

**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  
May 24-25, 2017**

**Date and Time:** Wednesday, May 24, 2017, 9:00 a.m. – 5:15 p.m.  
Thursday, May 25, 2017, 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 peer review of EPA’s Integrated Science Assessment for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter – Ecological Criteria (First External Review Draft)

**Participants:**

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

Dr. Ivan Fernandez  
Dr. Dr. Edith Allen  
Dr. Praveen Amar  
Dr. James Boyd  
Dr. Elizabeth Boyer  
Dr. Douglas Burns  
Ms. Lauraine Chestnut  
Dr. Charles Driscoll, Jr.  
Dr. Mark Fenn  
Dr. James Galloway  
Dr. Frank Gilliam  
Dr. Daven Henze  
Dr. Robert Howarth  
Dr. Donna Kenski  
Dr. William McDowell  
Dr. Erik Nelson  
Dr. Hans Paerl  
Mr. Richard Poirot  
Dr. Armistead (Ted) Russell  
Dr. Stephen Schwartz  
Dr. Kathleen Weathers

*EPA Science Advisory Board (SAB) Staff:*

Thomas Armitage, Designated Federal Officer  
Iris Goodman, Designated Federal Officer  
Christopher Zarba, Director, SAB Staff Office

*EPA Representatives:*

John Vandenberg  
Tara Greaver  
Jennifer Richmond-Bryant

*Other Attendees (either present at the meeting or requested information to listen via phone or audio webcast):*

Lea Anderson, EPA  
Tina Bahadori, EPA  
Micah Bennett, EPA  
Kurt E. Blasé, BlaseGroup LLC  
Troy Bourne  
Elizabeth Chan, EPA  
Jana Compton, EPA  
Sharon Cooperstein, EPA  
Christine Davis, EPA  
Marion Deerhake, RTI Institute  
Steve Dutton, EPA  
Aaron Flynn, Hunton and Williams  
Nicole Hagan, EPA  
Scott Hagerthy, EPA  
Jeffrey Herrich, EPA  
Bob Hetes, EPA  
Andrew Hotchkiss, EPA  
John Janson  
Annie Jarabek, EPA  
Samantha Jones, EPA  
Leila Lackey, EPA  
Meredith Lassiter, EPA  
Sylvia Lee, EPA  
Jason Lynch, EPA  
April Maxwell, EPA, ORISE  
Steve McDow, EPA  
Brian Moore  
Georgia Murray, Appalachian Mountain Club  
Will Ollison, American Petroleum Institute  
Carrie Page, EPA  
Stuart Parker, IWP News  
Jennifer Phelan, RTI Institute  
Doug Price, Tesoro  
Theresa Pugh  
Kristin Riha, EPA  
Vicki Sandiford, EPA  
Erika Sasser, EPA  
Rich Scheffe, EPA  
Kate Schofield, EPA

Travis Smith, EPA  
Ted Streichert, American Petroleum Institute  
Ginger Tennant, EPA  
Randy Waite  
Karen Wesson, EPA  
Clint Woods, Association of Air Pollution Control Agencies (AAPCA)  
Frank Wzoshuary

## **Meeting Summary:**

**Wednesday, May 24, 2017**

### **Convene the Meeting**

Dr. Thomas Armitage, Designated Federal Officer (DFO) for the CASAC Panel, convened the meeting at 9:00 a.m. on Wednesday, May 24, 2017. He stated that the Secondary NAAQS Review Panel for Oxides of Nitrogen and Sulfur operated as part of the EPA Clean Air Scientific Advisory Committee 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>1</sup> meeting agenda,<sup>2</sup> and Panel roster.<sup>3</sup> 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](mailto:armitage.thomas@epa.gov) to let him know that they were on-line.

Mr. Christopher Zarba, 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. He indicated that the Panel would be meeting for the next two days to review the EPA draft document titled *Integrated Science Assessment for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter – Ecological Criteria* (draft ISA).<sup>4</sup> He indicated that the document had been developed by the EPA to provide an evaluation and synthesis characterizing the ecological effects caused by oxides of nitrogen and sulfur and particulate matter.

Dr. Fernandez noted that: (1) the Panel had been asked to review each chapter of the Integrated Science Assessment, as well as the executive summary and the appendices, and respond to charge questions that focused on the accuracy, clarity, level of detail, and relevance of the material in the document; (2) the Panel would develop a consensus report of findings and recommendations in response to the charge questions; (3) after the Panel completed its report, the report would be reviewed and approved by the Chartered CASAC; and (4) upon approval by the Chartered CASAC, the report would be transmitted to the EPA Administrator.

Dr. Fernandez stated that the Panel would begin to develop its report at the meeting. He indicated that the Panel would hear presentations from EPA staff, deliberate on responses to the Agency's charge questions, and identify the key points in the responses to the questions. Dr. Fernandez reviewed the meeting agenda and noted that:

- After hearing from EPA speakers, there was time on the agenda to hear oral public comments, but no requests had been received to present comments.
- A second short public comment period was also scheduled. EPA staff and members of the public who wished to provide short (2-3) minute clarifying public comments during the second comment period should register at the sign-in table outside the meeting room or inform the Designated Federal Officer (Dr. Armitage).
- There was time on the agenda for the Panel to discuss the charge questions<sup>5</sup> (posted on the CASAC meeting website).
- The Panel would discuss responses to each of the charge questions. Lead discussants (listed on the agenda) would begin the discussion of each question by providing brief initial comments. Lead writers (listed on the agenda) should keep track of the key points raised in the discussion of their assigned charge questions.
- Before adjourning, the Panel would review the key points discussed in the response to each charge question. At that time, each of the lead writers would briefly summarize the key points discussed.
- Following the meeting, lead writers would work with the lead discussants for their assigned charge question 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 draft report.

### **Remarks from EPA**

Drs. John Vandenberg, Jennifer Richmond-Bryant, 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>6</sup> were posted on the CASAC meeting website). Dr. Vandenberg indicated that the EPA gives careful consideration to the comments received from the CASAC. He noted that the draft ISA was a large and complex document and he indicated that the Agency would be updating the review of the literature. He said that he looked forward to receiving the Panel's input.

Dr. Richmond-Bryant outlined the review process for National Ambient Air Quality Standards. She indicated that this process involved development of: an integrated review plan, integrated science assessment, risk/exposure assessment (if warranted), and policy assessment. She noted that the risk/exposure assessment described the development of the causal determinations which underlie the policy assessment.

