30 March 2010 Preliminary Review Comments of the NO_x-SO_x Welfare Panel on EPA's *Policy Assessment for Review of the Secondary NAAQS for NO_x and SO_x*

Comments received:

Dr. Praveen K. Amar **2**
Dr. Charles T. Driscoll **7**
Dr. Naresh Kumar **25**
Mr. Rich Poirot **30**
Mr. Dave Shaw **42**

Dr. Praveen K. Amar

Chapter 3: Considerations of Adversity to Public Welfare

Charge Question 4. What are the views of the Panel regarding the characterizations of adversity to public welfare presented in the document? What are the views of the Panel regarding the use of the ecosystem services framework as an additional metric to inform questions of adversity? What are the views of the Panel regarding the usefulness of including economic valuation of some of these ecosystem services in the policy assessment document?

Chapter 3 covers three areas of :a) adversity to public welfare, b) application of ecosystem services framework as a way/metric to address adversity to public welfare, and , c) usefulness of economic valuation approaches to "value" ecosystem services, when doable. I think that the overall effort is quite good. My main and general comment and concern is that of the three attributes of the adversity, "type, intensity, and scale," (page 62, line 9), Chapter 3 needs to be improved with respect to explaining the *scale* of adversity to public welfare driven by "delta" or *changes* to ecosystem services as a function of *changes* in atmospheric deposition of SOx, NOy, and potentially *no changes* (potentially increases) in atmospheric deposition of reduced NHx. The Chapter presents many quantitative numbers in dollars without the proper context (at least for me) when economic valuation data are presented. I would note that the "purpose of numbers is not numbers at all but insights." And, insights for policy makers are missing here. Also, see my response to Charge Question 5 below.

Charge Question 5. To what extent is the presentation of the ecosystem services in the document scientifically sound and clearly communicated?

The concept of ecosystem services and its relationship to adversity and public welfare is reasonably clear to me. However, as I note above, the communication of quantitative information can be and should be improved. One suggestion is that many "*changes"* in dollar values for ecosystem services caused by increased or decreased SOx and NOy deposition should be presented in Figures and Tables (or both) for better communication with the reader. It would also be helpful to write and comparatively explain these numbers so that the audience knows that "$0.69 million, or only $690,000" (value of "public welfare gains related to U.S. sugar maple and red spruce forest markets by eliminating critical load exceedances," page 84) is quite "different" (in fact, different by four orders of magnitude or, by a ratio of 10,000 to 1) than $11.59 billion or $11,590,000,000 (annual benefit for California residents from trail hiking, page 88). Do these two numbers make sense in a comparative economic valuation mode? I do not know, but I am puzzled. Please present all dollar numbers with comparative insights. Otherwise, they are just numbers and not insights.

Charge Question 6. What are the views of the Panel on the critical uncertainties associated with articulating adversity to public welfare that need to be characterized in terms of their potential implications for the secondary standards?

It seems to me that the valuation (monetized or not) of all types of ecosystem services (provisioning, regulating, cultural, and supporting) needs to be addressed with the recognition that different levels of uncertainty are associated with valuation (monetized or not) of the four important services ecosystems provide towards public welfare.

I commend EPA for asking the question on uncertainty "correctly" in that it focuses not on the uncertainties associated with articulating adversity to public welfare themselves ("there will always be uncertainties," what else is new ?), but on the *effect* of uncertainties on the "implications for the secondary standards." My understanding is that the second draft of Policy Assessment will be more descriptive and more quantitative than this draft on how overall uncertainties across the whole spectrum of this approach (atmospheric and ecological models, measurements of atmospheric and ecological data, valuation of ecosystem services, etc.) will be addressed. It will be a good idea if all the uncertainties and their implications be described in one place under one chapter in some integrated and relative manner (in an Appendix?).

Chapter 5: Conceptual Design of an Ecologically Relevant Multi-Pollutant Standard

Charge Question 10. What are the views of the Panel on staff's proposed conceptual framework for the structure of a multi pollutant, ecologically relevant standard for NOx and SOx? To what extent does the Panel agree that this suggested structure adequately represents the scientific linkages between ecological responses, water chemistry, atmospheric deposition, and ambient NOx and SOx?

The proposed framework and structure of the proposed standard (s) is very well-thought out for addressing various components and connections between these components (ecological effects, atmospheric wet and dry deposition, atmospheric concentrations of NOy and SOx, and surface water chemistry), with one major exception noted below.

Even though the framework and the structure "takes into account" the reduced ambient NHx and its deposition in designing AAPI (atmospheric acidification potential index) , it does so in a manner such that future control strategies and policy options most probably will not allow EPA to address and require reductions in national ammonia emissions under proposed standard setting structure. Ammonia emissions are currently at about 4 to 5 million tons per year, and are rising. As the Executive Summary notes on Page ES-7, this approach assumes that "the reduced forms of nitrogen deposition are relatively constant over time. This assumption could lead to over or under protection for an area depending on whether the actual concentrations of reduced forms of nitrogen increase or decrease over time." For the case of unregulated ammonia as a criteria pollutant at the present time, emissions (and resulting ammonia and ammonium concentrations and reduced nitrogen deposition levels) are only expected to increase by as much as ten percent over the next few decades because of increased food production and increased CAFO sources (confined animal feeding operations) in the U.S.

Notwithstanding my concern about not addressing reduced nitrogen directly, the proposed structure more than adequately represents the scientific linkages between ecological effects, surface water chemistry, atmospheric deposition, and ambient levels of NOy and SOx.

Charge Question 11. What are the views of the Panel on the *relevance* of the conceptual design for developing standards to protect against aquatic acidification effects?

Charge Question 11. a. What are the views of the Panel on staff's proposed options for the ecosystem acidification model (s) to represent the ecological response function?

I do not have background or expertise in the design and application of ecosystem acidification models (MAGIC, FAB, SSWC, etc.) used in this Policy Assessment and I found it difficult to follow the general flow of discussion. A general comment that can be made about these models is that they need to be "validated/verified/calibrated" to increase confidence in their results. This Chapter notes that model such as MAGIC, "because of their aggregated nature, need to be calibrated to observational data from a system before it can be used to examine potential system response." A large set of observational data on stream water quality, soil chemical and physical characteristics, etc., are needed. My general question is on the degree and extent of evaluation of ecological acidification models compared to, say, the evaluation/calibration of atmospheric models such as CMAQ. For example, recognizing that these models do involve different physical, chemical, and biological systems, is the level of confidence in these models at a "comparable" level?

Charge Question 11. b. What are the views of the Panel on the relative merits of the two techniques for calculating Neco, the parameter representing the amount of deposited nitrogen that is available for acidification due to uptake, denitrification and immobilization?

As in above question, this is not my area of expertise and I am not sure which approach is more reliable. It appears to me, however, that the second approach (equation (4)), based on measured N leaching in a catchment, and may be more accurate. Is it? Is it also more protective? The text (page 160) briefly (but, not clearly) describes a *third* approach where SSWC results on critical load are constrained by Neco (how and by how much?). Which of the three approaches provide the optimum balance between accuracy/reliability and ease of use? I assume our ecology colleagues will shed more light on this question.

Charge Question 11. c. What are the views of the Panel on staff's proposed options for developing acid sensitivity classes to categorize the national landscape? Is it appropriate to base this classification on bedrock geology? Should multiple criteria be used to inform the sensitivity categories?

The literature and published research in the field indicates that bedrock geology is an acceptable basis for developing acid-sensitivity classes on the larger scale of the U.S. One way to answer the question whether other multiple features/multiple criteria, in addition to bedrock geology, may/should be used as the basis for national categories of acid-sensitivity would be to do a "sensitivity analysis." This could involve other variables to which acid-sensitivity has been

shown to be correlated with (for example, elevation, watershed area, percent forested watershed, etc.). However, this type of investigation needs to be well-designed and focused, taking into account co-variables and would need to be validated with actual field data (for example, with surface water chemistry data) before multiple criteria are selected to redefine acid-sensitivity categories on the national scale,

Charge Question 11. d. What are the views of the Panel on staff's proposed options for how to aggregate acidification modeling from the catchment-scale to represent acid-sensitivity categories at the national-scale?

Of course, this question is on how to "add up" results of acidification modeling at catchment-scale to represent acid-sensitivity categories at the national scale. As the Policy Assessment notes, the proposed standard would be designed such that "a specified percentage of a population of water bodies does not exceed a critical load for the specified value of ANC." What is not clear is how this percent of lakes/streams would be chosen. For example, would one choose, say, 50% of lakes or 95% of all lakes to be protected? I assume it is a policy call of EPA. This also implies that this percent number will be chosen for a certain area of certain spatial extent/size (all of Adirondack? Adirondack subdivided by geologic characteristics? by elevation?). The issue here is the difficulty of deciding an acceptable degree of representativeness of a small sample of measured lakes to represent the whole population of lakes/streams with a large acid-sensitivity distribution. One potential and, may be better, approach would be to only include those lakes in the sample and in the total population that, based on current and/or historic conditions, are considered to have high level of sensitivity to acidification in the first place. This is analogous to establishing primary (public health) NAQQS, based on protecting the most sensitive fraction of human population.

Charge Question 11e. What are the views of the Panel on staff's suggested method to account for reduced nitrogen in the deposition metric?

As I note in response to Charge Question 10, even though the framework and the structure of proposed approach "takes into account" the reduced ambient NHx and its deposition in designing AAPI (atmospheric acidification potential index), it does so in a manner such that it most probably will not allow EPA to address and require reductions in national ammonia emissions under the proposed standard structure. Ammonia emissions are currently at about 4 to 5 million tons per year and, unlike SOx and NOx emissions, are rising. As the Executive Summary notes on Page ES-7, this approach assumes that "the reduced forms of nitrogen deposition are relatively constant over time. This assumption could lead to over or under protection for an area depending on whether the actual concentrations of reduced forms of nitrogen increase or decrease over time." For the case of unregulated ammonia, emissions (and resulting ammonia and ammonium concentrations and deposition of reduced nitrogen) are only expected to increase by as much as ten percent over the next few decades because of higher human population, increased food production and increased CAFO activity (confined animal feeding operations) in the U.S.

Charge Question 12. What are the views of the Panel on the relevance of the conceptual design for developing standards to protect against terrestrial acidification effects? terrestrial nutrient enrichment effects? aquatic nutrient enrichment effects? Does the Panel

have suggestions on additional data or methods that might enable EPA to expand the current aquatic acidification approach to cover additional effects?

The design approach developed here for aquatic acidification should be relevant to developing future standards for terrestrial acidification effects. The "BC/Al" ratio appears to have the same level of robustness as an ecological indicator as ANC is for lakes and streams. It meets the important criterion that it can be correlated with ecological effects on forests and soils, and also through models, to acid deposition levels. As the Assessment notes, in general, the aquatic critical loads offer greater protection to the watersheds than do the terrestrial critical loads. However, this relationship changes depending upon whether lakes are of " low sensitivity", "not sensitive", "highly sensitive" or "moderately sensitive" etc. Therefore, it would be useful for EPA to allow sufficient flexibility into the process of expanding the approach outlined here to terrestrial acidification, as well as to other ecological effects. For the case of nutrient enrichment of coastal estuaries, it would be extremely useful to increase the level of confidence (through additional modeling and measurements) in determining the fraction of reactive N (including reduced nitrogen, NHx) loading that is attributable to atmospheric deposition.

