1.0 INTRODUCTION AND BACKGROUND

The primary purpose of this proposed state implementation plan (SIP) revision is to demonstrate that New Jersey and its associated multi-state nonattainment areas will attain the 1997 fine particulate matter ($PM_{2.5}$) national ambient air quality standards (NAAQS) by April 5, 2010. While New Jersey plans to fulfill its obligations under the Federal Clean Air Act and the State's Air Pollution Control Act with respect to both the 1997 and 2006 $PM_{2.5}$ standards (see discussions of these standards in this Section 1.1), the State faces several other air quality related challenges, including meeting other criteria pollutant NAAQS (such as 8-hour ozone), reducing diesel and other air toxic emissions, and improving visibility, that are interrelated with the $PM_{2.5}$ initiative. In determining air quality management plans, the State must not only meet federal and state requirements, it must also address the local needs and requirements. These needs and requirements are embodied in the State's Energy Master Plan, New Jersey Department of Environmental Protection (NJDEP) Action Plan, the State Development/Redevelopment Plan, and the State's Environmental Justice Plan, to name a few. See Section 1.3 for more information on how this proposed $PM_{2.5}$ SIP revision helps meet these air quality related challenges. Significant progress has been made in improving New Jersey's air quality. Even more needs to be done to meet all of these requirements, and it is important that the State coordinate to work toward consistency in implementing the most efficient and effective emission reduction strategies. The remainder of this chapter includes:

- An explanation of $PM_{2.5}$ and its associated health standards
- A discussion of the health and welfare impacts associated with $PM_{2.5}$ and its likely precursors
- A discussion of how this proposed SIP revision relates to the State's other air quality goals

1.1 Fine Particulate Matter and its Associated Health Standards

Fine particulate matter in the atmosphere is composed of a complex mixture of particles: sulfate, nitrate, and ammonium particles; particle-bound water; black carbon (also known as elemental carbon); a great variety of organic compounds (or volatile organic compounds (VOCs)); and crustal material. Fine particulate matter, also known as $PM_{2.5}$, is referred to as "primary" if it is directly emitted into the air as a solid or liquid particle and its chemical form is stable. $PM_{2.5}$ formed near its source by condensation processes in the atmosphere is also considered primary $PM_{2.5}$. Primary $PM_{2.5}$ includes soot from diesel engines, a wide variety of organic compounds condensed from incomplete combustion, and compounds such as arsenic, selenium, and zinc that condense from vapor formed during combustion or smelting. The concentration of primary $PM_{2.5}$ in the air depends on source emission rates, transport and dispersion, and removal rate from the atmosphere.

$PM_{2.5}$ that is formed by chemical reactions of gases in the atmosphere is referred to as "secondary" $PM_{2.5}$. These reactions form condensable matter that either form new particles or condense onto other particles in the air. Most of the sulfate and nitrate and a

portion of the organic particles in the atmosphere are formed by such chemical reactions. As such, sulfur dioxide (SO_2), oxides of nitrogen (NO_x), some VOC,[1] and ammonia can be considered $PM_{2.5}$ precursors.[2] Secondary $PM_{2.5}$ formation depends on numerous factors including the concentrations of precursors; the concentrations of other gaseous reactive species such as ozone, hydroxyl radicals, peroxy radicals, or hydrogen peroxide; atmospheric conditions including solar radiation and relative humidity; and the interactions of the precursors and pre-existing particles with cloud or fog droplets or with the liquid film on solid particles. The United States Environmental Protection Agency (USEPA) recognizes that NO_x, SO_2, VOCs, and ammonia can precursors of $PM_{2.5}$ from a scientific perspective because these pollutants can contribute to the formation of $PM_{2.5}$ in the ambient air. The USEPA has established a policy regarding $PM_{2.5}$ precursors for planning and regulatory purposes in its $PM_{2.5}$ Implementation Rule,[3] which focuses on NO_x and SO_2 in the Eastern United States. For more information on this policy, see Chapter 3. The health and welfare impacts of $PM_{2.5}$ and its precursors are described in Section 1.2 of this Chapter.

The USEPA, under the authority of the federal Clean Air Act, identified $PM_{2.5}$ as a criteria air pollutant, and established National Ambient Air Quality Standards (NAAQS), for $PM_{2.5}$. Specifically, the Clean Air Act (42 U.S.C. § 7409(b)(1) (Section 109(b)(1)) requires the USEPA to set primary NAAQS "the attainment and maintenance of which…, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health." The Clean Air Act (42 U.S.C. § 7409(b)(2) (Section 109(b)(2)) further requires the USEPA to set secondary NAAQS "requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of such air pollutant in the ambient air." When an area does not meet the established NAAQS for a criteria pollutant, the area is subject to a formal designation process by the USEPA, which establishes the area as nonattainment for that pollutant.

1997 $PM_{2.5}$ NAAQS:

On July 18, 1997, the USEPA 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); and
- a daily (24-hour) $PM_{2.5}$ health-based standard of 65 micrograms per cubic meter ($\mu g/m^3$) (24-hour average).[4,5] (This has since been revised to 35 $\mu g/m^3$).

[1] According to the USEPA, high molecular weight organic compounds (typically 25 carbon atoms or more) are emitted directly as primary organic particles and exist primarily in the condensed phase at ambient temperatures. Accordingly, high molecular weight organic compounds are considered a primary $PM_{2.5}$ emission for the purposes of the $PM_{2.5}$ implementation program (72 Fed. Reg. 20592 (April 25, 2007)).
[2] 72 Fed. Reg. 20586-667 (April 25, 2007).
[3] 72 Fed. Reg. 20586-667 (April 25, 2007).
[4] 62 Fed. Reg. 38652-760 (July 18, 1997).
[5] The USEPA 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 Fed. Reg. 38652 (July 18, 1997)). In 2006, the USEPA revoked the annual PM_{10} standard (71 Fed. Reg. 61144 (October 17, 2006)). New Jersey was not designated in nonattainment of the PM_{10} NAAQS and continues to meet the revised PM_{10} standards.

