Draft response to Agency charge questions

Chapter 3: Considerations of Adversity to Public Welfare

1. What are the Panel's views on the definitions of adversity that are appropriate to consider in determining what constitutes adversity to public welfare relative to the NOx and SOx secondary standards?

Ecosystem services provide a framework to characterize and describe how changes in ecosystem function affect public welfare, even if they cannot be specifically quantified. The link is well-documented between the selected ecosystem effects indicator, ANC, and the public welfare effects of lost value of recreational fishing, biodiversity, and habitat as fish populations (and in some cases whole species) are not sustained in lakes and streams with lower ANC levels. The text mentions nonuse value several times, but it would be helpful to make explicit that this includes value for the preservation of habitat and biodiversity independent of human use value (which fall into the category of cultural services). More could be done to explain and characterize the qualitative links between deposition and lost ecosystem services that are known and documented, but cannot be specifically quantified for a specific amount of deposition, especially for terrestrial and eutrophication effects. The total value of these services is clear; what is important to convey the degree to which they are diminished at current deposition levels.

Evidence of community, local and state actions to reduce acidification is informative regarding adversity even though it doesn't provide specific estimates of welfare changes. Including federal actions, such as the Title IV program, to address acidification would be appropriate here.

Chapter 4: Addressing the Adequacy of the Current Standards

2. What are the Panel's views on staff's approach to translating the available evidence and risk information and other relevant information into the basis for reaching conclusions on the adequacy of the current standards and on alternative standards for consideration?

a) In light of the Panel's views on the appropriate definitions of adversity to public welfare (see Chapter 3), do you agree that the current levels of NOy and SOx deposition are adverse to public welfare?

3. Has staff appropriately applied this approach in reviewing the adequacy of the current standards and potential alternative standards?

4. Has staff appropriately acknowledged the potential beneficial effects of nitrogen inputs into nutrient limited ecosystems, while maintaining the focus of the review on preventing adverse effects in nitrogen sensitive ecosystems?

(from Ellis)

The present draft PA document is designed to evaluate options for wise management of airborne nitrogen and sulfur inputs and effects in aquatic and terrestrial ecosystems. The

ecosystems of greatest concern are freshwater lakes and streams in drainage basins that are covered by forests, shrub vegetation, or natural grasslands. Emphasis in this PA document is focused primarily on adverse effects on fish populations and other aquatic biota induced by current atmospheric deposition loadings of acidifying nitrogen and sulfur compounds. EPA has historically interpreted air-pollution-induced "adversity" to include "disruptions in ecosystem structure and function" that are regarded as important to the people of this country.

While considering the well documented adverse effects of acidification in various acid-sensitive regions of the US as outlined in the ISA, REA and summarized in Chapters 2 and 3 of this PA, it also must be recognized that:

a) Both nitrogen and sulfur are essential nutrients for growth and development of all types of living organisms;
b) Essentially all forest lands, many shrubland areas, and some grassland areas in the US are nitrogen limited;
c) Vegetation on such lands will increase growth in response to atmospheric deposition of essentially any chemical form of airborne nitrogen;
d)These positive effects on growth of plants occur in essentially all terrestrial ecosystems – whether they are agricultural crop lands, intensively managed commercial forest lands, or relatively "unmanaged" forest, shrub, or grassland areas.
e) Typical nitrogen requirements for optimum production of wheat, corn, and loblolly pine timber are approximately 150 kgN/ha/yr, 300 kg/ha/yr, and 60 kgN/ha/yr, respectively;
f) These rates are very much larger than current rates of atmospheric deposition in "unmanaged" forest, scrub vegetation, and grassland areas where total nitrogen inputs are typically in the range of 0.2-5.5 kgN/ha/yr.

Thus, the principal challenges in this PA document are to:

a) Assess the adequacy of current scientific knowledge about both beneficial and detrimental effects of airborne nitrogen and sulfur; and
b) Explore options for an NAAQS-based system of air-quality management that will protect acid-sensitive aquatic ecosystems from "disruptions in ecosystem structure and function that are important to the people of this country" in regions where annual rates of airborne nitrogen and sulfur deposition are in this same approximate range -- 0.2-5.5 kgN/ha/yr.