Charge Question 13. What are the views of the Panel on the critical uncertainties associated with the conceptual design of an ecologically relevant multi-pollutant standard that need to be characterized in terms of their potential implications for the secondary standards?

This is important question and, equally important, is asked "correctly" in that it focuses not on the uncertainties themselves ("there will always be uncertainties") but on the *effect* of uncertainties on the implications for setting the secondary standards. My understanding is that the second draft of Policy Assessment will be more descriptive and more quantitative than this draft on how uncertainties across the whole spectrum of this approach (atmospheric and ecological models, measurements of atmospheric and ecological data, ecosystem services) will be addressed. It will be a good idea if all the uncertainties and their implications be described in one place under one chapter in some integrated and relative manner (in an Appendix?).
The discussion of "uncertainties" in this draft (in this Chapter and throughout the report) is generally descriptive in nature. It is, however, not helpful in providing a quantitative and relative sense of uncertainties in various components (emissions, wet and dry deposition predictions and measurements, ecological models versus CMAQ, etc.). For example, it would be useful to state that NH_3 emissions are much more uncertain than NOx emissions that in turn are less certain than SO_2 emissions. It may also be useful to state that dry deposition is simply not measured but inferred from model calculations. For variables that have uncertainties of unknown magnitude, sensitivity studies could be useful to put bounds on the results.

14. To what extent do the figures and examples aid in clarifying the text? Should more or less information of this type be included in the second draft?

The Figures, Tables, and examples were very useful in understanding the text material, especially when subject discussed was not in my area of expertise (ecological models). If anything, I would have preferred more Tables, Figures, and examples to explain abstract ideas in the text.

Dr. Charles T. Driscoll

General Comments

Modify the wording of the document by refraining from stating that inanimate objects like figures or chapters on documents state or do things.

Need to define acronyms that are not defined.

The referencing of the document is very uneven. Some references are provided. However in some sentences detailed information is provided without proper citation.

Please refrain from using the word reduce. The word reduce can mean to decrease, but it can also mean to chemically reduce. Confusion will be less if the word reduced was only used to indicate chemical reduction.

Also the word level is not a very specific term. Using it in the document leads to confusion. Does level refer to concentration or deposition? It is best to use the actual term of interest.

Deposition units should be kg (indicate mass basis)/ha-yr not kg/ha/yr.

P67. TMDLs. In addition to Chesapeake Bay, there are TMDLs for surface water pH in at least two states NY and TN. Shouldn't these be mentioned?

P157 (Section 5.2.2.2). The models used are steady-state models. I think some discussion of the advantages and disadvantages of steady-state vs. dynamic models is critical here. I think this would be an essential foundation to this and other sections. Without such a discussion, the section is lacking.

P164. I think it is a great idea to evaluate additional landscape features in categorizing landscape sensitivity. Elevation is a logical one. Others might include forest cover and watershed area.

P164, line 25 This statement is not entirely true and should be re-written. Reduced nitrogen can be converted to nitrate but not always. It can be assimilated into soil and biomass. In fact most studies show it largely goes into soil. It can be denitrified. Also I don't believe that nitrate deposition has the same effect as ammonium deposition. Generally it would not. It depends on the associated cation and anion respectively.

P167, line 20. I like the analysis of terrestrial and aquatic acidification. However, I suspect the analysis would be flawed by the application of steady-state models. Steady-state models assume that the soil exchange remains consistent over time. In reality, the base saturation of soil decreases with acidic deposition. So the sensitivity of terrestrial ecosystems to acidic deposition likely decreases with time. This aspect of acidification should be addressed in the text.

P178, equation 2. Is this equation (2) correct? It does not seem possible. Doesn't the lake retention term need to be prorated by its area? Does this equation assume some land cover other than forest and lake? Some description of this equation is essential to inform the reader of the intent behind it.

P193. This line of reasoning of short-term atmospheric events having important implications for episodic acidification is flawed. Episodic acidification largely results from shifts in hydrologic flow paths (Chen et al. 1984). Inputs of nitrogen and sulfur from snowpack and atmospheric deposition largely cycle through soil. Short-term direct inputs from atmospheric deposition are not important in episodic acidification.

P197, line 4 and elsewhere. I am concerned that the Neco term does not include organic nitrogen. This could be problematic. Some discussion of organic nitrogen should be given.

P214, line 2. Again, I question the validity of comparing terrestrial and aquatic ecosystem sensitivity given the steady-state modeling approach used. In some systems soil loss of exchangeable basic cations will continue over time. It would be more appropriate to use a dynamic model to evaluate this point.

Specific Comments

P2, line 19	Change to: A summary of ecological… from the ISA and REA is provided in Chapter 2.
P2, line 21	Change to: Those ecological effects are placed within the context of "public welfare" in Chapter 3…
P2, line 23	Change to: The adequacy of the … ecological effects is discussed in Chapter 4.
P2, line 24	Change to: The conceptual design … multi-pollutant standards is developed in Chapter 5.
P2, line 25	Change to: Options for developing … conceptual design are presented in Chapter 6.
P2, line 27	Change to: How secondary … other ecological endpoints is described in Chapter 7.
P2, line 28	Change to: A consideration … and oxidized forms of nitrogen is provided in Chapter 8.
P3, line 1	Change to: Preliminary staff conclusions are summarized in Chapter 9, regarding …
P3, line 10	… NO_x and/or SO_x, but …
P4, line 2	… including total reactive …

P5, line 6	Change to: In the ISA the ecological … to ecosystems are highlighted other …
P5, line 7	Change to: In this assessment information on gas-phase … on vegetation is evaluated, but effects of gas-phase NO_x … on multiple ecological receptors are emphasized.
P7, line 28	Change to: framework, in the next section, we provide …
P8, line5	draft Air Quality Criteria Document (AQCD) …
P8, line 6	Change to: In this draft document a comprehensive assessment was provided …
P12, line 1	Change to: In the petition other adverse … criteria pollutants were also listed …
P13, line 3	Change to: NO_x and SO_x for a combined secondary standard at this time
P13, line 6	Change to: The conceptual framework was introduced in the REA for …
P13, line 14	Change to: The framework we are considering for the structure … standard is depicted in Figure 1-1.
P13, line 24	What is meant by levels? Concentrations? Levels is not a very specific word. Please clarify.
P13, line 25	Change to: a particular extent of ecosystem protection are those concentrations that …
P14, line 5	Change to: As more information is available on effects … NO_x and SO_x, this approach …
P14, line 9	Change to: such as atmospheric characteristics and ecosystem sensitivity.
P14, line 20	Change to: effects
P15, line 18	Change to: … humans following inhalation of air pollutants …
P15, line 26	Change to: … discussed in the ISA, the REA and …
P19, line 3	Change to: … variables controlling the relationships of the ecological response to deposition.

P19, line 7	Change to: … weathering rates, elevation, climatic factors or biological factors that …
P19, line 9	What is meant by high natural background acidification? Do you mean high internal supply of naturally occurring organic acids? Please clarify.
P20, line 23	Change to: … nitrogen deposition diminished when NO_x related deposition is decreased?
P22, line 2	Change to: In this chapter we address …
P22, line 17	Change to: Those effects are evaluated in Chapter 3 within the …
P23, line 19	Change to: base saturation of soil decreases. Continued … can deplete the available base cation pool in soil.
P23, line 22	Change to: The ability of a watershed to neutralize acidic deposition … factors including weathering rates, bedrock composition, vegetation and microbial processes, physical and chemical characteristics of soil and hydrologic flowpaths (REA 2.1).
P24, line1	Change to: increases in inputs of N and S to ecosystems and the associated …
P24, line 2	These sentences are confusing. The first phrase refers to short-term deposition. The second part of the sentence and the following sentence refers to episodic acidification. I am confused. It appears that some text is missing.
P24, line 5	Change to: Episodic <u>acidification</u> refers …
P24, line 20	Delete the last phrase in the sentence after the comma.
P24, line 24	Define surplus of base cations. Change to: … in surface waters, the sum of base cations, ANC, dissolved inorganic aluminum and pH (Note that calcium is a base cation).
P25, lines 1 and 2	Change to: <u>dissolved</u> inorganic Al
P25, line 9	Change to: Similarly, <u>decreases</u> <u>in</u> prey …
P25, line 19	Change to: about 15 to 20%, exchange
P25, line 21	Change to: <u>dissolved</u> inorganic Al<u>.</u> The effect …
P25, line 28	Change to: <u>Acidic</u> <u>deposition</u> <u>and</u> <u>soil</u> acidification has …
P26, line 3	Change to: <u>S</u>ugar maple

P26, lines 10, 11, 19 & 20	Forests are the only terrestrial ecosystem type that is sensitive to acidic deposition. Should the word "terrestrial" be changed to "forest" in these sections and elsewhere to be more specific?
P27, line 4	Change to: deposition in this region is less clear
P27, line 23	Change to: integrity occur because the energy …
P28, line 12 Figure 2-1	Change to: Ecological effects associated with alternative levels of acid neutralizing capacity (ANC)
P29, line 1	17 - and 5 - fold higher than what? Please clarify.
P29, line 4	This is a mistake and needs to be corrected. Virtually all watersheds experience episodic acidification. Are you referring to acidic episodes (i.e., short-term decreases in ANC to low values that would cause biological effects)? Please clarify.
P31, line 7	Change to: are less sensitive sites
P31, line 8	Change to: Note that studies …
P31, line 15	Change to: commonly consumed by sport fish
P31, line 7	Again as in the earlier Adirondack section 10 – and 32 – fold higher than what? Please clarify.
P31, line 10	Again virtually all watersheds experience episodic acidification. Do you mean acidic episodes?
P31, line 17	Change to: a decrease in the condition …
P 34, line 8	Change to: are less sensitive sites.
P34, line 9	Would it be good to refer to "forest acidification" rather than "terrestrial acidification"?
P34, para. starting at line 10	It is necessary to clarify the basis of the ratios. I believe these are molar ratios. If I am correct, they should be clarified as such (e.g., line 10 Bc/Al soil saturation molar ratios. Line 14 Critical soil Bc/Al molar ratio … and throughout the remainder of the document.
P35, line 16	Change to: … can be decreased by 20% … growth can be decreased …
P35, line 21	Change to: For red spruce
P36, line 17	(i.e., ANC)
P36, line 28	Change to: Terrestrial (Forest?) Acidification

