

**Summary Minutes of the  
U.S. Environmental Protection Agency Science Advisory Board  
Clean Air Scientific Advisory Committee (CASAC)  
Secondary NAAQS Review Panel for Oxides of Nitrogen and Sulfur  
Public Meeting  
September 5-6, 2018**

**Date and Time:** Wednesday, September 5, 2018, 9:00 a.m. – 5:15 p.m.  
Thursday, September 6, 2018, 8:00 a.m. – 3:30 p.m.

**Location:** Hilton Durham Hotel Near Duke University, 3800 Hillsborough Road, Durham,  
NC 27705

**Purpose:** To conduct a review of: (1) EPA’s Integrated Science Assessment for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter – Ecological Criteria (Second External Review Draft), and (2) EPA’s risk and exposure assessment planning document for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter.

**Participants:**

*Members of the EPA Clean Air Scientific Advisory Committee (CASAC) Secondary NAAQS Review Panel for Oxides of Nitrogen and Sulfur*

Dr. Ivan Fernandez, Chair  
Dr. Dr. Edith Allen  
Dr. Praveen Amar  
Dr. Elizabeth Boyer  
Dr. Douglas Burns  
Ms. Lauraine Chestnut  
Dr. Mark Fenn  
Dr. Frank Gilliam  
Dr. Daven Henze  
Dr. Donna Kenski  
Dr. William McDowell  
Dr. Erik Nelson  
Dr. Hans Paerl  
Mr. Richard Poirot

For full Panel see Roster<sup>1</sup>

Thomas Armitage, Designated Federal Officer (DFO)  
Thomas Brennan, Acting Director, SAB Staff Office

Tara Greaver, EPA ORD  
Rob Pinder, EPA OAQPS  
Erika Sasser, EPA OAQPS  
Travis Smith, EPA OAQPS  
John Vandenberg, EPA ORD  
Karen Wesson, EPA OAQPS

Other Attendees (See Attachment A)

## **Meeting Summary:**

**Wednesday, September 5, 2018**

### **Convene the Meeting**

Dr. Thomas Armitage, Designated Federal Officer (DFO), convened the meeting at 9:00 a.m. on Wednesday, September 5, 2018. He stated that the Secondary NAAQS Review Panel for Oxides of Nitrogen and Sulfur (referred to later as the Panel) operated as part of the EPA Clean Air Scientific Advisory Committee (CASAC) which is a Federal Advisory Committee chartered under the Federal Advisory Committee Act (FACA). He indicated that the CASAC was empowered by law to provide advice to the EPA Administrator on the technical bases for EPA's National Ambient Air Quality Standards (NAAQS). He stated that summary minutes of the meeting would be prepared and certified by the Panel Chair. He noted the Panel's compliance with ethics requirements. Dr. Armitage also indicated that meeting materials were available on the CASAC web site. These meeting materials included: the Federal Register Notice announcing the meeting,<sup>2</sup> meeting agenda,<sup>3</sup> and Panel roster. He noted that time had been included on the meeting agenda to hear oral public comments but no requests to speak had been received. In addition, he indicated that public access to the meeting had been provided through a conference line and live audio webcast. He asked members of the public listening to the webcast to send him an email at armitage.thomas@epa.gov to let him know that they were on-line.

Mr. Thomas Brennan, Acting Director of the EPA Science Advisory Board Staff Office, welcomed the members of the Panel, EPA staff, and members of the public to the meeting. He noted the importance of the topic addressed by the Panel and thanked members of the Panel for providing advice to the EPA.

### **Review of Agenda and Purpose of the Meeting**

Dr. Ivan Fernandez, Chair of the CASAC Panel, welcomed members of the Panel and other attendees to the meeting and asked Panel members to introduce themselves. He indicated that the Panel would review two EPA documents. The first document to be reviewed was titled *Integrated Science Assessment for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter – Ecological Criteria (Second External Review Draft)*.<sup>4</sup> Dr. Fernandez indicated that the Panel had held a meeting in May 2017 to review the first draft of the Integrated Science Assessment (ISA). It was revised to incorporate changes in response to CASAC recommendations, and the Panel was reviewing the second draft. Dr. Fernandez indicated that the second document to be reviewed was EPA's Risk and Exposure Assessment Planning Document (REA Planning Document)<sup>5</sup> which outlined EPA's plan for conducting a risk and exposure assessment of ecological effects associated with oxides of nitrogen, oxides of sulfur, and particulate matter

Dr. Fernandez described EPA's charge<sup>6</sup> to the Panel for review of the second draft of the ISA. He noted that the charge for review of the second draft of the ISA focused on the Executive Summary and Integrated Synthesis of the document. He indicated that the CASAC had been asked to: (1) comment on whether the revised Executive Summary and Integrated Synthesis conveyed the main scientific findings of the ISA; (2) comment on how effectively the revisions to the ISA reflected the recommendations and comments received from the CASAC and public comments; and (3) identify any additional revisions to

the ISA that would substantively strengthen the identification, evaluation, and communication of the main scientific findings. Dr. Fernandez indicated that the Panel had been asked to review specific sections of the Executive Summary and Integrated Synthesis chapter. Dr. Fernandez noted that the Panel would develop a consensus report of findings and recommendations in response to charge questions for the second draft of the ISA. He indicated that the chartered CASAC would approve the final report before it was transmitted to the EPA Administrator.

Dr. Fernandez stated that EPA's charge<sup>7</sup> for review of the REA Planning Document asked the Panel to comment on: (1) the Overall Analytical Approach, (2) the Ambient Air Quality Analyses, and (3) the Ecological Risk Assessment. He noted that the EPA had requested a consultation on the REA Planning document, not a formal peer review. Therefore, a consensus report would not be developed for the REA Planning Document review but the Panel would discuss the document and provide individual comments to EPA.

Dr. Fernandez reviewed the meeting agenda and noted that:

- The meeting agenda had two parts. On the first day the Panel would discuss responses to charge questions on the second draft of the ISA. On the second day, the Panel would discuss responses to the charge questions on the REA Planning Document. Before adjourning the Panel would review key points to be included in the consensus report on the second draft of the ISA.
- The Panel would first hear a presentation from EPA on the second draft of the ISA. The EPA speakers would be Drs. John Vandenberg and Tara Greaver of the EPA National Center for Environmental Assessment.
- There was time on the agenda to hear oral public comments on the second draft of the ISA but no requests to present oral public comments had been received.
- Following public comments, there was time on the agenda for the Panel to discuss the ISA charge questions and ask clarifying questions.
- After discussion of the ISA charge, the Panel would discuss responses to the ISA charge questions. The lead discussants for each ISA section were listed on the agenda.
- On the second day of the meeting, the Panel would hear a second EPA presentation on the Risk and Exposure Assessment Planning Document. The EPA speakers would be Drs. Erika Sasser, Karen Wesson, Rob Pinder, and Travis Smith of the EPA Office of Air Quality Planning and Standards.
- After the second EPA presentation there was time on the agenda to hear public comments on the REA Planning Document and discuss the charge. No requests to provide oral public comments had been received.
- Following the second public comment period the Panel would discuss responses to the REA Planning Document charge questions.
- Following the meeting, the ISA lead writers would work with the lead discussants for their sections of the ISA to develop the written responses to the charge question. Dr. Fernandez would

work with the DFO to develop a first draft of the Panel's report and a public conference call would be scheduled for the Panel to discuss the report.

## **Remarks from EPA**

Drs. John Vandenberg and Tara Greaver of EPA's National Center for Environmental Assessment in the Office of Research and Development presented EPA remarks (EPA's presentation slides<sup>8</sup> were posted on the CASAC meeting website). Dr. Vandenberg indicated that the EPA had revised the second draft of the ISA to incorporate changes previously recommended by the CASAC. He thanked the Panel for its review of the first draft, noted that the review had improved the document, and said that he looked forward to receiving input on the second draft. He then reviewed the schedule for release of the final ISA.

