UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

[**Insert date**]

EPA-CASAC-09-XX

The Honorable Stephen L. Johnson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

Subject: Peer Review of EPA's *Risk and Exposure Assessment to Support the Review of the Secondary National Ambient Air Quality Standard for Oxides of Nitrogen and Sulfur: First Draft*

Dear Administrator Johnson:

The Clean Air Scientific Advisory Committee (CASAC or Committee) NO_x & SO_x Secondary National Ambient Air Quality Standards (NAAQS) Review Panel (Panel held a public meeting on October 1-2, 2008 to review EPA's *Risk and Exposure Assessment to Support the Review of the Secondary National Ambient Air Quality Standard for Oxides of Nitrogen and Sulfur: First Draft* (see Enclosure 1 for the Panel roster). The Panel's draft report was completed during a November 19, 2008 public teleconference.

Overall, the Panel found the first draft of the Risk and Exposure Assessment (REA) to be a credible beginning in the development of the assessments needed to support rule-making. The time constraints under which the present first draft REA was prepared and that much of the analyses and the subsequent interpretation have yet to be completed are duly noted (e.g., Chapter 7 is focused primarily towards acidifying deposition and Chapter 8 only begins to explore how a secondary NAAQS might be structured). The Panel has many suggestions for strengthening the document in response to the Agency's charge questions. Individual comments from the CASAC Panel members are provided in Enclosure 2.

The Panel strongly supports the up-front inclusion of a policy-focused interpretation of each of the key scientific findings in the Integrated Science Assessment (ISA). These policy interpretations should be included in an Executive Summary, as well as in the applicable sections of the REA. As discussed in prior reviews of the ISA and Scope and Methods documents, the REA must give attention to all forms of reactive nitrogen (Nr, which includes oxidized, chemically reduced and organic nitrogen forms) deposition because all forms can contribute to

both acidification and nutrient enrichment. Moreover, the science would suggest that ecological effects could be ameliorated by decreasing deposition of any of those forms. From a scientific standpoint, this intricate relationship indicates that the applicable NAAQS standard(s) should address total nitrogen (N) deposition. Thus, the Panel affirms that science-based secondary NAAQS standards for nitrogen and sulfur should consider the ecological consequences of total Nr deposition. However, it is noted that the present regulatory authority of EPA recognizes only oxidized forms of nitrogen and sulfur as Criteria Pollutants. The Panel recommends that the EPA move forward with establishing scientifically based standards that effectively protect the environment, while recognizing the current constraints.

<u>Scope of the Review</u>

1. *Chapters 1 and 2 provide the background, history, and framework for this review, including a discussion of our focus on the four key ecological effect areas (aquatic acidification, terrestrial acidification, aquatic nutrient enrichment, terrestrial nutrient enrichment). Is this review appropriately focused in terms of characterizing the important atmospheric and ecologic variables that influence the deposition and, ultimately, the ecologic impacts of nitrogen and sulfur? Does the Panel have any further suggested refinements at this time?*

Chapters 1 and 2 of the REA do in theory satisfy the goals of providing a clear and correct framing of the issues, providing a coherent method for reaching conclusions required in the NAAQS review process, summarizing the relevant policy questions and building on the ISA. The appropriate effects are considered in the REA and the potential relationships between atmospheric deposition and ecologic effects are outlined, at least conceptually.

The Panel commends EPA on its use of figures and diagrams throughout Chapters 1 and 2: such illustrations help orient the reader and provide a framework for discussions. It would be helpful if Figure 1.4-1 were accompanied by descriptions in the text that explain how well each of the steps can be executed, what the major uncertainties are, and where each component is addressed in the later parts of the REA. Such modifications would assist in guiding the reader through the material in the document. It would also be beneficial for the Agency to include a paragraph on the central position of “loading" because this concept is pivotal to the document. Similarly, the concept of “N saturation” needs to be introduced earlier in the document with a clear delineation of how this concept is, or should be, used in evaluating the effects of N loadings. There should be greater coherence between the text, figures and policy statements with respect to reduced and organic forms of N: both forms of N are mentioned here and in the ISA, and are important contributors to the effects being exhibited by ecosystems in response to N deposition. In the present version of the REA, the chemistry figures and the policy questions essentially address only the oxidized form. The material should be modified to address reduced and organic nitrogen as well.