(from Dale)

The PA acknowledges the potential beneficial nutrient effects of N deposition that would be diminished if N deposition were lowered. The question of how significant this loss in public welfare can be sidestepped at this point while the focus is on a potential standard to protect against aquatic system acidification, but it will come up again when it is time for regulatory and implementation assessment. Carbon sequestration due to increased growth in N limited ecosystems is probably the most significant category of potential beneficial effects of N deposition. Carbon sequestration is not addressed in the PA, but the issue of N-induced increased growth is given a considerable amount of space in the negative context of creating unwanted fuel for the next wildfire in fire prone ecosystems. C sequestration is also implied by the inclusion of Climate in Table 3-1, and is of more practical relevance than" Climate Control" or "Regulating Climate" as is now shown in the table.

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

5. What are the Panel's views on staff's revised conceptual framework for the structure of a multipollutant, ecologically relevant standard for NO_x and SO_x? 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 NO_x and SO_x?

The revised conceptual framework and structure of the proposed standard (s) is well-thought out for addressing various components and connections between these components (ecological effects, atmospheric wet and dry deposition, atmospheric concentrations of NO_y and SO_x, and surface water chemistry), with some exception noted below.

For example, the framework and the structure "takes into account" the reduced ambient NH_x and its deposition in designing AAPI (atmospheric acidification potential index) , it does so in a manner that would not allow EPA to address and require reductions in U.S. ammonia emissions under proposed standard setting structure. The revised treatment of ammonia, however, is an improvement over the first draft in that AAPI will annually (?) update changes in NH_x concentrations. Ammonia emissions are currently at about 4 to 5 million tons per year. Emissions of ammonia (which is an unregulated air pollutant) and resulting ammonia and ammonium concentrations and reduced nitrogen deposition levels are expected to increaseover the next few decades because of increased food production and increased activity in CAFO sources (confined animal feeding operations) in the United States.

The conceptual framework for the proposed multipollutant ecologically relevant standard for NO_x and SO_x is sound with considerable support from the scientific literature on how the generation of strong mobile acids result in the acidification of soils and water. Some of the information, however, is not correct or is incomplete. For example, the discussion of nitrate sources during snowmelt is incorrect in indicating that most of the nitrate is atmospheric. The vast majority of nitrate mobilized during snowmelt is derived from nitrification in the soil. Also the assumptions associated with atmospheric sulfur input being equal to drainage water losses are not correct. The soil can serve as a substantial source or sink depending on soil properties and history of atmospheric sulfur sources.

Notwithstanding these concerns, the proposed structure more than adequately represents the scientific linkages between ecological effects, surface water chemistry, atmospheric deposition, and ambient levels of NO_y and SO_x.

From a theoretical standpoint the conceptual framework looks fine, but the practical usefulness of the framework depends on its robustness. The uncertainty analysis in Charge Question 14, but one way the AAPI can be tested is by hindcasting. There are measurements of ANC available for some aquatic systems. Wherever such measurements are available, one could use the AAPI to get a trajectory of changes in AAPI in response to changes in SOx and NOy concentrations. The values of other components of the AAPI (Q, Neco, [BC]o, LNH_x, TNO_y and TSO_x) can be what have already been estimated by EPA. It is critical to do this hindcasting at

more than one location. The changes in predicted AAPI should more or less match the changes in ANC (may be with some lag).

6. What are the Panel's views on the appropriateness of considering a single national population of waterbodies in establishing standards to protect against aquatic acidification? What are the Panel's views on consideration of alternative subdivisions of the U.S. to identify the spatial boundaries of populations of waterbodies and acid-sensitivity categories, specifically:

a) the use of Ecoregion III areas to aggregate waterbodies ?

b) the use of ANC to further aggregate Ecoregion III areas into different categories of sensitivity?

c) the relative appropriateness of the suggested methods for categorizing spatial boundaries of sensitivity, e.g. on nation, binary sensitive/less-sensitive classes, cluster-analysis based sensitivity classes, and individual ecoregions?

