

**Recommendations in support of primary  
fine particle National Ambient Air Quality Standards  
to protect northeastern populations**



July 1, 2005

## Executive Summary

The U.S. Environmental Protection Agency (EPA) is currently re-examining health-based particulate matter (PM) air quality standards, with a final decision scheduled for December 20, 2005. Recent health studies have found that U.S. populations are experiencing adverse effects at or below present standards for particles 2.5  $\mu\text{m}$  in diameter or less (PM<sub>2.5</sub>), which can be inhaled into the deep lung. In addition, the existence or non-existence of a threshold level below which health effects are not detectable has not been determined. Adverse health effects include total and cardiorespiratory mortality, hospital admissions, emergency room visits and other medical visits for various respiratory or cardiovascular diseases, respiratory illness and symptoms, and lung function changes. In view of the Clean Air Act's mandate to protect public health—including susceptible populations—with an adequate margin of safety, EPA, the Clean Air Scientific Advisory Committee (CASAC), and NESCAUM find that epidemiologic and risk assessment evidence support more stringent PM<sub>2.5</sub> standards.

Whether EPA's revised standards will adequately protect public health in the northeastern U.S. is not certain, as the range under consideration varies in stringency level and leaves open the possibility of an improved but still insufficient PM standard. NESCAUM's analysis finds that a large fraction of the New England/NJ/NY population is susceptible or vulnerable to PM air pollution based on disease condition, age, and exposure status indicators. While all populations will benefit from lower PM levels, populations at increased risk that would especially benefit from stringent standards include the 4-18% of the total population of adults with cardiopulmonary or diabetes health conditions, the 12-15% of the total population of children with respiratory allergies or lifetime asthma, and the 38% of the total population who are younger than 18 years or 65 years and older. The population density of the region is among the highest in the nation, with over 30 million persons (70%) living in urban areas that experience the region's highest PM levels, which give rise to heightened exposure scenarios.

NESCAUM believes matching 24-hr and annual levels on the lower end of EPA and CASAC's current range of suggested standards are necessary to protect public health across the 8-state region. Our Board of Directors advocate for a 24-hr standard of 30  $\mu\text{g}/\text{m}^3$  (98<sup>th</sup> percentile form) and an annual standard of 12  $\mu\text{g}/\text{m}^3$ . Within EPA and CASAC's currently recommended primary PM<sub>2.5</sub> standard ranges, unless a 30  $\mu\text{g}/\text{m}^3$  or lower 24-hr (98<sup>th</sup> form) standard combination is selected a substantial percentage of urban monitors in the NESCAUM region will receive fewer nonattainment designations—and therefore less ability to reduce emissions to protect populations with an adequate margin of safety—than the U.S. Given that intervention studies in the U.S. and other countries have related reductions in ambient PM to observed improvements in respiratory or cardiovascular health, incrementally more stringent standards would offer the expectation of increased public health protection from PM<sub>2.5</sub> exposures. A requirement to reduce current emissions of PM<sub>2.5</sub> and its precursors to meet a 12/30  $\mu\text{g}/\text{m}^3$  standard would result in 84% of the NESCAUM region's population directly benefiting from improved air quality due to emission control strategies, including about five times more people in susceptible subgroups than at current standard levels. The Board recognizes the considerable implications of promoting standards that will place the majority of the region's counties into PM<sub>2.5</sub> nonattainment. Nonetheless, NESCAUM believes this is the correct public health action.

## Background

The Clean Air Act calls on the Environmental Protection Agency (EPA) to reassess National Ambient Air Quality Standards (NAAQS) every five years. EPA last revised its particulate matter NAAQS in 1997, creating new 24-hr and annual standards for fine particulate matter 2.5 micrometers or less in diameter (PM<sub>2.5</sub>). At present, EPA is reviewing PM standards for both fine and coarse particles. Agency staff completed the Final PM Staff Paper and Risk Assessment on June 30, 2005 and the Administrator will publish his final decision on December 20, 2005.