Dr. Greaver identified the team that had developed the draft ISA and discussed the contents of the document. She reviewed the topics covered in the fourteen ISA chapters and the appendices and she identified the chemical species studied and their sources of emissions. She also summarized conclusions in the draft ISA concerning nitrogen (N) deposition, sulfur (S) deposition, and acidifying deposition. Dr. Greaver then presented a summary of nineteen causal determinations in the draft ISA and discussed ISA findings concerning: the phytotoxic effects of gas-phase NO<sub>y</sub> and SO<sub>x</sub>; terrestrial N enrichment effects; terrestrial nitrogen critical loads; terrestrial acidification effects (N+S deposition); freshwater acidification (N+S deposition); N enrichment/eutrophication in freshwaters, estuaries, and wetlands; N-

nutrient enhanced coastal acidification; S-nutrient effects; climate modification of ecosystem response to N and ecosystem services; case studies at five locations in the U.S.; and evidence for effects of particulate matter on ecological receptors. Dr. Greaver then presented the timeline for development of the Risk and Exposure Assessment Planning Document for the NO<sub>x</sub>/SO<sub>x</sub>/PM secondary NAAQS review and the second and final drafts of the Integrated Science Assessment.

Dr. Fernandez thanked the EPA speakers for their presentations and called for questions from the Panel. A member commented that there was some redundancy among chapters in the draft ISA and the coverage was uneven. EPA staff responded, indicating that in developing the second draft, the team planned to work on cross-chapter connections to normalize coverage and style.

A member asked EPA staff to comment on science to be included in the Risk and Exposure Assessment and Policy Assessment. EPA staff responded, indicating that the draft ISA presented science available in the published literature and that the Policy Assessment would focus on interpretation of the science.

A member noted that the draft ISA addressed recovery and he asked EPA to comment on a definition of recovery. EPA staff responded, indicating that the draft ISA addressed recovery processes in North America based on information available in the published literature. The member suggested that the EPA avoid using the term “hotspots” and instead focus on “extent.”

A member commented that in the discussion of coastal acidification it should be noted that carbon dioxide from respiration was causing lower pH at night in some coastal waters.

A member asked whether additional papers could be discussed in the draft ISA. EPA staff indicated that additional literature could be discussed if it had been peer reviewed or accepted for publication. He noted that the draft ISA focused only on primary sources, not book chapters.

## **Public Comments**

The Chair 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 understood and to give members an opportunity to ask clarifying questions. Dr. Fernandez indicated that the Panel had been given fifteen charge questions focusing on the ISA coverage of effects of N and S oxides and particulate matter. He noted that the panel had been asked to comment on the accuracy, clarity, level of detail, and relevance of information presented in each chapter.

Dr. Fernandez asked members whether any of the charge questions needed clarification or discussion and whether members had questions for EPA concerning the charge (the charge questions are included in the meeting materials available on the CASAC website – see materials cited).

A member asked EPA to elaborate on the information it was seeking in the Panel’s review of the ISA appendices. EPA staff indicated that the Agency would appreciate suggestions about data that would be useful for risk and exposure assessment and other informative topics to be included. A member questioned whether the Panel should consider research needs when responding to the charge questions.

EPA staff indicated that the draft ISA was not intended to be a research needs assessment. There were no further comments or questions. Dr. Fernandez indicated that the Panel would begin the discussion of the responses to the questions.

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

Dr. Fernandez noted that Panel members had already provided their preliminary written comments<sup>7</sup> in response to the charge questions, and that the comments had been distributed to members and posted on the CASAC website. He noted that preliminary comments from individual Panel members were draft and did not represent the consensus views of the Panel.

Dr. Fernandez indicated that the lead discussant assigned to each charge question would provide initial comments, and then the response would be discussed by the entire Panel. He indicated that the Panel would begin by discussing the response to Charge Question 2. He noted that the response to Charge Question 1 (which addressed the executive summary and Chapter 1 of the draft ISA) would be discussed after the other questions.

#### *Charge Question 2 – Atmospheric Chemistry of Nitrogen and Sulfur Species (Chapter 2 of the draft ISA)*

The Panel discussed the response to Charge Question 2. The Chair indicated that the question asked for comments on accuracy, clarity, level of detail, and relevance of the information presented on: (1) sources, chemistry, and measurement and modeling of ambient concentrations; and (2) measurement, modeling, prediction, and trends of atmospheric deposition of N and S, including particulates, and related processes.

A member commented that Chapter 2 of the draft ISA was extremely thorough. She suggested that that the chapter could be improved by making it shorter and more concise. She also noted that the detailed chemistry discussion in the chapter appeared to obscure the importance of chemical species and their pathways. Members suggested that: (1) the EPA include a table on causality and its significance; (2) the atmospheric transport section be integrated with the discussion of models; (3) a discussion of model performance and results be added; (4) Section 2.5 of the draft ISA contain a more straightforward discussion of the NO<sub>2</sub> federal reference method; (5) the discussion of flux in Section 2.7.2 be included in the modeling discussion; (6) if possible, the discussion of transference ratios be expanded and new data be included; (7) the importance of monitoring networks (and the need for continuing support) be emphasized; and (8) a better explanation of uncertainty and “what it means for risk assessment” be provided.

Members commented on the importance of ammonia emissions and suggested that the EPA consider the effects of total reactive N. A member commented that the summary of emissions in Table 2.1 had not been sufficiently referenced throughout the document. He also suggested that additional information be provided on agricultural emissions of ammonia and noted that fertilizer was a component of soil ammonia and soil NO<sub>x</sub>. He also noted that in the draft ISA, the discussion of the uncertainty of transference ratios could draw upon the discussion of atmospheric lifetimes. In addition, he commented that the draft ISA should contain more discussion of scales (e.g., the discussion of atmospheric transport should address small-scale upslope measurement, regional transport, and international transport) and additional information on emissions from particular sectors in particular geographic areas.