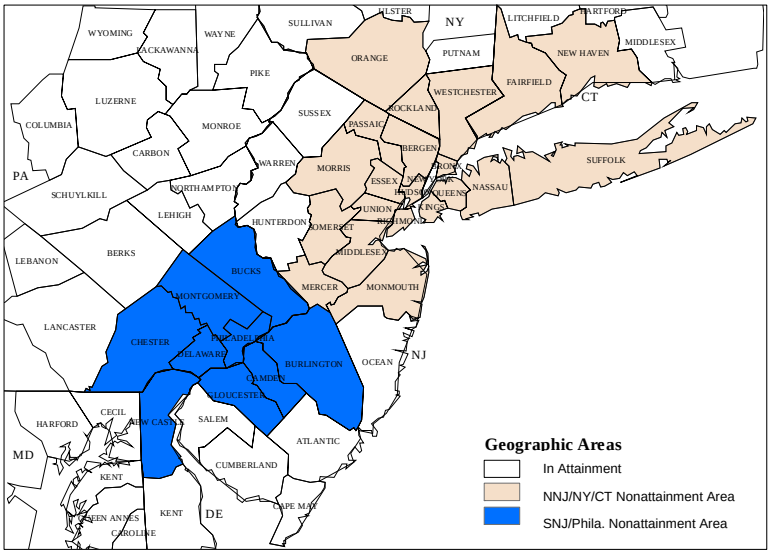
Simultaneously, the USEPA established secondary (welfare-based) $PM_{2.5}$ standards identical to the primary standards. These standards are hereafter referred to as the 1997 $PM_{2.5}$ standards. The USEPA set the $PM_{2.5}$ standards with 24-hour and annual averaging times to protect against effects 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.[6] Specifically, the USEPA'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 USEPA'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 USEPA's 1997 ambient air quality standards for $PM_{2.5}$.

Clear of all legal challenges, on December 17, 2004, the USEPA finalized attainment/nonattainment designations for the 1997 $PM_{2.5}$ standards, which became effective on April 5, 2005.[7] Thirteen of New Jersey's 21 counties were designated as nonattainment for the 1997 $PM_{2.5}$ standards, and are associated with two multi-state nonattainment areas (the Northern New Jersey/New York/Connecticut (NNJ/NY/CT) $PM_{2.5}$ nonattainment area and the Southern New Jersey/Philadelphia (SNJ/Phila.) $PM_{2.5}$ nonattainment area). Figure 1.1 shows New Jersey's 1997 $PM_{2.5}$ multi-state nonattainment areas.

[6] USEPA. 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.
[7] 72 Fed. Reg. 20586-667 (April 25, 2007).

Figure 1.1: New Jersey-Associated 1997 $PM_{2.5}$ Nonattainment Areas



These designations triggered the Clean Air Act (CAA) requirement, 42 U.S.C. § 7410(a)(1) (Section 110(a)(1)), that states submit attainment demonstrations for their nonattainment areas to the USEPA by no later than three years after the promulgation of a NAAQS. However, given the delays in finalizing the implementation of the 1997 $PM_{2.5}$ standards, the USEPA provided supplemental guidance requiring states to submit attainment demonstrations for their 1997 $PM_{2.5}$ nonattainment areas to the USEPA by no later than three years from the effective date of designation (that is, April 5, 2008).[8] The primary purpose of this proposed SIP revision is to meet that requirement for the 1997 annual $PM_{2.5}$ standard by presenting New Jersey's plan for attaining the annual $PM_{2.5}$ NAAQS by its attainment date of April 5, 2010.

2006 $PM_{2.5}$ Standards:

42 U.S.C. § 7409(d)[1] (Section 109(d)) requires the USEPA to review and, if appropriate, revise the NAAQS for each criteria air pollutant every five years. On October 16, 2006, the USEPA promulgated a revised $PM_{2.5}$ NAAQS, which became effective December 18, 2006.[9] This revised NAAQS did not result in any changes to the annual standard established in 1997 but resulted in a more stringent daily standard of 35 $\mu g/m^3$. The 2006 PM NAAQS retained the level of the annual standard of 15.0 $\mu g/m^3$. These standards are hereafter referred to as the 2006 $PM_{2.5}$ standards. Table 1.1 compares the 1997 and 2006 $PM_{2.5}$ standards.

[8] USEPA. Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, 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.

[9] 71 Fed. Reg. 61144-233 (October 17, 2006).

Table 1.1: 1997 and 2006 $PM_{2.5}$ Standards

	1997 $PM_{2.5}$ Standards	2006 $PM_{2.5}$ Standards
Primary Annual	15 $\mu g/m^3$	15 $\mu g/m^{3*}$
Primary Daily	65 $\mu g/m^3$	35 $\mu g/m^3$
Secondary Annual	15 $\mu g/m^3$	15 $\mu g/m^{3*}$
Secondary Daily	65 $\mu g/m^3$	35 $\mu g/m^3$

*The form of the annual standards changed with respect to the criteria for spatial averaging.

Although fine particulate concentrations have improved since December 2004, New Jersey recommended that the annual nonattainment boundaries for the 2006 annual standard remain the same as previously designated for the 1997 annual standard since the State continued to either exceed the 2006 annual $PM_{2.5}$ standard (which remained the same as the 1997 annual $PM_{2.5}$ standard) or contribute to an exceedance of that standard in an upwind area at the time these recommendations were due (see Figure 1.1).

As with the 1997 $PM_{2.5}$ standards, the USEPA must designate areas that are not attaining the 2006 $PM_{2.5}$ standards. In accordance with 42 U.S.C. § 7407(d)(1)(A) (Section 107(d)(1)(A)), of the Clean Air Act, each state is allowed to make recommendations to the USEPA on which areas of their state should be designated nonattainment with respect to any new NAAQS. For the 2006 $PM_{2.5}$ standards, states were required to submit their attainment/nonattainment recommendations by December 18, 2007. Although fine particulate concentrations have improved since December 2004, the air quality in several areas of New Jersey does not meet the 2006 24-hour $PM_{2.5}$ NAAQS (see Chapter 2) or contribute to an exceedance of that standard in an upwind area at the time these recommendations were due (see Figure 1.1). New Jersey recommended that the nonattainment boundaries designated for the 1997 annual $PM_{2.5}$ standard also apply for the 2006 24-hour $PM_{2.5}$ standard with one addition.[10] The State requested Knowlton Township in Warren County be designated nonattainment and be associated with the Allentown-Bethlehem-Easton $PM_{2.5}$ nonattainment area in Pennsylvania (which Pennsylvania has recommended include Lehigh and Northampton counties).[11] The final daily $PM_{2.5}$ designations will be issued by the USEPA by no later than December 18, 2008.

As the USEPA goes through the process of officially designating these areas as nonattainment for that new standard, New Jersey need not wait for those designations to address that new standard, particularly since it is the State's obligation to meet NAAQS as expeditiously as practical to protect human health and welfare. Therefore, New Jersey considered its need to meet this additional 2006 Federal standard in the near future when developing the action plan proposed in this proposed SIP revision to meet the 1997 $PM_{2.5}$

[10] For more information on New Jersey's nonattainment area recommendations, see the letter from NJDEP Commissioner Lisa P. Jackson to USEPA Regional Administrator Steinberg dated December 18, 2007. The letter is posted on the NJDEP's website at http://www.nj.gov/dep/baqp/pm25desig2007.pdf.