P36, line 30	Change to: USFS – Kane Experimental Forest
P37, line 2	Change to: was decreased by 20%.
P37, line 4	Change to: by soil available Ca^{2+} depletion …
P37, line 21	Change to: nitrogen (e.g., NH_x)
P38, line 8	Change to: chronic additions of N
P38, lines 13, 14, 15	
P39, lines 7, 8	
P41, line 2	
P38, line 13	Change to: NO_3^- leaching, soil C:N ratio, rates of N mineralization, nitrification, and denitrification …
P38, line 29 & throughout doc.	Units of flux should be kg/ha-yr, not kg/ha/yr.
P39, line 28	Change to: directly deposited to the water surface can pollute the surface water.
P41, line 15	Change to: Figure 2-8.
P42, Figure 2-8	Define MCF – Mixed Conifer Forest; CSS – Coastal Sage Scrub.
P43, Figure 2-9	Can these locations be reorganized so they are easier to follow, either west to east or east to west or terrestrial vs. aquatic. The numbers do not seem to appear in any logical order. Also change # 10 to elevated NO_3^- leaching.
P45, line 29	Change to: NO_3^-
P46, line 21	Change to: DO, decreases in biodiversity …
P46, line 21	Change to: desired decrease in load
P46, line 23	Change to: must be controlled
P46, line 24	Change to: decrease of total nitrogen
P46, line 25	Change to: indicated decreases in atmospheric … could not eliminate coastal …
P46, line 27	Change to: by decreasing atmospheric
P49, line 5	Acronym correct? Define please.
P50, line 11	Change to: At sufficient concentration
P51, line 5	Change to: decreases in photosynthesis
P51, line 6	Change to: fixation, decreased k^+
P63, line 9	Change to: to decrease or impair

P65, lines 4-8	This sentence is confusing. Can it be re-written?
P65, line 8	Change to: While the
P66, line 11	alkalinity is equivalent (not roughly, it is).
P67, line 27	There are also TMDLs for surface water pH. At least for the states of NY and TN. Shouldn't these be mentioned?
P72, line 1	delete etc. in paranthesis
P73, line 11	Change to: The spatial relationships … deposition levels are illustrated in Figures 3-4 and 3-5.
P74, 75; Figures 3-4 and 3-5	Give the units of deposition in figures.
Figure 3-4	Change to: … deposition of nitrogen and sulfur …
Figure 3-5	Change to: … deposition of nitrogen and sulfur …
P77, line 21	Change to: (e.g. bald eagle – should be lower case)
P77, line 22	Change to: willingness to pay (WTP)
P78, line 16	In brief for each region experiencing ecological effects, ecological indicators …
P78, line 22	The wording of this sentence is confusing. It should be re-written. Change to: figure
P79, line 4	Change to: In the next four sections, we summarize …
P79, line 17	Change to: northeastern United States
P80, line 21	Change to: In the previous section, we describe the ecosystem …, and summarize evidence … existing NO_x/SO_x levels has not been quantified.
P81, line 9	Change to: In this case study, estimates of changes … services are determined, as well …
P81, line 15	What is meant by "zero-out" emissions? Please clarify.
P82, line 20	Bc:Al molar (?) to decreased tree …
P82, line 27	Change to: northeastern United States
P83, lines 3, 10, 29	Change to: northeastern United States
P83, line 11	space after 2006
P85, lines 20, 28	decreases not reduction
P86, line 13	Change to: $2 billion (add space between $2 and billion)
P87, line 4	Change to: nitrogen decreases the …

P88, line 30	Change to: nitrogen deposition
P101, line 11	Change to: In this chapter, we address …
P101, line 12	Change to: In the chapter, we begin
P102, line 9	Change to: as indicators, the current
P102, line 11	Should inputs of reduced N be mentioned here?
P102, line 16	Change to: acid inputs is decreased as natural buffers are depleted more rapidly than they …
P103, line 11	Change to: In addition, in this chapter we qualitatively address … SO_x and set up arguments …
P104, line 25	Change to: This information suggests…
P105, line 6	Change to: … joint impact of the multiple pollutants …
P105, line 8	Change to: This information suggests
P105, line 23-24	Change to: deposition falling on base-rich soils underlying calcareous deposits have a … falling on shallow acidic soils …
P105, line 25-26	Change to: detriment to elevated acidic deposition while … may experience a marked loss in fish communities to a similar input.
P106, line 18	Change to: plus ammonium, NH_4
P108, line 11	Change to: 4-8 sites in the Southeast …
P110, line 9	Change to: and IMPROVE networks. In addition
P111, line 1	Change to: primary compliance purposes capture (delete "do")
P111, line 4	Southeast, there are…
P111, line 22	Change to: of nitrate, ammonium, sulfate and other
P111, line 29	Change to: The organic nitrogen is …
P112, line 8	Change to: deposition through monitoring and models?
P113, line 19	define FAB
P114, line 114	define PAD
P115, line 10	Change to: reactive nitrogen and sulfur,
P115, line 25	Change to: throughout the eastern United States
P115, line 29	Change to: (NH_3 and NH_4),
P115, line 30	Change to: are provided in figures 4-5
P116, line 3	Change to: In addition, figures 4-12

P116, line12	Change to: associated with the formation of
P116, line 16	Change to: Ambient conditions include …
P116, line 18	Change to: This information is consistent
P120, Figure 4-8	Change to: ammonia, NH_4
P125, Figure 4-14	Change to: … from reporting stations in Air Quality System (AQS).
P126, Figure 4-15	Change to: … CMAQ modeled oxidized nitrogen deposition (kgN/ha-yr).
P127, Figure 4-16	Change to: … CMAQ modeled oxidized sulfur deposition (kgS/ha-yr).
P130, line 11	Change to: In the previous sections we have
P130, line 13	Change to: This pattern suggest that
P131, line 1	Change to: In this section we focus on …
P131, line 7	Change to: (N deposition in the eastern U.S. includes …
P131, line 8	Change to: locations with greater than 9 kg N/ha-yr,
P131, line 12	Add reference
P131 and throughout	Change from ha/yr to ha-yr
P132, line 1	Change to: flux of methane (CH_4), and …
P132, line 8	Change to: In Chapter 3 of the REA a thorough assessment is provided …
P132, line 15	Change to: As discussed throughout the REA document, …
P133, line 12	Change to: fully overlap. The locations of the case studies evaluated in the REA are shown on Figure 4-20.
P133, Figure 4-20	Change to: …map highlighting the nine case study …
P134, line 8	Change to: measuring the acid neutralizing capacity…
P134, line 16	Change to: and SO_x and loss of ANC in sensitive ecosystems, and
P134, line 23	Change to: … case study area is 62.1 μeq/L (moderate …
P134, line 25	Change to: ANC of 50 μeq/L, and …
P134, line 26	Change to: This information indicates …
P134, line 28	Change to: … with greatly diminished fish species ….
P135, line 10	Change to: 57.9 μeq/L, indicating …

P135, line 12	Change to: … area, this information suggests …
P135, line 18	Change to: In the ISA it is noted that large portions of the eastern U.S. …
P135, line 21	Should also note that the deposition is much lower.
P135, line 26	A reference should be provided for this report.
P136, line 1	Change to: … could be classified as acid-impacted based on …
P136, line 2	Change to: … lakes classified as acid-impacted based on chronic
P136, line 5	Change to: … in the eastern U.S. …
P136, line 9	Change to: … services such as recreational fishing.
P136, line 24	Change to: … with significant effects on …
P137, line 1	Change to: … sugar maple growth can be decreased by 20 percent.
P137, line 10	Change to: … for a Bc/Al ratio …
P137, line 13	Change to: … range for sugar maple (e.g. Arkansas, Illinois) no plots …
P137, line 16	Change to: … loads for a BC/Al ratio of …
P137, line 18 and 19	Need a reference
P137, line 22	Do you mean concentrations rather than levels?
P138, line 23 and 24	Change to: 150 kg/ha-yr and 300 kg/ha-yr …. 0 to 5.5 kg/ha-yr
P138, line 30	Change to: In the ISA it is noted that …
P138 & 139, line 31 & 1	Change to: In addition, forest management practices can significantly affect the nitrogen cycling, and …
P139, line 17	Change to: in those locations decreases …
P139, line 30	Change to: … deposition are limited,
P140-141	Change all ha/yr to ha-yr
P142, line 26	Many watersheds throughout North America may be conducive to methyl mercury production (e.g. Everglades, Southeast).
P145, line 11	Change to: There are now sufficient data …
P145, line 14	Change to: (e.g. elevation, groundcover)
P145, line 19	Change to: … are presented in Chapter 6.
P146, Figure 5-1	Change to: … conceptual design of the NO_x and SO_x secondary standard.
P146, line 20	Change to: In the following section, we describe …

P147, line 9	Change to: ... NH_x is often a large component of the …
P147, line 13	Change to: … application to aquatic acidification are presented …
P147, line 20	Need to define ANC limit.
P147, line 23	Change to: … is known, one could calculate …
P148, line 17	Define tradeoff curve.
P149, line 11	Change to: In this section we present the ecological components …
P149, line 20	Change to: … acidification is one that is measurable
P149, line 26	Change to: … indicators that could be used …
P150, line 15	Change to: … input of strong acid anions (e.g. NO_3^-, SO_4^{2-}).
P150, line 16	Change to: … indirectly via drainage from terrestrial ecosystems. … when the strong acid anions are …
P151, line 1	Define F-factor
P151, line 3 & 4	Change to: … N and S deposition on predicted pre-industrial ANC value. Note that acidification …
P151, line 15	Change to: … sulfur deposition, although this relationship is altered by landscape factors (e.g. geology, soils, land cover).
P151, line 22	Change to: … two case study areas. These data were used to compare …
P151, line 23	Change to: … (i.e. preacidification, 1860).
P152, line 1	Change to: … marked increase in the number of acid-impacted lakes, characterized …
P152, line 14	Change to: … correspond to important conditions along the ANC response surface that are …
P152, line 19	Define critical limit of deposition.
P152, line 23	Change to: … (REA 4.2). Note that a given level of ANC …
P152, line 25	Change to: … concludes that a quantitative relationship …
P153, line 8	Change to: that will result in adequate biogeochemical conditions to sustain ecosystem health. Adequate biogeochemical conditions is a subjective term … (e.g. ANC = 20, 50, 100 μeq/L) representing different degrees of protection of aquatic ecosystems against acidic deposition.
P153, line 13	Change to: base cation supply to an ecosystem
P153, line 14	Change to: response to acidic deposition

P153, line20	Change to: models are rather extensive
P154, line 3	Change to: modify the surface water ANC
P154, line 25	Change to: Appendix 4
P154, line 27	Why the New England EMAP probability survey and not the Adirondack EMAP survey?
P155, line 12	Change to: include:
P155, line 13	Change to: model;
P155, line 14	Change to: concern;
P155, line 25	Change to: data are
P156, line 2	Change to: parameters are
P156, line 4	Change to: that are
P156, line5	Change to: scale are not
P156, line 26	Change to: include: (1) … model; (2)
P156, line 27	Change to: concern;
P156, line 29	Change to: chemistry are not
P157, line 17	Change to: steady-state SSWC
P157, line 21	font shift ????
P157, line 24	Change to: is incorrect because in many ecosystems nitrate
P157, line 25	Change to: If nitrate is leaching
P157, line 25	"Nitrate leaching is determined from the sum of measured concentrations of nitrate and ammonium in the runoff". This sentence makes no sense. Admittedly in many systems concentrations of nitrate are low, but really. What about organic nitrogen? Why is this ignored? It should be at least addressed in the text.
P158, line 1	Change to: calculation are
P158, line 9	Change to: ; 2
P158, line 10	Change to: ; and 3)
P158, line 16	This figure title is not very detailed or descriptive. A more detailed figure title should be given.
P159, line 3	Change to: μeq/L
P159, line 4	Change to: μeq/L

