The Honorable Lisa P. Jackson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: Review of the "Near-road Guidance Document – Outline" and "Near-road Monitoring Pilot Study Objectives and Approach"

Dear Administrator Jackson:

The Clear Air Scientific Advisory Committee (CASAC) Ambient Air Monitoring and Methods Subcommittee (AAMMS, or the Subcommittee) met September 29-30, 2010, in Research Triangle Park to review EPA's Draft Guidance Outline and the Proposed Near Road Pilot Study. EPA asked the Subcommittee to review the outline and pilot program and respond directly to 14 Charge Questions. The Subcommittee wants to thank EPA for asking for input at this relatively early stage in the process. The CASAC and AAMMS membership is listed in Enclosure A. The Subcommittee's consensus responses to the Agency's charge questions are presented in Enclosure B. Individual review comments from the Panel are compiled in Enclosure C.

The Subcommittee viewed the outline as providing the general factors that should be considered in developing a near road monitoring network and factors that should be considered in siting monitoring locations. A weakness in the current outline is that the objectives of the network are not well defined. The objectives and the associated reasoning should be clearly stated.

Currently the primary focus of the monitor site selection process is on annual average daily traffic (AADT). The Subcommittee views that there is currently an overemphasis on AADT, and that others factors, including those identified, are likewise important. Those factors include both the physical characteristics (e.g. those identified as "Other Candidate Near-road Site Considerations), modeling information, and preliminary monitoring (e.g., multiscale/saturation studies). EPA should allow flexibility in the site selection process.

The AAMMS is concerned about the timing proposed for the current network deployment, as well as the Pilot Study that is planned to help in the network design. The current time frame does not allow for adequate time to appropriately plan, execute and analyze the data from the Pilot Study to most effectively provide the information on which the near-raod network can be designed. Further, we suggest that the deployment of the network be staged, e.g., with 10-20 sites the first year, 20-40 the next and the rest in the final year. In this way, the network evolution can respond to not only what is learned during the Pilot Study, but during the operation of the initial sites. Further, the Subcommittee is concerned that there could be a decrease in the number of population-oriented NO2 monitors in the new network. Many of the health studies that were utilized

in the latest NAAQS NO2 review were based on the current monitoring network. Also, the Subcommittee recommends a tiered approach to the design of the near-road monitoring sites. A few sites should be comprehensively equipped such that they can provide much more detailed information about the composition of mobile source emissions and how that source changes with time and in response to controls. The bulk of the sites cold be more modestly equipped. We provide more detail in our response to the associated charge questions.

Sincerely,

Dr. Armistead (Ted) Russell, Chair
CASAC Ambient Air Monitoring & Methods Committee

Dr. Jonathan M. Samet, Chair
Clean Air Scientific Advisory Committee

Enclosures

Charge Question 1:

Main Consideration:

Based on the material in the Pilot Study draft, it is not clear that EPA has yet identified the reasons (scientific objectives) for the multi-pollutant monitoring. We recommend that EPA clearly identify the monitoring and associated scientific objectives for the near-road monitoring program, and the document then be built around these objectives. A possible set of objectives focused on NO_2, for example, might be:

- Identification of hourly averaged NO_2 by the most artifact free method available.
- Identification of concentrations of other NAAQS pollutants which accompany the observed NO_2 concentrations.
- Identification of the atmospheric processes which contribute to the observed concentrations of NO_2.
- Identification of the sources which contribute to both measured concentrations of NO_2 and the other measured NAAQS pollutants

The document should then discuss fully these objectives and the scientific basis for these objectives in the Introduction. This will, in turn, support the selection of the recommended pollutants to be monitored in the program and the protocols to be followed.

In addition, we suggest the following more minor areas where the Guidance Document needs strengthening.