A member commented that development of the draft ISA was a massive undertaking. He noted the need to review models more thoroughly in Chapter 2 of the document. He also indicated that it would be useful

to include a spatial plot of emissions next to a profile of estimated depositions. Another member commented that a figure linking the pH of rainwater to reduced emissions should be highlighted. He also suggested including a summary at the beginning of the chapter. Members commented on the need for quantification of uncertainty in estimated deposition. They suggested distinguishing between maps in the ISA that were based on monitored and modeled data. Members suggested that it would be helpful to provide information on compliance with air quality standards. They noted that this would provide context to consider the appropriateness of standards that were based on concentrations, rather than on deposition rates.

Other members commented that the EPA had developed an impressive document and suggested that the Agency incorporate slides from its presentation to the Panel into the ISA. A member reiterated the suggestion that the EPA address the importance of maintaining monitoring networks and suggested that the Agency assess the adequacy of current monitoring networks. Another member commented that it was important to note the relative importance of sources of ammonia. He indicated that, although agriculture was a dominant source of ammonia, in some locations on-road vehicle emissions and diesels were becoming important ammonia sources.

*Charge Question 3 – Effects of Gas-Phase SO<sub>2</sub>, NO<sub>2</sub>, NO<sub>x</sub>, PAN, and HNO on Vegetation (Chapter 3 of the draft ISA)*

The Panel discussed the response to Charge Question 3. The Chair noted that the charge question asked the Panel to comment on EPA's characterization of the effects of gas-phase SO<sub>2</sub>, NO<sub>2</sub>, NO, peroxyacetyl nitrate (PAN), and HNO<sub>3</sub> on vegetation. The question also asked the Panel to comment on the integration of new information into the evidence on this topic.

A member commented that the chapter was relatively short but few data updates had become available on the topic since the previous ISA was published. A member commented that the chapter only addressed the effects of oxidized N. The Panel discussed the need to consider reduced forms of N. Members suggested that reduced forms of N be addressed in the chapter. Members indicated that there were a number of studies that could be cited. A member noted that, in Europe, critical loads had been developed for ammonia.

EPA staff commented that the current secondary NAAQS had been developed for oxidized N. A member commented that the current secondary NAAQS was based on NO<sub>2</sub>, which was measured less frequently than nitrate and nitric acid. She suggested that the relationship between NO<sub>2</sub> and nitric acid be discussed in chapters 1 and 3 of the draft ISA. Several members commented on ecological effects of ammonia. Members further discussed sources of ammonia emissions. The Chair thanked members for the discussion and indicated that the Panel would next discuss the response to Charge Question 4.

*Charge Question 4 – Biogeochemical Responses of Soils to Nitrogen and Sulfur Deposition (Chapter 4 of the draft ISA)*

The Panel discussed the response to Charge Question 4. The Chair noted that Chapter 4 of the draft ISA characterized the scientific evidence on the biogeochemical response of soils to N and S deposition. He indicated that the Panel had been asked to comment on the accuracy, clarity, level of detail, and relevance of the discussion regarding indicators, processes, models, monitoring and characterization of national-scale sensitivity.

A member noted that the chapter referred to recovery. He commented that a discussion of “what is recovery” should be included in the document. The Panel discussed recovery and it was suggested that recovery trajectory and hysteresis be addressed in the ISA. The Panel also discussed critical loads and members suggested that three kinds of critical loads (empirical, steady state, and dynamic) and their implications be discussed in the ISA. A member commented that it would be useful to characterize the magnitude of the impacts resulting from S and N deposition. Members also suggested that the use of ecosystem specific endpoints, rather than fixed endpoints, for critical loads calculations be discussed in the ISA.

A member commented that additional supporting information was needed to explain: (1) the high level of feedlot manure in the California desert, and (2) high deposition in Wyoming documented in the chapter. She questioned how EPA intended to set standards (and specifically raised the question of which model would be selected for use). A member commended EPA for its work to develop the chapter. He indicated that more detail on carbon pools and decomposition rates should be included. Members also discussed the importance of nitrous oxide as a greenhouse gas and the importance of fertilizer as an emission source.

*Charge Question 5 – Terrestrial Biological Responses to Acidifying Deposition (Chapter 5 of the draft ISA)*

The Panel discussed the response to Charge Question 5. The Chair noted that Chapter 5 of the draft ISA characterized the scientific evidence on terrestrial biological responses to acidifying deposition, including effects on physiology, productivity, and community composition, as well as a discussion of critical loads for these effects. He noted that the Panel had been asked to comment on the accuracy, clarity, level of detail, and relevance of the discussion regarding terrestrial biological responses to acidifying deposition and the critical loads for these effects.

Members commented that the chapter indicated that even low levels of acidification could be associated with negative effects due to reduced soil calcium. Members commented that it was a challenge to differentiate acidification effects from eutrophication effects and suggested separating the literature on acidification and eutrophication. A member commented that the draft ISA reviewed the effects of naturally occurring acidification as background to physiological changes to plants and animals. She noted that this was helpful, but said that other information was needed to determine critical loads. A member commented that fertilization studies were useful.

A member commented that the Chapter 5 text on soil biota was brief, but this topic was more extensively addressed in Chapter 6. He suggested that connections be made across the two chapters. Members again discussed the need to address uncertainty. They commented that, as part of expanding the discussion of uncertainty overall, the ISA should address uncertainty regarding the Bc (base cation):Al ratio that was protective for various species or conditions.

Members commented that high variability from modeling outputs for critical loads using base cation weathering may argue for basing critical load assessments on empirical studies. A member noted that modeled values varied widely (by orders of magnitude) within and among studies. Empirical studies varied within the range of deposition by region and species sensitivities.

A member commented that the sugar maple response tracked well with Ca/Al ratios. He suggested that an additional paper on red spruce recovery be included in the ISA.

*Charge Question 6 – Terrestrial Biological Responses to Nitrogen Enrichment (Chapter 6 of the draft ISA)*

The Panel discussed the response to Charge Question 6. The Chair noted that Chapter 6 of the draft ISA characterized the scientific evidence of terrestrial biological responses to N enrichment. He indicated that the Panel had been asked to comment on the accuracy, clarity, level of detail, and relevance of the discussion regarding physiological mechanisms, ecological processes, and the characterization of sensitivity among biomes, among ecoregions, and nationally.

Members commented that Chapter 6 was thorough and well written but there were some inconsistencies between parts of the text in Chapters 5 and 6. A member noted that Chapter 6 was the longest chapter in the draft ISA. He commented that a large number of papers on terrestrial biological responses to N enrichment had been included in the previous ISA, and that many more were presented in the current draft. Members recommended that the Chapter 6 conclusions be more concisely presented and summarized. A member commented that the chapter should be more clearly connected to the previous chapter. Several members recommended that additional references be cited in the chapter and indicated that they would send citations to the DFO.