Dr. Greaver outlined the process for EPA's review of National Ambient Air Quality Standards. She indicated that this process involved development of: an integrated review plan, integrated science assessment, risk and exposure assessment, and policy assessment. Dr. Greaver then provided an overview of the key revisions that had been incorporated into the second draft of the ISA. Key revisions included:

- A new ISA structure including an executive summary, integrative synthesis, and appendices to significantly reduce the length of the main document and focus on key messages;
- A revised literature base that included additional references suggested by CASAC and updated literature through May 2017;
- Improved cross-referencing among chapters on key topics.

Dr. Greaver outlined key revisions in the integrative synthesis chapter of the second draft ISA. She noted that the integrative synthesis chapter contained an expanded discussion clarifying the purpose and scope of the ISA. A new section titled "Connections, Concepts, and Changes" had been included in the chapter. The "Connections" section provided a roadmap showing how subjects related across the ISA. The "Concepts" section included discussion of: ecosystem scale, structure and function; deposition; critical loads; the importance of biodiversity; reduced versus oxidized forms of nitrogen; and scientific advancements of the Aquatic Acidification Index.

The "Changes" section discussed key changes (since the 2008 ISA) in the understanding of atmospheric sciences and ecological effects.

Dr. Greaver also discussed revisions incorporated into parts of the integrative synthesis that addressed:

- Emissions and atmospheric chemistry
- Causality determinations
- Soil biogeochemistry
- Biological effects of terrestrial nitrogen enrichment
- Aquatic biogeochemistry
- Biological effects of nitrogen enrichment and acidification in freshwater
- Biological effects of nitrogen enrichment in near coastal ecosystems
- Biological effects of nitrogen enrichment in wetland ecosystems
- Biological effects of sulfur enrichment on wetlands and freshwaters
- Uncertainty

- Effects of particulate matter and ecosystem recovery
- Climate modification of ecosystem response and ecosystem services

Dr. Greaver indicated that there had been no change in the main conclusions of the second draft of the ISA. She noted that current NO<sub>2</sub> (nitrogen dioxide) and SO<sub>2</sub> (sulfur dioxide) standards were based on foliar injury and there was no new evidence that foliar injury occurred at current concentrations in the U.S. She noted that nitrogen enrichment from atmospheric deposition altered many ecosystems, that national nitrogen deposition rates had been broadly constant with decreasing NO<sub>y</sub> (total oxidized nitrogen) deposition offset by increased NH<sub>x</sub> (reduced nitrogen) deposition, that new critical loads were available for biological effects, and that surface waters received nitrogen deposition and nitrogen inputs from agriculture and urban sources. Dr. Greaver also noted that acidification from nitrogen and sulfur deposition continued to affect ecosystems, that the negative effects on fish, plants, and plankton were well documented, and that sulfur enrichment from deposition altered aquatic and wetland ecosystems.

Dr. Fernandez thanked EPA staff for the presentation and asked whether members had questions. A member asked when the ISA would be completed. EPA staff responded that the Agency anticipated completing the ISA in mid-2019.

### **Public Comments**

Dr. Fernandez indicated that no requests to present oral public comments had been received and that the Panel would next review the charge questions.

### **Review of the Charge Questions**

Dr. Fernandez asked the Panel to review the charge questions. He said that the purpose of reviewing the charge questions was to make sure that they were clear to the Panel and to give members an opportunity to ask clarifying questions. He noted that in its charge, EPA had stated that the Executive Summary and Integrated Synthesis served as the main body of the ISA and that the charge to the CASAC focused on the Executive Summary and Integrated Synthesis. The CASAC had been asked to: (1) comment on whether the revised Executive Summary and Integrated Synthesis conveyed the main scientific findings of the ISA; (2) comment on how effectively the revisions to the ISA reflected the recommendations and comments received from the CASAC and public comments; (3) identify any additional revisions to the ISA that would substantively strengthen the identification, evaluation, and communication of the main scientific findings. Dr. Fernandez stated that EPA had asked the Panel to focus on the following sections of the document.

1. Executive Summary and Connections, Concepts, and Changes (Chapter 1.2).
2. Emissions and atmospheric chemistry (Chapter 1.3).
3. Gas-phase direct phytotoxic effects (Chapter 1.4).
4. Terrestrial nitrogen enrichment and acidification (Chapter 1.5).
5. Freshwater nitrogen enrichment and acidification (Chapter 1.6).
6. Estuarine and near-coastal nitrogen enrichment and nitrogen-driven acidification (Chapter 1.7).

7. Wetland ecosystem nitrogen enrichment (Chapter 1.8)
8. Freshwater and wetland ecosystem sulfur enrichment (Chapter 1.9).
9. Ecological effects of Particulate Matter other than nitrogen and sulfur deposition (Chapter 1.10)
10. Recovery, climate modification, key scientific uncertainties, and ecosystem services (Chapters 1.11, 1.12, 1.13, and 1.14)

Dr. Fernandez asked members whether the charge questions needed clarification or discussion. There were no comments or questions from the Panel. Dr. Fernandez indicated that following a short break, the Panel would begin the discussion of the responses to the questions.

### **Discussion of the Panel's Responses to the ISA Charge Questions**

Following the break, the Panel discussed its responses to the ISA Charge. Dr. Fernandez noted that some Panel members had provided preliminary written comments<sup>9</sup> in response to the charge questions, and that the comments had been distributed and posted on the CASAC website. He noted that preliminary comments from individual Panel members did not represent the consensus views of the Panel.

Dr. Fernandez indicated that the lead discussant assigned to each charge question would begin the discussion by providing initial comments, and then the response would be discussed by the entire Panel. He indicated that the Panel would begin by discussing Section 1.3 of the second draft of the ISA (Emissions and Atmospheric Chemistry). He noted that the Executive summary and Chapter 1.2 would be discussed after other sections of the document.

#### *Emissions and Atmospheric Chemistry (Chapter 1.3 of the Second Draft ISA)*

The Panel discussed Chapter 1.3 of the second draft of the ISA. A member commented that the chapter was a good summary of the detailed information presented in the Appendices to the document. She indicated that the information included in the chapter and the level of detail were appropriate. The member noted that some additional information on transference ratios, modeling methodology, and uncertainty would be helpful but recognized that the integrated synthesis should be concise. She also noted a minor revision needed in Section 1.3.2, paragraph 2 (p. 29 lines 4-6). The text in this paragraph stated that “unmeasured component species of NO<sub>Y</sub> and concentrations of all NO<sub>Y</sub> species in data-sparse regions must be provided by regional models in conjunction with satellite data.” The member noted, however, that NO<sub>2</sub> was the only component species detected by satellites, and the only one described in Appendix section 2.4.2. The member suggested that the paragraph be reworded to be more precise about the abilities of satellites to detect NO<sub>2</sub> vs. NO<sub>Y</sub> and more accurately convey the information from Appendix section 2.4.2.

Members agreed that the EPA had done a good job developing Chapter 1.3. A member noted that some technical clarifications were needed and indicated that he had provided suggested clarifications in his written comments. He noted that the ISA should clearly state that animal waste and fertilizer applications were two distinct and separate operations resulting in substantial ammonia emissions. He commented that, since these two agriculture sources were different, it would be helpful to split the two categories under “agriculture” in Table 2-1 of Appendix 2 and provide separate emission estimates. He noted that concentrated animal feeding operations were a larger source of ammonia emissions than fertilizer. He noted that there had been decreases in NO<sub>x</sub> (defined in the second draft of the ISA as the

sum of NO and NO<sub>2</sub>) and SO<sub>2</sub> emissions in the U.S, and this was clearly stated in the ISA. However, he commented that it was important to provide quantitative information about increases in NH<sub>3</sub> emissions. He suggested that information be provided to estimate future increases in ammonia emissions under “business as usual” scenarios taking into account increases in animal waste and increased fertilizer application for food production.