[11] PADEP. Recommendations to the U.S. EPA for 24-Hour Fine Particulate ($PM_{2.5}$) Attainment/Nonattainment Areas. Bureau of Air Quality, Pennsylvania Department of Environmental Protection, December 2007. Accessible at http://www.dep.state.pa.us/dep/deputate/airwaste/aq/attain/pm25des/2007_PM2.5_Attain-Non.pdf.

NAAQS. Hence, this proposed SIP revision, while focused on achieving the annual $PM_{2.5}$ NAAQS, will also make progress toward achieving the 24-hour $PM_{2.5}$ NAAQS.

In addition to the USEPA, some states, including New Jersey, have the authority to establish air quality standards. These state standards must either be equivalent to or more stringent than those established by the USEPA. While New Jersey has not taken official steps to establish its own air quality standards for $PM_{2.5}$, the NJDEP's air quality goal for an annual $PM_{2.5}$ standard is 12 $\mu g/m^3$. A goal of 12 $\mu g/m^3$ is a 20 percent reduction from the Federal annual $PM_{2.5}$ NAAQS established in 1997. New Jersey, in commenting on the USEPA's proposal for revising the $PM_{2.5}$ standard, argued that, given the preponderance of health studies cited in the USEPA Staff Paper, peer-reviewed and supported by the Clean Air Scientific Advisory Committee (CASAC), that suggest that significant segments of the Unites States population are experiencing adverse health effects from exposures to ambient concentrations of $PM_{2.5}$, even at levels below the annual standard of 15 $\mu g/m^3$, the USEPA should act decisively on this critical public health issue by decreasing the annual $PM_{2.5}$ health standard to 12 $\mu g/m^3$.[12] The USEPA subsequently decided to retain the annual standard of 15 $\mu g/m^3$. This goal also acknowledges that the California Air Resources Board's (CARB) revised California's annual $PM_{2.5}$ standard to 12 $\mu g/m^3$ (annual mean), which is more stringent than the Federal NAAQS established in 1997, and retained in 2006.[13,14] The CARB's establishment of a more stringent annual $PM_{2.5}$ health-based standard to provide greater public health protection gives reason to re-evaluate whether or not the Federal standard of 15 $\mu g/m^3$ is protective enough, given that no threshold had been established below which there are no health effects from exposure to particulate emissions. Achieving the NJDEP's goal of 12 $\mu g/m^3$ will provide greater protection of its citizens than would be achieved at 15 $\mu g/m^3$ ambient levels. The implication of adopting such a goal requires that New Jersey take aggressive action to ensure that $PM_{2.5}$ health and welfare impacts are alleviated as soon as possible.

1.2 Health and Welfare Impacts of $PM_{2.5}$ and $PM_{2.5}$ Precursors

1.2.1 Fine Particulate Matter

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;
- decreased lung function and difficulty breathing;

[12] Letter dated December 16, 2005 from then NJDEP Commissioner Bradley M. Campbell to USEPA Region II Administrator Stephen L. Johnson.

[13] CAEPA. Staff Report: Public Hearing to Consider Amendments to the Ambient Air Quality Standards for Particulate Matter and Sulfates. Prepared by the Staff of the Air Resources Board and the Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (CAEPA), May 3, 2002.

[14] Adopted in 2002, pursuant to the Children's Environmental Health Protection Act (Senate Bill 25, Senator Martha Escutia; Stats. 1999, Ch. 731, Sec. 3).

- asthma attacks; and
- serious cardiovascular problems, such as heart attacks and cardiac arrhythmia.[15,16,17]

The USEPA 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.[18] In addition, attainment of these standards would prevent hundreds of thousands of doctor visits, absences from work and school, and respiratory illnesses in children. Individuals particularly sensitive to fine particle exposure include older adults, people with heart and lung disease, and 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. Thus, some individuals particularly sensitive to fine particle exposure may be adversely affected by fine particle concentrations below those for even the revised 2006 annual and daily standards. Hence, the NJDEP intends to achieve cleaner air than the current NAAQS to increase health benefits.

Incorporating new scientific literature on premature mortality due to $PM_{2.5}$ exposure, an analysis of the relative risk of premature death in California attributed to $PM_{2.5}$ conducted by the California Air Resources Board demonstrated that 14,000 to 24,000 premature deaths (uncertainty range: 4,300 – 41,000) occur statewide each year.[19] These estimations were based upon the revised relative risk factor, a 10 percent increase in premature death per 10 mg/m^3 increase in $PM_{2.5}$ exposures (uncertainty interval: 3 to 20 percent), and the lowest threshold of ambient $PM_{2.5}$ which is associated with premature death, 7 mg/m^3 in a general population.

A particular concern for New Jersey with respect to $PM_{2.5}$ is its ability to aggravate asthma. The NJDEP has estimated that approximately 1,900 deaths and 53,000 cases of asthma in the State each year are attributable to exceedances of the $PM_{2.5}$ annual standard, with associated medical costs of approximately $15 billion.[20] According to the last Federal estimate (1998),[21] more than 600,000 New Jersey residents have asthma. In 2001, asthma sufferers in New Jersey accounted for nearly 14,000 hospital admissions,

[15] 62 Fed. Reg. 38652-690 (July 18, 1997).
[16] 72 Fed. Reg. 20586-87 (April 25, 2007).
[17] USEPA. 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.
[18] 62 Fed. Reg. 38652-690 (July 18, 1997).
[19] CARB. Methodology for Estimating Premature Deaths Associated with Long-term Exposures to Fine Airborne Particulate Matter in California, Draft Staff Report. California Air Resources Board, May 22, 2008. Available at http://www.arb.ca.gov/research/health/pm-mort/pm-mortdraft.pdf.
[20] State of New Jersey. Diesel Retrofit Program Rule Proposal. New Jersey Department of Environmental Protection, Office of Air Quality Management, Motor Vehicle Commission, and Department of the Treasury, December 18, 2006. Proposal Number: PRN 2006-409, DEP Docket Number: 22-06-11/559. Available at http://www.nj.gov/dep/aqm/Diesel%20Retrofit%20Program%20Rule%20Proposal.pdf.
[21] NJDHSS. Asthma in New Jersey. New Jersey Department of Health and Senior Services, February 2003.

roughly one out of every one hundred hospitalizations. In 1999, the deaths of 80 New Jersey residents were attributed to asthma. The Centers for Disease Control and Prevention estimate that 4.5 million children in the United States have asthma. According to the Pediatric/Adult Asthma Coalition of New Jersey (Coalition), "approximately 10-13% of New Jersey's students have asthma."[22] According to the New Jersey Department of Health and Senior Services, "children are more likely to be hospitalized with asthma than adults."[23] The risk of death from asthma increases considerably with age, with the 65-plus population having the highest rates.[24]

In addition to asthma, a recent report by the New Jersey Clean Air Council states that only smoking and obesity outrank particulate matter in the estimated number of premature deaths caused every year.[25] These statistics show that asthma is a significant health risk in the State but there are other serious health impacts from $PM_{2.5}$.