During the past two years, NESCAUM staff has worked to define the range of 24-hr and annual primary fine particle standards that the Northeast states might want to advocate for in the national debate. At the November 2004 NESCAUM Board of Directors Meeting, the Board reached a recommendation advocating for a 24-hr average standard of 30 µg/m<sup>3</sup> (98<sup>th</sup> percentile form) and an annual standard of 12 µg/m<sup>3</sup>. This white paper summarizes current health effects evidence of PM, provides context relating to PM standard setting, and presents the rationale guiding the Directors' recommendation for more stringent PM<sub>2.5</sub> NAAQS.

## Health effects

The large body of scientific evidence accumulated over the last decade shows that significant health effects occur from exposure to ambient PM<sub>2.5</sub> concentrations at levels below current federal standards. Time-series epidemiological studies have found associations between PM and daily deaths, and cohort studies that incorporate risk associated with longer-term exposure report even higher risk estimates. In addition, clinical and epidemiological evidence now suggests that acute cardiac health effects may be associated with PM exposures with averaging times less than 24 hrs. Short-term exposure PM<sub>2.5</sub> is likely causally associated with mortality from cardiopulmonary diseases, hospitalization and emergency department visits for cardiopulmonary diseases, increased respiratory symptoms, decreased lung function, and physiological changes or biomarkers for cardiac changes. Long-term exposure to PM<sub>2.5</sub> is likely causally associated with mortality from cardiopulmonary diseases and lung cancer, and effects on the respiratory system such as decreased lung function or the development of chronic respiratory disease.

During the last decade, regulatory agencies have increasingly recognized that persons sensitive or susceptible to PM are more numerous and diverse than once thought. These subgroups are potentially at increased risk and comprise a large fraction of the U.S. population, including people with respiratory disease, heart disease, or diabetes; older people; young children; and populations experiencing heightened exposure levels (e.g., involved in outdoor exercise, or living near high PM sources such as busy roadways). Given the likely heterogeneity of individual responses to air pollution, the severity of health effects experienced by a susceptible subgroup may be much greater than that experienced by the population at large. Therefore, varying host susceptibility factors may hinder adequate protection of an entire population, even at low exposure levels.

Despite regulatory efforts over the past 40 years to improve air quality, the protection of public health using air quality standards is constrained by the inability of scientists to determine a level of exposure to PM<sub>2.5</sub> below which populations are safe. Epidemiologic evidence provides no clear basis for identifying the existence or non-existence of population thresholds for PM-mortality relationships for either long-term or short-term PM exposures. Thresholds have not been detected within the range of air quality concentrations observed in studies, even at fairly low PM levels, leading to the consideration that associations found between PM and adverse health outcomes are not significantly different from linear associations. However, uncertainty in findings increases at low concentration ranges, making definitive conclusions difficult.

### **Current standards and recommendations**

NAAQS provisions require EPA to establish standards protective of public health with an adequate margin of safety at a level that avoids unacceptable risks. Legislative history has interpreted the NAAQS margin of safety provision as requiring the protection of both general populations and susceptible populations. The current NAAQS review process charged to select PM<sub>2.5</sub> primary standards adequate to protect public health delineates a range of annual and 24-hr concentration levels based, in part, on findings of health effects associated with chronic and acute exposure to PM<sub>2.5</sub> concentrations. Given the inability of the majority of health studies to identify the existence or non-existence of any justifiable threshold concentration below which adverse health effects are not detectable, selecting a range of primary standards is largely a public health policy judgment.

With respect to the PM NAAQS, more stringent standards lead to requirements for more extensive control strategies used to reduce PM emissions. Intervention studies in the U.S. and other countries have related reductions in ambient PM to observed improvements in respiratory or cardiovascular health. Accordingly, reduction in ambient PM levels presumably reduces the public health toll exacted by PM pollution. But even were PM<sub>2.5</sub> NAAQS attainment reached, health risks within the U.S. population would not be totally eliminated. Nevertheless, the stringency of PM<sub>2.5</sub> standards can determine the magnitude of the PM<sub>2.5</sub>-related health burden that decision makers choose to place upon society. Incrementally more stringent standards would offer the expectation of increased public health protection from PM<sub>2.5</sub> exposures. This underscores the importance of setting appropriately stringent PM<sub>2.5</sub> standards to trigger control measures intended to reduce ambient PM<sub>2.5</sub>.