P160, line 15	Change to: model are less certain.
P160, line 26	Change to: indication to be utilized is ANC.
P160, line 28	Change to: is known, the
P161, line 2	I Change to: In the following discussion, we
P161, line 4	Change to: loads is
P162, line 12	Change to: (Figure 5-4)
P162, line 13	Change to: Sullivan et al. (2007)
P162, line 17	Change to: Sullivan et al. (2007)
P163, line 9	Change to: have greater soil depth receive
P164, line 25	This statement is not entirely true and should be re-written. Reduced nitrogen can be converted to nitrate but not always. It can be assimilated into soil and biomass. In fact most studies show it largely goes into soil. It can be denitrified. Also I don't believe that nitrate deposition has the same effect as ammonium deposition. Generally it would not. It depends on the associated cation and anion respectively.
P165, line 21	Change to: from
P170, line 20	Change to: A relationship for … concentrations is provided in Equation 5.
P171, line 2	Change to: aggregated deposition (space)
P172, line 25	Change to: The oxidized sulfur … values are listed in Table 1.
P173, line 1	Change to: simulations of (space)
P173, line 5	Change to: Annual inverse … simulations are shown in Figure 5-5.
P173, line 8	Change to: SO_x concentrations
P173, line 9	Change to: An example … ratios is shown in Figure 5-6.
P173, line 10	Change to: Section 6 for (space)
P173, lines 11, 15	Are these figure numbers correct? Figure 1, Figure 3
P173, line 15	Change to: CV values … areas (Figure 5-7)
P174, Figure 5-5	It is difficult to read the scale of this figure.
P175, line 2	Change to: schematic diagram
P177, line 3	Change to: A proposed … application is described in Section 5.2.
P177, line 5	Change to: strong acid anions
P177, line 9	Change to: aquatic biota.

P177, line 12	Change to: strong acid anions
P177, line 16	Change to: In this section, we summarize and provide … the approach to calculate: (1) … level; (2) … level; and (3) …
P178, line 3	Change to: µeq/L
P178, line 4	Change to: µeq/L
P178, line 25	Change to: can contribute to acidification
P178, line 28	(NO_x + S)
P179, line 12	Change to: evaluated
P179, lines 18, 19	50 µeq/L
P180, Table 5-4	Change to: Example calculations from determining the percent of water bodies achieving target ANC levels ... and conduct analysis right hand column ANC ≥ 50 µeq/L
P180, line 2	Change to: 50 µeq/L
P182, line 9	Change to: 50 µeq/L
P182, line 11	Change to: Neco is eliminated
P182, Table 5-6	Change to: 50 µeq/L… units are in meq/m^L-yr
P183, Figure 5-10	Change to: NO_x
P184, line 1	Change to: m^2
P184, Figure 5-12	Change to: NO_x
P185, Figure 5-13	Change to: NO_x
P186, line 1	Change to: that neutralize the acidifying
P186, line 5	Change to: will vary in Equations 1 and 5
P186, line 19	Change to: is separated into
P190, line 3	What is by "mixture of the criteria pollutant(s). Please clarify.
P190, line 4	Change to: whether an area is in attainment of the
P190, line 7	Change to: (e.g. annual average).
P190, line 7	The term level is not clear. Please clarify. Do you mean concentration?
P190, line 8	Change to: specific concentration (?) to …
P190, line 22	Change to: A conceptual framework … standard was described in Chapter 5.

P190, line 27	Change to: Chapter 5, a set of potential …
P191, line 13	Change to: In Section 6.2, we discuss
P191, line 14	Change to: In Section 6.3, we suggest
P191, line 15	Change to: In Section 6.4, we provide
P191, line 17	Change to: In Section 6.5, we discuss
P191, line 18	Change to: In Section 6.6, we address
P191, line 19	Change to: Finally in Section 6.7, we conclude
P192, line 9	Change to: S_2O
P192, line 25	Define IMPROVE, if not previously defined.
P193, line 7	Change to: Note that chemical
P193	This line of reasoning of short-term atmospheric events having important implications for episodic acidification is flawed. Episodic acidification largely results from shifts in hydrologic flow paths (Chen et al. 1984). Inputs of nitrogen and sulfur from snowpack and atmospheric deposition largely cycle through soil. Short-term direct inputs are not important in episodic acidification.
P194, line 17	Change to: (See 75 FR 2938, 2999; January 19, 2010)
P195, line 11	Change to: ecosystem, can potentially consume the acid neutralizing capacity of the … to additional loading from acidic deposition.
P195, line 20	Change to: to re-evaluate
P196, line 6	Change to: are atmospheric concentrations
P196, line 12	Change to: Equation (1)
P196, line 18	Change to: As such, the
P197, line 4 and elsewhere	I am concerned that the Neco term does not include organic nitrogen. This could be problematic.
P197, line 7	Change to: Chapter 4
P197, line 23	Change to: variable
P197, line 28	Change to: measured
P198, line 1	Change to: (e.g., to develop … and N_x)
P198, line 14	Change to: sensitive
P198, line 19	Change to: Note for this form
P198, line 20	Change to: different combinations (space)

P198, lines 21, 22	Change to: Equation (1)
P198, line 23	Do you mean g?
P200, lines 7, 8, 10, 12	total nitrogen retention (?) The term nitrogen buffering doesn't make much sense. Do you mean something else like retention?
P200, line 13	Change to: to watershed nitrate leaching and associated acidification.
P200, line 16	Change to: 50 µeq/L
P200, lines 18, 22	Do you mean watershed rather than water body?
P200, line 25	Do you mean g?
P201, line 2	Change to: areas (e.g. sensitive… Figure 6-1; reproducing …
P201, line 9	Change to: (e.g. the 75th or 95th … aquatic ecosystems),
P201, line 9	Do you mean g?
P201, line 16	Change to: from decreases
P201, line 25	Change to: naturally acidic
P201, line 26	Change to: naturally acidic areas, decreasing deposition
P203, line 21	Change to: The rational … is discussed in Chapter 5
P204, line 2	Change to: natural acid neutralizing capacity
P204, line 24	Change to: also reaches a maximum at … This pattern suggests
P205, lines 1, 17, 18, 23, 24, 25, 26, 28, 30	Give unit 50 µeq/L
P205, line 4	Change to: lead to decreases
P205, line 17	Change to: show a marked
P205, line 18	Change to: This pattern
P205, line 20	Change to: to decrease the
P206, lines 1,2	Change to: 100 µeq/L (give units)
P207, lines 9, 10, 19, 20	Change to: 50 µeq/L (give units)
P208, line 7	Change to: (Section 3.2)
P208, line 12	What is NCore? Please clarify.
P208, line 15	Define EPA CSN, if not done previously.
P209, line 28	Change to: largely oriented towards populated areas
P210, line 1	Change to: every watershed would not be feasible and may not …
P210, line 11	Change to: the NO_x and SO_x Secondary Standard

P210, line 27	Change to: (e.g. ANC may be naturally low)
P210, line 9	Change to: assessment.]
P211, lines 10, 24, 26, 28	µeq/L (give units)
P211, line 20	Change to: large decreases
P212, line 5	Change to: 100 µeq/L
P213, line 4	Change to: In this chapter, we focus
P213, line 11	Change to: NO_x and SO_x Secondary Standard
P213, line 14	Change to: 50 µeq/L, soil Bc:Al molar ratio
P213, line 21	Change to: 50 µeq/L
P213, lines 22, 23, 24, 26	Change to: soil Bc:Al molar ratio
P213, line 26	Change to: Table 7.1
P214, Table 7.1	Change to: ANC 50 µeq/L … soil Bc:Al molar ratios … lakes or streams
P214, line 2	Again I question the validity of comparing terrestrial and aquatic ecosystem sensitivity given the approach used. In some systems soil loss of exchangeable basic cations will continue over time. It would be more appropriate to use a dynamic model to evaluate this point.
P214, line 11	Change to: soil Bc:Al
P217, line 31	Change to: aquatic ecosystems;
P218, line 2	Change to: impacts;
P219, line 18	Change to: in the REA
P220, line 19	Change to: by decreases in ANC
P220, line 22	Change to: 50 µeq/L
P221, lines 4, 7, 10, 14, 15	Change to: soil Bc:Al
P221, line 22	Change to: SO_x.
P222, line 9	Change to: S_2O
P222, line 24	Change to: standard (e.g. the target ANC)
P224, line 1	Change to: NO_x and SO_x Secondary Standard

References:

Chen, C. W., S. A. Gherini, N. E. Peters, P. S. Murdoch, R. M. Newton, and R. A. Goldstein. 1984. Hydrological analysis of acidic and alkaline lakes. Water Resources Research **20**:1875-1882.

Dr. Naresh Kumar

Chapter 2: Known or Anticipated Ecological Effects

1. What are the views of the Panel on the appropriateness of staff's weight-of-evidence approach which assesses information from across the various ecological research areas described in the NOx/SOx Secondary Standards Integrated Science Assessment (ISA), including studies of acidification and nutrient-enrichment in aquatic and terrestrial ecosystems, and laboratory research on responses of plant and animal species to acidification and nutrient enrichment? To what extent is the presentation of evidence drawn from the ecological effects studies assessed in the ISA technically sound, appropriately focused and balanced, and clearly communicated?

The staff has adequately summarized the information contained the ISA.

2. To what extent are the interpretation and presentation of the results of the exposure and risk assessment technically sound, appropriately balanced, and clearly communicated?

The staff has adequately summarized the information contained in the REA, but their communication could be improved for clarity.

Additional discussion should be provided on the assumptions and limitations of the models used in the ecological effects studies.

3. What are the views of the Panel on the critical uncertainties associated with the risk and exposure analysis and the evidence from ecological effects studies that need to be characterized in terms of their potential implications for the secondary standards?

The discussion on critical uncertainties (Pages 35-37) requires a more rigorous treatment than what is included in the current draft. The ranking of uncertainty (high, fairly high, intermediate or low confidence) is based on staff judgment without any explanation of how the staff arrived at those rankings.

For example, have the models and input parameters been adequately evaluated to assign high confidence in them? If so, it is essential to provide justification for the assigned rankings.

Chapter 5: Conceptual Design of an Ecologically Relevant Multi-pollutant Standard

10. What are the views of the Panel on staff's proposed conceptual framework for the structure of a multipollutant, ecologically relevant standard for NOx and SOx? To what extent does the Panel agree that this suggested structure adequately represents the scientific linkages between ecological responses, water chemistry, atmospheric deposition, and ambient NOx and SOx?

Figure 5-1 correctly depicts the linkages between ecological indicators, atmospheric deposition and ambient NOx and SOx concentrations. However, the uncertainties in the transformation functions between ecological response and deposition and between atmospheric deposition and air quality indicators have not been clearly explained.