Although fine particulate matter generated from all sources can cause serious health impacts, particulate matter generated from diesel combustion is particularly harmful. 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 other toxic air pollutants.[26] Diesel exhaust contains many of the hazardous air pollutants that are prevalent in urban areas, such as acetaldehyde, acrolein, benzene, 1,3-butadiene, formaldehyde, and polycyclic aromatic hydrocarbons. The USEPA has recently identified diesel particulate matter and diesel exhaust organic gases as a Mobile Source Air Toxic and has classified diesel exhaust as a likely human carcinogen when inhaled at environmental exposures. The State of California also identified diesel particulate matter as a toxic air contaminant in 1998, based on its potential carcinogenicity and other health impacts.[27] Therefore, in addition to the premature mortality associated with the inhalation of fine particulate matter in general, diesel exhaust has an added cancer risk that makes exposure to it more detrimental to human health. In New Jersey, exposure to diesel PM poses the most cancer risk statewide by an

[22] State of New Jersey. Diesel Retrofit Program Rule Proposal. New Jersey Department of Environmental Protection, Office of Air Quality Management, Motor Vehicle Commission, and Department of the Treasury, December 18, 2006. Proposal Number: PRN 2006-409, DEP Docket Number: 22-06-11/559. Available at http://www.nj.gov/dep/aqm/Diesel%20Retrofit%20Program%20Rule%20Proposal.pdf.
[23] NJDHSS. Asthma in New Jersey Annual Update 2005. New Jersey Department of Health and Senior Services, September 2005. Available at http://www.state.nj.us/health/fhs/asthma/documents/asthma_update2005.pdf.
[24] State of New Jersey. Diesel Retrofit Program Rule Proposal. New Jersey Department of Environmental Protection, Office of Air Quality Management, Motor Vehicle Commission, and Department of the Treasury, December 18, 2006. Proposal Number: PRN 2006-409, DEP Docket Number: 22-06-11/559. Available at http://www.nj.gov/dep/aqm/Diesel%20Retrofit%20Program%20Rule%20Proposal.pdf.
[25] Clean Air Council of New Jersey. Public Hearing – Fine Particulate Matter in the Atmosphere: Health Impacts in NJ & Need for Control Measures, April 2004. Available at http://www.state.nj.us/dep/cleanair.
[26] USEPA. 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.
[27] CARB. Summary of Adverse Impacts of Diesel Particulate Matter. Air Resources Board, California Environmental Protection Agency, July 2005. http://www.arb.ca.gov/research/diesel/diesel_health_effects_summary_7-5-05-1.pdf, accessed December 19, 2007.

order of magnitude; formaldehyde, which is also emitted by engines, poses the next most cancer risk.[28]

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 (between 0 and 2.5 $\mu g/m^3$), 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 these small particles enter deeply into the lung. Studies have shown that ultra-fine particles are so small that they are capable of penetrating the lungs and other tissue all the way to a cellular level, where they may induce structural damage in the body's core building blocks.

In addition to health effects, particulate matter is the major cause of reduced visibility in many parts of the United States. Visibility impairment caused by the collection of air pollutants (primarily $PM_{2.5}$) emitted by sources over a broad geographic area is known as regional haze.[29] See Section 1.3.5 for more information on visibility and regional haze initiatives. Other welfare impacts from direct $PM_{2.5}$ pollution include harmful effects to vegetation and ecosystems (e.g., sedimentation and loss of biodiversity), contributions to the formation of acid rain (e.g., making soils, lakes and streams more acidic), aesthetic damage to manmade structures, and damages to sensitive forests and farm crops.[30] Excessive fine particles in the air also alter the amount of radiation that penetrates the Earth's atmosphere, affecting the Earth's climate.[31] Of special concern, black carbon increases global warming.

1.2.2 Sulfur Dioxide (SO_2)

Sulfur dioxide, or SO_2, contributes to the formation of fine particulates. SO_2 belongs to the family of sulfur oxide gases (SO_x). Sulfur is prevalent in raw materials such as crude oil, coal, and metal ores. SO_x gases are formed when fuels containing sulfur, such as coal and oil, are burned, when gasoline is extracted from oil, or when metals are extracted from ore. The sulfur is then oxidized and emitted as SO_x gases. SO_2 can be oxidized to form sulfuric acid in three ways: by the hydroxyl radical (OH) to form sulfuric acid, by dissolving in cloud water and oxidized by various oxidants to form sulfuric acid, or by the reactions that take place in the particle-bound water in the aerosol particles.[32] Sulfate can exist in particles as sulfuric acid, and sulfate is an important contributor to increased concentrations of $PM_{2.5}$ around the country.

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[28] NJDEP. New Jersey Statewide Average 1999 NATA Modeled Air Concentrations Compared to Health Benchmarks. New Jersey Department of Environmental Protection, November 21, 2006, http://www.nj.gov/dep/airtoxics/nj.htm, accessed January 18, 2008.
[29] 64 Fed. Reg. 35714 (July 1, 1999).
[30] USEPA. Health and Environment, Particulate Matter. United States Environmental Protection Agency, http://www.epa.gov/air/particlepollution/health.html, accessed November 8, 2007.
[31] 71 Fed. Reg. 61203 (October 17, 2006).
[32] 72 Fed. Reg. 20594-20595 (April 25, 2007).

SO_2 dissolves in water vapor to form acid and interacts with other gases and particles in the air to form sulfate particles and other products that can be harmful to people and the environment. SO_2 and the pollutants formed from SO_2, such as sulfate particles, can be transported over long distances and deposited far from the point of origin, contributing to air quality problems far beyond the areas where they were emitted. The associated health effects with exposure to SO_2 include increased respiratory disease, aggravated existing heart disease, and temporary breathing difficulty, particularly for people with asthma.[33] The elderly and children are at highest risk of health effects from exposure to SO_2.