The first approach (option 1) that considers the whole United States as one unit and provides for a single deposition metric is simple and easy to use, but its weaknesses are too many to consider this as the preferred approach (e.g., over protection for the least sensitive areas and under protection for areas that are most sensitive necessitates having a system with more spatial resolution.).

The "Ecoregion III" approach is reasonable approach that takes advantage of the extensive information on various ecosystem components including both abiotic and biotic components. (However, Panel recommends that the revised PA include a clear and more detailed description of this approach and a justification for its applicability to aggregate waterbodies in the US.)

The use of ANC is consistent with the overall emphasis on the standard to protect sensitive surface waters from further acidification and have deposition levels that will allow those water bodies that have been deleteriously impacted by acidic deposition to recover as indicated by increasing ANC values.

The analysis on relative appropriateness of the suggested methods for categorizing spatial boundaries is interesting, showing the different distributions of sensitivity and that categorization that captures substantial variation should be used. This will be a compromise between "one nation" versus using large number of individual ecoregions.

Between options 2a, 2b, and 2c, the approach based on cluster analysis (option 2b) seems to provide the right balance when compared to approach that is not detailed enough (option 2a) or too detailed (option 2c).

7. What are the Panel's views on the appropriateness of the critical loads that form the basis for the population assessment to determined deposition metrics?

Using a concept of Critical Loads is logical and appropriate for development of a secondary standard for biological effects of NOx and SOx. This approach links concentrations of the atmospheric oxidized forms of nitrogen and sulfur with N & S deposition and their

acidifying effects on aquatic ecosystems and includes consideration of reduced forms of atmospheric N.

a) What are the views of the Panel on the appropriateness of generalizing the f-factor approach to apply to lakes and streams in the Western U.S. and other portions of the Eastern U.S.

The F-factor approach is a reasonable initial approach to evaluate the response of aquatic ecosystems to changes in atmospheric deposition. However the F-factor approach is a steady-state calculation and ecosystems are not at steady state. Ultimately it would be useful to move toward the applications of dynamic models as management tools to evaluate ecosystem effects of atmospheric deposition.

Differences between the use of MAGIC and the SSWC methods to determine background concentrations of base cations is not sufficiently described in the PA and the proposed procedures and differences between the two approaches and should be improved. It is suggested that the charge question is modified to: "Is the proposed methodology for obtaining BCo values adequately described and what the Panel's opinion on extrapolating the knowledge gained for the Adirondacks lakes and the Southern Appalachian streams to the rest of the US water bodies?"

b) What are the views of the Panel on the filtering criteria used to remove lakes and streams that are naturally acidic or not sensitive to atmospheric deposition?

Filtering of lakes and streams with high concentrations of organic acids and with low historical ANC should be avoided since these are often highly sensitive sites. However, water bodies that have been impacted by mine drainage can be eliminated.

8. What are the Panel's views on the suggested methods for determining appropriate values of reduced nitrogen deposition in establishing NO_x/SO_x tradeoff curves?

The proposed approach makes sense and utilizes the best available knowledge on levels and distribution of reduced N based on the CMAQ outputs. Potentially the NADP chemistry and PRISM precipitation results could also be utilized. Due to a high NH_3 deposition velocity, steep concentration gradients near the NH_3 source areas can be expected. Therefore averaging N_{red} concentrations over larger areas may lead to missing smaller areas where NH_3 concentrations may be seriously elevated with potentially high ecological effects. Consequently, option "2" is preferable since it allows for additional spatial refinement of sensitive areas to reflect the heterogeneity of NH_x deposition". A better understanding of spatial and temporal distribution of reduced N, especially NH_3, in the US is critical and therefore efforts should be continued to assure the nation-wide monitoring of NH_3, especially in remote areas

9. What are the Panel's views on the revised characterization of the deposition transference ratios (T_{NOy} and T_{SOx})?