Discussions of uncertainty in Section 2.4 are generic and qualitative: it is unclear when uncertainty is being discussed and when variability is the real issue. The document needs to be explicit that variability and uncertainty are two important but different concepts, with different impacts on establishing secondary NAAQS. The issue of uncertainty is paramount in the

discussion of monitoring networks. The sparse data from the existing network introduces significant uncertainty in the calculation of deposition. The Panel recommends that Chapters 1 or 2 address uncertainty, with a discussion of the implications on the EPA's ability to perform the assessments outlined in Chapters 7 and 8. Additionally, the uncertainty issue extends to the discussion of climate change, for which there are both beneficial and adverse effects of atmospheric Nr deposition. The REA is unclear on how a change in the secondary NAAQS will affect climate change (and in what direction). If the science is uncertain on the level and direction of effects on climate, it should be clearly stated in the REA.

The Panel recognizes that including a discussion of the potential primary NAAQS (i.e., based on public health) for NO_x, SO_x and PM is premature at present. However,, future drafts of the REA should include such a discussion. This discussion could include an analysis of how the estimates of ecological exposure and risk are impacted by the range of primary standards under consideration and if the respective primary NAAQS would (or would not) be adequately protective of the full range of environmental risks.

<u>Air Quality Analyses</u>

1. *To what extent are air quality characterizations and analyses presented in Chapter 3 technically sound, clearly communicated, appropriately characterized, and relevant to the review of the secondary NAAQS for NOx and SOx?*

2. *Section 3.2.1 describes an approach for evaluating the spatial and temporal patterns for nitrogen and sulfur deposition and associated ambient concentrations in the case study locations. This draft document includes the analysis for the Adirondacks case study. Does the Panel agree with this approach and should it be applied to the other Case Study Areas?*

3. *Section 3.2.2 describes the relative contributions of ambient emissions of nitrogen and ammonia to nitrogen deposition for the case study areas. To what extent is the approach taken technically sound, clearly communicated, and appropriately characterized?*

Assuming the many and important missing "placeholder" sections in Chapter 3 are satisfactorily completed, the air quality characterizations and analyses presented in this chapter should provide a reasonably sound and clearly communicated characterization of estimates of deposition of total reactive nitrogen and acidifying species to the specific case study areas. The Chapter, if completed should also provide information that is relevant to potential revisions to the current secondary NAAQS for NO_x and SO_x.

Given that most of Chapter 3 is devoted to the presentation of model results from the Community Multiscale Air Quality (CMAQ) model and Response-Surface Model (RSM), a major limitation of the current chapter is the absence of any evaluation of model performance on simulated levels and atmospheric deposition rates of the various forms and phases of sulfur- and Nr-containing species. It is critical that EPA Fill in the placeholders that relate to model/measurement comparisons and the characterizations of uncertainty in model results. Per the panel's previous recommendations on the ISA, much of the needed evaluation of the CMAQ

model should be included in the ISA. There is also a need – either in the ISA or here in the REA – for a more detailed description of the RSM and an evaluation of its performance for the S and N species. With the relatively extensive sets of air quality, atmospheric deposition and environmental measurements available for the Adirondacks, this may be a good Case Study area in which to evaluate model performance prior to extending this approach to other case study areas.

The complex terrain in sections of the Adirondacks also raises concerns. It is not appropriate to compare the 12-km spatial resolution of the modeled deposition with the spatial patterns in actual deposition (including orographic precipitation increases and cloud water deposition) or the spatial patterns in sensitive environmental species and ecosystems. A sensitivity analysis on variations within selected Adirondack model grid cells could help evaluate the importance of spatial variability and its affect on deposition estimates.

The Panel was pleased to note the efforts of the Agency to link the atmospheric models (relating emissions to deposition) with watershed or landscape models (relating deposition to environmental effects). The temporal disconnect in the time scales between atmospheric (i.e., CMAQ) and watershed models is a major issue. Atmospheric models typically provide predictions at relatively fine time scales (e.g., hourly) over a single year, while the watershed models provide results on the scale of decades to centuries. To the extent possible, it would be helpful if CMAQ could be run for a number of recent years (2002-2006), varying both meteorology and emissions, to provide a better understanding of inter-annual variability and longer-term spatial patterns. This would effectually provide a more robust basis for model/measurement comparisons.

Assuming the model evaluations indicate reasonable performance for species of concern, the Panel recommends that the model results (for both sulfur and reactive nitrogen species) be used to generate a number of maps that illustrate the spatial of:

- Emissions (preferably interpolated to better illustrate high-emitting regions),
- Atmospheric concentrations (gaseous and aerosol and combined species),
- Deposition (wet, dry, total S, total N, oxidized N, chemically reduced N, etc.), and
- Ratios of deposition to atmospheric concentrations and deposition to emissions

Such maps would provide the reader a more direct understanding of the spatial relationships that exist between emission location, ambient concentrations and the resulting deposition. The maps would also be useful in proposing a structure for a secondary NAAQS.