With respect to environmental effects, SO_2 harms vegetation and ecosystems, contributes to the formation of acid rain (e.g., making soils, lakes, and streams more acidic), and damages trees, crops, buildings, and monuments.

1.2.3 Oxides of Nitrogen (NO_x)

NO_x is a gas-phase precursor that contributes to the formation of $PM_{2.5}$. Oxides of nitrogen consist of a mixture of gases comprised mostly of nitric oxide (NO) and nitrogen dioxide (NO_2).[34] These gases are emitted from the exhaust of motor vehicles, the burning of coal, oil or natural gas, and during industrial processes such as welding, electroplating, and dynamite blasting. Although most NO_x is emitted as NO, it is readily converted to NO_2 in the atmosphere. The primary processes developed in the past century that convert unreactive nitrogen to reactive nitrogen are the manufacture of fertilizer, the combustion of fossil fuels, and the planting of nitrogen-harnessing croplands.[35] The oxidation of atmospheric N_2 during combustion is the source of most of the atmospheric NO_x (i.e., NO, nitrous oxide (N_2O), and NO_2).[36] NO_2 is a reddish-brown, highly reactive gas that is formed in the air through the oxidation of NO. In the troposphere, near the Earth's surface, NO_2, provides the primary source of the oxygen atoms required for ozone formation.

In addition to contributing to the formation of $PM_{2.5}$ and ozone, NO_x is also harmful if directly inhaled. Long-term exposure to elevated levels of NO_x causes damage to the mechanisms that protect the human respiratory tract and can increase a person's susceptibility to, and the severity of, respiratory infections and asthma.[37] Long-term exposure to high levels of NO_x can cause chronic lung disease and may also affect

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[33] USEPA. Health and Environmental Impacts of SO_2. United States Environmental Protection Agency, http://www.epa.gov/oar/urbanair/so2/hlth1.html, accessed November 9, 2007.
[34] NJDEP. 2005 Nitrogen Dioxide Summary, 2005 Air Quality Monitoring Report. New Jersey Department of Environmental Protection, Bureau of Air Monitoring, 2006.
[35] Aber et al. Nitrogen pollution: sources and consequences in the U.S. Northeast. High Beam Encyclopedia from Environment, September 1, 2003. Accessed at http://www.encyclopedia.com/doc/1G1-107217746.html.
[36] Hemond, H. F. and Fechner-Levy, E. J. Chemical Fate and Transport in the Environment, Second Edition. Academic Press: New York, 2000, pg. 292.
[37] Queensland Government EPA. Nitrogen Oxides. Queensland Government Environmental Protection Agency, Queensland Parks and Wildlife Service, December 31, 2006, http://www.epa.qld.gov.au/environmental_management/air/air_quality_monitoring/air_pollutants/nitrogen_oxides/, accessed January 2, 2007.

sensory perception. Other health effects of exposure to NO_x include shortness of breath and chest pains.

In addition to harmful health impacts, NO_x is also harmful to the environment. It combines with other pollutants to form ozone and acid rain that harms vegetation and ecosystems.[38] Acid rain causes deterioration of cars, buildings, and historical monuments and causes lakes and streams to become acidic and unsuitable for many fish. NO_x contributes to nutrient overload that impairs water quality, leads to oxygen depletion, and reduces fish and shellfish populations. It also contributes to global warming.

1.2.4 Other $PM_{2.5}$ Precursors – Volatile Organic Compounds and Ammonia

On April 25, 2007, the USEPA established a policy for which $PM_{2.5}$ precursors needed to be considered for $PM_{2.5}$ planning and regulatory purposes at this time. This policy specifically exempts volatile organic compounds (VOCs) and ammonia (NH_3) from consideration as precursors unless a state can make a compelling argument for including either of these precursors. For more information on the USEPA's precursor policy, see Chapter 3. Even though New Jersey and the states that share its associated nonattainment areas agree with the USEPA's precursor policy regarding VOC and ammonia, the NJDEP is providing a discussion of the health effects associated with VOCs and ammonia.

NJDEP is already regulating VOC emissions as a precursor to ozone. Additionally, high molecular weight organic compounds (typically 25 carbon atoms or more) are emitted directly as primary organic particles and exist primarily in the condensed phase at ambient temperatures. Accordingly, high molecular weight organic compounds are not volatile in nature, and are regulated as primary $PM_{2.5}$ emissions for the purposes of the $PM_{2.5}$ implementation program. The low molecular weight organic compounds are VOCs, as they are chemicals or mixtures of chemicals that evaporate easily at room temperature. They include compounds known as hydrocarbons, which only contain carbon and hydrogen, and carbonyls, which contain a carbon atom double-bonded to an oxygen atom. VOCs can be found in both indoor and outdoor environments, and some VOCs are more harmful than others. Sources of VOCs include vehicle and industrial exhaust; the evaporation of gasoline; and a variety of consumer products from paints, solvents, and adhesives to carpeting, deodorants, cosmetics, hair products, and cleaning fluids; as well as biogenic (naturally occurring) emissions.

In addition to contributing to the formation of $PM_{2.5}$ and ozone, many VOCs are also considered air toxics and are harmful if directly inhaled, depending upon the concentration. Long-term exposure to low concentrations of some VOCs includes elevation of serum enzyme levels, mild cellular changes, and changes in lipid metabolism. At higher concentrations, breathing VOCs may cause irritation of the respiratory tract.[39] Acute effects include eye irritation/watering, nose irritation, throat

[38] USEPA. Health and Environmental Impacts of NO_x. United States Environmental Protection Agency, http://www.epa.gov/air/urbanair/nox/hlth.html, accessed November 8, 2007.
[39] CDPHE. Volatile Organic Compounds Health Effects Fact Sheet. Colorado Department of Public Health and Environment, November 2000, http://www.cdphe.state.co.us/hm/schlage/vocfactsheet.pdf.

irritation, headaches, nausea/vomiting, dizziness and asthma exacerbation. Chronic effects include cancer, liver damage, kidney damage and central nervous system damage.[40] In addition, some VOCs are substances that cause serious health effects, including cancer, birth defects, nervous system problems and death due to massive accidental releases.[41] See Section 1.3 for more information about New Jersey initiatives to address air toxics.

VOCs also negatively impact the environment. The most significant environmental impact of VOCs is their contribution to the formation of ozone. VOCs can also form PM (specifically, secondary organic aerosol (SOA)).[42] The significance of organic compounds to the formation of SOA depends upon emissions from local sources, atmospheric chemistry, and the season. Studies have shown that SOA can be a major component of carbonaceous PM in the summer due to the warmer temperatures increasing the chemical reaction rates. The environmental impacts of $PM_{2.5}$ are discussed earlier in this Section. In addition, vegetation is a source of biogenic VOCs, and these naturally occurring VOCs contribute to the haze aerosols formed over forested areas.[43] VOCs from emission sources can accumulate in plants and have detrimental impacts to protective mechanisms, which then can affect the entire ecosystem.