- General. The success of the near-road pilot project is critical to the future deployment of the ~110 near-road monitoring sites by the end of 2012. Thus timing (and resources) are tight. EPA needs to focus on defining the objectives for the program and identify those key elements of the program essential to meeting those objectives. Not all ideas discussed in the consultation will be essential. EPA needs to identify how to leverage existing sites, how the sites will be operated, how the data analysis will be accomplished, and how many sites are needed to meet the objectives of the program. Finally we encourage EPA to evaluate the near-road excess (or deficiency) for key indicators, e.g. NO_2, CO, black carbon, ultrafine particles. This will necessitate background measurements which allow an estimation of the gradient away from the road.
- Background. The background should document the scientific basis for the multi-pollutant objectives, as outlined in the bullets above. The literature review needs to be more comprehensive than at present. A conceptual model should be formed in this section that includes dispersion, deposition, chemical conversion and physical conversion. Special attention should be given to NO_2 formation by the titration of O_3 and NO_2 depletion by photochemistry. The Background section should include language suggesting the finding a site where NO_2 and the various measure other pollutants all have the highest concentrations is not likely and

compromises will be necessary and acceptable.

- Identifying Candidate Near-road Site Areas. We believe the criteria outlined for this section are generally adequate for the identification of a site where maximum NO_2 concentrations near a given near-road site may be determined. However, there is an apparent assumption that AADT is the primary siting criteria. The importance of meteorological and terrain variables should be emphasized. Further, since NO_2 is a secondary pollutant, and it's concentrations will be effected by both emissions from the roadway and from the effects of other nearby elevated pollutants (VOC, ozone, etc.), these factors should be considered in the site identification process. One critical element that is missing from the outline is the importance of the specific distance from the roadway chosen for study. The effect of differences in the gradient from the roadway of the multi pollutants studied needs to be acknowledged and discussed. (Rich, what else would you add here?)

- Modeling.

- Monitoring. This section should provide a summary of methods used in past roadside measurement studies, passive and active monitors that can be efficiently deployed at many locations and methods to interpret the data acquired. The emphasis at this level should be on the identification of high NO_2 hourly average concentrations. Care needs to be taken to insure that the use of mobile monitoring methods give results that do reflect the diurnal and seasonal locations of peak concentrations.

- Near-road Site Selection. The items outlined here seem reasonable. This section might draw from some of the existing guidance for sampler siting.

- Recommended Near-road Site Documentation. The adequacy of this section will be dependent on the adequacy of the EPA objectives for the Pilot Study in addressing the appropriate multi-pollutant monitoring objectives. This will be better defined as the objectives of the near-road monitoring program are better defined.

Charge Question 2:

The list and ranking of pollutants varied across the committee members. Some members questioned the usefulness of these indicators for the compliance purpose. The following ranking is based on the votes for the pollutants that had at least five votes from thirteen members of the committee who submitted votes, taking into consideration the average ranking and its variability. Many of the committee members also emphasized the importance of measuring meteorological parameters (wind speed and direction). Several members considered traffic counts as potentially important information. Other pollutants mentioned by some members include "true NO_2" measured by techniques such as

photolytic conversion difference, hourly metals by automated on-line XRF, and nephelomer measurement.

The committee also recognizes that not all of the pollutants on the list can be measured at all the monitors because of the level of the cost and operational logistics. Therefore, the committee recommends a tiered approach, in which a few of the monitors would collect a more comprehensive set of pollutants, while a majority of them would measure only the first tier of pollutants in the list.

Pollutant group	Rationale and comments
NO_2, NO, NOx	• Same instrument
Black carbon	• Diesel tracer • Potential health relevance • Continuous methods available • Not a direct measure of carbon
CO	• Gasoline vehicle tracer • Dilution factors • Potential health relevance • Continuous methods available • Pending new NAAQS
Ultra-fine particles / particle number concentration	• Strong roadside gradient • Potential health relevance • Continuous methods available
Particle-size distribution	• For a limited number of sites • Potential health relevance • More comprehensive health relevance than just particle number
$PM_{10-2.5}$	• Potential health relevance • Re-suspended roadside particles • Speciation for metals • Important in future PM NAAQS reviews
$PM_{2.5}$	• Continuous methods available • Potential health relevance • Speciation for metals • Possibly FDMS to include semi-volatiles
EC/OC	• Potential health relevance • Direct measure of carbon
CO_2	• Normalization of pollutants to CO_2 allows estimation of fuel-based emission factors • Could be important if signal large enough
Ozone	• To understand photo-chemical processes • Not to be used for health effects analysis
NOy	• Total nitrogen oxides and mass closure

