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November 30, 2007

U.S. Environmental Protection Agency
Clean Air Scientific Advisory Committee
c/o Mr. Fred Butterfield, Designated Federal Officer (DFO)
EPA Science Advisory Board (1400F)
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW.
Washington, DC 20460

Re: November 30, 2007 public teleconference meeting of the CASAC PM Review Panel to conduct a consultation on EPA's "Draft Integrated Review Plan [IP] for the NAAQS for Particulate Matter."

Dear EPA and CASAC:

Thank you for the opportunity to comment on EPA's "Draft Integrated Review Plan [IP] for the NAAQS for Particulate Matter." My comments address EPA's efforts to characterize population exposure, evaluate the nature of health effects, and assess public health risk in non-urban areas. The IP considers conducting a quantitative exposure assessment to inform existing PM epidemiological literature and to estimate population exposures in representative urban areas across the U.S. The draft plan, however, says little about whether EPA plans to address non-urban exposures and health risk. Where PM sources could pose a risk, our less populated areas should enjoy the same level of examination as our urban areas.

Variability in the spatial and temporal behavior of PM2.5 concentrations across the federal reference monitoring network suggests the necessity of having a PM NAAQS metric responsive to as much exposure variability as possible (Johnson and Graham 2006). Traditional epidemiologic investigations and fixed site measurements have contributed broadly to our knowledge of urban-scale exposures and health effects, and warrant continued analysis as proposed in the IP. But available evidence relating to the potential for exposures in non-urban areas indicates the need for increased attention.

In non-urban areas, a combination of factors may influence population exposures to PM, including terrain prone to inversions, densely inhabited population centers, and receptor proximity to large sources of biomass PM2.5 rich in carbonaceous material. In many parts of the U.S., rural population centers are located in confined low-lying drainage areas. Topographical conditions suggest these catchment areas can experience periodic or frequent inversions. Demographic considerations show that in hamlets, towns, and cities across the non-urban landscape, population densities can exceed 1,000 persons per square mile. Fieldwork performed

in wood smoke source regions finds a substantial accumulation of pollution under stagnant conditions. Studies also demonstrate that a small number of wood burning devices can expose a large number of residents spread out across a population center when diurnal and multi-day inversion conditions occur, as PM2.5 infiltrates into homes (Anuszewski 1998; Larson et al. 2004, 2007; Luhar et al. 2006; Polissar et al. 2001; Su et al. 2007). When considered together, these factors suggest a public health concern for non-urban populations (Johnson 2007).

The 2005 National Emissions Inventory estimates that wood stoves and fireplaces contribute 420,000 tons per year of direct PM2.5. This amount exceeds highway and non-road diesel contributions by more than 100,000 tons per year (EPA 2006). These wood combustion emissions likely predominate in non-urban areas where climate encourages the use of wood heat during cold weather seasons, making their exposure impact especially severe in certain places and times. Separate estimates find that outdoor wood boilers (OWB) may emit anywhere from upwards of 37,000 to 250,000 tons per year (EPA 2006; NESCAUM 2006). These hydronic heaters, proliferating in rural areas, are a rapidly emerging class of wood burning device with no federal regulation. Many existing units lack effective emissions controls, have low stacks that can fumigate and impinge neighbors, operate 24/7 all year to generate hot water, and can be used to burn trash and other dirty fuels (NYT 2006; Schreiber et al., 2005).

Numerous toxicology and epidemiology studies find adverse health effects associated with wood smoke emissions, including wood smoke PM, especially for children (Brown et al. 2007; Naeher et al. 2007; Zelikoff et al. 2002). Study findings in areas where wood smoke is a predominant source of PM conclude there is no reason to think that the adverse impacts of acute wood smoke exposure would be less than those associated with other sources of ambient PM (Boman et al. 2003). In other words, non-urban exposures to wood smoke PM could exert similar or even greater health effects than urban exposures to PM.

The attached pictures, taken by a citizen in the Midwest, illustrate the unique threat wood burning devices can pose to rural populations. The first picture shows a valley extending several miles filled with smoke from an OWB. The second picture shows the citizen's backyard in relation to an OWB source. The citizen lives about 1/3 mile from the unit. Her pulmonary doctor has diagnosed her with reactive airway dysfunction syndrome and attributes her condition to the OWB source. I hear similar stories from other citizens elsewhere in the Midwest and in the Northeast. Of note, some states are moving to regulate OWB emissions in part by using setback distances, typically less than 500 feet, based on Gaussian models incorporating the revised 24-hr PM2.5 standard. Unfortunately, these requirements might not protect non-urban populations from area-scale exposures under valley inversion conditions. They also might not protect populations from micro-scale exposures beyond the setback distance. Nor do they adequately take into account complex terrain conditions.

With respect to traffic emissions in non-urban areas, exposure assessment could reveal the potential for public health concern. Most exposure studies focus on urban populations living near mobile source emissions. Few studies, however, have comprehensively assessed rural population exposure. In non-urban areas, major roads that connect population centers can typically serve as the primary transportation corridor for a large number of vehicles. If these conditions are analogous to PM spatial gradients seen in urban areas across a range of traffic

volumes, it is possible that the traffic-exposure issues could apply to non-urban population centers. In New York State, for example, inventory analysis has found that mobile source emissions comprise a large fraction of carbonaceous PM2.5 emissions in urban *and* rural areas. A forthcoming report on carbonaceous PM2.5 in New York State found that a large number of New York populations in suburban, urban *and* rural counties live within 150 and 300 m of major roads. In three rural New York State counties, 24-41% of persons lived within 300 m of major roads. In these counties, the population density within 300 m of major roads was two to five times greater than total county densities (NESCAUM forthcoming).