When taking into account sensitive subgroups and thresholds, major regulatory organizations set enforceable or target standard levels to limit PM<sub>2.5</sub> concentrations below those where epidemiologic evidence is most consistent and coherent, and where estimates of risk reductions associated with alternative annual and/or 24-hr standards are considered most protective. This approach recognizes both the strengths and the limitations of the full range of scientific and technical information on the health effects of PM, as well as associated uncertainties. **Table 1** facilitates a comparison of corresponding standard levels and forms in the U.S. and Canada. Differences in stringency may reflect the varying levels of health protection required by the controlling statute and the level of public health protection commitment.

**Table 1. PM<sub>2.5</sub> primary standards or position of selected agencies, scientific review panels, and organizations**

When	What	24-hr PM <sub>2.5</sub> (µg/m <sup>3</sup> ) <sup>a</sup>	Annual PM <sub>2.5</sub> (µg/m <sup>3</sup> ) <sup>b</sup>
1996	NESCAUM recommendation on NAAQS	35-40	14-16
1996	U.S. EPA staff NAAQS recommendation	18-65	12.5-20
1997	U.S. EPA NAAQS	65	15
2000	Canada-wide target standard <sup>c</sup>	30	n/a
2002	State of California	~18-20 <sup>d</sup>	11-11.5 <sup>e</sup>
2004	NESCAUM recommendation on NAAQS	30	12
2005	U.S. EPA staff NAAQS recommendation	25-35 <sup>f</sup>	15
		30-40 <sup>g</sup>	12-14 <sup>g</sup>
2005	CASAC NAAQS recommendation	30-35	13-14
2005	U.S. EPA NAAQS	tbd	tbd

<sup>a</sup> California 24-hr level normalized to reflect equivalent 98<sup>th</sup> percentile form.

<sup>b</sup> California annual level normalized to reflect equivalent 3-year mean form.

<sup>c</sup> Target implementation to be achieved by 2010 and ratified by ministers on June 2000.

<sup>d</sup> CA proposed a new 24-hr average standard for PM<sub>2.5</sub> at 25 µg/m<sup>3</sup> (not to be exceeded form) in May 2002 but subsequently deferred a final decision.

<sup>e</sup> CA's annual standard for PM<sub>2.5</sub> at 12 µg/m<sup>3</sup> (not to be exceeded form) amounts to new clean air goals for the state and took effect in June 2003.

<sup>f</sup> Based on a 98<sup>th</sup> percentile form for a standard set at the middle to lower end of this range, or a 99<sup>th</sup> percentile form for a standard set at the middle to upper end of this range.

<sup>g</sup> With either the annual or the 24-hr standard, or both, at the middle to lower end of these ranges.

### NESCAUM rationale for more stringent primary PM<sub>2.5</sub> standards

Health studies indicate that Northeast populations are experiencing adverse health effects at or below present PM<sub>2.5</sub> standards. These effects include total and cardiorespiratory mortality, hospital admissions, emergency room visits and other medical visits for various respiratory or cardiovascular diseases, respiratory illness and symptoms, and lung function changes. In view of the Clean Air Act's mandate to protect public health, including susceptible populations, with an adequate margin of safety, EPA, the Clean Air Scientific Advisory Committee (CASAC), and NESCAUM find that more stringent PM<sub>2.5</sub> standards are required.

EPA staff and CASAC's currently recommended standard ranges correspond to levels believed necessary to protect public health based on epidemiologic and risk assessment evidence. Taking these ranges into consideration, the recommendation of NESCAUM's Board of Directors is based on analyses of Northeast demographic data and monitoring data. These analyses support our recommendation of a 24-hr standard of 30 µg/m<sup>3</sup> (98<sup>th</sup> percentile form) and an annual standard of 12 µg/m<sup>3</sup> in order to ensure sufficient public health protection across NESCAUM's 8-state northeastern region.

