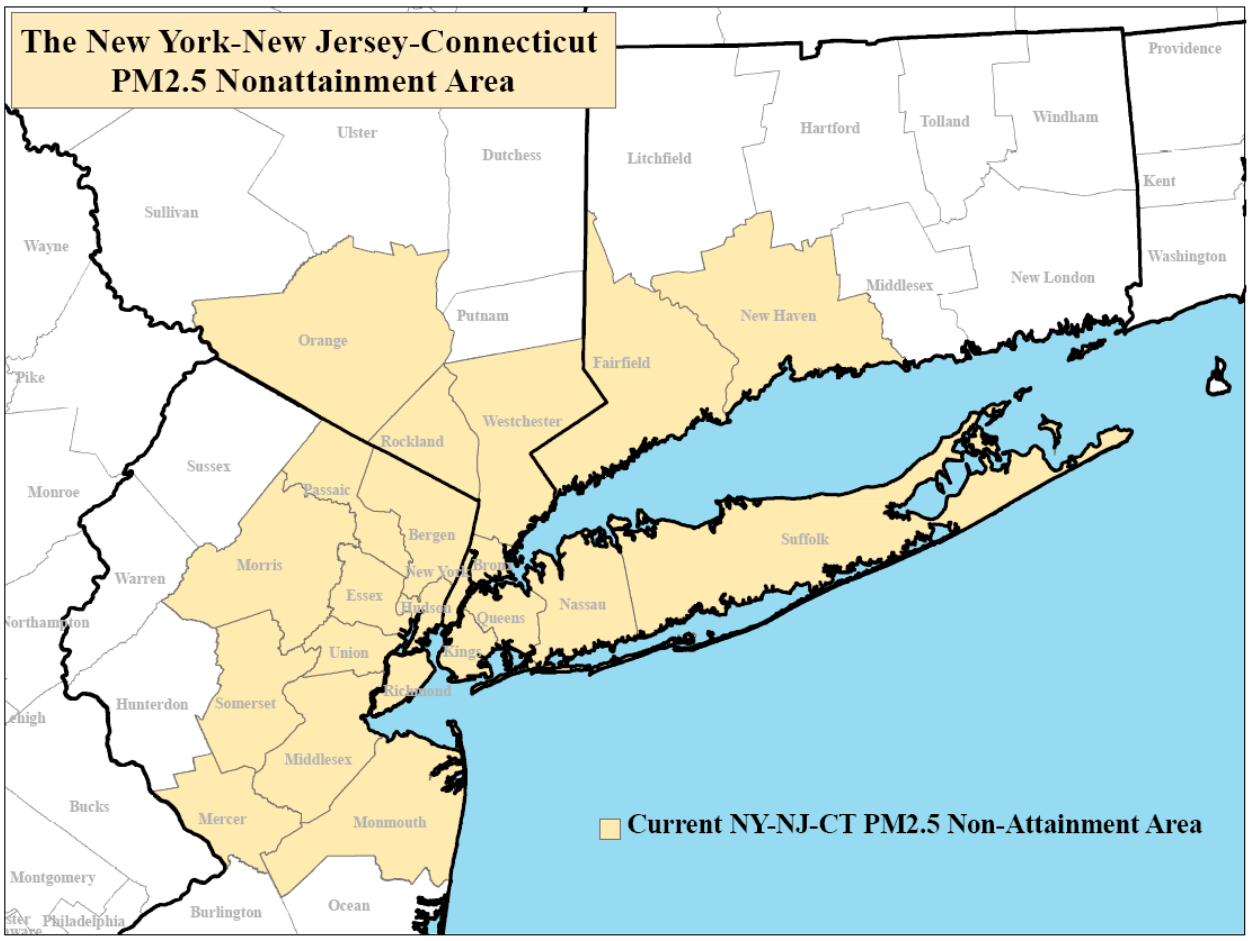
[8] EPA. Fact Sheet: Areas Designated Nonattainment for the Fine Particle National Air Quality Standards. United States Environmental Protection Agency, December 17, 2004, http://www.epa.gov/pmdesignations/documents/final/factsheet.htm, accessed June 28, 2007.

[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.