A member commented that information about ammonia measurements was presented in appendices to the ISA but the summary of this material in Chapter 1.3 omitted detail. He noted that it would be useful to provide more information on remote sensing of ammonia. The member also suggested clarification of several points in the discussion of particulate matter (PM) composition. There were no additional comments from members so Dr. Fernandez called for discussion of Chapter 1.4.

#### *Gas-phase Direct Phytotoxic Effects (Chapter 1.4 of the Second Draft ISA)*

The Panel discussed Chapter 1.4 of the second draft of the ISA. A member commented that Chapter 1.4 was brief compared to other chapters of the ISA but she noted that Chapter 1.4 included a new summary of information about oxidized nitrogen and sulfur gas phase pollutants and their impacts. She noted that additional explanatory information was provided in Appendix 3. She further commented that the length of the chapter (and the material presented) was appropriate because little new supporting research had been conducted in this area. She noted that levels of NO<sub>2</sub> and SO<sub>2</sub> had declined below regulatory secondary standard levels across most of the U.S. and there was no evidence that these levels were associated with direct gas-phase effects on vegetation. She commented, however, that Chapter 1.4 and Appendix 3 did not contain a summary of information on gas-phase effects of ammonia on vegetation. She suggested that literature on the impacts of gas-phase reduced nitrogen on vegetation be cited. She indicated that work had been conducted in Europe on ammonia fumigation and noted that these studies were cited in her written comments.

A member commented that Chapter 1.4 provided a clear summary of the current understanding of gas-phase direct phytotoxic effects of oxidized nitrogen and sulfur. He noted that there was no clear understanding of how much of the atmospheric nitrogen or atmospheric nitrogen and sulfur effects observed in a particular area were due to direct gaseous uptake by plant canopies as opposed to deposition to external canopy surfaces or ground-level surfaces that were washed off by precipitation and transported into the soil. He also indicated that, although phytotoxic effects of gaseous nitrogen and sulfur pollutants appeared to be uncommon in the U.S., physiological effects from direct canopy uptake of atmospheric nitrogen and sulfur were probably widespread. He noted that studies had indicated that stomatal uptake of gaseous nitrogen and sulfur pollutants was widespread but quantification of uptake and the importance of uptake was not well understood. The member suggested that in the ISA the discussions of the direct effects of SO<sub>x</sub> and NO<sub>x</sub> include phytotoxic effects as well as nonvisual harmful physiological effects and fertilizing effects that may or may not be ecologically desirable.

A member commented that, although little or no new work had been done on the direct effects of gas-phase oxidized nitrogen and sulfur, previous studies had indicated that there was a causal relationship between plant exposure and injury to vegetation. He also noted that confounding effects were observed, for example stomatal closure with high temperatures or drought, in some studies.

A member commented that Chapter 1.4 was the only section of the ISA where the causal statement indicated that effects may not be occurring at current levels of exposure. He noted that in all other causality statements in the ISA, there seemed to be an implication that effects were occurring at current levels. He also noted that nitric acid may be affecting lichen in Southern California. Another member

commented that lichens had been declining in Southern California. She noted, however that it was not clear whether this was a gas-phase effect or a long-term nitrogen effect. She also indicated that some lichen species were declining and some were increasing. She commented that some of the effects of nitrogen on lichens were appropriately discussed in Chapter 1.5 and its associated appendix rather than in Chapter 1.4.

A member commented that future gas-phase phytotoxic effects associated with ammonia could be observed. He suggested that this be addressed in the ISA. EPA staff responded that ammonia gas was not part of the secondary NAAQS and the ISA had not addressed the direct phytotoxic effects of ammonia because this was not in the scope of the standard. EPA staff also indicated that the structure of the second draft of the ISA for the NO<sub>x</sub>/SO<sub>x</sub>/PM secondary NAAQS (providing a shorter integrative assessment with supporting information in appendices) was being viewed as a model for the development of future ISAs.

A member commented that information provided throughout the ISA indicated that ecological effects were occurring at current levels of exposure. She commented that current standards could therefore be viewed as inadequate and suggested that this be made clear in the ISA. EPA staff responded that effects would be documented in the ISA but the EPA Administrator must make the policy decision concerning the standard. There were no further comments on Chapter 1.4.

#### *Terrestrial Nitrogen Enrichment and Acidification (Chapter 1.5 of the Second Draft ISA)*

The Panel discussed Chapter 1.5 of the second draft of the ISA. A member commented that the Chapter was well written. He indicated that a publication by Horn et al. on individual forest tree species mortality and growth responses across the U.S. was likely to be published within the next two months and would be a major contribution to the literature. He also noted that he had provided some editorial comments in his preliminary written comments. Another member commented that in general, the Chapter was well done. She noted that, in comparison to Chapter 1.4, a large amount of detailed information had been presented. She commented that the length of the Chapter could be reduced by moving some of the explanatory material into Appendix 4. For example, she noted that the explanation of belowground carbon allocation or the role of nitrogen deposition in decomposition could be included in the Appendix.

Another member agreed that the chapter was well written. He commented that Table 1.2, which summarized key soil biogeochemical processes and indicators associated with eutrophication and acidification, was effective. He suggested that the ISA be clarified where it referred to “upper soil horizon.” He noted that if this referred to the O horizon or forest floor, it should be explicit. If it was meant to refer to the upper mineral soil, that should be clear as well. He noted that in many of the forests studied in the northeastern U.S. there was a difference between the surface O horizon and underlying mineral soil horizons for most response mechanisms regarding nitrogen and sulfur impacts.

Another member commented that in Chapter 1.5, more detail could be provided in the description of nutrient enrichment. He noted that the text indicated that N additions generally stimulate plant growth and productivity (cumulative growth of all vegetation within a community). He commented that it was also important to indicate that nitrogen-enhanced growth and productivity stimulation varied substantially among species, favoring faster-growing N-loving species at the expense of their slower-growing neighbors, leading to alterations in community composition and diversity. Members commented that there was a better discussion of the impacts of ammonia in Chapter 1.5 than in Chapter 1.4.

*Freshwater Nitrogen Enrichment and Acidification (Chapter 1.6 of the Second Draft ISA)*

The Panel discussed Chapter 1.6 of the second draft of the ISA. A member expressed approval of the changes that had been incorporated into the second draft of the ISA. He noted that the document was well written and the appendices were well referenced. The bolded conclusions in the document were well supported by evidence in the text. He noted that in his written comments he had provided a few minor suggestions, corrections, and points of clarification.

A member commented that Chapter 1.6 was a good acknowledgement of progress that had been made in understanding the ecological effects of freshwater nitrogen enrichment and acidification. She noted, however, that the chapter had not been streamlined. She commented that the structure of the chapter seemed to be less effective than the previous version because in the revised chapter it was necessary to search appendices to find information. However, she indicated that she was very supportive of the second draft of the ISA. She noted that new literature had been added to provide more evidence supporting the conclusions.

Another member indicated that Chapter 1.6 provided responses to the CASAC's previous comments. He noted that the ISA had been improved by addition of growth and productivity endpoints. He noted that it would be useful to emphasize how nutrient enrichment and chemistry had changed over time. He noted that long-term data sets on total organic carbon were available and this information could be highlighted. He indicated that Chapter 1.6 appeared to be longer than other chapters because more was known about the topic. However, he suggested that the chapter could benefit from editing.