In addition to these maps, the Panel recommends the EPA use scatter plots of gridded model results to further illustrate the key relationships between the deposition metrics most relevant to environmental effects and alternative air quality metrics upon which the secondary NAAQS might be based. The scatter plots could also be used to inform the uncertainty analysis.

<u>Case Study Analyses</u>

The proposed use of ecological indicators that can be linked to varying severity or magnitudes of effects (and related losses in ecosystem services) goes beyond the concept of estimating critical loads at which ecosystems experience no effects according to present

knowledge. An important consideration as these indicators are selected and further developed is how to describe effect indicators of varying severity rather than providing a "no effects" threshold. A continuum of indicator effects will provide important information on the range of adverse responses, and quantifying the response indicators to various emissions and deposition levels will be important for the eventual assessment of what ecological effects are considered to be adverse. A separate section may be needed to discuss the ecological implications of various levels of ANC (and associated effects), and its application to evaluating effects of acidifying deposition. This discussion should include a consideration of the implications for moving beyond single critical load 'no-threshold' approaches to more comprehensive approaches that offer varying degrees of ecosystem protection within specified levels of statistical probability.

The modeling approaches used to develop critical loads for these case studies are very different. Evaluating these different approaches could be very instructive. In particular, a discussion of the relative merits of dynamic models vs. steady state models in these specific applications is needed. For example, MAGIC does not effectively simulate watershed nitrogen dynamics, so if this is an important component of the critical load there will undoubtedly be some errors. The question could be asked if it is a good idea to use a dynamic model for the aquatic assessment and a steady-state model for the terrestrial assessment. Forest ecosystems are losing exchangeable cations and accumulating S and N, so by definition they are not steady-state systems. Applying a steady-state model to such systems is problematic as a critical loads assessment tool.

In these case study Attachments, the discussions of varying amounts of ANC and their associated effects on ecosystem function differ from what is presented in the main chapters of the REA document. A more consistent approach is needed for setting the ANC limits of concern with respect to ecosystem sensitivity to acidification and recovery from acidification. The panel suggests that full protection of fish species (set at 100 μeq/L) should be considered in the case study scenarios.

It would be useful and instructive to include an N-limited site among the case studies. One example is the rapidly-growing and N-demanding Douglas-fir forest ecosystem in the Pacific Northwest or a loblolly pine dominated forest stands in the Southeastern US. For better understanding of the regional effects of N deposition in the southern Sierra Nevada, EPA should consider a comparison of responses in mixed conifer forests (e.g., the Kings River Project area) as compared to ANC changes in the nearby lakes of the sub-alpine and alpine zone (e.g., such as leaching of nitrate to streams, lichen species composition, and invasion of invasive grasses).

Additionally, it may be useful to include an up-front discussion of soil solution and possible surface water acidification responses to the introduction of mineral acid anions. In an already acid soil, intensity effect (which can be instantaneous for both) increases and recovery from acidification requires no change in the soil itself, as opposed to an acidification effect via soil change, which can take a long time and essentially is not reversible without liming.

1. *Attachment 2 presents a GIS analysis to define geographical areas that are sensitive to acidification and nutrient enrichment. Are the national geospatial datasets chosen adequate to identify sensitive areas? Are there other data sets that have not been identified by this analysis that we should consider? Does the panel agree with this approach or can they suggest alternatives?*

The selected datasets and the general GIS approach are appropriate for this analysis, and the Panel has no recommendation for additional datasets to consider. The age of several datasets (e.g., range of red spruce) and the spatial representativeness of the acidophytillic lichen database are possibly important limitations that should be noted.

2. *Attachment 3 presents our current progress on evaluating the effect of aquatic acidification in the Adirondacks. It describes the use of the MAGIC model to evaluate ANC levels in selected streams and lakes in Adirondacks and Shenandoahs. To what extent is the approach taken technically sound, clearly communicated, and appropriately characterized?*

The selection of the Adirondacks and the Shenandoah Park as case study areas and the use of MAGIC as the modeling tool are appropriate; however, this section needs to be edited for clarity. At present, it is generally confusing, especially the modeling approach and descriptions of MAGIC and ASTRAP models. Numerous errors make it difficult to fully assess technical merits of the discussion in Attachment 3.