SO_2	• To verify fuel content compliance • Pending new NAAQS
BTEX	• Potential health relevance • Continuous methods available • Provides unique information as to how changing fuel characteristics and control systems are impacting emissions • Can provide additional info on which class of vehicle is impacting monitor

Charge Question 3:

The specific factors identified in this charge question can all usefully inform the selection of near-road monitoring locations. An additional factor that may exhibit characteristic gradients in larger MSA is the middle-scale oxidant or odd-oxygen concentration, $[O_3]+[NO_2]$. The Subcommittee recommends against an over-emphasis on AADT, noting for example that peak NO_2 concentrations can occur in areas where widespread congestion limits AADT. To account for such interactions between different factors' effects, the Agency should consider developing a conceptual or screening model to guide their integration. This would be intended as a tool to help rank candidate locations, and would not require quantitative concentration predictions. Recognizing the near-road NO2 measurement's intended focus on NAAQS compliance rather than population exposure, the Subcommittee stresses the importance of exposure in the overall balance of siting considerations.

In response to specific elements of this charge question, the Subcommittee's recommendations are as follows.

a. States and cities vary considerably in the resolution of information available for fleet characteristics and fleet mix. States can be encouraged to use all available data in their planning, including local features such as truck routes and parkways, or toll-collecting operations.

b. Ambient monitoring is conducted in the 'here and now'. Fleet turnover is too slow to require consideration of its future effects in the initial planning. However, the transition to 'cleaner' diesels may have the effect of increasing primary tailpipe emissions of NO2.

c-e. The Subcommittee agrees that roadway design, terrain, and congestion patterns all merit consideration. As noted above, it recommends that the interactions and tradeoffs among their effects be accounted for in a screening tool developed by the Agency for this purpose.

f. The Subcommittee agrees that it is undesirable to site a near-road monitor climatologically upwind.

Charge Question 4:

Like the various considerations discussed in Charge Question 3, modeling tools can also be used to inform the likely location of the maximum NO_2 levels in an area. Taking a

centralized approachl, emissions and air quality models could be used to develop screening tools or screening criteria that incorporate many of the factors discussed in Charge Question 3. Alternatively, the models could directly be used by state and local agencies to inform the siting process. MOVES, along with other emissions inventory modeling tools, can provide valuable information about the spatial intensity of traffic-related NOx emissions, as well as NOx emissions from other sources. MOVES is a link-based model which has significant advantages for this application over the historical emissions models that were based on trip-average cycles. Air quality models, such as the CMAQ and CAMx chemical transport models and the AERMOD and CALINE dispersion models, can also be used to help identify candidate geographic areas within the metropolitan area and to compare and contrast candidate specific candidate monitoring sites, respectively. It is appreciated, however, that there significant uncertainties associated with the use of models for simulating the location of an extreme concentration statistic. The approaches used by AERMOD to simulate the conversion of NO to NO_2 are relatively crude, and guidance should be given as to which approach should be used. State and local agencies should be encouraged to use spatially-resolved emissions estimates, and if readily available or available with relatively modest effort, air quality model results.

Charge Question 5:

"Multi-scale" monitoring is a more specific term than saturation monitoring. Before the pilot study or site selection, a literature review should be conducted that summarizes past roadside measurement and modeling studies, passive and active monitors that can be efficiently deployed at many locations, and methods to interpret the data acquired. Roadside monitoring for site selection and long-term monitoring would benefit from small, portable sensors that don't require a large infrastructure (i.e., shelter, air conditioning, etc.) to operate.