A member commented that she appreciated the new additions to Chapter 1.6. Members discussed whether the term dissolved organic carbon could be replaced with dissolved organic nitrogen. Members noted that when discussing acid-base chemistry it was appropriate to talk about dissolved organic carbon. Another member commented that it was important to discuss the role of climate and that Appendix 13 was a useful addition to the document.

*Estuarine and Near-Coastal Nitrogen Enrichment and Nitrogen Driven Acidification (Chapter 1.7 of the Second Draft ISA)*

The panel discussed Chapter 1.7 of the second draft of the ISA. Panel members complemented EPA for the work to develop the chapter. Members indicated that the issues of ammonia and organic nitrogen were important and had been addressed. Members noted that the length of the chapter was appropriate. A member commented that the chapter should not focus on nitrogen driven estuarine acidification. He indicated that available peer reviewed data from the Chesapeake Bay and Albemarle Pamlico Sound showed that there had been no significant decrease in the pH of these estuarine waters. The member displayed slides of the data<sup>10</sup>. He indicated that EPA should be careful about generalizing conclusions concerning acidification in estuaries.

Another member commented that she was pleased with the revisions that had been incorporated into Chapter 1.7. She indicated that the separation of the discussion of freshwater and coastal water was appropriate. She also commented on Section 1.7.1.2 which discussed models. She noted that the modeling discussion was an improvement of the previous version of the ISA, and a new section on uncertainty was informative. She commented that there were some new models added in the new

version, and this highlighted the point that a number of model inter-comparison activities generally show that various models which were developed for different goals/places/timeframes were generally consistent with one another.

A member commented on the discussion of the Dynamic Land Ecosystem Model and SPARROW models, noting that they were very different approaches and represented a continuum from statistical or empirical models to physically based/deterministic models. She noted that these two approaches came to similar conclusions about nitrogen loads in the U.S.

A member commented on external organic matter loading to estuarine and coastal waters. He noted that external organic matter loading to these waters appeared to be increasing. He indicated that the relative role of atmospheric deposition of nitrogen in total nitrogen loading (as well as in productivity and biogeochemical cycling and possibly acidification responses) was an important topic to be addressed.

#### *Wetland Ecosystem Nitrogen Enrichment (Chapter 1.8 of the Second Draft ISA)*

The Panel discussed Chapter 1.8 of the second draft of the ISA. A member commented that the chapter effectively highlighted the potential effects of excess nitrogen and acidification on a wide variety of wetland ecosystem types. He noted that the literature survey in the ISA focused on recent work. He noted that there was a clear statement in the ISA indicating that the body of evidence was sufficient to infer a causal relationship between nitrogen deposition and the alteration of biogeochemical cycling in wetlands. He noted that the chapter was clear in stating that the body of evidence was sufficient to infer a causal relationship between nitrogen deposition and the alteration of growth and productivity, species physiology, species richness, community composition, and biodiversity in wetlands.

A member commented that the chapter was succinct and that two new review and synthesis studies had been cited to strengthen the chapter. He noted that the bolded causal statements in the chapter were well supported by the evidence provided in the chapter and related appendices. Another member expressed approval of the chapter.

#### *Freshwater and Wetland Ecosystem Sulfur Enrichment (Chapter 1.9 of the Second Draft ISA)*

The Panel discussed Chapter 1.9 of the second draft of the ISA. Members commented that discussion of freshwater and wetland ecosystem sulfur enrichment had been improved by adoption of a new organizational format in the second draft of the ISA. Members noted that EPA had added substantial new, policy-relevant, peer-reviewed literature to the revised chapter. A member commented that one example of this was new information about the relationship between mercury and dissolved organic carbon, and mercury and sulfur sources. The member noted that this particular topic had not received a lot of research until recent work focusing on sulfide toxicity and links to formation of methylmercury.

A member commented that the causal statements in the chapter had been made in a more direct and succinct manner, and they were well supported by the available literature. For example, the causal determination about sulfide phytotoxicity had been expanded from the first draft of the ISA to include growth and productivity as end points; and the causal determination about mercury had been reworded from the first draft to highlight that evidence was sufficient to infer a causal relationship between sulfur deposition and increased methylation of mercury in surface water, sediment, and soils in aquatic environments.

Another member expressed approval of the chapter. She noted that the causal statements had been strengthened. A member commented that much of the material had been moved into appendices. He commented that there was a growing body of science on sulfur enrichment. He noted that sulfur had been added to fertilizer and there were a number of agricultural studies that could be mentioned in the ISA appendix. He indicated that additional references had been included in his written comments.

*Ecological Effects of Particulate Matter Other Than Nitrogen and Sulfur Deposition (Chapter 1.10 of the Second Draft ISA)*

The Panel discussed Chapter 1.10 of the second draft of the ISA. Members commented that Chapter 1.10 and Appendix 15 were well written and responded to the input of the CASAC on the first draft of the ISA. A member commented that the second draft of the ISA discussed new methods and new studies. He noted that there were not many new studies discussed in the appendix and suggested that the new findings be clearly stated.

A member commented that she concurred with the addition of a “likely causal” statement (between deposition of particulate matter and a variety of effects on individual organisms and ecosystems) that had been added to the section. She indicated that the studies summarized and cited in Appendix 15 provided sufficient evidence to support this determination.

A member commented that in describing particulate matter, the EPA had used the term “elemental and organic carbon.” He noted that a better descriptive term might be “particulate organic matter.” He also indicated that a significant part of particulate matter deposition was from sea salt. Members commented that Chapter 1.10 could be improved by including a brief description of the role that the “crustal material” component of particulate matter plays as a significant source of cations. Members noted that, while soil was a relatively minor component of PM<sub>2.5</sub>, it was typically the largest component of coarse particle mass (PM<sub>10-2.5</sub>), and larger particles dry deposited more efficiently than small ones. Members commented that airborne soil could be a significant source of base cations (e.g., Ca<sup>+</sup>, Mg<sup>++</sup>, K<sup>+</sup>, Na<sup>+</sup>) that may partially buffer acidifying deposition. Members also noted that airborne soil was also the one component of PM that appeared to be increasing, at least in some regions and seasons.

Another member commented that it would be helpful if the EPA noted the extent to which studies indicated had ambient levels of particulate matter that were above and below standards.

There were no further comments so Dr. Fernandez indicated that there would be a change in the agenda for the session following the lunch break. He indicated that, after discussing the remaining report sections, members would meet in writing groups to develop the key points to be included in the Panel’s report and then the lead writers would then summarize the key points for the entire Panel before recessing for the day.

*Recovery, Climate Modification, Key Scientific Uncertainties and Ecosystem Services (Chapters 1.11, 1.12, 1.13, and 1.14 of the Second Draft ISA)*

In the afternoon, the Panel discussed Chapters 1.11, 1.12, 1.13, and 1.14 of the second draft of the ISA. Members suggested that the EPA consider whether the definition of ecological recovery as mimicking of pre-industrial conditions was overly narrow. Members noted that a definition more attuned to interdependencies between humans and ecosystems might be considered. Members commented that a system generating ecological processes and functionality similar to those found in the latter half of the 19<sup>th</sup> century might be considered as one that had recovered. Members noted that this may better reflect

concerns about recovering processes and functionality than duplicating conditions that existed 150 years ago.

Members commented that the summary discussion of climate modification was rather brief but the appendices on this topic were quite extensive and contained qualitative and quantitative discussion of many recent works. Members suggested that the summary discussion of climate modification go beyond pointing to the existence of research in particular areas and summarize specific research findings. Members commented that a lack of detail in the summary might imply that understanding of climate modification of ecosystem response to nitrogen and sulfur addition was too immature and uncertain to be included in this round of secondary NAAQS analysis.