ANC has been selected as a metric to quantify the current acidic conditions and biological impacts because, in many studies, it was found to be the best single indicator of the biological response of aquatic communities in the acid-sensitive ecosystems and it is relatively easy to simulate in watershed biogeochemical models. Based on the ANC values and fish populations responses, five classes of biological responses (acute, severe, elevated, moderate and low concerns) have been developed and can by used for evaluation of risk assessment using the critical loads concept. For better protection of fish species, EPA should consider using a more conservative value of 100 μeq/L instead of 50 μeq/L.

Some comparisons of these case study results with other efforts to evaluate acid deposition/biogeochemical responses in each of these sites (especially the Adirondacks) would be useful to indicate either differences from or support for these modeling efforts.

3. *Attachment 4 presents our current progress on evaluating the effect of terrestrial acidification. It outlines a plan to use the Simple Mass Balance Model to evaluate current deposition on forest soil ANC for sugar maple in Kane Experimental Forest and red spruce in Hubbard Brook Experimental Forest. To what extent is the approach taken technically sound, clearly communicated, and appropriately characterized?*

The selection of the study area is reasonable. Chapter 3 and its several Attachments are highly uneven. Substantial detail has been provided in some cases, while broad generalizations are made in others. It is difficult for the reader to ascertain the salient points in this chapter.

4. *Attachment 5 presents our current progress on evaluating the effect of aquatic nutrient enrichment. It outlines a plan to evaluate how changes in nitrogen deposition affect the eutrophication index in two estuaries: Chesapeake Bay and Pamlico Sound. The analysis will model one steam reach (Potomac River and Neuse River) to determine the impact on the eutrophication index for the estuary. To what extent is the approach taken technically sound, clearly communicated, and appropriately characterized?*

The approach is appropriately characterized. The Chesapeake Bay has been the focus of considerable efforts relating to the effects of nitrogen loading on eutrophication. Extensive investigations have been made to identify Nr sources within both the very large airshed and the much smaller watershed areas of the Chesapeake region. However, a potential drawback of the two areas chosen is that it is not likely that atmospheric nitrogen deposition is the dominant component of the total nitrogen loading, and thus may not be as sensitive to atmospheric deposition changes as other ecosystems.

5. *Attachment 6 presents our current progress on evaluating the effects of terrestrial nutrient enrichment. It describes an approach to evaluate the effects of N deposition on the Coastal Sage Scrub community in California and mixed conifer forests in San Bernardino and Sierra Nevada Mountains. To what extent is the approach taken technically sound, clearly communicated, and appropriately characterized?*

The selection of coastal sage scrub (CSS) and mixed conifer forest ecosystems is appropriate. Attachment 6 provides a comprehensive review of existing scientific knowledge for these two ecosystems and the findings have been clearly communicated. For development of critical loads for CSS, accumulation of biomass of invasive grasses (critical level for occurrence of catastrophic fires) could be considered (see Minnich, ____). For the mixed conifer forests, change in lichen communities is a good indicator for ecosystem effects at the low end and nitrate leaching to surface water is a good indicator at the high end of total Nr deposition loads.

The REA as a whole still needs to show how the results of the two case studies (specifically, the relationships between the observed chemical and biological changes and N atmospheric deposition, possibly expressed as critical loads) can be linked to the traditional NO_x/SO_x standards that are based on ambient concentration. It is imperative that this additional linkage information is incorporated in the next draft of Chapter 8.

<u>Additional Effects</u>

1. *In this chapter, we have presented results from some initial qualitative analyses for additional effects including the impact of sulfur deposition on mercury methylation, the impact of nitrous oxide on climate change, and the impact of nitrogen deposition on carbon sequestration. Are these effects sufficiently addressed in light of the focus of this review on the other targeted effects in terms of available date to analyze them?*

These descriptions and level of detail in Chapter 6 seem adequate, but the relevant issues go beyond those associated with carbon sequestration, mercury methylation and increasing nitrous oxide emissions. The chapter would be much improved by providing a short summary that describes additional welfare effects of SO_x and NO_x for which deleterious impacts are expected (e.g., effects on visibility, climate and materials; as well as the terrestrial, aquatic, atmospheric systems and structures). Additional information is needed as to the effect of changes in pH on mercury concentrations in fish and other organisms. This summary should indicate both the importance of these ecosystems to individual regions and, in the context of the entire United States, the overall adverse ecological impacts. In considering the impacts of nitrogen deposition on carbon sequestration, the positive (e.g., increased forest growth and

harvestable timber production) and the negative relationships need to be considered and presented in a balanced fashion.