The Chair thanked members for their comments. He indicated that the Panel would discuss the response to Charge Question 8 before discussing the Charge Question 7 response.

*Charge Question 8 – Biological Indicators of Acidifying Deposition and Effects on Biodiversity of Freshwater Biota (Chapter 8 of the draft ISA)*

The Chair noted that Chapter 8 summarized biological indicators of acidifying deposition and effects on biodiversity of freshwater biota. He indicated that the Panel had been asked to comment on the accuracy, clarity, level of detail, and relevance of information presented on the biological indicators of acidifying deposition and the effects of deposition on biodiversity in freshwater biota.

A member commented that the chapter was very well done. He suggested that more information be provided to indicate what was meant by recovery. He noted that recovery could mean different things and suggested that the document refer to recovery trajectory. He noted that the information provided about Atlantic salmon was particularly useful. Another member suggested that a specific reference on spruce recovery be cited. A member suggested that the document point out differences between soil liming and watershed liming. He also suggested that in Section 8.5.1 of the document, it would be helpful to make a distinction between controls in glaciated and unglaciated regions.

Another member indicated that the chapter was clearly written and comprehensive. He also suggested that the meaning of recovery be clarified. He suggested that more information about the effect of acidification on aquatic systems, particularly confounding factors, be included in the chapter. In particular, he recommended including more information about factors affecting amphibian recovery and invasive fish species.

*Charge Question 7 – Aquatic Biogeochemical Response in Freshwater and Estuarine Systems to Nitrogen and Sulfur Deposition (Chapter 7 of the draft ISA)*

The Panel discussed the response to Charge Question 7. The Chair noted that the chapter characterized scientific evidence on aquatic biogeochemical response in freshwater and estuarine systems to N and S

deposition. He indicated that the Panel had been asked to comment on the accuracy, clarity, level of detail, and relevance of the information and provide suggestions to further improve the chapter.

A member noted that he appreciated the information EPA had provided on N and acidity in estuaries. He indicated that the document needed a clear working definition of recovery because the studies cited focused on modeling the recovery of acid neutralizing capacity to conditions that may never have existed. Members discussed the need to include studies of large rivers. A member noted that recent studies on alkalinity trends in large rivers were available and would provide useful information. Several specific papers were discussed.

A member commented that it would be useful to provide additional information in the ISA on time frames for recovery (in particular, information about cases where changes in soil base cations may affect stream recovery).

Members discussed the models that were described in the draft ISA. A member suggested that a summary of model results be included in the document. She recommended that the text describe the state of the art for source apportionment. The Panel discussed different modeling approaches (e.g., statistical models and measurement-based models) and the limitations in these approaches. A member commented that the SPARROW model had not been described correctly in the draft ISA. Members commented that suggested corrections had been provided in their individual comments. A member commented that, although various modeling approaches were structured differently, the modeling results in the draft ISA appeared to be largely in agreement with regard to sources of N and S.

A member noted that in the draft ISA, the description of dissolved organic carbon in surface waters was not clear. He indicated that the text should reflect available information about the importance of dissolved organic carbon in assessing recovery (e.g., more dissolved organic carbon tended to be associated with more nitrate removal). Another member commented on the importance of dissolved organic carbon to light penetration. A member suggested that the EPA include in the ISA recent information concerning phosphorus (P) shifts that affect N to P ratios. A member commented that Figure 7.1 in the draft ISA did not appear to include the removal mechanism of denitrification and he recommended that the figure be revised.

The Panel further discussed the effect of N on lakes and aquatic systems. Members noted that it was important to indicate that these systems appeared to be showing more sensitivity to N, perhaps due to legacy P in eutrophic systems.

*Charge Question 9 – Biological Effects Associated with N Deposition to Freshwater Systems (Chapter 9 of the draft ISA)*

The Chair indicated that Chapter 9 of the draft ISA summarized the biological effects associated with N deposition to freshwater systems. He noted that the Panel had been asked to comment on the accuracy, clarity, level of detail, and relevance of the chapter.

A member commented that Chapter 9 was an impressive review. She indicated, however, that there was overlap with other chapters and suggested cross referencing material in these chapters. She noted that members had suggested adding additional references (cited in their individual comments). A member commented that the summary slide used in EPA's presentation to the Panel provided a good organizing framework for the chapter. She also noted that in the Chapter 9 discussion of emerging issues, very little

data had been presented about disease outbreaks in animals. She suggested that this section could be deleted.

A member commented that the chapter provided up-to-date information but the text appeared to imply that P was not important. He noted that N and P were tightly coupled, and that P deposition appeared to be increasing in many parts of the world. In his individual comments he provided references to be cited. He also commented that the inconclusive studies cited in Section 9.1.5 of the chapter should be included in Section 9.1.4. A member commented that Chapter 9 was an excellent chapter and that it contained a very good summary.

Another member commented that the paradigm of nutrient limitation (P for freshwater and N for marine and estuarine systems) was changing. He noted that this was likely due to a long history of nutrient loadings that was changing the limiting nutrient. As an example, he noted that Lake Erie was P limited in the western Basin.

*Charge Question 10 – Biological Indicators and Effects of Nitrogen Enrichment in Coastal Areas (Chapter 10 of the draft ISA)*

The Chair noted that Chapter 10 described biological indicators and effects of N enrichment in coastal areas. He indicated that the Panel had been asked to comment on the accuracy, clarity, level of detail, and relevance of information presented on the biological indicators and effects of N enrichment in coastal waters and on nutrient-enhanced coastal acidification.

A member commented that the chapter was well written. He indicated that in his individual comments he had provided citations for additional papers to be included in the ISA. He also commented on nutrient limitation, noting that many coastal systems showed N and P co-limitation. He also noted that chlorophyll a was the best indicator of eutrophication. He suggested that the ISA address ammonium deposition. He noted that ammonium deposition was significant in the mid-Atlantic coastal region. He also noted that, for some opportunistic phytoplankton species, ammonia was a preferred source of N. Another member agreed that reduced N was important and commented that urea fertilizers were being used widely and tended to dissociate to ammonium.