A major concern with TNO_y and TSO_x is that although they are the critical links between NO_y and SO_x ambient concentrations and their deposition, they are derived using a model that can not be evaluated because of lack of measurements of dry deposition. It is recommended that

EPA evaluate the stability of these ratios using different models and different emissions and meteorological conditions. It is recommended to show these ratios for the following model simulations (in addition to what has already been done):

- CMAQ and CAMx models (it is okay, in fact preferable, to use different emissions and meteorological conditions)
- Different chemical mechanisms
- Different model grid resolutions (36-km v/s 12-km or even 4-km, if available)

The PAD notes the possibility of large amount of sulfur and nitrogen deposition in the forest ecosystems in the coarser particle mode and that CMAQ does not account for deposition in the coarse particle mode. It is not clear how big this issue is and how it should/would be addressed. A more clarification is sought on this issue.

On a related topic, the Subcommittee suggests that the Agency consider the feasibility of calculating an alternative deposition transfer ratio for oxidized nitrogen, using a combination of nitric acid and particulate nitrate, as an alternative to using NO_y. A possible advantage of this approach is that nitric acid is the component of NO_y that deposits most efficiently, and correlates best with total oxidized N deposition, so the resulting total deposition estimate would be less dependent on CMAQ model performance. A second possible advantage is that this calculation (as well as the TSO_x calculation) could be made using currently available and relatively low cost CASTNET filter pack measurements, and so would not be dependent on the establishment of a large new network of continuous NO_y and SO_2

10. What are the Panel's views on staff's conclusion that an averaging time of 3 to 5 years is appropriate given the AAPI form of the standard?

The Agency makes a good case for using the averaging time of three years and the panel agrees with that recommendation.

11. What are the Panel's views on the preliminary staff conclusions regarding alternative target ANC levels that are appropriate for consideration and the rationale upon which those conclusions are based?

Based on the available scientific data available, the range of target ANC values considered in the PA is appropriate, i.e., 0, 20, 50 and 100 µeq/L as target levels. These values encompass the range of ANC classes of surface waters in the literature. Note, there are a range of biological responses to this range of ANC levels. So any specific target ANC is an artificial value. There will likely be biological effects of acidification at higher ANC values within this range, and there are relatively insensitive organisms that are not impacted at ANC values at the low end of this range. As indicated in the PA, there are clear and marked biological effects at ANC values near 0 µeq/L, so this is probably not an appropriate target value for the AAPI. At a target value of 20 µeq/L, aquatic biota will experience acidification effects. Moreover, at this level of ANC many surface waters will experience episodic acidification and associated biological effects. As a result target ANC values of 50 to 100 µeq/L are in the range of appropriate values for the AAPI.

The document would benefit from a deeper consideration of the differences in time lag between acidification of the soil as opposed to acidification of soil solution and resultant drainage waters as a mechanism by which atmospheric deposition can cause the acidification of surface waters. Introduction of mobile sulfate or nitrate anions into acidic soils (whether naturally acid or acidified by pollution) can result in near instantaneous acidification of waters, whereas acidification of soils is a long-term process occurring over decades or longer. Similarly, recovery of surface waters from acidification could happen relatively quickly if mobile sulfate and nitrate are removed, but recovery of acidic soils is highly questionable as soils in humid systems naturally acidify but do not spontaneously become less acid. The rate of acidification of soils should decreases with reduced inputs, however.

a) In light of the Panel's views on the appropriate definitions of adversity to public welfare (see Chapter 3), what are the Panel's views on the appropriateness of the information related to adversity considered by staff in evaluating alternative target ANC levels?

The information on adversity concerning associated with the effects of aquatic organisms and ecosystems at different levels of ANC is appropriate given the available literature. There is relatively little information on the temporal biological response of acid impacted aquatic ecosystems to marked decreases in acidic deposition. Most of the information on biological response to acidification is developed from spatial data. It may be useful to clarify that it is unclear if the biological patterns observed for spatial data of varying ANC will similarly occur in surface following increases in ANC due to decreases in acidic deposition.

12. What are the Panel's views on the approaches considered by staff for assessing alternative target percentages of water bodies for protection at alternative ANC levels?

