



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
NATIONAL CENTER FOR ENVIRONMENTAL ASSESSMENT

OFFICE OF  
RESEARCH AND DEVELOPMENT

June 29, 2018

**MEMORANDUM**

**SUBJECT:** CASAC Review of the Second External Review Draft Integrated Science Assessment for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter – Ecological Criteria

**FROM:** John Vandenberg, Ph.D. /s/  
Director  
National Center for Environmental Assessment  
Research Triangle Park Division (B243-01)

**TO:** Tom Armitage  
Designated Federal Officer  
Clean Air Scientific Advisory Committee Secondary NAAQS Review Panel for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter – Ecological Criteria  
EPA Science Advisory Board Staff Office (1400R)

The Second External Review Draft *Integrated Science Assessment for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter – Ecological Criteria* (hereafter referred to as the second draft ISA) prepared by the U.S. Environmental Protection Agency's (U.S. EPA) National Center for Environmental Assessment – Research Triangle Park Division (NCEA-RTP) as part of EPA's ongoing review of the secondary (welfare-based) National Ambient Air Quality Standards (NAAQS) for oxides of nitrogen, oxides of sulfur and particulate matter was released on June 26, 2018. Electronic copies are available for download at <http://www.epa.gov/isa>. This second draft ISA will be reviewed by a panel of the Clean Air Scientific Advisory Committee (CASAC) at a public meeting scheduled for September 5-6, 2018. I am requesting that you forward this second draft ISA and charge to the CASAC panel reviewing this document.

This ISA is intended to “accurately reflect the latest scientific knowledge useful in indicating the kind and extent of all identifiable effects on public health or welfare, which may be expected from the presence of [a] pollutant in the ambient air” [Clean Air Act, Section 108; 42 U.S.C. 7408(b)]. This draft ISA integrates the scientific evidence for review of the secondary (welfare-based) NAAQS for oxides of nitrogen, oxides of sulfur, and particulate matter, and provides draft findings, conclusions, and judgments on the strength, coherence, and plausibility of the evidence.

The second draft ISA includes revisions developed in response to the comments and advice provided by the CASAC panel and comments received from the public on the first external review draft ISA. We have carefully considered all comments provided by the CASAC panel and the public in creating this second draft ISA. In addition, we have incorporated information from relevant studies published through May 2017 (the first draft ISA was current through December 2015). The revisions reflected in the second draft ISA focus on several overarching recommendations provided by the CASAC panel:

- Reorganize the document by moving the detailed discussion of subject matter to appendices and focus on key messages in the Executive Summary and Integrative Synthesis (Chapter 1)
- Adding additional references suggested by CASAC
- Improved cross-referencing among chapters and appendices on key topics

The Executive Summary and Integrated Synthesis now serve as the main body of the document. The Executive Summary is intended to be a concise synopsis of key findings targeted to a broad audience, whereas the Integrated Synthesis is a more detailed synthesis of the ISA's most policy-relevant scientific findings. The length of the second draft ISA has been reduced by moving material into appendices, and the Executive Summary has been edited for brevity. The Integrated Synthesis has been expanded and serves as the main body of the document, while detailed information on each of the subject areas is presented in the appendices. A description of some key revisions made to the second draft ISA are found in the Attachment. Revisions include:

#### Executive summary

- more concise
- new integrating figures

#### Integrated Synthesis (Chapter 1)

- new section on uncertainty
- new sections on recovery
- text added to clarify the purpose of the scope of the ISA with respect to the Risk and Exposure Assessment (REA) and Policy Assessment (PA), as well as text defining the components of the standard
- new section describing the scientific elements of the Aquatic Acidification Index
- new text describing the strengths and limitations of approaches to develop critical loads
- new section on concepts, connections and changes

#### **Charge to the CASAC Panel**

The Charge for review of this ISA by the CASAC panel is provided below. Consistent with the reorganization of the ISA, we are focusing the Charge to the CASAC panel on the Executive Summary and Integrated Synthesis (Chapter 1). The areas identified for CASAC comment are not intended to limit the scope of the panel's review but rather are intended to assist the panel by

highlighting specific areas where the Agency is particularly interested in seeking input.