Ammonia (NH_3) is a gaseous pollutant that can also contribute to the formation of $PM_{2.5}$. Ammonia emissions come from natural and anthropogenic sources. Emission inventories for ammonia are considered to be among the most uncertain of any species related to PM. In addition, though recent studies have improved our understanding of the role of ammonia in aerosol formation, ongoing research is required to better describe the relationships between ammonia emissions, particulate matter concentrations, and related impacts. The control techniques for ammonia and the analytical tools to quantify the impacts of reducing ammonia emissions on atmospheric aerosol formation are both evolving. Area-specific data are needed to evaluate the effectiveness of reducing ammonia emissions on reducing $PM_{2.5}$ concentrations in different areas, and to determine where ammonia decreases may increase the acidity of particles and precipitation.[44] For instance, reducing ammonia emissions where sulfate concentrations are high may increase the acidity of particles and precipitation, which can be associated with adverse health effects and increased concentrations of secondary organic compounds.

Exposure to high levels of ammonia in the air may cause skin, eye, throat, and lung irritation, and may also cause burns and coughing.[45] Extremely high concentrations of ammonia may lead to lung disease and death. Individuals with asthma are more sensitive

[40] MDH. Volatile Organic Compounds – VOCs Fact Sheet. Minnesota Department of Health (MDH), http://www.health.state.mn.us/divs/eh/indoorair/voc/, September 2005.
[41] USEPA. The Plain English Guide to the Clean Air Act. United States Environmental Protection Agency, Air and Radiation (ANR-443), EPA 400-K-93-001, April 1993.
[42] 72 Fed. Reg. 20592-93 (April 25, 2007).
[43] USEPA. Air Quality Criteria for Particulate Matter, Volume I of II. United States Environmental Protection Agency, October 2004, EPA/600/P-99/002aF.
[44] 72 Fed. Reg. 20591 (April 25, 2007).
[45] ATSDR. ToxFAQs™: Ammonia. Agency for Toxic Substances and Disease Registry, September 2004, accessed June 27, 2007.

to ammonia exposure. Ammonia serves an important role in neutralizing acids in clouds, precipitation and particles. In particular, ammonia neutralizes sulfuric acid and nitric acid, the two key contributors to acid deposition (acid rain), forming sulfates and nitrates in the process. Deposited ammonia also can contribute to problems of eutrophication in water bodies, and deposition of ammonium particles may effectively result in acidification of soil as ammonia is taken up by plants.

1.3 Integrating $PM_{2.5}$ with Other Air Quality Goals

As discussed in Section 1.0, attaining and maintaining the 1997 $PM_{2.5}$ standards is one of many interrelated air quality goals that New Jersey is striving to achieve. The actions included in this proposed SIP revision are part of the State's overall plan for reducing PM-related emissions. The remainder of this Section discusses in detail other PM-related actions anticipated in the near future or already in place that comprise the rest of the State's overall plan for reducing PM-related emissions.

1.3.1 Environmental Justice in New Jersey

While unhealthy air quality can negatively impact human health throughout the northeastern United States and New Jersey, these health risks are higher for populations living near roadways and in urban areas. Improving air pollution in these affected areas is one of the NJDEP's greater challenges, particularly since many of the areas that are currently targeted for redevelopment throughout the State are located in New Jersey's urban communities. New Jersey is committed to revitalizing these urban areas by mitigating a legacy of environmental degradation, including air pollution, and the resulting adverse consequences to public health and the environment to ensure that all people, regardless of race, color, national origin, or income, live in vibrant communities that are safe from environmental pollution. The actions proposed in this SIP revision will help New Jersey meet this commitment by working to reduce $PM_{2.5}$ emissions from the mobile and industrial sources impacting New Jersey's urban areas.

As stated in Section 1.2.1, the health effects associated with exposure to fine particulate matter are significant, and epidemiological studies have shown a significant correlation between elevated fine particle levels and premature mortality. Other significant health impacts include aggravating existing heart and lung diseases, increasing asthma attacks, and emergency room visits. Urban residents in particular are regularly exposed to greater amounts of $PM_{2.5}$ from multiple local sources, including heavy-duty diesel truck traffic, congested roads, industrial and commercial operations, airports, marine ports, trains, and, junk yards. These sources all contribute to the formation of localized high levels of air pollution.

New Jersey's 2004 Environmental Justice Executive Order #96[46] recognizes these significant health impacts, especially the disproportionate increase in childhood asthma for Black and Latino/Hispanic children in urban communities, and the link of this

[46] NJDEP. Environmental Justice Program. New Jersey Department of Environmental Protection, http://www.nj.gov/dep/ej/ejeo.pdf , accessed September 19, 2007.

increase, in part, to poor air quality. Further, the Executive Order #96 charges the NJDEP and the New Jersey Department of Transportation (NJDOT) to "develop a coordinated strategy for reducing the public's exposure to fine particulate pollution in affected communities, particularly from diesel emissions from stationary and mobile sources."

As discussed further in Section 1.3.2, the NJDEP is working with the USEPA on a number of national air toxic reduction programs. To address disproportionate impacts of air toxic hazards across urban areas on highly exposed population subgroups, and predominately minority and low-income communities,[47] the NJDEP is developing methods and strategies to assess air impacts from multiple sources at the community scale. These strategies build upon the pilot projects that were initiated in Camden and Paterson, two of New Jersey's most urbanized areas, which assessed community scale air impacts. The NJDEP is also committed to assessing technical and policy options to address the cumulative impact of multi media exposure (beyond air pollution exposure) at the local level. Reducing $PM_{2.5}$ concentrations in urban areas will help address environmental justice.

1.3.2 Air Toxics

The efforts to reduce $PM_{2.5}$ and its precursors in this proposed SIP revision will benefit the efforts to reduce the concentrations of air toxics, e.g., diesel particulates, in the State. Sources of particulate air toxics are the same as some of the sources of $PM_{2.5}$ and $PM_{2.5}$ precursors, i.e., traditional industrial and utility sources, smaller manufacturing and commercial sources, mobile sources (e.g., cars, trucks, buses, and trains), residential activities (such as oil burning for home heating), and construction equipment.[48] Several State and federal initiatives to reduce the public's exposure to the health impacts of air toxics have multi-pollutant benefits. New Jersey is taking action in local communities to address severe air quality issues.