This question is difficult to address without specifying the filtering criteria for the watersheds. Some members of CASAC are not enthusiastic about the approach/criteria suggested in the PA for eliminating waters with low background ANC and/or high DOC. If the filtering criteria are modified to include more waters in the AAPI analysis, then the target percentages would be lower as a result. It would be helpful to see some analysis for implications of the filtering criteria for the target percentages. Regardless like a target percentages in the range of 95% to 80% might be appropriate for the AAPI. However it is difficult to suggest target percentages without more information on subdivisions of the U.S. to be used and the distribution of ANC values in these subdivisions.

The DL factors, which clearly are numerical indices of some kind should either be formally defined in the form of equations or it should be made clear how the numerical values for them presented in Tables 5-12 and 5-13 were derived.

Chapter 6: Co-protection for Other Effects Using Standards to Protect Against Aquatic Acidification

13. What are the Panel's views on the utility of the additional analyses of co-protection benefits to inform consideration of alternative levels of the standard?

The analysis and conclusion in Chapter 6 are important because the decision to focus on the effects of acidification on aquatic ecosystems means that in the current standard setting process, other important effects on ecosystems (documented in the ISA), are not being explicitly taken into account. To the extent that standards set to protect against effects of acidification on aquatic ecosystems also provide some amount of protection against the other effects of deposition, then this provides support that the proposed standards are justified and beneficial.

The analyses reported in Chapter 6 are adequate for this purpose, but the interpretation of the conclusions could be broadened. One analysis suggests that sensitive terrestrial systems located in the same watersheds with sensitive aquatic systems would be protected by the deposition levels that would be needed to protect the aquatic systems. A relevant question then is what share of sensitive terrestrial ecosystems are co-located with sensitive aquatic systems throughout the country.

Related to this is whether there are benefit to reductions in deposition that are short of the targets for full protection for these other effects categories. This depends on whether the dose-response relationships are continuous or subject to thresholds. For example, what percentage of the needed reduction in N deposition to meet the TMDL is achieved by the N deposition reduction for a target ANC of 50 in the Chesapeake watershed?

This chapter does not warrant further analysis, but the broader context would be better communicated if it included a comprehensive list of co-benefits (e.g., human health, visibility via PM and ozone), and dis-benefits from lost nutrient enrichment (e.g., carbon sequestration) that would be expected as a result of reductions in NO_x and SO_x concentrations.

Chapter 7: Evaluation of Uncertainty and Variability in the Context of an AAPI standard, including Model Evaluation, Sensitivity Analyses, and Assessment of Information Gaps

14. What are the Panel's views on the following:

a. The degree to which the chapter appropriately characterizes the potential role of information on uncertainty, sensitivity, and variability in informing the standards?

b. The appropriateness and completeness of the evaluation of CMAQ model performance and sensitivity to critical inputs?

c. The utility of the analyses of temporal and spatial variability in the deposition transference ratios (TNOy and TSOx)?

(Draft response to be added)

15. What are the Panel's views on the insights provided by the AAPI sensitivity analysis including:

a. The evaluation of elasticities of response?

b. The multivariable ANOVA analysis?

(Draft response to be added)

16. What are the Panel's views on the discussion of uncertainty in the critical loads models including MAGIC and SSWC?

There is a clearly fair amount of uncertainty associated with model calculations. However, what has not been acknowledged in the PA is that there is a considerable amount of empirical field data to support application of this secondary standard. Through monitoring studies there are about 30 years of observations providing a quantitative understanding of how and the extent surface waters and soils have responded to decreases in atmospheric deposition. Through these observations and some field based experiments, there is also a good understanding of the compensatory response of ANC to changes in concentrations of sulfate and nitrate. These empirical data should be used to support the justification and the target parameter values for the AAPI.

There has been limited uncertainty analysis of both MAGIC and the SSWC. Some uncertainty analysis for MAGIC is presented in the REA. This activity is important and should be continued.