Members commented that the introduction and overview of uncertainty was well written, but it would be useful to more thoroughly incorporate this information throughout the ISA. Members commented that incorporation of the uncertainty discussion throughout the document could provide information to indicate: (1) which system (e.g., atmospheric science, ecological science, etc.) contributed the most uncertainty to results, (2) the type of uncertainty that dominated in that system (e.g., statistical, scenario, etc.) and (3) ways uncertainty could be reduced for each system. Members suggested that the discussion of uncertainty could include an introduction to the adopted uncertainty framework within the concepts reviewed in Section 1.2. Members also suggested that the discussion on uncertainty could conclude with a guidance paragraph on analysis of data on system uncertainty, addressing questions such as: How should it affect analysis of the secondary standard? How should uncertainty affect judgments on the relative ecological health and integrity of ecosystems?

Members commented that the overview of ecosystem services was quite brief and seemed to be disconnected from the broader needs of the ISA. Members commented that the summary could be improved by including an expanded introduction focusing on how the ecosystem services literature helped provide an understanding of why nitrogen and sulfur mattered for public welfare. A member noted that this introduction could be provided in Chapter 1.13 or within the definition of key concepts in Section 1.2.

A member commented that he liked the way climate change had been incorporated. He noted that it was important to consider how climate change might influence the boundary conditions that would determine decisions concerning the secondary NAAQS.

#### *Executive Summary and Connections, Concepts, and Changes (Chapter 1.2 of the Second Draft ISA)*

The Panel discussed the Executive Summary of the ISA and the Chapter on Connections, Concepts, and Changes. A member commented that the Executive Summary provided a concise review of the science underlying the current NAAQS review, with emphasis on areas of improved understanding since the last (2008) NO<sub>x</sub>/SO<sub>x</sub> ISA. Members commented that the Executive Summary was well organized, clearly written, and directly responsive to previous CASAC comments. A member commented that key findings were concisely summarized in Table ES-1 and links were provided to more detailed supporting discussions in the appendices. A member commented that the graphics were well done.

Members commented that more emphasis or clarity could be provided concerning: the importance of ammonia (reduced nitrogen), concepts of chemical and biological recovery, and the definition of ecosystem services. Members commented that it would be useful to include links in Table ES-1 to appropriate sections of the Integrated Synthesis (in addition to the links to the appendices). A member stated that it was particularly important to include in the Executive Summary additional information on

the importance of ammonia. She noted that all chapters in the second draft of the ISA except Chapter 1.4 discussed ammonia and this topic should be emphasized in the Executive Summary.

Members commented that the causality discussion of direct effects of gaseous SO<sub>x</sub> and NO<sub>y</sub> on vegetation had been modified by the observation that there was no evidence that these effects were continuing at current levels of exposure. Members noted that it was not always clearly stated in the Executive Summary or Integrated Synthesis that other causal associations were occurring at current levels of nitrogen and sulfur deposition. A member commented that it would be helpful to be more explicit about what recovery means.

Members commented that the Chapter 1.2 discussion of connections, concepts and changes (since the 2008 ISA) was well organized, clearly worded and responsive to previous CASAC comments. A member noted that the summary figures were excellent and helped explain some of the complex concepts and connections discussed later in the ISA.

A member suggested that it would be helpful to include in Chapter 1.2 additional discussion of the concept of ecosystem services. Another member commented that some introductory discussion of the concepts of chemical and biological recovery would be helpful because these concepts related to ecological effects but were not discussed until Chapter 1.11. A member commented that the expected nature and time scales associated with recovery seemed to be important for effects associated with a combination of historical deposition followed by smaller continuing levels of sulfur and nitrogen deposition.

A member suggested inserting the word “Understanding” before “Changes” in the title of the chapter. Another member suggested that in the chapter “Source Apportionment” be changed to “Source Contribution” because the term source apportionment had a different meaning in association with atmospheric modeling studies. Members suggested that it might be helpful to add links in Table 1-1 to sections of the Integrated Synthesis, in addition to the links to the appendices.

Following the discussion Dr. Fernandez thanked Panel members for deliberating on the responses to the charge and indicated that after a short break, members would meet in writing groups to develop the key points to be included in the Panel’s report. He indicated that after meeting in groups, the Panel would reconvene and the lead writers would summarize the key points for their assigned chapters.

### **Discussion of Key Points in the Responses to the Charge**

Members met in writing groups for approximately 90 minutes and the Panel reconvened to discuss the key points in the responses to the charge. The lead writers for the ISA chapters summarized the key points in the responses to the charge (listed below).

#### *Executive Summary*

- There was relatively little discussion of reduced nitrogen in the Executive Summary. This information could be brought forward from other parts of the ISA.
- The concept of recovery was not discussed in the Executive Summary.
- Ecosystem services should be defined and briefly discussed in the Executive Summary.
- Links to sections of Chapter 1 should be included in the Executive Summary.
- The report should more clearly indicate whether causal associations were occurring at current levels of nitrogen and sulfur deposition.

### *Connections, Concepts, and Changes*

- There should be more definition of the concept of ecosystem services and why they are important.
- The concept of chemical and biological recovery should be introduced early in this chapter.
- The words “in understanding” could be included in the title of the chapter after “changes.”
- The chapter could refer to “source contribution,” not “source apportionment.”

### *Chapter 1.3*

- The chapter contains the appropriate level of detail.
- The rationale for the emphasis on inorganic constituents of PM could be clarified.
- The relative magnitude and spatial distributions of reduced nitrogen emissions from animal waste and fertilizer application could be discussed.
- Section 1.3.2 could contain more detailed information on ammonia measurements.
- The discussion of satellite NO<sub>2</sub> data could be enhanced.

### *Chapter 1.4*

- Levels of NO<sub>2</sub> and SO<sub>2</sub> have declined below secondary standard levels across most of the U.S. and there is little new evidence that these levels have direct gas-phase effects on vegetation. However, some lichen species are declining at current levels.
- It would be helpful to include in the chapter some information describing the range of effects of ambient nitrogen and sulfur.
- There is no clear demarcation in the chapter of how much of the atmospheric nitrogen and sulfur effects are due to direct gaseous uptake by plant canopies versus deposition to external canopy or ground level surfaces. This point could be mentioned in the related appendix.
- The chapter does not contain a summary of gas-phase effects of ammonia. The potential role of ammonia on vegetation should be discussed.

### *Chapter 1.5*

- The chapter is well written and provides a clear summary of the effects of nitrogen and acidifying deposition on terrestrial ecosystems.
- When referring to soil indicators it is important to be explicit about the soil material being discussed. In most instances the chapter refers to mineral soils which are very different from the surface horizons in forest soils.
- Some of the detailed information could be moved into Appendix 4.
- It would be useful to point out that the Clark et al. 2018 study provides a single critical load value that could be considered depending upon the intended application.

### *Chapter 1.6*

- The chapter is an excellent summary of the known effects of atmospheric deposition of sulfur and nitrogen on acidification and nutrient enrichment in freshwaters.
- The chapter is long but provides much useful information.

- The bolded conclusions in the chapter are well supported.
- In the chapter, the term dissolved organic matter should be used instead of dissolved organic carbon to broadly refer to this material.
- A number of minor suggestions, corrections, or points of clarification were noted.