The NJDEP generally divides air pollutants that it regulates into two broad categories: criteria pollutants and air toxics. The USEPA has established National Ambient Air Quality Standards (NAAQS) for six criteria pollutants (ozone, particulate matter, carbon monoxide, sulfur dioxide, nitrogen dioxide and lead). For the State's regulatory purposes, other air pollutants that are not criteria pollutants, and that are emitted into the air in quantities that may cause cancer or other adverse health effects, are classified as air

[47] USEPA. Fact Sheet, The Air Toxics Strategy. United States Environmental Protection Agency, http://www.epa.gov/ttn/uatw/urban/strategyfs0303.pdf, accessed November 28, 2007.

[48] In addition to these sources, diesel engines emit a complex mixture of air pollutants, composed of both solid and gaseous material, the visible portion of which is known as particulate matter. Diesel particulate matter includes many carbon particles (also called soot), as well as gases that become visible as they cool. The major sources of diesel particulate matter are onroad and nonroad vehicles powered by diesel engines; however, diesel engines are also used in construction vehicles, agricultural equipment, trains, marine vessels, and stationary diesel electric generators.

toxics.[49] These broad categories are not mutually exclusive, as there is overlap between air toxics and criteria pollutants. For example, many of the VOCs that contribute to the formation of ozone and, as discussed later in this Section, can also contribute to the formation of $PM_{2.5}$, are also air toxics. Additionally, particulate matter can be air toxics or a "carrier" for certain air toxics that adhere to the particle itself, as is the case with diesel emissions. Lead (Pb) is considered both an air toxic and a criteria pollutant. Given this overlap, efforts to reduce the concentrations of $PM_{2.5}$ and its precursors in this proposed SIP revision will also benefit the efforts to reduce many air toxics.

Supporting the effort to achieve lower emissions of $PM_{2.5}$ and its precursors, the NJDEP has a multi-pronged approach to decreasing air toxic emissions, including PM and PM precursors in the State:

1. Permit Review: A combination of control technology (e.g., maximum achievable control technology (MACT) standards) and risk assessment requirements employed in the air permitting process.
2. Voluntary Reductions: Initiatives that encourage facilities to reduce air toxics emissions through Pollution Prevention opportunities, Right-to-Know, and similar disclosure and compliance assistance programs.
3. Traditional Pollutant Control Programs: Air toxics reductions that result from direct regulation or as a side-benefit of control programs that address ozone precursors, particulate matter, and other pollutants (e.g., point, area, and mobile source controls)
4. Air Toxics Initiatives: Risk assessments, dry cleaners, other projects.

Several of these programs address direct $PM_{2.5}$ and $PM_{2.5}$ precursors, and can be found in Chapter 4 (Control Measures); specifically, the National Low Emission Vehicle Program (NLEV), Nonroad Diesel Engine Standards, and New Jersey's Enhanced Inspection and Maintenance (I/M) Program. The projects conducted by the NJDEP Air Toxics Program also help to reduce $PM_{2.5}$ emission levels in New Jersey. The Camden Waterfront South Air Toxics Pilot Project, a project that began in 2002, was designed to develop tools to assess air quality problems in a community (with a focus on air toxics). In addition, the Urban Community Air Toxics Monitoring Project in Paterson City, New Jersey (UCAMPP) is a multi-faceted air quality monitoring and modeling project.

On a national level, under the Federal Clean Air Act Amendments of 1990, the USEPA is required to adopt a number of national air toxic reduction programs. The NJDEP works with USEPA to implement these programs in New Jersey. Two of these programs are the adoption of MACT standards for large sources (such as chemical manufacturing), and the Integrated Urban Air Toxics Strategy and generally available control technology (GACT) for small sources (such as hospital sterilizers). To date, the USEPA has promulgated 96 MACT emission standards, some of which were included in the photochemical modeling used to demonstrate attainment of the 1997 $PM_{2.5}$ NAAQS (See Chapter 5). The USEPA

[49] The USEPA also refers to air toxics as hazardous air pollutants (HAPS), which are listed under 42 U.S.C. § 7412 (Section 112). (USEPA. About Air Toxics. United States Environmental Protection Agency, June 6, 2007, http://www.epa.gov/ttn/atw/allabout.html, accessed January 4, 2008.)

is under a court ordered schedule to promulgate standards for 50 area source categories by June 15, 2009, which will also help to reduce direct $PM_{2.5}$ and $PM_{2.5}$ precursor emissions. Released by the USEPA in July 1999 and discussed in Section 1.3.1, the Integrated Urban Air Toxics Strategy is a framework for addressing air toxics in urban areas from stationary, mobile, and indoor sources.[50] It complements the MACT and GACT standards and other aspects of national air toxics initiatives.

With respect to mobile sources, the USEPA finalized the rule "Control of Hazardous Air Pollutants from Mobile Sources in early 2007."[51] This program will lower emissions of air toxics by lowering the benzene (a potential ozone and $PM_{2.5}$ precursor) content of gasoline. The USEPA has required or proposed controls for new construction vehicles, agricultural equipment, trains, and marine vessels (see Chapter 4). The USEPA conducts voluntary programs for reduction of diesel emissions, which include Clean School Bus USA, the Voluntary Diesel Retrofit Program, and the National Clean Diesel Campaign.

1.3.3 Greenhouse Gases and Climate Change

New Jersey is planning to reduce New Jersey's carbon footprint and is pushing for mandatory federal action to combat global climate change. All of the measures currently planned to combat Global Warming (and discussed in this section) will not only reduce greenhouse gas emissions, but will also have supplemental benefits of reducing $PM_{2.5}$ and $PM_{2.5}$ precursor emissions, including NO_x and SO_2, as well as other air contaminants. Reducing atmospheric $PM_{2.5}$ levels could also help to slow global warming, because some particles result in darkening effects on snow and ice, which causes those areas to absorb sunlight rather than reflect it.

On February 13, 2007, Governor Jon S. Corzine signed an Executive Order to adopt proactive goals for the reduction of greenhouse gas emissions in New Jersey. [52] The order calls for reducing greenhouse gas emissions to 1990 levels by 2020, an approximately 20 percent reduction from 2006, followed by a further reduction of emissions to 80 percent below 2006 levels by 2050. These provisions were enacted into law under the Global Warming Response Act in New Jersey on July 6, 2007, making New Jersey the third state in the nation to make greenhouse gas reduction goals law.[53]

New Jersey is playing a leadership role in the Regional Greenhouse Gas Initiative (RGGI), a ten-state cooperative effort to implement a regional mandatory cap-and-trade program in the Northeast and Mid-Atlantic, addressing CO_2 emissions from power plants.