A member commented that another issue to be considered was that in eutrophic systems more carbon dioxide was taken up by photosynthesis and this could cause a net increase in pH. Another member noted that careful source apportionment was needed to support statements about causal relationships.

The Panel discussed coastal acidification. A member noted that a carbon dioxide budget indicating autotroph utilization versus heterotroph release had not been set up to determine net effects on pH. He commented that this was an evolving area of science. Another member suggested that the ISA discuss available cruise data showing nutrient inputs and effects. She indicated that the National Science Foundation had supported this work.

*Charge Question 11 – Effects of Nitrogen Enrichment in Freshwater Wetlands and Coastal Wetlands (Chapter 11 of the draft ISA)*

The Chair noted that Chapter 11 described biological indicators and effects of N enrichment in freshwater wetlands and coastal wetlands. He indicated that the Panel had been asked to comment on the accuracy, clarity, level of detail, and relevance of information presented on the biological indicators and effects of N enrichment in freshwater and coastal wetlands.

Members commented that the chapter was comprehensive and well written. Members indicated that the causal relationship between N deposition and the alteration of biogeochemical cycling in wetlands was supported by evidence presented in the document. A member suggested that the EPA cite a paper indicating that responses of bogs and/or fens in Europe to N were different than in the U.S. He noted that possible explanations for these differing responses were discussed in the paper. He indicated that the complete citation was provided in his individual comments.

*Charge Question 12 – Sulfur Enrichment in Freshwater Aquatic and Wetland Ecosystems (Chapter 12 of the draft ISA)*

The Chair noted that Chapter 12 of the draft ISA described biological effects and indicators of S enrichment in freshwater aquatic and wetland ecosystems and that the Panel had been asked to comment on the accuracy, clarity, level of detail, and relevance of information presented.

Members commented that the chapter adequately covered the topic, although some technical corrections were needed and these were provided in members' individual comments. A member indicated that a major recent study by Gerson and Driscoll (provided in individual comments), could be included in the analysis. He noted that this study examined relationships among total mercury (Hg), methyl Hg, and long-term decreases in  $\text{SO}_4^{2-}$ .

A member proposed that the chapter be reorganized to provide an improved synthesis linking the various cause-effect chains that are embedded in the detailed analysis. He noted that many of the cause-effect chains were non-linear or context-dependent. He indicated that reorganization and streamlining the chapter might help to make these relationships clearer to the reader.

The Panel discussed interactions among S,  $\text{SO}_4^{2-}$  reducers, and Hg methylation rates. Members noted that these interactions were complex and involved both bacteria and archaea. Members commented that Chapter 12 could include an overview figure, such as the summary figure in a 2011 study by Gilmour (provided in individual comments), that addressed the apparent inconsistency in the role of  $\text{SO}_4^{2-}$  inputs in driving changes in methyl Hg production and bioaccumulation. Members noted that there were four environmental factors that potentially limited the production of methyl Hg: inorganic Hg supply, oxygen or redox status, labile organic C, and  $\text{SO}_4^{2-}$ . Members noted that any one of these factors could limit methyl Hg production, and there was a "Goldilocks" effect: too much or too little could depress production.

*Charge Question 13 – Climate Modification of Ecosystem Response to Nitrogen and Sulfur Deposition (Chapter 13 of the draft ISA)*

The Panel discussed the response to Charge Question 13. The Chair noted that Chapter 13 described how climate, specifically temperature and precipitation, modified ecosystem response to N and S deposition. He noted that the Panel had been asked to comment on the accuracy, clarity, level of detail, and relevance of information presented.

Members commented that they supported inclusion of a chapter on climate change effects in the ISA but they suggested a number of revisions to clarify the message. Members noted that it was important to emphasize that a changing climate has modified, and will continue to modify, the processes discussed throughout the ISA. Members commented that it was important to cross-reference Chapter 13 with other

chapters in the ISA to illustrate the connections that climate change has to most aspects of atmospheric deposition of S, N, and particulate matter.

A member noted that most of the examples in the chapter focused on N. He indicated that additional information could be provided on the S cycle. Another member commented on the importance of discussing regional effects of climate change. He suggested that the EPA consider whether some regional analyses could be added to Chapter 13. A member commented that it would be helpful to consider how additional N would affect carbon sequestration.

A member commented on the importance of considering uncertainty. Members noted that issues such as how changing precipitation, temperature, and rising CO<sub>2</sub> may change emissions, reactions, and deposition (and thus change ecosystem responses) should be discussed. Another member commented that it would be helpful to include a conceptual framework in the chapter and, in this context, discuss the science that should be developed.

Members discussed how the chapter might be reorganized. Members suggested that in the other chapters of the ISA the EPA discuss the connections between climate change and the secondary effects of S, N, and particulate matter. Members also suggested that the EPA retain an integrated synthesis chapter on the effects of climate change.

#### *Additional Discussion of the Response to Charge Question 7*

The Panel discussed some additional points concerning the response to Charge Question 7. A member commented that Chapter 7 of the draft ISA was a good review of the science for freshwater systems. He indicated that additional information was needed for marine and estuarine systems. The member indicated that available monitoring information for estuarine systems had not been well characterized in the draft ISA. He recommended that the EPA cite additional studies of estuarine systems and noted that he had provided citations in his individual comments. The member also noted that some critical processes such as dissimilatory nitrate reduction to ammonium were not mentioned in the draft ISA. The member suggested that, instead of reviewing many individual papers, important synthesis papers could be reviewed.

A member commented that nutrient inputs to the Chesapeake Bay had started to decrease as a result of the Clean Air Act. He suggested that this be mentioned in the ISA. He also commented on sources of N deposition to estuaries and mentioned that motor vehicles were an important source.

#### *Charge Question 14 – Effects of Anthropogenic Nitrogen on Ecosystem Services (Chapter 14 of the draft ISA)*

The Panel discussed the response to Charge Question 14. The Chair indicated that the chapter addressed the effects of anthropogenic N on ecosystem services. He noted that the Panel had been asked to comment on the accuracy, clarity, level of detail, and relevance of the information in the draft ISA.

A member recommended that in the chapter the EPA define ecosystem services. He indicated that providing a definition was important because people used the term in different ways. He mentioned, for example, that ecologists sometimes referred to “nutrient cycling” as an ecosystem service, but others would not if they could not see a link between the cycling of nutrients and human welfare. He noted that it was important to think about new endpoint categories and indicated, for example, that farmers cared about vegetation damage.