Our demographic analysis finds that a large fraction of the Northeast population is susceptible or vulnerable to PM air pollution based on age, disease prevalence, and exposure status. Combined, these indicators characterize the potential magnitude of PM<sub>2.5</sub> health impacts within the 8-state NESCAUM region. Specifically:

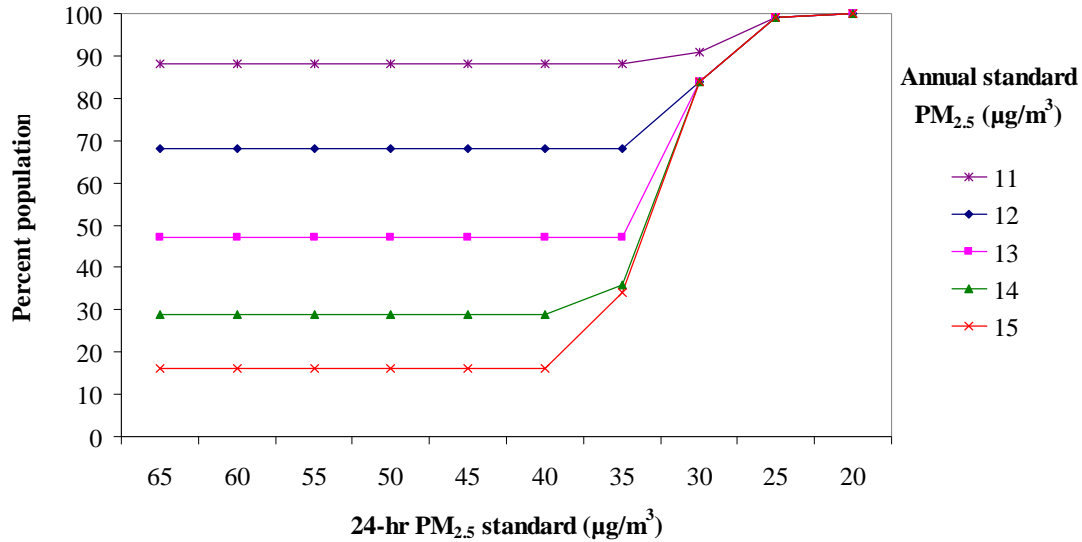
- About 38% of the NESCAUM region's total population is potentially susceptible to PM<sub>2.5</sub> based on age group (ages <18 or ≥65 yrs).
- For people in potentially susceptible subpopulations based on health status (e.g., people with preexisting health conditions such as respiratory disease, heart disease, and diabetes), 4-18% of the total population of adults have cardiopulmonary or diabetes health conditions, and 12-15% of the total population of children have respiratory allergies or lifetime asthma.
- The population density of the NESCAUM region is among the highest in the nation, as 5 of 8 states (NJ, RI, MA, CT, and NY) are among the 6 most densely populated states in the U.S.
- 30 million persons or more than 70% of the NESCAUM region's population (across child, adult, and elderly age groups) live in urban areas that combined consist of 6% of the total land mass.
- Age groups susceptible to PM exposure (ages <18 or ≥65 yrs) living in urban areas comprise 27% of the region's total population.
- Many of these urban populations are vulnerable to pollution-related effects because Northeast urban areas experience the region's highest PM levels and give rise to heightened exposure scenarios.

Our monitoring data analysis assessed how various 24-hr and annual standard combinations influence the distribution and level of PM<sub>2.5</sub> concentrations throughout the NESCAUM region. Such a method facilitates the percentage estimation of the total population living in areas that would be out of compliance at selected pollution levels. Presumably, areas that fail to attain PM<sub>2.5</sub> standards would take steps to reduce concentrations, thereby diminishing population exposures and associated adverse health outcomes. In addition, more stringent PM<sub>2.5</sub> standards would potentially benefit all populations, not just those living in nonattainment areas. Findings include:

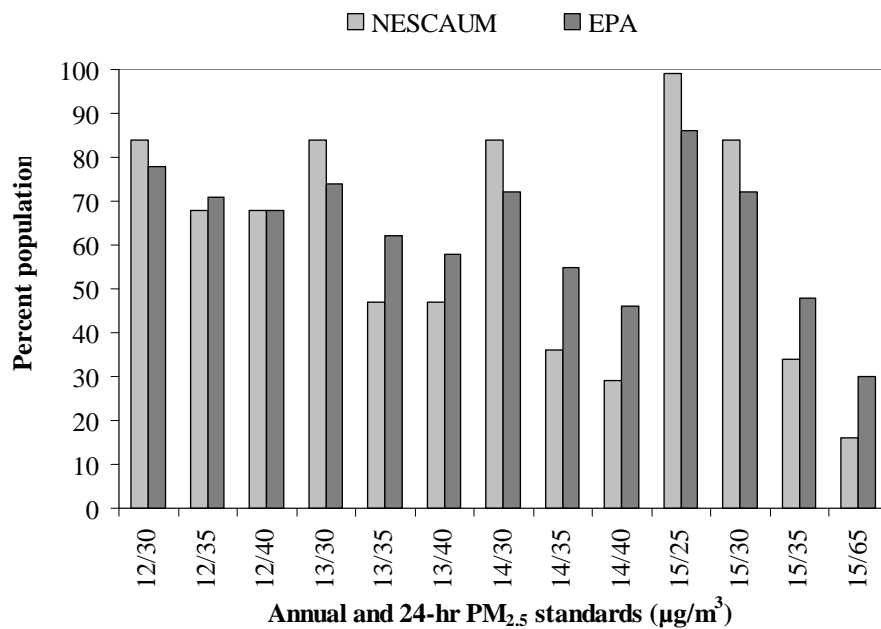
- Mismatched standards permit areas with high 24-hr-to-annual mean PM<sub>2.5</sub> ratios—as well as high annual-to-24-hr ratios—to experience levels at which health effects occur when the backstop standard fails to constrain PM<sub>2.5</sub> concentrations. This phenomenon demonstrates the need for both a protective long-term and short-term standard, and argues against using a single controlling annual standard as practiced and recommended by EPA. Within EPA's selected range of standard combinations, stringent matching annual/24-hr (98<sup>th</sup> percentile form) standards of 12/30 µg/m<sup>3</sup> would provide a more uniform level of protection across the largest monitoring network area possible (See **Figure 1**).