### *Chapter 1.7*

- The treatment of estuarine and coastal atmospheric nitrogen enrichment impacts is greatly improved in the second draft of the ISA.
- The emphasis and detail on the roles of atmospheric deposition of nitrogen in eutrophication and altered biogeochemical cycling and biodiversity in estuarine and near coastal systems is excellent.
- Chapter 1.7 and related appendices discuss the importance of reduced forms of nitrogen.
- Organic nitrogen can be 20-30 percent of atmospherically deposited nitrogen and its role in eutrophication and biogeochemical cycling is an important issue to be addressed.
- The suggestion that increasing atmospheric deposition of nitrogen may be changing nutrient limitation from nitrogen to nitrogen and phosphorus colimitation is largely speculative. However, there are a few coastal systems where excessive nitrogen loading may periodically alter nutrient limitation (e.g., the Mississippi plume region of the northern Gulf of Mexico).
- There is a need to deemphasize the importance of acidification in association with atmospheric deposition of nitrogen to estuarine and near coastal waters. The proposed connections between nitrogen enrichment and acidification of estuarine and near coastal systems are largely speculative and not supported by long-term monitoring of pH and related environmental variables (e.g., in the Chesapeake Bay and Neuse River, NC).
- The modeling section on eutrophication largely addresses coastal nitrogen loading models. The Dynamic Land Ecosystem model could be added to the discussion.
- A challenge in undertaking the risk and exposure assessment is to understand uncertainty in models.

### *Chapter 1.8*

- The chapter highlights the potential effects of excess nitrogen and acidification on a wide variety of wetland ecosystem types.
- The chapter is a clearly written succinct summary of material that was included in the first draft of the ISA.
- The causal relationships between nitrogen deposition and alteration of biogeochemical cycling and the effects of wetland biota are clearly described and well written.

### *Chapter 1.9*

- The discussion of freshwater and wetland ecosystem sulfur enrichment is much improved in the second draft of the ISA.
- New literature has been included.
- Causal statements are succinctly written and are supported by the available literature.
- The text has been reworded to emphasize that evidence is sufficient to infer a causal relationship between sulfur deposition and increased methylation of mercury in surface water and sediment.
- The chapter could indicate that nitrogen uptake by microbes or removal by denitrification may limit the usefulness of nitrogen concentrations in water for quantifying the ecological effects of atmospheric inputs of reactive nitrogen.

- Members noted that a decline in sulfate inputs to terrestrial systems has been found to result in sulfur deficiency in crops.

#### *Chapter 1.10*

- Chapter 1.10 and Appendix 15 are well-written reviews of the literature.
- Chapter 1.10 could be improved by including a brief description of the role that the crustal material component of particulate matter plays as a source of cations.
- Other minor clarifications were mentioned.

#### *Chapter 1.11*

- The definition of ecological recovery (to pre-industrial conditions) appears to be narrow.

#### *Chapter 1.12*

- Some of the climate change studies included in the appendices could be discussed in more detail in Chapter 1.12.
- There is a need to clarify the scope of what is considered as “climate” (meteorological factors over a five-year horizon in contrast to long-term climate change or associated changes in CO<sub>2</sub> concentrations and impacts on biogeochemistry).

#### *Chapter 1.13*

- The framework for defining and viewing uncertainty could be more thoroughly incorporated throughout the ISA. The framework could indicate: (1) which component (e.g., atmospheric science, ecological science) contributes the most uncertainty to results, and (2) the type of uncertainty that dominates in each component.
- It would be useful to include a guidance paragraph on how to address system uncertainty.

#### *Chapter 1.14*

- Chapter 1.14 seems to be somewhat disconnected from the other parts of the ISA. The chapter could be improved by including an expanded introduction indicating how the ecosystem services literature provides an understanding of why nitrogen and sulfur deposition matter to public welfare.
- The chapter should include a distillation of quantitative results showing which ecosystem services are most severely affected by NO<sub>x</sub>, SO<sub>x</sub>, and particulate matter.
- A number of minor corrections and points of clarification were discussed.

Dr. Fernandez thanked the lead writers and Panel members for discussing the responses to the charge questions. He indicated that there was time on the agenda to hear brief clarifying comments from members of the public and the EPA. EPA staff thanked the Panel for its review of the second draft of the ISA. There were no comments from members of the public.

Dr. Fernandez then asked the lead writers to develop written responses for their charge questions and to incorporate comments from the lead discussants. He indicated that the lead writers should send their

written responses to the DFO by Friday, September 28<sup>th</sup>. He would then work with the DFO to incorporate the responses into a draft of the Panel's report.

Dr. Fernandez stated that the Panel would recess and reconvene at 8:00 a.m. the following day to provide comments on the EPA's draft Risk and Exposure Assessment Planning Document.

## **Thursday, September 6, 2018**

### **Reconvene Meeting**

The Designated Federal Officer reconvened the Panel meeting at 8:00 a.m. on Thursday, September 6, 2018. Panel chair, Dr. Ivan Fernandez, reviewed the agenda for the day. He indicated that the Panel members would discuss responses to the EPA's charge questions on the Risk and Exposure Assessment (REA) Planning Document. He indicated that the Panel would probably be able to complete the discussion by noon or 1:00 p.m. He stated that the Panel would first hear a presentation on the REA Planning Document from the EPA, then hear any public comments, review the charge questions, and discuss the responses to the charge questions. He reminded members that the Panel would not be developing a consensus report on the REA Planning Document but would be providing individual comments from members to the EPA. He asked members whether they had questions about the agenda for the day. There were no questions.

### **EPA Presentation on the Risk and Exposure Assessment Planning Document**

Dr. Fernandez indicated that the next agenda item would be the EPA's presentation on the REA Planning Document<sup>11</sup>. He indicated that the EPA speakers would be Drs. Erika Sasser, Karen Wesson, Rob Pinder, and Travis Smith from the EPA Office of Air Quality Planning and Standards and asked the speakers to begin their presentation.

Dr. Erika Sasser, Director of the Health and Environmental Impacts Division in the Office of Air Quality Planning and Standards, welcomed the panel members and thanked them for reviewing the REA Planning Document. She indicated that the CASAC review would be helpful to the EPA in developing the risk and exposure assessment to evaluate the NO<sub>x</sub>/SO<sub>x</sub>/PM secondary NAAQS. She introduced the EPA speakers. A number of topics were covered in EPA's presentation.

- The definition of secondary NAAQS was reviewed. Agency staff explained why the EPA was looking at the standards for NO<sub>x</sub>/SO<sub>x</sub> and particulate matter together. The linkage of these criteria pollutants was discussed.
- The chemical species included in the NO<sub>x</sub>/SO<sub>x</sub>/particulate matter review were identified.
- The process of the EPA's NAAQS review was explained and the documents to be reviewed by the Panel (the Integrated Review Plan, Integrated Science Assessment, Risk and Exposure Assessment Planning Document, Risk and Exposure Assessment, and Policy Assessment) were described.
- An overview of the REA Planning Document was provided. EPA staff explained that:
  - The REA Planning document discussed the limitations and uncertainties related to ecological risk and exposure as assessed in previous NAAQS reviews, and provided conclusions indicating that there was support for new and updated assessments of ecological risk and exposure.
  - In the document a quantitative plan for the REA was proposed.
  - The REA Planning Document discussed assessment of air concentrations and deposition.
  - National-scale analyses and case study analyses were planned.

- A national-scale surface of current nitrogen and sulfur deposition levels would be created using a fused model and measurement approach, model simulation would distinguish the contribution of air concentrations of ammonia and ammonium to wet and dry deposition. Variability in dry deposition would be examined using several models and approaches.
- Several different approaches were being considered for adjusting air quality to reflect just meeting current standards and any potential alternative standards.
- A statistical approach would be used to link changes in concentration with changes in nitrogen and sulfur deposition.
- Ecological effects would be assessed using: national scale analyses to characterize the magnitude of risks and exposures under current conditions and case study area analyses to characterize the magnitude of changes in risk and exposures when air quality was just meeting the current standards and any potential alternative standards.
- Additional analyses would be used to assess the uncertainty and variability of ecological risks.
- Terrestrial ecological effects would be assessed by considering: forest health (soil acidification critical loads and base cation-aluminum ratios), effects on individual tree species, and community composition and species richness.
- Aquatic ecological effects would be assessed by considering: freshwater acidification (exceedance of critical loads and modeled impacts of changing deposition in case study areas), and freshwater nitrogen enrichment (exceedance of critical loads, estimated changes in nitrate levels in case study areas, and relationships between nitrate levels and ecological effects on biota).