For example, the Agency plans to use CMAQ model to develop relationship between SOx and NOx concentrations and the atmospheric deposition. However, CMAQ model was not adequately evaluated (either for its prediction capability for different species concentrations or for wet deposition, as a test of overall model capability) for the 2005 application that was used in the REA.

Although the data for evaluation may be sparse, it would still be useful to know how relationships between deposition and ambient concentrations obtained using the data compare against those using the model.

Given the uncertainties in the models (both atmospheric and aquatic) and the data bases, the Policy Assessment provides no indication on what ambient concentrations of SOx and NOx would meet a particular ANC. Simply stated, the Policy Assessment document does not provide information on what the confidence interval for the ambient concentrations may be (For example, is it a factor of 2, 5 or even 10).

The agency should conduct a thorough analysis of the sensitivity to different assumptions at every stage of the linkages depicted in Figure 5-1 to provide quantitative estimates of the uncertainty range in the final ambient concentration numbers needed to meet a particular level of ANC.

11. What are the views of the Panel on the relevance of the conceptual design for developing standards to protect against aquatic acidification effects?

a) What are the views of the Panel on staff's proposed options for the ecosystem acidification model to represent the ecological response function?

The modeling approach suggested by the staff to represent the ecological response function seems reasonable; however, the key question is how the different terms in the equation are estimated.

For example, the two approaches suggested by staff for estimating Neco give very different results and (as noted by the staff) it is not clear which approach is better.

The approach to calculate [BC] is not clearly articulated in the Policy Assessment or its appendices. Furthermore, there is a lack of any discussion about the *quantitative impact* of uncertainties in estimating [BC].

b) What are the views of the Panel on the relative merits of the two techniques for calculating Neco, the parameter representing the amount of deposited nitrogen that is available for acidification due to uptake, denitrification and immobilization?

The staff should attempt to reconcile the difference in the two approaches as they give very different results. In addition, the staff should indicate how data for use in these calculations will be collected and with what frequency.

As noted earlier, both methodologies should be used as part of a sensitivity study to explore the impact of all input parameters and assumptions on final concentration values.

c) What are the views of the Panel on staff's proposed options for developing acid sensitivity classes to categorize the national landscape? Is it appropriate to base this classification on bedrock geology? Should multiple criteria be used to inform the sensitivity categories?

As noted in the Policy Assessment, bedrock geology is a key factor influencing acid sensitivity, but there are additional factors. Other factors include topography, elevation, soil depth, soil composition/pH, meteorology, and land use. The assessment should explain how additional factors may influence the classification process.

d) What are the views of the Panel on staff's proposed options for how to aggregate acidification modeling from the catchment-scale to represent acid-sensitivity categories at the national-scale?

The example provided in the Policy Assessment document used the 169 catchments within the Adirondacks. However, the impact of extending this methodology to the national scale is unclear. In doing so, is there not the potential for developing a standard that is more than requisite in many regions of the country?

Given that there are multiple judgments (appropriate ANC level, percentage of catchments) and multiple uncertainties in the calculations leading to the index (Neco calculation, BC calculation) and multiple uncertainties in the back-calculation to atmospheric concentrations, the Policy Assessment has a major omission in not explaining how all these factors influence the range of potential values for a secondary NAAQS (as also noted earlier).

e) What are the views of the Panel on staff's suggested method to account for reduced nitrogen in the deposition metric?

The approach to account for reduced nitrogen is problematic.

First, it puts the onus of improving acidification on NOx and SOx alone when reduced nitrogen (NHx, both inorganic and organic) can be quite a considerable part of acidification in many cases.

Second, the assumption that NHx deposition is constant over time is definitely wrong.
Third, uncertainties associated with ammonia emissions and using CMAQ to calculate NHx deposition—as well as wet and dry deposition of SOx and NOy are high and have not been clearly explained or quantified. Although measurement data will be "blended" with model data, the overall capability of the model to represent ambient concentrations and loss terms is essential to informing judgment on the model's overall role in back-calculating a secondary NAAQS.

Chapter 6: Options for Elements of a Standard to Protect Against Effects from Aquatic Acidification

16. What are the views of the Panel on the degree of uncertainty associated with each element of the suggested standard, e.g. the ecological indicator; the concentration to deposition ratios, reduced nitrogen, the natural background ANC, and the ambient indicator and averaging time for NOx and SOx , and its relationship to the degree of protection that could be expected from the standard? What are the views of the Panel on how to fairly characterize the uncertainty associated with the degree of protection that such a standard would provide from aquatic acidification?

The uncertainties associated with various elements of the standard have not been clearly delineated. As a result, it is difficult to state with any degree of confidence on the degree of protection that could be expected from a given standard. As mentioned earlier, the best way to characterize uncertainty associated with the proposed approach would be to conduct a sensitivity study for each element of the standard and propagate these uncertainties to arrive at a range of protection that a given standard would provide from aquatic acidification.

18. What are the views of the Panel on the use of regional air quality modeling (e.g., CMAQ) results to establish the concentration-to-deposition ratio (VNOy, VSOx) and reduced nitrogen deposition (NHx) in the AAPI calculation? What are the views of the Panel on the critical uncertainties associated with the use of CMAQ to generate these parameters, and the potential implications of these uncertainties for the secondary standards?

There are a variety of problems with the use of regional air quality modeling to establish VNOy, VSOx and NHx. Although CMAQ is a regional air quality model that has been under development for many years, it lacks in its capability to correctly predict the concentrations of different species within NOy, SOx, NHx and the wet deposition of these species. Although the model cannot be evaluated for dry deposition because of lack of measurements, evaluation of the ability of the model to represent ambient levels can serve as a proxy for its ability to represent dry deposition.

A comparison of CMAQ derived values with measurements is needed before any confidence can be derived on the use of the model to generate the desired parameters.

There are many sources of uncertainties that can affect the final numbers derived from the model. These include, but are not limited to:

- large uncertainty in emissions (particularly NHx emissions, but also NOx emissions);
- inability of models to correctly predict clouds (both in cloud cover and liquid water content) and precipitation; and
  incomplete representation of chemistry (particularly cloud chemistry, nighttime chemistry and reactions with soil components).

Mr. Rich Poirot

<u>Chapter 4: Addressing the Adequacy of the Current Standards</u> <u>(Revised)</u>

7. What are the views of the Panel on staff's assessment of the adequacy of the form of the existing NOx and SOx secondary standards? To what extent does the Panel agree with staff's assessment of the protection provided by existing standards, given the current levels, forms, averaging times, and indicators?

Chapter 4 presents clear and convincing arguments questioning the ecological relevance the current SO_2 and NO_2 secondary standards (and many of their individual components) and concludes that current standards do not adequately protect against adverse environmental effects from SO_X and NO_X pollutants. Well-documented observations of chemical and ecological effects of S + N acidification in aquatic chemistry and effects monitoring programs like TIME, LTM and EMEP, combined with the observations that there are no exceedances of current NO_2 or SO_2 standards in areas experiencing effects of aquatic or terrestrial acidification or nutrient enrichment provide a general indication that current standards are not adequate. As the environmental effects from SO_X and NO_X occur primarily through the long-term cumulative deposition of multiple S and N compounds, combined together rather than individually, the chapter persuasively shows how the elements of the current secondary standards are inappropriate in terms of indicators, averaging times, levels and forms, as well as in their single pollutant approaches to multi-pollutant problems.

8. What are the views of the Panel on the time frame of ecological response related to current deposition? The adequacy evaluation relies on recent NOx, SOx, deposition, and on long-term steady state ANC. Does the panel agree that long-term steady state ANC is the most appropriate representation of ANC for evaluating the adequacy of the current standards?

Other panel members will have more informed opinions on this question. Of necessity, a NAAQS needs to be based on current air quality (and in this case associated deposition), but current effects reflect the cumulative influences of both current and historical deposition, just as future chemical indicators like ANC and ecological effects may show a substantial lag time before "recovery", and may never recover to pre-industrial conditions. I don't know of a better or more responsive indicator than steady state ANC, and think it is a reasonably strong indicator of aquatic effects which has also been observed to be responsive to increasing and decreasing S and N emissions, air quality and deposition over time.

It seems possible that some aquatic systems may be especially susceptible to effects from episodic acidification in ways that may not be directly reflected by long-term steady state ANC. I'm not sure how these kinds of systems could be better protected, but again think that other panelists can offer better advice – if this is even a significant concern.

9. To what extent are the characterizations of ambient air quality and deposition

appropriately characterized, relevant to the review of the secondary NOx and SOx NAAQS, and clearly communicated?

The characterizations of air quality and deposition presented in Chapter 4 are, for the most part, appropriately characterized and relevant to the review of secondary NO_X and SO_X standards. While the chapter is nominally focused on evaluating the adequacy of current standards, it also includes considerations of the potential to use current monitoring networks (supplemented by additional measurements and/or by CMAQ model results) for the development of potential new standards and/or determining compliance with them. While most of the map information is useful and clearly presented, several of the maps appear to have inaccurate legends or captions (Figures 4-8 through 4-11; see more detailed comments below). It would also be useful to include maps of total NH_X N deposition, as well as the fraction of total N deposition contributed by reduced (or oxidized) N.

There are some important maps showing the relationships between atmospheric concentrations and total deposition of S and N ($V_{S/N}$) presented with poor clarity in Chapter 5 (Figure 5-5). These kind of maps and the relationships they display are important and could be introduced (much more clearly), and expanded upon in Chapter 4. Presumably, it could be clearly demonstrated, through use of CMAQ ratio maps and scatter plots based on grid point comparisons, that NO_Y is a much better predictor or indicator of total oxidized N (N_{OX}) deposition than NO_2 is, and this would directly support your evaluation of adequacy. If time/resources allow, it could also be informative to consider if (NO_Y minus NO) might actually be a better indicator than total NO_Y of total N_{OX} deposition, since NO (is measured along with NO_Y but) does not deposit efficiently and may not be as good an indicator of local N deposition as are other NO_Y components). At some point it may also be useful to ask if NO_Y is a substantially better indicator of N_{OX} deposition (in rural/remote areas affected by acid deposition) than is the sum of HNO_3 + PNO_3. The reason I suggest asking this is that if HNO_3 + PNO_3 is an adequate indicator, then monitoring for new standards (including SO_2 + PSO_4) could be accomplished by relatively modest enhancements to existing filter pack networks – less interesting but much less costly than adding new continuous SO_2 and NO_Y monitors at many rural/remote locations.

Other Comments on Chapter 4

P 101, line 7: Change “sensitivity” to “sensitive”.

P 104, lines 1 & 5: You refer to “the last review” of secondary SO_2 NAAQS, and then cite an EPA 1982 reference. Wasn’t there a review – or at least a decision not to revise – made in1988?

P 105, line 12: You could add “directly” between “not” and “address”

P 105, line 19: Change “grouping” to “groupings” or “groups”.