- Because 24-hr values in the NESCAUM region cluster within the 30-35  $\mu\text{g}/\text{m}^3$  range, across EPA's entire current annual standard range (12-15  $\mu\text{g}/\text{m}^3$ ) the most substantial impact on nonattainment status in the region would occur were the 24-hr standard lowered from the current 65  $\mu\text{g}/\text{m}^3$  to below 35  $\mu\text{g}/\text{m}^3$  (98<sup>th</sup> percentile form) (See **Figure 1**).
- In the NESCAUM region, current PM<sub>2.5</sub> standards affect only 16% of the general population, which lives in counties that do not meet the existing annual/24-hr (98<sup>th</sup> percentile form) standard of 15/65  $\mu\text{g}/\text{m}^3$ . More stringent annual/24-hr standards currently under review by EPA would benefit a large fraction of the region's total population and would especially benefit and a large number of adult and children populations with chronic health conditions (See **Figure 1**).
- A requirement to reduce emissions of PM<sub>2.5</sub> and its precursors in order to meet an annual/24-hr (98<sup>th</sup> percentile form) standard of 12/30  $\mu\text{g}/\text{m}^3$  would result in 84% of the NESCAUM region's population benefiting from improved air quality due to PM<sub>2.5</sub> emission control strategies (See **Figure 1**). By establishing this standard combination, about five times more people in susceptible subgroups would benefit from improved air quality.
- The PM<sub>2.5</sub> standards NESCAUM has recommend are consistent with those currently in effect in California (12  $\mu\text{g}/\text{m}^3$  for the annual standard - not to be exceeded) and Canada (30  $\mu\text{g}/\text{m}^3$  for the 24-hr standard - 98<sup>th</sup> percentile). More protective PM<sub>2.5</sub> standards falling within normalized ranges recommended by California and Canada would protect 84-100% of the NESCAUM region's population (See **Figure 1**).
- Within EPA and CASAC's currently recommended primary PM<sub>2.5</sub> standard ranges, unless a 30  $\mu\text{g}/\text{m}^3$  or lower 24-hr (98<sup>th</sup> percentile form) standard combination is selected a substantial percentage of urban monitors in the NESCAUM region will receive fewer nonattainment designations—and therefore less ability to reduce emissions to protect populations with an adequate margin of safety—than the U.S.
- Within CASAC's recommend primary PM<sub>2.5</sub> standard range, in the NESCAUM region the difference between a 13/30 and 13/35  $\mu\text{g}/\text{m}^3$  annual/24-hr (98<sup>th</sup> percentile form) standard amounts to a substantial difference in protectiveness, amounting to 37% of the total Northeast population. For the entire U.S., the difference is only 12%. For a 14/30 and 14/35  $\mu\text{g}/\text{m}^3$  standard, the difference is 48% (Northeast) and 17% (U.S.) (See **Figure 2**).
- A suitably stringent 24-hr standard may lead to meaningful reductions in shorter-term hourly average concentrations, thus providing some degree of protection from acute elevated levels that may lead to a significant portion of an individual's daily exposure, especially in high source environments such as along roadways or in urban areas.
- PM<sub>2.5</sub> maxima vary according to the stringency of 24-hr percentile forms. To achieve an equivalent 24-hr average, a 98<sup>th</sup> percentile form 24-hr standard would need to be about 5  $\mu\text{g}/\text{m}^3$  more stringent than a comparable 99<sup>th</sup> percentile form standard.

**Figure 1. Percent of NESCAUM region population that would benefit from compliance with alternative annual/24-hr (98<sup>th</sup> percentile form) PM<sub>2.5</sub> standards**



**Figure 2. Percent NESCAUM region population vs. EPA U.S. population that would benefit from compliance with alternative annual/24-hr (98<sup>th</sup> percentile form) PM<sub>2.5</sub> standards**





## Conclusion

During both the 1997 and 2005 PM standard setting cycles, a central question has been which combination or suite of short-term and long-term primary PM<sub>2.5</sub> standards is needed to protect general and susceptible populations with an adequate margin of safety across a range of concentrations that vary spatially and temporally. Based on the weight of evidence of health effects findings and regional demographic and monitoring data, NESCAUM believes a 24-hr PM<sub>2.5</sub> standard of 30 µg/m<sup>3</sup> (98<sup>th</sup> percentile form) and an annual PM<sub>2.5</sub> standard of 12 µg/m<sup>3</sup> are necessary to protect public health across the 8-state Northeast region. Such standards would result in a larger percentage of populations living in counties that would not meet the regulation through nonattainment designation. Areas that fail to attain PM<sub>2.5</sub> standards would have the authority to take steps to implement greater emission reduction requirements and more extensive control strategies to reduce PM concentrations. Populations would thereby benefit from diminished exposures and associated adverse health outcomes. Thus, EPA's decision to select or not select appropriately stringent PM<sub>2.5</sub> standards has consequential public health implications for populations in the NESCAUM region.

NESCAUM's recommended standard levels represent an appropriate balancing of the conflicting pressures facing the states: maximizing public health protections and minimizing the economic impacts of nonattainment. The recommendation is stringent in terms of public health protection because it represents a substantial increase in the regional population that would benefit from improved air quality as a result of additional PM<sub>2.5</sub> control strategies. This strong level of protection is justifiable as it recognizes current unresolved issues concerning the existence or non-existence of a threshold, as well as the extent to which protection of all populations—including susceptible groups—can be achieved with an adequate margin of safety based on best available scientific evidence. The NESCAUM Board recognizes the considerable implications of promoting standards that will place the majority of the region's counties into PM<sub>2.5</sub> nonattainment. Nonetheless, we believe this is the correct public health action.

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