A member commented on other ecosystem services analysis work being conducted by the EPA. He indicated that it would be helpful to improve the connection of Chapter 14 to the rest of the document and suggested that ecosystem services be “built in” to the consideration of effects.

Another member commented that the chapter appeared to have been developed as an afterthought. She indicated that the discussion should be distilled to clearly address “why ecosystem effects matter to people.” A member commented that it was important to clearly illustrate what ecosystem services are and summarize why people care about them.

Panel members discussed ecosystem services analysis (ESA) and recommended that a definition of ESA be included in the ISA. Members indicated that ESA did not just entail “trying to put a monetary value on any ecosystem outcome.” Members indicated that ESA usually involved linking, via causal analysis, studied outcomes (deposition, ambient concentrations) to impacts on human health, human welfare, and natural systems (such as biodiversity) that people cared about. A member recommended that the ISA contain a discussion of how ESA could be used to help make the Clean Air Act public welfare determination. She noted that the public needed to be given some idea of how the immense amount of scientific review in the Draft ISA would ultimately be used when a regulatory decision was made. A member suggested that the “Summary of Causal Determinations Table” (Slide 18) in EPA’s presentation to the CASAC Panel be expanded and adapted to an ESA framework to illustrate some of the causal relationships.

#### *Charge Question 15 – Appendices*

The Panel discussed the response to Charge Question 15. The Chair indicated that Charge Question 15 focused on the appendices in the draft ISA. He noted that these appendices contained case studies and a discussion of the ecological effects of particulate matter components other than N and S. He indicated that the Panel had been asked to comment on the adequacy of the information in the case studies and the characterization of non-N and non-S particle associated components and their ecological effects.

Members commented that the case studies provided useful information and the graphics and maps in the appendices were well done. A member suggested that the EPA include an additional case study on the Adirondacks ecosystem. He noted that the Adirondacks ecosystem had been significantly impacted by N and S deposition over a long period of time in the past and had very long-term data on aquatic and terrestrial acidification as well as long-term data on dry and wet deposition. Members also indicated that the Adirondacks ecosystem was one of the most extensively studied and evaluated ecosystems in the U.S.

Members indicated that there was a large amount of information included in the case studies. They noted that this information was dense and noted the value of providing concise summary sections in the case studies. Members indicated that it would be useful to clearly present the “lessons learned” and “bottom line” for each case study.

A member indicated that some of the deposition maps did not represent time periods. He suggested that the case studies include deposition maps of the whole U.S. (with location of case studies clearly marked) that showed not only current deposition levels, but also historical levels as well. A member suggested that the appendix of case studies include a section comparing aspects of the case studies (where such a comparison could provide useful insights). The member mentioned, for example, that the Northeast case

study included a section on recovery but there was no parallel section on recovery for the Southeast case study.

The Panel discussed the appendix that addressed the effects of particulate matter. Members indicated that the appendix included a well-written summary of current research in the field of direct and indirect effects of non-N and non-S particles. Members commented that the information in the appendix provided an adequate update on the narrowly focused topic, which included only ecological effects. Members commented that they had provided some technical corrections in their individual comments.

Dr. Fernandez thanked Panel members for their comments and indicated that the meeting would recess for the day and reconvene the following morning. He indicated that the next day the Panel would discuss the response to Charge Question 1 and then discuss key points in the responses to all of the charge questions. He asked the lead writers to be prepared to summarize the key points discussed in the responses to their assigned charge questions. He also reminded members of the public who wished to provide clarifying comments the next day to register with the DFO. The DFO then indicated the meeting would reconvene at 8:00 a.m. the next day.

**Thursday, May 25, 2017**

### **Reconvene Meeting**

The Designated Federal Officer reconvened the Panel meeting at 8:00 a.m. on Thursday, May 25, 2017. The Chair summarized findings that had been discussed on the previous day. He mentioned that the following points had been raised by members of the Panel: (1) the draft ISA was well done; (2) the draft ISA was lengthy; (3) EPA's presentation to the Panel had been good and parts of it should be included in the ISA; (3) it was important to address uncertainty; (4) It was important to define background and recovery; (5) the linkage to the previous ISA could be strengthened (e.g., including an Adirondacks case study); (6) it was important to address key issues like deposition of reduced N and the importance of monitoring; (7) a more integrated description of models may be useful; and (8) it was important to answer the question of "why ecological effects matter" clearly and more directly.

Dr. Fernandez then reviewed the agenda for the day. He indicated that before lunch the Panel would discuss the response to Charge Question 1 and further discuss other issues that needed clarification. After lunch, the Panel would hear any clarifying comments from members of the public and discuss the key points in the responses to the charge questions. the Chair indicated that that the meeting was scheduled to adjourn at 3:30 p.m. He then called for continued discussion of the responses to the charge questions.

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

#### *Charge Question 1 – Executive Summary and Chapter 1 of the draft ISA*

The Panel discussed the response to Charge Question 1. The Chair noted that: (1) the Executive Summary and Chapter 1 provided overviews of the ISA; and (2) EPA had indicated that Chapter 1 was intended to be a synthesis of the ISA's most policy-relevant findings. He noted that the Panel had been asked to comment on: the extent to which the Executive Summary and Chapter 1 met their objectives; and the extent to which the causal framework was appropriately applied to evidence for each of the effect categories in chapters 3-12 to form causal determinations.

A member indicated that the Executive Summary was well done but he suggested creating an introduction that contained a comparison of the current ISA and the previous ISA. He recommended that the current ISA discuss the aquatic acidification index (AAI). Another member commented that the Executive Summary was good but, given its length, it could be improved by including a more succinct summary. Another member suggested that the Executive Summary and Chapter 1 clearly indicate why ecological effects mattered and provide background information about the concepts of ecosystems and biodiversity.

The Panel discussed the need to provide information on how to provide critical load information in a format that could be understood by the public. Members suggested that this information could be included in Chapter 1.

Another member commented that the draft ISA was well written. He noted that it contained a large amount of specific information and that critical loads were sometimes presented as “bright lines.” He suggested that a caution be provided to indicate that critical loads may represent shifts in gradients. He suggested placing the section on emission reductions in context by discussing continuing effects from historic levels of high deposition.