P 106, lines 1-4: this seems like somewhat of an odd question since it is really more the effects-based monitoring programs like TIME and LTM that clearly show adverse effects occurring despite widespread attainment of the obviously inadequate current NAAQS. The subsequent

review of existing air quality and deposition networks, while helpful, seems to relate more to how well those networks could support the new standards under consideration. Toward that end, I think it might be useful to consider the extent to which existing networks might be adequate/inadequate or enhanced – both at minimal and at more scientifically ideal levels to support new standards. For example, CASTNET already measures SO_2 & $SO_4^=$ and IMPROVE could be similarly enhanced by adding back-up treated filters to catch SO_2. CASTNET already measures HNO_3 and $PNO3^-$ (& PNH_4^+) by filter pack. Similar filter-based measurements might be added to IMPROVE, and possibly NH_3 by analyzing denuder extracts. If the sum of HNO_3 and PNO_3^- could be related to total N_{OX} deposition nearly as well as NO_Y can, it (combined with the use of filter pack SO_2) could save a lot of $ compared to the alternative of adding new continuous NO_Y and SO_2 monitors in rural areas.

P 106, line 13: Does this mean that when you refer to NO_Y, you mean "all oxidized N expressed as if it were NO" or do you mean "expressed as total N". Similarly on lines 19, 20, I assume you mean that TS refers only to the sulfur from and not the actual sum of SO_2 & $SO_4^=$.

P 108, line 6: Capital V in Visual.

P 109, line 6: Change "longe term" to "long-term"

P 111, lines 12-15: I don't get your point. You could have all the new SO_X and NO_Y monitors in the world and it would tell you absolutely nothing about whether S+N deposition occurring despite attaining the current SO_2 and NO_2 standards is causing adverse effects. Your existing SO_2 and NO_2 network is adequate to tell whether standards are attained (they are) and your existing aquatic effects networks (TIME, LTM, etc.) are adequate to tell you if sensitive aquatic resources are protected (they're not).

P 111, lines 28-29: I don't dispute that NADP + CASTNET are valuable networks and might be useful starting points for new measurements to assess a new standard (or evaluate its effectiveness). However, it should be noted that relatively few NADP sites and no CASTNET sites are operated by state or local air agencies – whose jurisdictions might fall into non-attainment as a result as measurements made by EPA contractors (or academic research groups in the case of NADP) using funds that would otherwise be allocated to the states. Could make the states cranky…

P 111, line 30 & continuing: It's also likely that the current configuration of NADP sites is more suitable for evaluating acidification effects than is the current configuration of (predominantly urban) air monitoring sites. So its more likely that air quality measurements might be added to NADP. However, as a practical matter, you won't actually need NADP data to evaluate compliance with a new NAAQS, though it will be useful to evaluate whether your assumed deposition to air quality ratios are, and are remaining, reasonable.

P 112 lines 9-16: This whole paragraph needs a re-write. Also (lines 11-12) it seems a bit harsh and certainly premature to condemn CASTNET as a flimsy research effort that will never attempt to develop better operational methods. Meanwhile in other sections of the PA (like the

preceding page) you propose CASTNET as the logical starting point for a new compliance network.

P 113, line10: You could add NH_3 to this list of important gasses not measured by CASTNET.

P 114, line 15: Delete either "treating" or "simulating".

P 115, line19: the semicolon should be a comma (or be consistent and also use ";" in the next line after NO_x.

P 115, lines 26 & 27: Change to either "… where the more aged air masses consist…" or "with the more aged air masses consisting…"

P 115, lines 29-30: Try to be more careful and consistent with subscripts, superscripts, charge signs for ions, etc. – lest the reader waste time trying to figure out if you mean something different when you use ST and S_T.

P 116, lines 10-12: Just curious, but I wonder if these runs incorporate a recently developed CMAQ bi-directional flux algorithm for NH_3 (seen in recent talk by Robin Dennis) that roughly doubled the effective transport distance for NH_3?

p. 116, lines 18-21: I don't really buy this logic. If the (annual) NO_2 standard were set low enough (and attained), the deposition of oxidized N and its effects would certainly be diminished. There are better indicators than NO_2, but if you used NO_Y, set the level appropriately and attained it, levels of NO_2 will be much lower than they are now and much, much lower than the level of the current NO_2 secondary standard. Further, efforts to reduce NO_2 concentrations have not uniquely focused on reducing "NO_2 emissions", but more typically emissions reductions (or permit conditions) are based on reductions of NO or NO_X emissions. I like the inclusion of the Figure 4-19 NO_2/NO_Y ratios (inversed), but this alone isn't really sufficient to show the inadequacy of NO_2. What you would really need for that would be a comparison of the superior effectiveness of NO_Y as a surrogate for N_{OX} (oxidized N) deposition. You could do this by showing CMAQ Ndep/ NO_2 ratio maps, similar to the Ndep/NO_Y maps in Figure 5-5 (but make them legible). A test of the strength of the predictors could be shown as a scatter plot & correlation of the deposition vs. atmospheric predictors, where each point would be a CMAQ grid cell location. In theory, NO_Y should be a better predictor – and especially if you constrained the comparison to rural locations where acidification may be a problem.

P 117, Figure 4-5: would it make any sense to express this in $\mu g/m^3$ of N, for a more direct comparison with its S counterpart (Figure 4-9), and to provide more common units and comparability in deposition/air quality ($V_{S/N}$) ratio maps (Figure 5-5)?

P 120: In figure caption, "ammonia" should be "ammonium".

PP 120-123: I think there's a problem (probably with the units) in some of these, as the scale for total SO_X or ST, expressed "as $\mu g/m^3$ S" in Figure 4-9 goes from 0 to 10, but the scale for SO_2-only in Figure 4-10, also indicated as being expressed "as $\mu g/m^3$ S", goes from 0 to 20. The SO_4

plotted in Figure 4-11 also looks too high to be in the indicated units of $\mu g/m^3$ S, and so I suspect that 4-10 and 4-11 are probably showing $\mu g/m^3$ of SO_2 and SO_4 respectively (not just the S).

P 124: The VIEWS figures are useful, but you might include a footnote explaining that the "plume" in the central US is an artifactual error from the interpolation & plotting routine, and not "real".

P 130: The scale indicates "ppbv" but the indicated ratio that's plotted should be unitless.

P 131, line 5: Another good example of the confusing use of terms. In this case, I assume, but don't really know, that you're using "NO_X" to mean "the nitrogen from the total wet and dry deposition of all oxidized nitrogen compounds", and that by " total atmospheric deposition" you mean the "total wet and dry deposition of all reactive nitrogen". This reminds me that it would have been useful to include maps of total NHx N deposition, and of the ratio of total N deposited by oxidized N compounds.

p. 131, line 24: It's not clear where "summarized above" is pointing to. If you mean way back in section 1.4, why not say so, and save the reader a lot of unnecessary page flipping.

P 134, lines 21-26: Could you also include % of lakes exceeding CL for ANC of 100 μeq/l, since that threshold is still on the table as a possible indicator level. Isn't it?

P 135 lines 2, 3 and elsewhere: You frequently invoke "brook trout" as a "sensitive species", but I tend to think it as one of the more acid-tolerant species (Charlie or Myron can clarify this). Also, it's not clear in this sentence whether an ANC of 20 is a base level which could dip even lower during an extreme event, or the level to which some baseline higher ANC might drop during an extreme event. I think this is an important concept that could be addressed in more detail. Finally, do you really mean to indicate a population decline <u>during</u> an event (fish kill)?

P 136, line 28 and lots of other places: Use either BC/Al or Bc/Al but not both.

P 141, line 28: Am I thinking backwards or shouldn't "sensitive ecosystems" in this context be ones where "N is limiting", such that excess N would cause shifts in species?

<u>Chapter 5: Conceptual Design of an Ecologically Relevant Multi-pollutant Standard</u>

10. What are the views of the Panel on staff's proposed conceptual framework for the structure of a multipollutant, ecologically relevant standard for NOx and SOx? To what extent does the Panel agree that this suggested structure adequately represents the scientific linkages between ecological responses, water chemistry, atmospheric deposition, and ambient NOx and SOx?

The proposed conceptual framework and the structure of the proposed standard do an excellent job (under very challenging Clean Air Act constraints) of representing the complex linkages between ecological effects, aquatic chemistry, atmospheric deposition and air quality. It is inconvenient that a direct measure of ANC in surface waters, or measurements of deposition of S

and (total reactive) N couldn't be used as a more direct basis for a NAAQS. However, given the limitations of the current CAA, the proposed structure employs some clever and innovative mechanisms to link air concentrations to ecological effects, recognize the combined influence of S and N, accommodate the varying inherent sensitivities of different ecosystems, and incorporate – without directly regulating - the additional influence of reduced N.

11. What are the views of the Panel on the relevance of the conceptual design for developing standards to protect against aquatic acidification effects?

a) What are the views of the Panel on staff's proposed options for the ecosystem acidification model to represent the ecological response function?

Others on the panel will have much more informed opinions on this than I could offer. On a related topic, I'm not sure that the concept of episodic acidification is adequately addressed in the acidification model(s) presented chapter – or elsewhere. It seems to be assumed that selection of a specific ANC limit – of say 50 μeq/l – would be intended to protect against both chronic and episodic effects. If this is the case, it should be stated explicitly. If there might be exceptions, for certain types of catchments or ecosystems, these should also be presented along with indications of how selection of alternative ANC limits might guard against these effects.

b) What are the views of the Panel on the relative merits of the two techniques for calculating Neco, the parameter representing the amount of deposited nitrogen that is available for acidification due to uptake, denitrification and immobilization?

Others on the panel will have much more informed opinions on this than I could offer. From the text explanation on p. 178, it would seem like equation 3 is both simpler and more readily accessible or "testable" through direct methods than equation 2. I would think it would be applicable, however, only in situations where (or when) "N breakthrough" has already occurred and is directly measurable, and therefore would only reflect current retention rates, which well may decline further with continuing deposition. Equation 2 may be a better, more protective approach to guard against longer-term future effects and assure that current rates of N deposition are "sustainable".

c) What are the views of the Panel on staff's proposed options for developing acid sensitivity classes to categorize the national landscape? Is it appropriate to base this classification on bedrock geology? Should multiple criteria be used to inform the sensitivity categories?

This sounds like a reasonable approach, and possibly other variables (surface soil composition and depth, weathering rate, slope, elevation, etc. could also be useful. It's difficult to judge this without seeing an example, but in general, I think it could be an extremely valuable exercise to go through in some detail, regardless of what the eventual end use(s) is (are). Conceivably multiple approaches to developing sensitivity classes could be considered and then evaluated – by comparing measured vs. predicted ANC using the different sensitivity classes. Would it be possible to use relatively abundant surface water chemistry data to guide this process?

d) What are the views of the Panel on staff's proposed options for how to aggregate acidification modeling from the catchment-scale to represent acid-sensitivity categories at the national-scale?

It's difficult to evaluate these options in the abstract, without seeing comparative examples. The approach of specifying a percentage of water bodies within a given area sounds reasonable, but would be critically dependent on how the areas were selected. Selecting a critical % of lakes to protect seems like a somewhat arbitrary decision in the first place, and when combined with optional methods of selecting the (size of, and distribution of lake characteristics within) spatial areas, the decision process could be extremely arbitrary. Within a small area at high elevation on the western slopes of the Adirondacks, 100% of lakes will exceed their critical loads to maintain a protective ANC, but as the area is expanded in size, the % of acidified lakes will eventually fall to single digits if aggregated at the statewide level, so where do you draw the line?