Portable active or passive monitors that can be easily and inexpensively deployed would provide a good indication of where concentrations might be highest. Levels are likely to vary by season, as noted in Figure 1 of Zou et al. (2006), and show an exponential decrease with distance from the curbside. Passive monitors using NO_2-absorbing filters have some potential biases, but they have also been shown to be comparable and correlated with continuous measurements for integration times on the order of weeks (Ayers et al., 1998; Beckerman et al., 2008; Berkowicz et al., 2008; Crouse et al., 2009; De Fouquet et al., 2007; Douglas and Beaulieu, 1983; Faus-kessler et al., 2008; Gilbert et al., 2005; Hauser et al., 2009; Heal and Cape, 1997; Heal et al., 1999; 2000; Henderson et al., 2007; Krochmal and Gorski, 1991; Mukerjee et al., 2004; Nash and Leith, 2010; Norris and Larson, 1999; Ozden and Dogeroglu, 2008; Parra et al., 2009; Piechocki-Minguy et al., 2006; Plaisance et al., 2004; Rava et al., 2007; Sekine et al., 2008; Shooter et al., 1997; Van Reeuwijk et al., 1998; Vardoulakis et al., 2009). Passive samplers are a cost-effective and practical technology for mapping average spatial gradients as a prelude to sampler siting. However, the validity and sensitivity of the portable, passive NO_2 sampling systems needs to be verified. To get better precision, a collocated continuous sampler with duplicate passive samplers is needed at some of the sites. Past studies show an average coefficient of variation for duplicate passive NO_2 measurements of 5 – 30%.

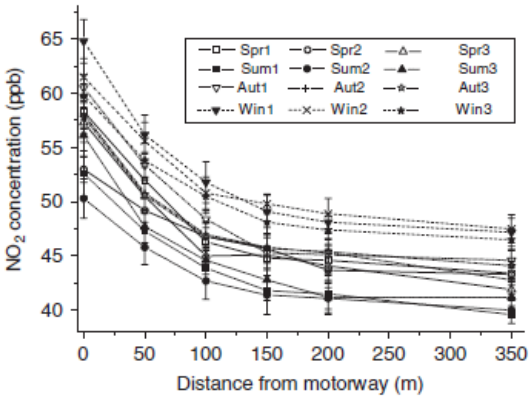

Fig. 1. NO_2 concentrations measured at different distances from the A20 highway in Shanghai ($3 \leqslant n \leqslant 6$) (Spr: spring, Sum: summer, Aut: autumn, Win: winter. 1, 2, 3 represents the different selected study area, respectively).

(Zou et al., 2006)

5a. Pros are low expense and operating cost. The major con is the much longer than one-hour averaging time. The key is to relate long-duration passive sampler NO_2 measurements to the one-hour NO_2 NAAQS, which is defined as the maximum allowable concentration in an area (primarily near major roadways), expressed as a three-year average of the 98th percentile of the annual distribution of daily maximum one-hour concentrations. One option is to collect samples from sub-daytime periods (e.g., morning and evening rush hours) that are integrated over several days. A timer-based sampler may be used for this application. Another option is to modify a passive sampler by making the flow "active," for example, using a combination of timer, sampler housing, and a small (~200 ccm) pump. If many of the passive samplers are used for multi-scale monitoring it is important to position the sampling inlet at the same height (1 – 1.5 m above ground) at all sites.

5b. Pros are short-duration samples, on the order of an hour or less. Cons are instrument procurement and operating expense, potentially higher than desired detection limits, and reliability of new technologies. There are several currently available or emerging technologies for microsensors (Brunet et al., 2008; Currie et al., 1999; Egashira et al., 1996; Forleo et al., 2005; Gurlo et al., 1998; Oto et al., 2001; Sitnikov et al., 2005; Talazac et al., 2001). NO can often be obtained from these same sensors. Miniature sampling systems (e.g., 2B NO monitor with NO_2 to NO converter option) have been used for remote monitoring, emission sampling, and unmanned aerial vehicles, and these might also be used for multi-scale monitoring These portable instruments need to be evaluated with regard to their sensitivity, stability, and accuracy. Data should be acquired over 1 min averages or less so that individual plumes can be detected.