Finally, the IP aims to take into account the magnitude and duration of PM exposures and frequency of repeated peak exposures. A growing number of health studies dating back to the late 1990s show evidence of pronounced health effects at hourly time scales. A recent urban study of acute asthma emergency department visits by the New York State Department of Health, for example, found that effect estimates were stronger for 1-hour maximum PM2.5 than for 24-hour average PM2.5 (NYS DOH 2006). In the greater Boston area, researchers have associated cardiac outcomes within a few hours after exposure (Gold et al. 2000; Peters et al. 2001). In a semi-rural area of southern California, Delfino et al. (2002) found same-day associations between 1-h and 8-h maximum PM10 levels and children's asthma episodes, noting that most pollutant effects were largely driven by concentrations in the upper quintile. In Seattle, researchers reported associations between hourly exposures to PM2.5 and airway inflammation and injury in children with asthma (Mar et al. 2005). In Sydney, Australia, Morgan et al. (1998) found that an increase in current day maximum 1-hour particulate concentration from the 10th to the 90th percentile was associated with an increase of respiratory and cardiac outcomes.

These health studies of transient exposures are useful to consider because exposure studies indicate commuter populations can experience the largest part of their daily exposure during the morning and evening hours when they are in proximity to elevated mobile source emissions (Adams et al. 2001; Fruin et al. 2004). Of note, the PM concentrations observed in these traffic cardiopulmonary health studies are substantially lower than transient PM concentrations observed in proximity to elevated wood smoke emissions (Johnson 2006). In wood burning areas, down wind populations can experience especially elevated transient exposures. For these populations, sub-daily time periods can describe a realistic exposure time frame, where transient peaking conditions can last from minutes to several hours and then disappear, only to reemerge later in the day, depending on operating variables and weather conditions, over weeks and months.

Should more robust exposure assessment find that non-urban populations experience pronounced exposures as a cumulative series of peaking, episodic events influenced by localized sources, can a 24-hour metric and centrally located monitors provide the best public health protection?

In summary, consideration of available evidence suggests the need to include non-urban populations in exposure assessment and risk characterization, which appear to be missing from EPA's IP. Such evidence exists in the form of terrain-meteorology, demography, inventory, monitoring, and health effects data. Considering these data, PM2.5 exposures to non-urban populations may potentially equal or exceed those experienced by urban populations, for certain segments. There is the possibility of widespread vulnerability to PM2.5 exposure in our non-

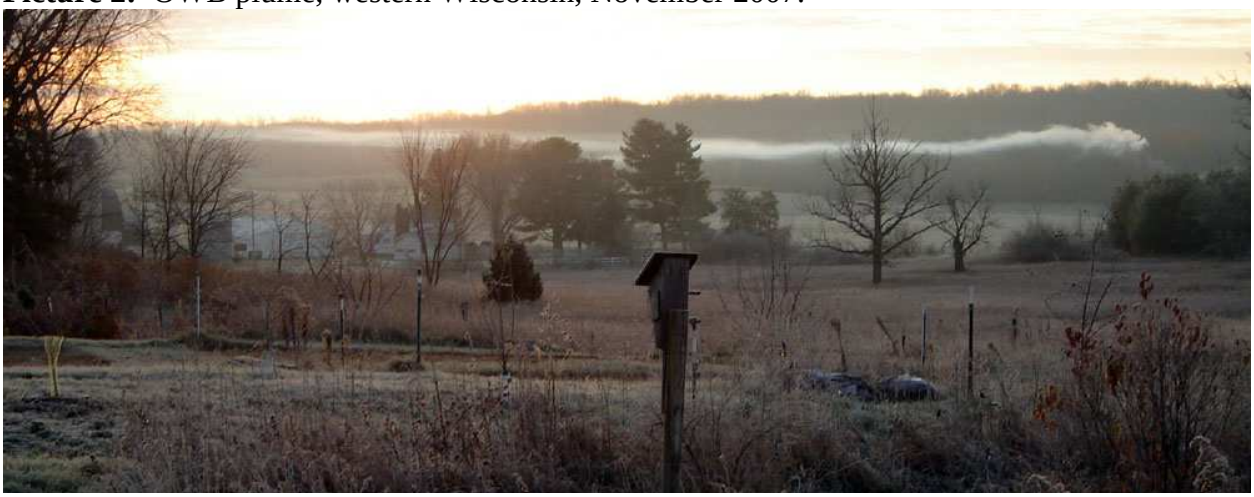
urban areas over variable spatial and temporal scales. This raises the question as to whether the PM NAAQS is sufficiently protective for these populations.

Sincerely,

Philip R.S. Johnson

Picture 1: OWB valley smoke, western Wisconsin, September 2007.

Picture 2: OWB plume, western Wisconsin, November 2007.



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