I wonder if it would be possible to modify the geographical area concept to include only the population of surface waters within that area to include only those considered "potentially susceptible" to acidification – based on characteristics of their underlying bedrock, soils, etc. This would minimize the importance of the specific areal selection, since the % affected metric would apply only to the lakes considered susceptible in the first place. Or maybe model estimates of preindustrial ANC levels could be used as an index of inherent sensitivity and a decision of adverse affects could be based on shifts in ANC categories over time, or based on a limit to the % change in ANC from preindustrial conditions within the population of potentially susceptible lakes in a given area.

In areas where acidified streams are at issue, it would be necessary to have some metrics for selecting the appropriate sections of streams to be evaluated, and this doesn't seem to be discussed in much detail in the Policy Assessment. As with the affected lakes, some metric that reflects past ANC changes over time might be a useful way to judge adversity of current conditions. Conversely, in might be useful to consider a progress-based metric (% increase in ANC, or % shift between ANC categories over time) to determine future compliance with the NAAQS. I think there are other examples where one test is applied to get an area into non-attainment, but a different test is required to get out of non-attainment.

e) What are the views of the Panel on staff's suggested method to account for reduced nitrogen in the deposition metric?

It's unfortunate that reduced N can't be more directly recognized as an important, unregulated pollutant and steps taken to reduce its emissions to the atmosphere and surface waters. However, given the constraints in the CAA definition of nitrogen oxides, staff have devised a rather ingenious method of accommodating its influence without regulating it directly. I would assume, however, that if NH_X deposition rates were reduced in an acid sensitive area, then proportionately higher levels of S + N_{OX} deposition could be accommodated.

12. What are the views of the Panel on the relevance of the conceptual design for developing standards to protect against terrestrial acidification effects? Terrestrial nutrient enrichment effects? Aquatic nutrient enrichment effects? Does the panel have

suggestions on additional data or methods that might enable EPA to expand the current aquatic acidification approach to cover additional effects?

The conceptual design for protection against terrestrial acidification effects seems reasonable and consistent with recent advances in the science and assessment methods. The BC/Al ratio seems like an excellent "chemical indicator" (directly measurable and predictable via models), which is directly responsive to deposition changes on one end and directly predictive of ecological effects on the other end. The currently considered range of levels (0.6 to 10) seems rather broad (relative to ANC ranges of 50 to 100, although from the comparisons of aquatic and terrestrial sensitivities provided, would seem to suggest that a BC/Al of 10 at the most protective upper limit considered is most similar (similarly protective) to ANC at 50 µeq/l (least protective) lower limit. In a general way, it would seem logical to expect that if chronic long-term deposition of acids, passing through soils supporting terrestrial ecosystems enter aquatic systems sufficiently un-buffered by associated cations or enriched in toxic Al to cause adverse aquatic effects, then we should expect that there would also be long-term terrestrial effects in those upstream watershed areas. That is, we should expect that ideal aquatic and terrestrial effects indicators might show similar sensitivities.

Your approach for aquatic effects is more completely developed, and you could probably justify a position that it is logical to start simply with a single indicator to protect against aquatic acidification – which would in many cases also afford added protection against terrestrial acidification effects. However, I think you could also make a good argument that an approach using both ANC and BC/Al indicators (& associated deposition & AQ limits) would provide better protection and over somewhat broader areas as there may be sensitive soils within catchments that have more well-buffered soils in other areas such that there are terrestrial effects upland of lakes or streams which are relatively insensitive.

Confidence is lower for setting specific standards for terrestrial and aquatic nutrient enrichment in the present review cycle, and a focus on acidification could be justified. I think however that the consideration of the carefully derived loading limits – and approaches to apportioning and reducing them – that have been / are being developed through EPA's TMDL process might be given more consideration in the future. There might be some innovative ways of combining TMDLs and NAAQS (for both acidification and for nutrient enrichment effects). In seeking reductions from point source or direct runoff discharges, some TMDL exercises (CT River discharge to Long Island Sound, for example) are assuming specific future CAA reductions in atmospheric N deposition loadings as part of their basis to specify and allocate reductions in direct N discharges. Conceivably a N deposition-related NAAQS could be considered exceeded throughout a watershed where downstream TMDLs are exceeded, and in the implementation phase, costs & ancillary benefits of decreasing N emissions from various source categories could be considered jointly. It should also be noted that TMDLs for critically acidified lakes have been developed in some states (VT & NH – based I think on ANC limits of 50 & 60 µeq/l respectively) and there may be some logic to combining the NAAQS & TMDL processes – as if there were a single EPA…

13. What are the views of the Panel on the critical uncertainties associated with the conceptual design of an ecologically relevant multi-pollutant standard that need to be

characterized in terms of their potential implications for the secondary standards?

Others on the panel will have much more informed opinions on this than I could offer. I think each of the acidification models and the CMAQ model have been subjected to periodic performance evaluations and sensitivity analyses, and that some of the most critical (most uncertain) model inputs, processes and parameters have been identified. Associated efforts are also periodically undertaken to identify and strengthen the weakest links in these models (or to develop better new ones) such that we can expect model-associated uncertainties to improve in the future. A strength of the proposed approach is that the AAPI is in effect a estimate derived from atmospheric measurements which has an approximate, measureable aquatic counterpart (ANC) indicator (and there are also various intermediate modeled deposition metrics that can be evaluated with measurements). As such, the net effect of the cumulative uncertainties and biases of the proposed regulatory metrics can be continually evaluated and refined.

14. To what extent do the figures and examples aid in clarifying the text? Should more or less information of this type be included in the second draft?

Given the complexity of the subject matter, the many associated equations and difficulty (for me at least) of "seeing" many of these concepts in the abstract, I found all of the illustrations and example calculations (from actual data) very helpful and would like to see more of the same. One figure in particular that seems important and could be presented more clearly is the display of modeled VS/N ratios (barely legible) in Figure 5-5. Larger-scale versions of these plots would help, along with scales selected to better show the ranges of values. Possibly use of the same scales for both the S and N ratios could be informative. It could also help to show zoomed-in versions the cover identified sensitive areas in the Adirondacks, Shenandoah, etc. It strikes me also that the accuracy of these CMAQ estimates could be tested (easily for S, not so easily for N) by comparing the modeled ratios to those from CASTNET & NADP measurements. You presented some CMAQ model performance evaluation information previously, but when model results are ratio-ed, there's a potential for errors/biases to get compounded (or offset)

I had a difficult time making it through this chapter with confidence that I was understanding the details of all the points being presented (in the 23 separate equations). I think this was due partly to it being outside my expertise, partly to the introduction of many new unfamiliar variables, and partly due to the inherent complexity of the subject (further confounded by the CAA constraints). However, I also think that the information could be presented more clearly, and here are some suggested approaches toward making this no more confusing than it needs to be:

- Be precise and consistent in your terminology (and triple check for typos especially in the equations). I see no useful reason whatsoever to use the terms NO_X and NO_Y to mean the same thing. NO_X has inherent meaning (sum of NO and NO_2, including the oxygen) to the air quality community and you can't revise this meaning with a disclaimer up front that "when we say night we really mean day". This gets further confused by the occasional use of the term N_{OX} to mean oxidized nitrogen". I actually like this term (we can pronounce it "ennox") and think it could be used nearly interchangeably with NO_Y, with the possible distinction that the former relates to the concept and the latter relates to our attempts to measure it. But I also see an occasional N_{OY} – which I assume is a typo (pronounced as "annoy"), but then that makes me wonder if/when N_{OX} is used as

intended. Is g(·) the same as g the same as G? If you mean $SO4^{=}$, write it that way and don't use Cl when you mean Cl^{-}. Use BC/Al or Bc/Al, but not both, etc.

- Number the equations sequentially from the beginning of the document – or at least from the beginning of each chapter (rather than anew each subchapter) so that there won't be 3 different equations #4 in a single chapter.
- For each chapter, or at least for chapter 5, or maybe as a stand-alone appendix applying to all chapters: develop a glossary-like list or table of all terms used in your equations, along with definitions and other pertinent information – possibly including things like how the term would be measured or estimated, its units, etc. The Table A-3 list of variables used in the SSWC model presented in Appendix A is a good example of what I mean.

Other comments on Chapter 5

P 145 & 6: The text describing Figure 5-1 refers to squares, triangles and circles, but the figure contains only rectangles, diamonds and ovals.

P 148, lines 9-12: Its difficult to grasp this concept in the abstract. Could you give an example? Are you thinking about 5 bins or 25?

P 148, lines 16-18: It might help to have a diagram to illustrate this concept.

P 150, line 21: Add "of" after "deposition".

P 153, lines 29, 30: Try to be consistent with use of charge signs for ions.

P 167, line 10 (& elsewhere): Be consistent in your use of terms: BC/Al or Bc/ Al?
P 167, lines 26-30: This summary of aquatic vs. terrestrial CL sensitivity seems inconsistent with the similar summary on p ES-13 of the executive summary.

P 168, lines 1 & 2: Is this observation that for the Shenandoah, the aquatic CLs provided much greater protection than terrestrial true for BC/Al ratios of both 10 and 1.2?

P 169, line 3: Add something like "addressing" between "for" and "these".

P 171 line 2: aggregated deposition.

P 172, line 25 "Table 1" should be changed to "Table 5-3".

P 172, line 28: The importance of large particle S & N deposition may be overstated here – especially with respect to acidification effects, which will tend to occur at higher elevation locations remote from coarse particle sources (which don't transport very far). Also, S or N in coarse particles is often in association with crustal material (containing Ca^{++}, MG^{++} K^{+}) or Na^{+} from sea salt – hence carrying its own buffers. At CASTNet sites (where open-faced particle samplers presumably include coarse particles), all particles contribute less than 6 % of total S deposition at sites with S dep > 5 Kg/Ha/yr. For CASTNet nitrate deposition, total particle nitrate deposition averages < 2% of total nitrate deposition across the whole network. So its not

likely that coarse particle deposition accounts for much of the total S + N deposition load at any sites where aquatic acidification is a problem.

P 173, line 1 simulations of.

P 173, line 5: text refers to "inverse" $V_{S/N}$ but Figure 5-5 caption does not indicate "inverse".

P 173, line 10: "6 for". Also this seems like an example of something I've noted on several occasions of referring to something "deposition load tradeoff curves" that hasn't been explained yet. Makes it harder to understand…

P 173, line 11: "Figure 1" should be "Figure 5.5", I think.

P 173 line 15: "Figure 3" should be Figure 5.7.

P 174, Figure 5-5: I would like to see these at larger sizes with scales that better show the range of values. These ratios seem very important (see response to Q 14). On a somewhat related topic, I would think that of all the NO_Y components, NO is likely to have the lowest deposition velocity, and otherwise be least reflective of N deposition at any specific location. I believe that in making NO_Y measurements the sampling is typically switched through and then bypassing the converter, such that concurrent NO and NO_Y data are available. Possibly then [NO_Y minus NO] might actually be a better AQ indicator of N_{OX} deposition than total NO_Y – both in reality and in CMAQ output. I would imagine this could be tested relatively easily with CMAQ.