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[50] USEPA. Urban Strategy. States Environmental Protection Agency, August 9, 2007, http://www.epa.gov/ttn/atw/urban/urbanpg.html, accessed January 4, 2008.
[51] USEPA. Mobile Source Air Toxics. United States Environmental Protection Agency, http://www.epa.gov/otaq/toxics.htm, accessed November 5, 2007.
[52] State of New Jersey Office of the Governor. Governor Calls for Sweeping Reduction of Greenhouse Gas Emissions in New Jersey. Available at http://www.nj.gov/governor/news/news/approved/20070213a.html. February 13, 2007.
[53] State of New Jersey Office of the Governor. Governor Signs Global Warming Response Act. Available at http://www.nj.gov/globalwarming/home/news/approved/070706.html. July 7, 2007.

As the first mandatory market-based program to reduce carbon emissions in the U.S., the program will cap regional power plant CO_2 emissions.

Other New Jersey greenhouse gas initiatives include standards for new automobiles and light trucks, the implementation of renewable portfolio standards, and an Energy Master Plan. New Jersey is continuing its interagency planning process that will culminate in the Energy Master Plan, a long-term energy vision for the state that plans for the State's energy needs through 2020.[54] Goals include 20 percent of the electricity used in the State to come from Class One renewable energy sources by the Year 2020 and to reduce future electricity consumption by 20 percent from projected 2020 consumption levels.

1.3.4 8-Hour Ozone

Given the fact that both NO_x and VOCs have the potential to generate ozone and $PM_{2.5,}$[55] the Northeastern states and associated regional agencies considered the impact on all four ozone and $PM_{2.5}$ related pollutants (NO_x, VOC, SO_2, and direct $PM_{2.5}$) in selecting control measures. These control measures were considered for inclusion in the modeling analysis used in New Jersey's (and the other states') attainment demonstration of the 8-hour ozone NAAQS,[56] anticipating the need for a comprehensive modeling analysis that could be used in both the 8-hour ozone and 1997 $PM_{2.5}$ attainment demonstrations. For example, a control measure that reduces NO_x will achieve the benefit of reducing both ozone and $PM_{2.5}$ concentrations since NO_x is a precursor for both pollutants. The control measures used in this modeling analysis are listed in Table 4.5, and discussed in detail in Chapter 4. For more information about the overlap and impact of the implementation of "ozone measures" on $PM_{2.5}$ levels throughout the region, see Chapter 5. For more information about New Jersey's efforts to attain the 8-hour ozone NAAQS, refer to its 8-Hour Ozone Attainment Demonstration SIP.[57]

1.3.5 Regional Haze

The Federal Clean Air Act protects Class I areas, which are usually large parks and wilderness areas,[58] from visibility impairment due to anthropogenic (manmade) sources

[54] State of New Jersey Office of the Governor. Governor Corzine Announces Initial Phase of Energy Master Plan. Available at http://www.nj.gov/governor/news/news/approved/20061003.html. October 3, 2006.

[55] Ozone is a highly reactive gas. In the troposphere, it is formed by complex chemical reactions involving oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight. Similar to the $PM_{2.5}$ precursors, NO_x and VOC are precursors to ozone.

[56] On October 29, 2007, New Jersey submitted its 8-hour ozone SIP revision to the USEPA for approval. Refer to the letter dated October 29, 2007 from then NJDEP Commissioner Lisa P. Jackson to USEPA Region II Administrator Alan J. Steinberg. Available at http://www.nj.gov/dep/baqp/8hrsip/commissioner's%20letter.pdf .

[57] NJDEP. State Implementation Plan (SIP) Revision for the Attainment and Maintenance of the Ozone National Ambient Air Quality Standard: 8-Hour Ozone Attainment Demonstration, Final. New Jersey Department of Environmental Protection, October 29, 2007.

[58] 64 Fed. Reg. 35715 (July 1, 1999): Areas designated as mandatory Class I Federal areas are those national parks exceeding 6000 acres, wilderness areas and national memorial parks exceeding 5000 acres, and all international parks which were in existence on August 7, 1977.

(42 U.S.C. § 7491 (Section 169A)).[59] The Clean Air Act requires the USEPA to establish regulations to abate regional haze and increase visibility in those areas to protect the scenic vistas. Visibility impairment caused by the collection of air pollutants emitted by sources over a broad geographic area is known as regional haze. Some particles and gases can either absorb or scatter light causing an effect known as "light extinction." A hazy condition is created as a result of these processes. The USEPA first promulgated regulations for regional haze in 1980. These regulations were updated and took effect on August 30, 1999.[60] The regional haze regulations were promulgated to accomplish the integration of air quality management planning for multiple pollutants, i.e., particulate matter (PM) and ozone,[61] recognizing that these pollutants have common precursors, emission sources, atmospheric processes, transport issues, and geographical areas of concern. The regional haze regulations require that states develop plans to protect 156 Class I areas. New Jersey is home to a federally protected Class I area, which is the Brigantine Wilderness Area of the Edwin B. Forsythe National Wildlife Refuge. The control measures contained within the State's regional air quality protection plan, designed to improve visibility in New Jersey's Class I area and other downwind Class I areas, will also help to reduce direct $PM_{2.5}$ and $PM_{2.5}$ precursors, since $PM_{2.5}$ is the primary component of regional haze.

The plans for regional haze occur in phases to achieve periodic goals. The first regional haze air quality protection plan for New Jersey will be completed this year. This first regional haze air quality protection plan must establish progress goals and control strategies through 2018. New Jersey must supplement its regional haze air quality protection plan to show reasonable progress every five years beginning in 2013. Beginning in 2018 and every 10 years thereafter, the State must reevaluate and revise its regional haze air quality protection plan and submit the revised plan to the USEPA. The final goal of the federal regional haze regulations is to achieve natural visibility conditions by 2064. New Jersey expects to propose its Regional Haze SIP around the same time as it proposes this $PM_{2.5}$ SIP. This proposal will be based on control measures and modeling developed through the Mid-Atlantic/Northeast Visibility Union (MANE-VU) regional organization. The MANE-VU process and control measure development is discussed in detail in Chapters 4 and 5.

[59] Other sections of the Federal Clean Air Act that are part of the visibility protection program include 42 U.S.C. §§ 7492 and 7410(a)(2)(J) (Sections 169B and 110(a)(2)(J)).
[60] On June 15, 2005, the USEPA published its final amendments to its July 1999 Regional Haze Rule (70 Fed. Reg. 39104-72 (July 6, 2005)).
[61] 64 Fed. Reg. 35714-74 (July 1, 1999).