Several other members indicated that the ISA should contain more information about the previous review of the secondary NAAQS for oxides of N and S. Another member suggested that the Executive Summary contain a synthesis section that addressed uncertainty. A member suggested that the discussion of uncertainty in a recent report of the Intergovernmental Panel on Climate Change was a good example of how the topic could be addressed. A member commented it might also be useful to include in Chapter 1 a short section that highlighted changes that had occurred over the past ten years.

Following the discussion of the response to Charge Question 1 the Chair thanked Panel members for their comments. He indicated that it would be helpful for EPA to provide a brief overview of the NAAQS review process and to discuss other overarching comments on the ISA. He noted that this would be the next topic on the meeting agenda.

### **Discussion of the Secondary NAAQS and other Overarching Issues**

EPA staff reviewed statutory requirements for secondary National Ambient Air Quality Standards, discussed the history of the review of secondary NAAQS for Oxides of Nitrogen and Oxides of Sulfur, and answered questions from Panel members.

Members asked EPA staff: whether standards had to be written as ambient concentrations and had to be nationally uniform; how criteria pollutants were defined; whether pollutant concentrations could be modeled; what the process and time frame were for developing the risk and exposure assessment; and how human and ecological effects were considered. EPA staff responded to questions. In particular, they noted that the Clean Air Act established a process for the Administrator to identify priority pollutants; NAAQS had to provide national protection; and that the CASAC was asked to review EPA’s draft risk and exposure assessment.

The Panel discussed approaches to characterizing uncertainty. A member commented that the Intergovernmental Panel on Climate Change approach to characterizing uncertainty was a useful example, but that it was difficult to characterize uncertainty in deposition.

The Panel continued to discuss uncertainty. A member commented that organisms were affected by more than just deposition. Panel members discussed the challenges of evaluating all of the drivers of ecological effects. A member commented on the need to consider how effects may vary at regional scales.

EPA staff commented on characterizing the uncertainty of the aquatic acidification index. Staff discussed linking deposition to acid neutralizing capacity, heterogeneity of ecological response, spatial boundaries of population response, and developing a national characterization.

A member indicated that it was important to describe uncertainty at fundamental levels of biogeochemical interactions. He noted that some principles could be associated with a high level of certainty but he noted it was important to recognize that local conditions may differ. He indicated that multiple levels of certainties should not be mixed. Dr. Fernandez agreed that it was important to consider conceptual certainty and local uncertainty.

The Panel discussed whether the effects of climate change should be addressed in each chapter of the ISA or in a separate chapter. A member suggested that each effects chapter should contain a discussion of climate change effects and that there should also be a separate climate change chapter.

EPA staff commented that, given the review process, the agency was limited to five to seven year increments of analysis and this affected the approach to considering climate change.

The Panel discussed how the draft ISA could be revised to more effectively communicate and provide dynamic linkages to information. EPA staff indicated that they welcomed the Panel's suggestions. A member mentioned a recent paper on the use of narrative to better communicate complexity. A member noted that the material in the ISA preface could be provided in an appendix and a more concise introduction could be included in the preface.

After discussing overarching issues, the Panel recessed for lunch. After lunch the Panel discussed the key points in the responses to the charge questions.

### **Brief Clarifying Public Comments**

No requests were received to present clarifying public comments so the Chair indicated that the Panel would discuss the key points in the responses to the charge questions.

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

The lead writers for each charge question subgroup summarized the key points in the responses to each question (listed below) and the Panel discussed the key points.

#### *Points Discussed in the Response to Charge Question 2*

- EPA is to be commended for its excellent work to develop the draft ISA. Several structural changes would improve the document.
- The concept of uncertainty needed additional discussion. This additional information could be included in Chapters 1 or 2.
- A summary should be moved to the beginning of Chapter 2.
- A more comprehensive discussion of modeling should be included in Chapter 2.

- The role of metrics for welfare impacts could be discussed
- The atmospheric deposition sections could be made shorter and combined with the modeling discussion.
- More data on model performance could be included.
- The discussion of ammonia emissions needed more documentation of uncertainty and more information on the increasing role of transportation.
- More discussion of the role of soil NO<sub>x</sub> was needed.
- Monitoring networks were critically important to science and they required continuing long-term support. The adequacy of these networks should be assessed.
- The discussion of transference ratios should contain additional information on mass balance and the effects of limited lifetimes of N and S on flux.
- Side-by-side images of fluxes of N and S emissions and depositions would provide useful visual comparisons (this information could be included in an appendix).
- Information should be provided on bidirectional exchange and how it affected model results.
- Information on deposition with regard to critical loads would be useful.
- Maps (CASTNET and others) provided good visuals but implied more certainty than existed.
- The use of models versus measured concentrations should be discussed.

*Points Discussed in the Response to Charge Question 3*

- A clear statement was needed about the relationship between NO<sub>2</sub>, N, and ammonia.
- Consideration should be given to the need for developing National Ambient Air Quality Standards that encompassed reduced forms of N.
- The chapter was well written.

*Points Discussed in the Response to Charge Question 4*

- Additional information on recovery should be included in the ISA. Information should address how indicators were linked to fast and slow recovery periods.
- It would be useful to further discuss site specific endpoints.
- In the ISA more detail should be provided on approaches for developing critical loads (e.g., the advantages and disadvantages of static versus dynamic modeling approaches).
- Evidence to infer causal relationships had been suggested. It would be useful to develop information on the variability of responses. Acidification maps showed differences across the U.S.

*Points Discussed in the Response to Charge Question 5*

- It was important to indicate whether effects occurred at or above EPA standards.
- Chapter 5 should contain linkages to Chapters 4 and 6.
- Cross references to other ISA material on eutrophication and acidification should be included in Chapter 5.
- References for eutrophication and acidification studies should be included in separate tables.
- A summary statement on acidification versus eutrophication effects on microorganisms should be included.
- The chapter made a strong case that the negative effect of N and S from reduced base saturation affected plant growth. It could be useful to present calcium addition studies.

- Much of the literature reviewed focused on natural variability in soil pH. These studies were useful for understanding effects, but studies that were not based on elevated N and S could not be used to assess critical loads.
- A range of critical loads could be presented visually.
- The ISA could address uncertainty in the base cation/Al ratio that was protective for various species or conditions.