5.c. Several mobile emissions systems have been applied to characterizing on-road and roadside concentrations (Bukowiechi et al., 2002; 2003; Cocker et al., 2004a; 2004b; Durbin et al., 2007; Herndon et al., 2005; Isakov et al., 2007; Kittelson et al., 2004; 2006; Morawska et al., 2007; Nussbaum et al., 2009; Pirjola et al., 2004). Pros are that these systems are moveable and obtain many different pollutant measurements. Unless state or local agencies are already equipped with a mobile sampling van, the disadvantages are the high cost of assembling or contracting these laboratories and the snapshot nature of their measurements, as they usually need to be attended and can be parked for only a short time period. However, local monitoring systems are useful for site selection if they can be parked at the same location and perform sampling for a few days to one week. The state or local agencies may also consider using a fully-equipped trailer rather than a mobile van for siting. Eventually, the trailer can be converted to a permanent monitoring location.

Charge Question 6a:

The spatial distribution of cold start vehicles associated with urban commuting is in general broad and short term and their contribution to emissions associated with major highways adjacent to residential neighborhoods is likely small. To the extent cold start emissions contribute, they would mainly be in terms of CO and not NO_2 concentrations and would not likely influence peak CO concentrations. That being said, at least one

exception comes to mind. The departure of motor vehicles from major events (e.g. stadiums) where 20-30K vehicles may be simultaneously started and caught in congestion for 10s of minutes to an hour or more. The cold start contribution, here again, is limited in time but could contribute significantly as an emissions hot-spot impacting commuter exposes and concentrations in nearby neighborhoods. The prioritization of congestion and cold start factors relative to AADT, fleet mix, roadway design, terrain and meteorology should consider sensitivity analyses using line source models as outline by the FHWA's procedures for assessing traffic impacts for CO.

6b:

The near-road NO_2 concentrations are closely tied to secondary reactions with urban ozone concentrations and entrainment processes, including lateral and downward mixing of ozone into highway line source NOx plumes. This in part, contributes to seasonal differences in near-road NO_2 concentrations and its fractional contribution to NOx. Other factors that affect near-road CO and NOx concentrations will be the distribution of gasoline and diesel vehicles and the primary NO_2 fraction of NOx exhaust emissions will vary with engine type (gasoline spark ignition or diesel) and control equipment, e.g., three way catalyst and diesel catalytic filter trap technologies. CO emissions come principally from the gasoline engine exhaust and their peak concentrations will occur in the immediate vicinity of the emission source, NO_2 peak concentrations will lag behind as NO emissions must react with entrained ozone to form NO_2. The entrainment and transformation time afford the opportunity for the exhaust plume to transport and diffuse resulting in peak NO_2 concentrations that are displaced in time and space as compared to CO.

Idling in urban street canyons is problematic and should be discouraged. If as in most case is due to major traffic congestion it will result in high exposures involving commuters, pedestrians and local residence. Decisions to monitor at such locations must consider these exposures relative to other near-road exposure environments associated with high density population regions.

Charge Question 7:

The majority of panelists acknowledged that there is an increment to $PM_{2.5}$ in the near road environment. They did not suggest that the near road environment will represent the areas of highest $PM_{2.5}$ concentration. This is due to the variety of sources of $PM_{2.5}$ including the combination of primary emissions and secondary formation processes. The committee was also generally in agreement that mass based measurements and specifically the $PM_{2.5}$ FRM is not appropriate for use at the near road NO_2 sites. The $PM_{2.5}$ FRM measurement has poor capture efficiency for the highly volatile emissions from mobile sources. The use of this method in the near road network would underestimate the significance of mobile sources and under predict the risk associated with this source of $PM_{2.5}$.

In general; the locations where maximum $PM_{2.5}$ concentration are likely to be found include areas that are; subject to regional transport and local stationary and area sources,

are primarily urban, and are away from sinks of PM including ventilated roadways, heavy vegetation and water bodies.