Charge: Do the revised Executive Summary and Integrated Synthesis convey the main scientific findings of the ISA? Please comment on how effectively the revisions to the ISA reflect the recommendations and comments received from CASAC and the public comments. Please identify any additional revisions to the ISA that will substantively strengthen the identification, evaluation and communication of the main scientific findings in these sections:

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 (Chapter 1.11, 1.12, 1.13 and 1.14)

Following the CASAC and public review of this second draft ISA, NCEA-RTP staff will produce a final ISA, which will address comments received from the CASAC panel and the public on the second draft ISA. The final ISA will provide the scientific basis for the U.S. EPA's decisions regarding the adequacy of the current secondary NAAQS for ecological effects of oxides of nitrogen, oxides of sulfur, and particulate matter.

Thank you for your assistance with this matter. Please let me know if you have any questions.

Attachment

cc: Tina Bahadori, ORD/NCEA  
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## Attachment

Highlighted revisions to the First External Review Draft *Integrated Science Assessment for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter – Ecological Criteria* made in response to comments from the public and CASAC panel.

### Atmospheric Chemistry (Appendix 2)

Appendix 2 describes scientific information on sources, atmospheric chemistry, measurement, modeling, ambient concentration trends, and atmospheric deposition of oxides of sulfur and nitrogen and suspended particulate matter. Revisions include:

- new information on emissions uncertainty estimates and methods
- a new section on bidirectional exchange, review of research and quantitative data on its importance
- combined sections on geographic distribution of concentration and geographic distribution of deposition to allow side by side comparison of emissions, concentrations, deposition, by species group
- a modeling section to replace first draft sections on transport and dry deposition, including definitive conclusions about transference ratios
- new material on ammonia emission estimate methods for livestock waste and fertilizer application
- a reorganized measurement section to address comments about the federal reference method (FRM) adequacy, to explain roles of various networks in deposition estimates, to emphasize methods actually used for deposition modeling, to include deposition measurement, to categorize by species/groups of species

### Gas phase effects (Appendix 3)

Appendix 3 characterizes scientific evidence on the effects of gas-phase SO<sub>2</sub>, NO<sub>2</sub>, NO, peroxyacetyl nitrate (PAN), and HNO<sub>3</sub> on vegetation. A map of 3-hour max SO<sub>2</sub> and other new information suggested by CASAC review of the 1<sup>st</sup> ERD ISA was included.

### Soil Biogeochemistry (Appendix 4)

Appendix 4 characterizes scientific evidence on the biogeochemical response of soils to nitrogen and sulfur deposition. Revisions include:

- critical mechanisms that control dissolved organic carbon
- biogeochemistry of soil recovery
- climate interactions with N response
- differential ecological effects for oxidized vs. reduced deposition
- calcium addition studies
- applications of the PnET-BGC model
- N-P dynamics

### Biological effects of Terrestrial Acidification (Appendix 5)

Appendix 5 characterizes the scientific evidence on the terrestrial biological responses to acidifying deposition. Revisions include:

- expanded linkages and cross-references to Appendix 4 and 6.
- a new section on climate modification of response to acidification
- an expanded discussion on uncertainty regarding the Bc (base cation):Al ratio for trees.

### Biological effects of Terrestrial Nitrogen Enrichment (Appendix 6)

Appendix 6 characterizes the scientific evidence on the terrestrial biological responses to nitrogen enrichment. Revisions include:

- a new section on climate modification of ecosystem response to nitrogen
- new material on how N alteration of mycorrhizal communities might affect ecosystem function.

### Aquatic Biogeochemistry (Appendix 7)

Appendix 7 characterizes scientific evidence on aquatic biogeochemical response in freshwater and estuarine systems to nitrogen and sulfur deposition. Revisions include:

- a more balanced treatment of coastal vs. freshwater biogeochemistry, including more detail on estuarine biogeochemical processes affected by N and addition of sections on estuarine monitoring and water quality criteria for estuaries
- new information on dissolved organic carbon
- new information on recovery related to chemical indicators
- new information on trends for dissolved inorganic aluminum and nitrate in surface waters
- a new section on climate modification of ecosystem response to nitrogen

### Biological effects of Freshwater Acidification (Appendix 8)

Appendix 8 summarizes biological indicators of acidifying deposition and effects on biodiversity of freshwater biota. Revisions include new information on:

- surface water acid neutralizing capacity (ANC)
- climate modification of ecosystem response to N and S
- biological recovery
- mitigation responses
- controls on biological response between glaciated and unglaciated regions

### Biological effects of Freshwater Nitrogen Enrichment (Appendix 9)

Appendix 9 summarizes the biological effects associated with N deposition to freshwater systems. Revisions include:

- the causal determination for this appendix has been expanded from the first draft to include productivity
- a new section on increased atmospheric deposition of phosphorus
- freshwater harmful algal bloom discussion expanded
- incorporated new papers on critical loads
- a new section added on climate modification of ecosystem response to N

#### Biological effects of Estuarine and Near Coastal Nitrogen Enrichment (Appendix 10)

Appendix 10 describes biological indicators and effects of nitrogen enrichment in coastal areas. Revisions include:

- expanded the causal statement for this appendix to include the endpoints of total primary production and total algal community biomass as per recommendation from CASAC
- additional information on differential ecological effects for oxidized vs. reduced deposition
- expanded the scope of the appendix to include nutrient effects on coral reef ecosystems
- a new section on climate modification of ecosystem response to nitrogen
- a new map of eutrophic and hypoxic coastal areas

#### Wetland Nitrogen Enrichment (Appendix 11)

Appendix 11 describes biological indicators and effects of nitrogen enrichment in freshwater wetlands and coastal wetlands. Revisions include:

- added information from the EPA 2011 National Wetlands Condition assessment
- a new section on climate modification of ecosystem response to nitrogen
- added information on the relationship between N and invasive plants in wetlands
- new information on differential ecological effects for oxidized vs. reduced N deposition
- new information on how N addition destabilizes marshes, threatening marsh persistence at coastlines
- more information presented from studies of European Union (EU) bogs

#### Sulfur Enrichment (Appendix 12)

Appendix 12 describes biological effects and indicators of S enrichment in freshwater aquatic and wetland ecosystems. Revisions include:

- the causal determination about sulfide phytotoxicity has been expanded from the first draft to include “growth and productivity” as endpoints
- changes to the causal determination about mercury (Hg) from the first draft : “The evidence is sufficient to infer a causal relationship between S deposition and increased methylation of Hg where the value of other factors is within adequate range for methylation in wetland and aquatic ecosystems” to the current causal determination: “The evidence is sufficient to infer a causal relationship between S deposition and the alteration of Hg methylation in surface water, sediment, and soils in wetland and

freshwater ecosystems”

- new sulfide toxicity values for ~15 American wetland plant species
- new information on Hg emissions and sources, and on correlation between Hg and S deposition near sources
- new evidence of Hg methylation by sulfate-reducers in terrestrial forest soils
- new information on Hg and dissolved organic carbon interactions in soil and water
- new information on correlations between algal blooms and Hg methylation

#### Climate Modification of Ecosystem Response (Appendix 13)

Appendix 13 describes how climate, specifically temperature and precipitation, modify ecosystem response to N and S deposition. New sections on this topic were added to all relevant Appendices, and these new sections are referenced in this Appendix.

#### Ecosystem Services (Appendix 14)

Appendix 14 is a summary of recent advances in ecosystem services frameworks, studies that evaluate the effects of anthropogenic nitrogen on ecosystem services and several “profiles” of threatened and endangered species for which nitrogen is listed as a stressor. Revisions include:

- new focus on ecosystem services that provide outcomes of ecological processes (biophysical or social)
- new discussion that defines ecosystem service analysis
- created several plain-spoken narratives (lichens and aquatic grasses)
- new information on economic impacts of ocean acidification
- new information on the final ecosystem goods and services-classification system (FEGs-CS)

#### Ecological effects of other components of PM (Appendix 15)

Particulate matter components other than nitrogen and sulfur and their transformation products have ecological effects. Revisions include:

- a causal determination was added for this Appendix

#### Case studies (Appendix 16)

Case studies at six locations in the U.S. are included to support potential place-based risk and exposure assessment options to be conducted by the Office of Air Quality Planning and Standards. Revisions include:

- an additional case study added for the Adirondack ecosystem, so that the case study areas are: Northeast, Adirondacks, Southeast Appalachia, Tampa Bay, Rocky Mountains, and Southern California