P 178, line 28: Is this basically the equation for "deposition load tradeoff curves" referred to previously and later in this section? If so, why not describe it as such here.

P 179, line 19: Is it really the "high variability in the data set" per se that results in "only 32%" of water bodies not exceeding their critical loads, or is it more that the selected population of lakes includes many which are relatively well buffered? Or are you making a point that use of "mean $DL_{\%ECO}$" can be problematic for areas with high variability? This isn't clear to me, but I'm concerned that use of a metric based on % lakes in "an area" becomes an important, but arbitrary factor (based entirely on how the areas are spatially defined).

P 180, 2nd line of Table 5-4 caption note: Delete either "across" or "on".

P 180, Table 5-4: From the descriptions of equations 2 and 3 on p 178, I would have assumed that for a given catchment either one equation or the other would apply (# 2 projecting the long-term additional N a system could handle before leaching – or # 3 based on measurements where saturation has already been reached). So I'm surprised to see in Table 5-4 that there are summary statistics for N_{eco} presented using both equations. I'm also surprised that the results for both N_{eco} and $DL_{\%ECO}$ are so different depending on which equation was used. Can this be explained more clearly?

P 184, lines 1, 2: Eight significant digits for these "aggregate effective deposition velocities" seems a bit much. I also agree with your plans to change the term to something like "deposition

ratio" for clarity. Why not do it the other way around and call it a deposition ratio in the text and use your footnote to explain that you used to use another, less appropriate term.

p. 187, line 9: You indicate here that equation 5 describes the "atmospheric concentration tradeoff curves". Is this correct or should it be equation 6?

P 187, line 2 & elsewhere: I think the term N_{OX} is a logical way to describe "oxidized nitrogen", but think it might be helpful to add a footnote caution that this should not be confused with NO_X (which you have already confused with NO_Y sometimes but not always). Also, I note that in equation 11, p 186 you use the new term N_{OY} which I assume is the same as NO_Y?

P 187, lines 11, 22: The tern "g(·)" in equation 11 has become just "g" in equation 12 (then back to "g(·)" in equation 13). Do these changes have a meaning (that I don't understand because I don't know what (·) means)? And are either of these the same thing as "G" referred to on p 198, line 23 and elsewhere in the PA?

Mr. Dave Shaw

General Comments

I believe a strong case has been made throughout the REA, ISA and this policy assessment (PA) that the current SO_x and NO_x NAAQS are not adequate or appropriately protective of welfare. A multi-pollutant strategy is appropriate and feasible to propose at this time with some considerations. As I have mentioned in previous comments, there are not enough monitors in most areas of the country to adequately characterize the sensitivities of regional ecosystems. While I do feel it is appropriate to use the existing data, and depend heavily on modeling at this time, it is necessary to commit to building the existing monitoring network throughout the country to better develop this NAAQS. Also, the models will be most useful if they are shared with all states which may wish to assist with refining them.

On that same note, I suggest a commitment of some kind be developed within a year which is specific about providing adequate data to quantify inputs and results. A plan should be outlined so that at the very least we can identify where monitoring is needed and perhaps prioritize to make the best use of limited resources. This multi-pollutant approach will help in decreasing resource needs by having, for example, one monitoring location for several pollutants. This proposed NAAQS is innovative but complicated and very model dependent, and because of that, it calls for these other commitments. As I have previously indicated, we should be aiming to significantly improve our ability to make modifications to the next NAAQS (which hopefully will be quicker than the last) based on significantly improved data and model outcomes. The best scenario would be that these monitors would already be in place. Our atmospheric conditions and pollutant loads are changing; we don't have any extra time for delaying.

Multi-Pollutant Approach

Multi-pollutant air quality planning is currently being evaluated in New York State. This may be a more efficient way to run and plan a State Air Quality program [than one pollutant at a time]. The ability to plan and regulate multi pollutants with one policy should be less resource intensive as well as give us a better understanding of co-benefits between pollutants. So far, we have found that multi-pollutant planning tools and approaches lend themselves well to supporting implementation and enforcement of multi-pollutant secondary standards such as NO_x and SO_x. Since our endpoints, such as surface water Acid Neutralizing Capacity (ANC), are far removed from the emissions point sources, a multi-pollutant planning approach can be used to model the policy drivers and the resulting wide range and variety of benefits.

I believe that a multi-pollutant planning approach that integrates air quality and climate goals may prove to be the best action to take to meet the forthcoming multitude of federal and state environmental requirements. NYSDEC is in the process of developing a comprehensive air quality management plan (AQMP) that is multi-pollutant in nature with the intent that it provide for a more efficient and proactive pollution control process.

Flexibility

The PA indicates that future drafts will be expanded to include effects other than aquatic acidification which I support as well as future actions in this direction. This assessment is based on available data and modeling and at this time, there is adequate data from New York's Adirondack Region as well as the Shenandoah Region concerning surface water acidification. Other regions in the country that currently do not have sufficient monitoring data or modeling efforts to characterize their own sensitive ecosystems may find that they must be more concerned with terrestrial acidification, nitrification or fresh water/coastal eutrophication. Therefore, I suggest that sufficient flexibility be built into the policy to allow for these future monitoring/modeling efforts and characterization.

Models & Data

Appendix A provides a good overview of the models, but could be improved by including an assessment of reliability and a description of what range of error is acceptable. It would be helpful to know what data exists for how many watersheds for what range of time. Page 28 mentions that there is a lot of variability from year to year; it would be helpful to know what is considered "a lot." Also, it would be helpful to state how many years of data or monitoring sites would raise the reliability of this data by 2 times, 10 times, etc.

I am concerned about the availability of accurate weathering data since this is such a critical variable in the models. Have the lacking weathering rates been developed for the sensitive regions?

Appendix A also discusses the supporting datasets for the MAGIC model. Datasets and the models should be made available to not only the EPA, but also the States which are responsible for implementing the NAAQS which are being proposed. I want to be certain that whatever models will be utilized, that the States have access to make refinements. This should help advance EPA's progress on the same.

Reliance on ANC

ANC is an available, good indicator; however, it might be misleading to call it an "excellent" indicator (p. 134, line 16). There are other indicators that could be discussed and utilized, for example, when toxic inorganic monomeric aluminum (Al_{im}) is not present, but ANC is low, then organically derived low pH and ANC might be more of a driver than mineral acidity from an air quality problem.

While ANC levels may be current (lines 28-29), the biological data associated with them are not. The ANC and fish diversity relationship is based on a 1469 lake data set from 1984-1987, and the losses in health and reproductive capacity from other sources may be just as old or older. While evaluating monitoring data, it would be helpful to include updated surveys in the modeled lakes.

Bedrock geology as an indicator

On pages 162 – 164, the discussion of acid sensitivity based on bedrock and multiple landscape features should also include a discussion of glaciated versus non-glaciated landscapes. In the glaciated Adirondack region, there are many areas where soils do not reflect the underlying bedrock. Surficial geology and depth of soil would be useful to discuss in this section.

Critical loads

I would like to see more discussion on critical loads data and models. While I understand that we would like to use landscape and effects data which are specific to the United States, I believe Canada and Europe have a wealth of experience in the use of critical loads models and their successes and limitations. From a policy perspective, it would be worthwhile to analyze their use of critical loads and what they have learned from various model approaches. Those experiences could inform the US NAAQS review and process.

Charge Questions

Chapter 9

25. What are the views of the Panel on the preliminary staff conclusions regarding the adequacy of the current standards, the need for an integrated multi-pollutant structure for revised standards, and the proposed form of the joint NO_x and SO_x standards for aquatic acidification?

26. What are the views of the Panel on the overall characterization of uncertainty as it relates to the determination of an ecologically-relevant multi-pollutant standard for NO_x and SO_x?

The document clearly demonstrates evidence that the current standard is not adequate due to the fact that ecosystems are still impacted. The short term average NO_x and SO_x concentrations are not protective or appropriate so there is a need to consider a new strategy. The evidence in the documents show that this is a multi-pollutant problem so a multi-pollutant approach is appropriate.

The current approach is acceptable because it is the most commonly used and understood. Knowing this, it would be best to stay mindful of the limitations of ANC as an aquatic endpoint and develop the policy to be open to refinement including other measures for aquatic endpoints such as Al_{im} and Base Cation Surplus (BCS).

That being said, I must re-state that we must make additional monitoring available for locations which currently have no monitoring available. While this approach is the best with what is available, we may find with additional data collection, that different ecosystems require different kinds of protection.

Specific

Draft Executive Summary (ES)

ES-3 para 4. Line 4 delete', acid'.
" para 4, line 6 substitute 'salmonids' or 'trout" for 'Atlantic salmon' if this is based on Adirondack evidence [Atlantic salmon are not common, found in only 13 out of 1469 lakes sampled during the ALS as opposed to brook trout found in 579 lakes].

ES-4 para 1. Since this is the first discussion of this topic it would be the best place to discuss the connection with springmelt (this occurs somewhere later in the ES). Also the ANC levels discussed are annual averages levels. Need to convey this clearly because, for instance, a springmelt ANC of 50 would not be associated with death or loss of biota, the effects description is associated with a baseflow or an annual average.

ES-5 full para 2 starting with Current acidification.
Line 3 Add the year associated with 78% Adk lakes, and 'baseflow (summer) or annual (it's one or the other, not both)' before ANC.
Line 4 Delete bluegill, since they are uncommon in the Adirondacks (occurring in only 4 out of 1469 lakes surveyed during the Adirondack lakes survey in 1984-87) and not raised to the level of recreationally significant in this region.

" para 3 line 2 add after 'recent' the year of the study.

ES-7 para 3. Bedrock geology may not be the best predictor of acid-sensitivity in the Adirondacks due to glaciation (see comment in main PA document).

ES-9 on use of equations. It would be more useful to describe the AAPI that use an equation (not recommended for an exec sum).
'" First para under Options. Delete entire.

ES-10 para 1. An important paragraph, it should stay in but be modified to be more clear and less wordy/redundant. It might also be moved up to the first paragraph in that section.
" para 3 line 1. Delete 'using equation 1 above'.
" para 3 line 7 "an AAPI level" repeated.
" para 3 last line. Run on sentence.
" Para 4,5,6 Suggest better to explain in text than to use model terms.

ES-12 full para 2. Important point. How to treat naturally organic ecosystems is a key aspect. How does this overall approach (including how well does MAGIC treat this?) come close to adequately addressing this?
" full para 4. Suggest delete, since all was stated earlier in the ES.

ES-13 last para first line after last review, include date.
last para sentence beginning with “In addition..” delete “substantial” and ‘information, based on” and “rigorous” because this could unintentionally mislead to belief that data and modeling are abundant.

ES-14 bullet 1 line 1 Some language is missing.
“ bullet 3 end of sentence, add “among others.”
“ bullet 6 Clarify replacing the current forms of what?

Policy Assessment

Pg 219 lines 9-10. Add after studies “since 1991-93”.

Pg 221 line 6. Is it “strongly” supported?