The Panel also discussed other fractions of PM in the near road environment including ultrafine particle count and size distribution and PMc. The siting for measurements of these size fractions are more suited to the near road environment.

Charge Question 8:
Other PM measurements that should be considered include sub 100 nm ultrafine particles (UFP), BC, and speciated coarse particles.

BC is an important vehicular emission that can be measured routinely in sampling networks. We recommend that it be measured.

Measurements of UFP could be made either with a condensation particle counter (CPC) or an aerosol mobility spectrometer. A CPC measures the total concentration larger than the CPC's minimum detectable size but provides no information about size. Mobility spectrometers provide information about particle concentration and size, which would be valuable for assessing health effects. Given current resource constraints, state and local agencies might be unable to collect and analyze data from mobility spectrometers. However, agencies might work collaboratively with interested universities. This would likely lead to a nested network design, with most stations using CPCs and a more limited number aerosol mobility spectrometers. Mobility distributions are currently being measured routinely in sampling networks worldwide.

Vehicles emit coarse particles and resuspend coarse road dust that may be coated with toxic contaminants. We recommend measurements of the coarse particle metal content.

Charge Question 9:
The Subcommittee recommends that sampling criteria for CO and other monitors at sites installed to monitor near-road NO_2 match those for NO_2. The sampling configurations of existing micro-scale CO monitors should be assessed in terms of their own sampling objectives, and need not necessarily conform to those of near-road NO_2 monitors.

Charge Question 10:
The Panel did not feel it had enough data to make a recommendation with respect to this charge question.

Charge Question 11:
To define "urban street canyons" in relevant regulations, the subcommittee recommends that EPA consider the following factors:

- Traffic information such as AADT, fleet mix, posted speed limit or/and actual speed, traffic light cycle
- Street geometry

- Ratio of the height of street side buildings to the width of the street (H/W ratio). Some approaches need to be developed to treat the following scenarios for H/W ratio calculation
  - different heights of buildings on the two sides of the street – use the lower one or use the average. Using the lower one may be better.
  - tiered buildings – possibly use the average of all tiers, or use a graduated factor based on the angle between the vertical line and the line drawn along the tiered building – the larger the angle (more opening on the top of the street canyon), the lower the effective height (H_e) will be used in the H/W calculation.
- One-way vs. two-way street (more plug flow in a one-way street and more turbulent flow in a two-way street).
- Is the street lined with trees on the sidewalk? Tree canopy may have an effect of an umbrella and trap portion of pollutants at the street level.
- Slope of the street – higher vehicle emission on steeper streets unless it is a one-way street and the traffic direction is downhill.
- Some way to normalize the H/W ratio with respect to number of traffic lanes on the street. This factor may not be important because the effect may have been incorporated by the combination of H/W ratio and the traffic volume (e.g., AADT). How about H*L/W, where L = # of lanes?

- Meteorological factors: the angle between the street and prevailing wind direction (higher concentrations are expected if the angle is 90 degree).
- Terrain: Frequency of calm conditions and/or drainage flow may influence concentrations.

Although a set of cut-off values reflecting the above mentioned factors could be used to define urban street canyons, it is not advisable to set some clear-cut criteria (insufficient information exists to set clear-cut thresholds). It may be more appropriate to consider a street an urban street canyon if more than a certain number of these conditions are met. This will be a qualitative approach to define urban street canyons.

For the definition of “urban core”, the subcommittee has some suggestions for EPA to consider. EPA may use the U.S. Census Bureau definition of an “urban area” as a starting point. Per U.S. Census Bureau, an urban area is defined as "Core census block groups or blocks that have a population density of at least 1,000 people per square mile and surrounding census blocks that have an overall density of at least 500 people per square mile." Land features such as a river or a ridge may divide a CBSA into multiple urban cores. EPA may use population density to rank urban cores. EPA may further enhance this definition by factoring in “traffic density”, which could be calculated as the sum of AADT for every unit of road length (e.g., a length comparable to street block) in an area under consideration divided by the size of the area.