*Points Discussed in the Response to Charge Question 6*

- The chapter could be improved by including linkages to Chapter 5.
- Some of the conclusions about acidification needed clarification.
- The mycorrhizae discussion did not address the importance of points covered (i.e., the “so what” question).
- With regard to critical loads, if ammonium was not considered, about half of the N deposition would be missed.

*Points Discussed in the Response to Charge Question 7*

- Chapter 7 provided three causal relationships: (1) N deposition and freshwater biogeochemistry; (2) N deposition and alteration of coastal and marine systems; and (3) N deposition and coastal acidification.
- The chapter should clearly state that acid neutralizing capacity was a useful indicator
- There was more information presented on freshwater systems than marine and estuarine systems. More detail on estuaries was warranted. EPA should rely on recent synthesis papers as citations.
- There was additional information available on the relationship between eutrophication and hypoxia.
- Not all eutrophic systems become hypoxic, this will depend upon the structure of the water column.
- The section on dissolved organic carbon needed to be rewritten.

*Points Discussed in the Response to Charge Question 8*

- There was one causal relationship provided in the chapter: the relationship between acidifying deposition and biological response (including decreased biodiversity). This relationship was well supported.
- There was less certainty in the response of aquatic biota to acidifying deposition than the response of terrestrial biota.
- Both biochemical and biological recovery should be discussed in the chapter.
- The use of acid neutralizing capacity as an indicator was relevant.
- There was redundancy between Chapters 7 and 8.
- The section on mitigation should discuss the difference between watershed and direct aquatic liming.

*Points Discussed in the Response to Charge Question 9*

- Chapter 9 was well written but there was some redundancy with the appendices and other chapters of the draft ISA.

- Additional references for Chapter 9 were provided by Panel members.
- Source apportionment was the key to understanding what drives systems. EPA should consider adding an appendix addressing challenges in modeling and source apportionment.

*Points Discussed in the Response to Charge Question 10*

- Chapter 10 was well written
- Chlorophyll a and diagnostic photopigments were good indicators to be used with satellite data coverages.
- Ammonium needed to be considered in an assessment of external N inputs. It could lead to harmful algal blooms of cyanobacteria and dinoflagellates. Animal feedlots and increased use of urea fertilizers were important sources.
- The effect of eutrophication on acidification should be clearly discussed. Increases in estuarine primary production resulting from excessive N loading was a source of organic matter that could be respired and mineralized, driving the pH down. However, increased primary production enhanced drawdown of CO<sub>2</sub>, which could lead to higher pH values. The balance between these two processes determined the net pH change on diel and longer-term time scales.

*Points Discussed in the Response to Charge Question 11*

- Chapter 11 was well written and comprehensive with regard to references and background information on freshwater and coastal wetland ecosystem types and functions. Some additional references were provided for the chapter.

*Points Discussed in the Response to Charge Question 12*

- Chapter 12 of the draft ISA provided new information that was not included in the previous ISA. There were several technical errors that should be corrected and some references should be added.
- The chapter could be reorganized to provide an improved synthesis linking the various cause-effect chains that were embedded in the detailed analysis.
- An overview figure should be added to illustrate the apparent inconsistency in the role of SO<sub>4</sub><sup>2-</sup> inputs in driving changes in methyl Hg production and bioaccumulation.

*Points Discussed in the Response to Charge Question 13*

- It is important to consider how the ISA will assist writers of the risk and exposure assessment.
- Cross referencing with other chapters could be improved.
- The National Climate Assessment should be used to show examples.
- The focus of the chapter was on N; the effects of S should also be discussed.
- Regional analysis would be helpful.
- The title of the chapter could be more descriptive.

*Points Discussed in the Response to Charge Question 14*

- A clearer definition of ecosystem services should be included in the document.
- A table should be created to link causal relationships to ecosystem services endpoints.
- Ecosystem services should be discussed early in the ISA.

- Ecosystem services should be viewed as biophysical descriptions that link to social welfare.
- Information on the relationship between critical loads and ecosystem services should be incorporated.
- The chapter should be better integrated into the whole ISA.
- The chapter should indicate that ecosystem services include things that people care about such as preservation of natural environments.

*Points Discussed in the Response to Charge Question 15*

- A separate case study on the Adirondacks ecosystem should be included in the appendices.
- Summaries should be created for all of the case studies.
- Lessons learned should be included in the case studies.
- Appendix D was well done. Some minor edits were suggested.

*Points Discussed in the Response to Charge Question 1*

- Chapter 1 and the Executive Summary were well done and achieve stated goals.
- Chapter 1 needed more information on how a standard might be set, how it could be applied nationally, and the work that has been completed on the aquatic acidification index.
- Chapter 1 needs an introduction and the Executive Summary could be improved by including an integrated synthesis.
- The idea of critical loads needs to be more thoroughly discussed.
- The causal determinations were well done.
- It would be useful to include a section on uncertainty in the Executive Summary
- A new section on changes, connections and concepts could be included in Chapter 1 and the Executive Summary. This would provide readers with a clearer view of: what was to be presented (e.g., important concepts such as deposition, critical load, and biodiversity); major conceptual changes in the science since the last review (i.e., Changes); how different aspects of the Draft ISA fit together (i.e., Connections); and specific aspects of the review of the science that might be most informative (i.e., Changes and Concepts).

**Summary of Next Steps**

Dr. Fernandez reviewed action items and the next steps to be completed. He 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 the written responses to the DFO by Friday, June 16th. 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 reminded Panel members of the specific action items to be completed and adjourned the meeting.

Respectfully Submitted:

Certified as Accurate:

/s/

/s/

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Dr. Thomas Armitage  
Designated Federal Officer

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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 May 24-25 meeting page of the Secondary NAAQS Review Panel for Oxides of Nitrogen and Sulfur.

<https://yosemite.epa.gov/sab/sabproduct.nsf/MeetingCal/12EA88DF8F465C4E85258083006E6CE7?OpenDocument>

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<sup>1</sup> Federal Register Notice

<sup>2</sup> Agenda

<sup>3</sup> Panel Roster

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

<sup>5</sup> Charge for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter Integrated Science Assessment - Ecological Criteria (First External Review Draft)

<sup>6</sup> Agency Briefing material: EPA Presentation - Integrated Science Assessment for Nitrogen Oxides, Sulfur Oxides, and Particulate Matter - Ecological Criteria, External Review Draft

<sup>7</sup> 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).