<u>Synthesis and Integration of the Case Study Results into the Standard Setting Process</u>

1. *The purpose of Chapter 7 is to summarize the Case Study results and characterize the relationship between levels of an ecological indicator and the associated degree of ecologically adverse effects. To what extent is this approach characterized at this point of the review? Does the Panel have any further suggested refinements at this time?*

Chapter 7 remains in a very early stage of development, thus it is difficult to provide summary comments on the overall content and direction of this chapter. The Chapter ends abruptly and seems incomplete.

In general terms, the outline and material included in the Chapter are appropriate to the intended summary. Table 7.1 will be very important in its final form in future drafts of the REA and thus EPA should carefully consider Panel comments on its content. The initial statement at the beginning of Section 7.2 strikes the right balance between important effects while recognizing their variable and their localized nature. As appropriate throughout Chapter 7 (and the entire REA), the wording should be scrutinized so that the reader is clear when NO_x and SO_x versus total S or N deposition are the real drivers for the effects being considered. In the summarized cases, the key metric is total deposition irrespective of the original chemical forms of the airborne S and N inputs.

<u>Considerations in the Structure of the NOx/SOx Secondary Standard</u>

1. *Chapter 8 begins to explore how a secondary NAAQS might be structured to address the targeted ecological effects discussed in the risk assessment. The next draft of this document will include one or more examples of how this structure might be used to relate specific levels of air quality indicators with a corresponding ecological indicator for a given location and/or scenario. To what extent is the described approach technically sound, clearly communicated and appropriately characterized at this point of the review? Does the Panel have any further suggested refinements at this time?*

As noted before, the Panel views that, scientifically, a NAAQS standard developed to protect ecological systems should focus on total acidifying deposition and excess nutrient enrichment, both of which include chemically reduced, organic and oxidized forms of total reactive nitrogen. The current constraints have led EPA to focus on developing a combined standard that is limited to sulfur and nitrogen oxides. The proposed approach is scientifically well-founded: it is designed to lead to atmospheric deposition rates that will protect at least some (and perhaps many) of the target ecosystems as measured by specific ecosystem-based indicators of adverse ecological effects (e.g., ANC). While the approach does not directly include targeted decreases in atmospheric deposition of reduced or organic forms of nitrogen, the approach does include consideration of chemically reduced and organic nitrogen loadings as part of the already existing conditions that contribute to acidification and nutrient enrichment of sensitive ecosystems. As such, the approach could provide for a substantial decrease in some of

the adverse ecological effects of acidification and nutrient enrichment in various part of the United States.

The Panel concludes that the approach presented is potentially innovative and environmentally relevant. The description should be clarified and more detail should be provided, specifically with regard to how the approach could be implemented in some of the proposed Case Study Areas. Further, how the approach would promote controlling chemically-reduced and oxidized nitrogen loadings as a means to decreasing ecological acidification and nutrient enrichment should be clarified.

Currently, the discussion in Chapter 8 on establishing an appropriate linkage between ambient air concentrations and ecosystem effects, and the importance of spatial and temporal scales, is limited. The Chapter should show how the proposed approach directly addresses the Panel's concerns that, from a scientific perspective, the resulting environmentally-focused standard would include all reactive N deposition. Further, the Panel questions the Agency's ability to implement a standard based on this approach. There are a number of complications that need to be addressed so as to fully inform policy-makers, particularly in preparation for the development of an appropriate Advanced Notice of Proposed Rule Making (ANPR). Critical questions that need to be elaborated upon include:

(1) whether (or how) a standard will integrate the multiple indicators identified in the case studies,
(2) identifying the appropriate spatial scales for each indicator and sensitive ecosystem,
(3) how varying levels of protection required by different ecosystems can be accommodated, and
(4) what level of protection is being provided to various ecosystems under alternative levels and forms of the standards.

In summary, the CASAC Panel was pleased to review this first draft of the Risk and Exposure Assessment to Support the Review of the Secondary National Ambient Air Quality Standard for Oxides of Nitrogen and Sulfur. The Agency's venture into new territory in the consideration of multi-pollutant standards is laudable. Shifting to standards that focus on ecological effects and employ metrics that are specifically relevant to ecosystems will have some inherent complexities and difficulties, and the Panel looks forward to following and contributing to the evolution of suggested approaches.

Sincerely,

Dr. Armistead (Ted) Russell, Chair
CASAC NO_x & SO_x Secondary
NAAQS Review Panel

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

Enclosures