Dr. Fernandez thanked the EPA staff for their presentation and asked whether members had questions. Several members had questions or comments. A member commented that it was important to clearly describe the tree data that would be used to assess forest health. Several members commented on the importance and challenges of assessing the risks of ammonium and ammonia.

EPA staff responded that the Agency had not yet developed a policy assessment. She indicated that the EPA had not yet made all of the decisions about the secondary NAAQS.

A member commented on use of the Bc:Al (base cation to aluminum) ratio and suggested that it might be useful to consider other approaches (e.g., base saturation). A member commented that the REA Planning Document did not provide specific information on some aspects of air quality assessment. Several members commented on the challenge of determining effects when areas were just meeting standards.

Dr. Fernandez thanked members for their comments and stated that time had been provided on the agenda to hear public comments on the REA Planning Document but no requests to present comments had been received.

### **Review of the REA Planning Document Charge Questions**

Dr. Fernandez reviewed the REA Planning Document charge. He noted that the Panel had been asked to comment on the proposed overall analytical approach, the ambient air quality analyses, and the ecological risk assessment. Dr. Fernandez reviewed the specific charge questions provided for each of these topics. There were no requests from Panel members for clarification of the charge questions.

### **Discussion of the Panel's Responses to the REA Planning Document Charge Questions**

Dr. Fernandez noted that Panel members' preliminary comments on the REA planning Document<sup>12</sup> had been posted on the CASAC website. He then called for the discussion of the responses to the REA Planning document charge questions. Members provided comments in response to the charge questions.

### *Overall Analytical Approach*

Members commented that the REA Planning Document provided a good framework for developing the risk and exposure assessment. A member commented that it would be helpful to include more detailed discussion of the conceptual model underlying the risk and exposure assessment. She noted that a conceptual model had been included in Figure 1.2 of the ISA. She also noted that it would be helpful to link the REA Planning Document to indicators that had been developed in the ISA. In addition, she noted that it would be useful to further discuss: the relationship between emissions and deposition, databases that could be used for the analysis, ways to address uncertainty, impacts on public welfare, and the social science component of the risk and exposure assessment.

A member commented that the proposed approach in Chapter 3 of the REA Planning Document had been well formulated but she noted that it would be helpful to consider other data and models that could be used. She noted the importance of considering the effects of precipitation in the analysis. She also noted the need to link the risk and exposure assessment to public welfare and provide an indication of the role of deposition. In this regard, she commented that it would be useful to look at source apportionment.

A member indicated that he supported the conceptual model in the REA Planning document. He commented that it would be useful to consider including microorganisms in the risk and exposure assessment. He noted that he was not supportive of using the Bc/Al ratio for evaluation of biogeochemical effects in soils because it was not a very sensitive indicator of risk. He noted that most recent studies used base saturation as an indicator.

A member commented that it made sense to use the critical load information available in the literature for the risk and exposure assessment. She noted, however, that when deciding which critical load evidence to use, it was important to consider the ecosystem services that the critical loads were protecting. She commented that in the case studies it was important to not limit the analysis to national parks. She noted the variability in the ecosystems across the county and indicated that it was important to show the relevance of the conclusions for any given case study to other similar areas. She also commented that it was important to understand how uncertainty, if known, would alter the conclusions in a substantive way. She noted that sensitivity analysis could be used to make such a determination.

A member commented that the draft REA Planning Document was well written and organized. He commented that some aspects of the conceptual model could be clarified. He noted that the discussion of the importance of environmental trends in temperature and precipitation in determining future risk from N (nitrogen) and S (sulfur) pollution could be strengthened. The member commented that, regarding the use of Bc/Al ratios, it would be useful to clearly define "soil" for these analyses. In addition, he commented that the use of case studies and the strategy to identify them was a good approach. However, he noted that some of the case study criteria appeared to favor sites without significant deposition history or sensitive species. He indicated that this eliminated whole regions that were affected by atmospheric N and S deposition.

A member noted that the background information, conceptual model, and key technical issues were clearly presented in the REA Planning Document. He commented on the proposed use of model-derived transfer functions to estimate the deposition from which the effects occur. He commented that measured deposition would seem to be a reasonable indicator of the presence of substances in the ambient air. He suggested that deposition measurements, with state-of-the-science PRISM and CMAQ model enhancements, could be used as the basis for determining compliance for secondary SO<sub>x</sub>/NO<sub>x</sub> NAAQS. He also encouraged the EPA to carefully consider how emission controls to address NAAQS exceedances would be logically distributed regionally and among source categories.

### *Ambient Air Quality Analyses*

A member commented on the importance of addressing reduced forms of nitrogen in the risk and exposure assessment. He recommended that the REA Planning Document clearly indicate that the contribution of reduced nitrogen compounds such as ammonia would be taken into consideration. He commented that the REA Planning Document provided a good description of proposed quantitative analyses of aquatic and terrestrial ecosystems effects (acidification and nitrogen enrichment) using the latest data on critical loads and exposure-response functions. He expressed support for conducting the risk and exposure assessment at national and case study scales.

A member commented that the text on pages 4-6 and 4-7 of the REA Planning Document was difficult to understand. He noted that this text discussed the technical challenges associated with adjusting air quality to reflect “just meeting” multiple standards. He suggested that it would be helpful to provide an example of how this would be undertaken.

A member noted that the proposed approaches for determining annual average deposition across the continental U.S. and analyzing potential error and uncertainty had been published and were well-studied. He noted that the proposed statistical modeling approach for arriving at deposition levels under adjusted conditions had not been fully developed or tested (unlike the methods discussed for developing estimates of the current state of deposition). He also noted that there was a large literature on statistical estimation in the environment which could provide information about combining a wider variety of inputs, such as meteorological conditions, in situ or remote sensing measurements, and estimates from multiple models.

A member commented that the proposed air quality analyses were reasonably comprehensive and well documented. She commented that in order to adjust air quality to “just meet” standards in a study area, it seemed inevitable that the upwind air quality must exceed standards. She noted that it was difficult to envision how a scenario raising study area concentrations to “just meet” standards did not also force concentrations in the surrounding area to unreasonable levels. She suggested that EPA consider using measured total deposition data to determine air quality that would meet critical loads.

Several members commented on the importance of considering the effects of ammonia in the risk and exposure assessment.

### *Ecological Risk Assessment*

A member commented that the overall approach described in the REA Planning Document to assess ecological risk was appropriate. She noted that comparing changes in response receptors (based on critical loads) to current air quality standards would provide a good estimate of whether current primary

and secondary standards were adequate. She noted that this approach had been used in Canada and Europe. She also indicated that the effects of ammonia should be addressed.

A member commented that the proposed criteria for selection of case study areas were appropriate but she questioned whether there would be enough sites with recent air quality declines to apply the criterion for recent declines in air quality. She questioned whether most of these sites would be in the dry western and central U.S., and noted that for long-lived tree species, recent declines in air quality was not an appropriate criterion.

A member commented that there was a good discussion of uncertainty in the REA Planning Document. She noted that uncertainty for mycorrhizal response would be high because the data were limited. She suggested that in the assessment it would be better to consider responses of other species. She also suggested including critical loads for tree survival and growth response in Table 4-3.

A member commented that some aspects of the ecological risk assessment approach could be clarified. He noted that the definitions of steady state and target critical loads were not obvious. He indicated that the critical load was a threshold, with a binary condition: either exceeded or not exceeded. He suggested that it would be useful to consider a dose-response framework built on actual trajectories of monitored aquatic ecosystems. In this framework, a target for biogeochemical “recovery” or some other desired endpoint could be established and the air quality standards that would result in achieving the target could be estimated.

A member commented that the use of Bc:Al or some other measure of base cation status in soils was appropriate for determining critical loads. He suggested using values of base cation status that provided a sufficient target, for a broad range of tree species, to determine critical loads for soil acidification. The member also commented that the focus on well-studied case study areas where additional data and insights were available was appropriate. He also noted that in the approach for assessing variability/co-variability and characterizing uncertainty, equal balance should be given to the critical loads and exposure-response curves.

A member commented that it was important to consider differences in critical loads for different forms of nitrogen. He indicated that algal species like cyanobacteria preferred reduced forms of nitrogen, and therefore it was important to look at the response curves for ammonium and organic nitrogen. He noted that 20-30 percent of atmospheric nitrogen deposition was in the form of organic nitrogen. He stressed that it was important to consider the community response to nitrogen deposition.

#### *Other Comments on the REA Planning Document*

Members provided additional comments on the REA Planning Document. A member commented that throughout the document there were references to protection of public welfare. In some places the document indicated that it was hard to quantify ecosystem services. She noted that certain ecosystem services could not be quantified. Therefore, she recommended that the document refer to “quantified and non-quantified” ecosystem services.

A member commented that the proposed criteria and approach for selecting case study areas was reasonable. However, he expressed concern about the restrictiveness of some of the case study criteria and the effort that would be required to conduct the modeling work. He commented that it did not seem to be an efficient use of scarce resources to spend much effort identifying the “controlling pollutant” and/or accuracy of “transference ratios.” He suggested that a more efficient approach might be to

conduct a general evaluation of assorted critical loads and critical load exceedances to show how much NO<sub>x</sub> (and/or SO<sub>x</sub>) emissions should be rolled back to meet critical loads regionally. He noted that these reductions for NO<sub>x</sub> (or SO<sub>x</sub> or NH<sub>x</sub>) could then be applied nationally (using rational source-specific controls).

A member commented that it was important to consider the impact of vegetative canopies on total deposition.

### **Brief Clarifying Public Comments**

Dr. Fernandez indicated that no requests had been received to present clarifying public comments. EPA staff thanked Panel members for their comments.

### **Summary of Next Steps**

Dr. Fernandez reviewed action items and the next steps to be completed. He thanked Panel members for their comments on the REA Planning Document. He noted that their comments would be transmitted to the EPA. He indicated that if members wished to revise their individual written comments, they should send any revisions to the Designated Federal Officer by September 28<sup>th</sup>.

Dr. Fernandez reminded the lead writers for the Panel's ISA report to send the written responses to their assigned charge questions to the lead discussants for review and then send the responses to the DFO by September 28<sup>th</sup>. Dr. Fernandez indicated that he would work with the DFO to incorporate the responses into a draft Panel report which would be sent to the entire Panel for review. He indicated that a Panel teleconference would be scheduled to discuss the draft report. He noted that the DFO would contact members to schedule the call. He also indicated that if there were areas of disagreement on the draft report they would be discussed on the teleconference.

Dr. Fernandez asked members whether there were additional questions or issues to be discussed. There were none, so he thanked the members of the Panel for their work and thanked the EPA staff for their presentations and responses to the Panel's questions. Dr. Fernandez then asked the DFO to adjourn the meeting. The DFO indicated that he would send Panel members a follow-up email reminding them of the next steps to be completed and adjourned the meeting.

Respectfully Submitted:

/s/

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Dr. Thomas Armitage  
Designated Federal Officer

Certified as Accurate:

/s/

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Dr. Ivan J. Fernandez, Chair  
CASAC Secondary NAAQS Review Panel  
for Oxides of Nitrogen and Sulfur

**NOTE AND DISCLAIMER:** The minutes of this public meeting reflect diverse ideas and suggestions offered by Panel members during the course of deliberations within the meeting. Such ideas, suggestions and deliberations do not necessarily reflect consensus advice from Panel members. The reader is cautioned to not rely on the minutes to represent final, approved, consensus advice and

recommendations offered to the Agency. Such advice and recommendations may be found in the final advisories, commentaries, letters or reports prepared and transmitted to the EPA Administrator following the public meetings.

## Materials Cited

The following meeting materials are available on the EPA Clean Air Scientific Advisory Committee website, [www.epa.gov/casac](http://www.epa.gov/casac), on the September 5-6, 2018 meeting page of the Secondary NAAQS Review Panel for Oxides of Nitrogen and Sulfur.

<https://yosemite.epa.gov/sab/sabproduct.nsf/MeetingCal/A4033EE2926CC0C385258273006B812A?OpenDocument>

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<sup>1</sup> Panel Roster

<sup>2</sup> Federal Register Notice

<sup>3</sup> Agenda

<sup>4</sup> Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter Integrated Science Assessment - Ecological Criteria (Second External Review Draft)

<sup>5</sup> Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter Risk and Exposure Assessment Planning Document for Secondary (Welfare-based) National Ambient Air Quality Standards (NAAQS)

<sup>6</sup> Charge for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter Integrated Science Assessment - Ecological Criteria (Second External Review Draft)

<sup>7</sup> Charge for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter Risk and Exposure Assessment Planning Document for Secondary (Welfare-based) National Ambient Air Quality Standards (NAAQS)

<sup>8</sup> EPA Presentation - Integrated Science Assessment for Nitrogen Oxides, Sulfur Oxides, and Particulate Matter - Ecological Criteria, 2nd External Review Draft

<sup>9</sup> 8-29-18 Preliminary Comments from Panel Members on EPA's Integrated Science Assessment for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter – Ecological Criteria (First External Review Draft).

<sup>10</sup> 9-5-18 Presentation from Dr. Paerl for the discussion of ISA Chapter 1.7

<sup>11</sup> EPA Presentation - Review of the Secondary Standards for Ecological Effects of Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter: Risk and Exposure Assessment Planning Document.

<sup>12</sup> 8-29-18 Preliminary Comments from Panel Members on the REA Planning Document.

**ATTACHMENT A -Other Attendees**  
**CASAC Secondary NAAQS Review Panel for Oxides of Nitrogen and Sulfur**  
**September 5-6, 2018 Public Meeting**

<b>Name</b>	<b>Affiliation</b>
Tina Bahadori	USEPA
Elizabeth Chan	USEPA
Justin Coughlin	USEPA
Christine Davis	USEPA
Pat Dolwick,	USEPA
Steve Dutton	USEPA
Mark Evangelista	USEPA
Emmi Felker-Quinn	
Brandon Gutierrez	
Shiela Igor	USEPA
Meredith Lassiter	USEPA
Stephen LeDuc	USEPA
Jeff Herrick	USEPA
Andrew Hotchkiss	USEPA
Casey Jany	USEPA
Doug Kaylor	USEPA/ORISE
Jim Kelly	
Jason Lynch	USEPA
Steve McDow	USEPA
Stuart Parker	IWP News
Caroline Ridley	USEPA
Kristin Riha	USEPA
Mary Ross	USEPA
Vicki Sandford	USEPA
Ted Streichert	American Petroleum Institute
Ginger Tennant	USEPA
Robert Ukeiley	Center for Biological Diversity
Bob Wayland	USEPA
Chelsea Weitekomp, EPA	USEPA
Linda M. Wilson	New York State Office of the Attorney General