Beyond uncertainty analysis, efforts should also be made evaluate model structure and compare this to the structure of other models available for use. Efforts should be made to test models, although it is difficult to test steady state models. Efforts should be made to improve and test the Neco calculation. Efforts should be made to compare results from steady-state with dynamic models to obtain a sense for the time scale to achieve target ANC values. Efforts should be made to evaluate the effects of variation and changes in climate on model calculations.

17. What are the Panel's views on the areas for future research and data collection outlined in this chapter, on relative priorities for research in these areas, and on any other areas that ought to be identified?

The future research areas outlined in Chapter 7 are appropriate. However there are other areas that should be considered for future research and data collection.
There is a need to improve understanding of ammonia deposition and bi-directional transport of ammonia.

Efforts should be made to develop dynamic models to simulate effects acidic deposition on soil, drainage waters and biota, to test these models and to apply these as tools in determining critical loads. Research should be conducted comparing results from steady-state and dynamic models.

There need for research efforts improving the linkages between atmospheric chemistry and transport models with watershed models. Atmospheric models typically have relatively large spatial scales and simulate over relatively short temporal scales. Watershed models simulating acidification of soil and surface waters, in contrast, have small spatial scales and simulate processes over long temporal scales. It is important to quantify the subgrid scale

variability in atmospheric deposition and how this variability can be addressed in simulations of watershed response to changes in atmospheric deposition.

It is essential that surface water monitoring programs be maintained and soil and biological monitoring programs be strengthened.

There need to be improvements of tools and models to predict nitrogen retention of nitrogen in watersheds.

There is a need to better understand the compensatory response of naturally occurring organic acids to decreases in acidic deposition.

Chapter 8: Monitoring

18. What are the Panel's views on using an open inlet to capture all particulate size fractions for the purpose of analyzing for sulfate?
What is your opinion on using existing CASTNET filter packs as a future Federal reference method for sulfate?

As a prefacing comment on these monitoring questions (18-20), this Panel is pleased to learn that the Agency plans to consult with the AAMM Panel to identify the most appropriate monitoring approaches for this NAAQS, and we expect that more informed responses to these and other monitoring questions will be provided in that process. In conducting that monitoring review, we encourage the Agency to emphasize not just compliance determination, but the multiple monitoring objectives outlined in chapter 8 of the PA, and to consider whether some of those objectives might be most effectively addressed by enhancement of and coordination among existing monitoring programs. In addition, we recommend that the membership of AAMMS be enhanced for that review by adding individuals with expertise in conducting deposition measurements, as well as in assessing the effects of deposited S and N pollutants on aquatic and/or terrestrial ecosystems.

The Panel is generally supportive of considering the use of open-faced samplers, and possibly the CASTNET sampler in particular, as a possible federal reference method (FRM) for particulate sulfate, as a component of the multiple pollutant measurements needed to determine compliance with this secondary standard. It should be recognized however, that the inclusion of coarse particle sulfate (excluded in sulfate measurements by more commonly deployed fine particle samplers) will not by itself provide any information on how much of the sulfate is present in coarse mode particles and which would contribute proportionately more to deposition than their fine particle counterparts.

Since the open-faced CASTNET samplers also measure particulate nitrate, and since coarse particle nitrate can be a significant contributor to nitrogen deposition, especially in areas influenced by marine aerosols (sea salt reaction products), consideration should be given to specifying the CASTNET filter pack method as a possible FRM for nitrate as well. CASTNET samplers also measure sulfur dioxide and nitric acid, and so if an alternative (to the T_{NOY}) nitrogen deposition transfer ratio could be developed (see response to question 9) based on

measurements of HNO_3 and pNO_3, all the measurements needed to determine compliance with this standard could be made by the existing CASTNET network, which could be enhanced by adding new sites in acid and nitrogen sensitive regions, and by adding more detailed measurements like continuous NOy, SO_2, etc. at a subset of those sites to better address important objectives other than compliance.

19. What are the Panel's views on requiring measurements of ammonia and ammonium to assist implementation of the standard?

Although NH_x deposition estimates could be supplied by CMAQ model output, additional NH_4 and especially NH_3 measurements would be extremely valuable for implementing the standard both directly - to quantify an unregulated but varying element of the compliance metric - and indirectly, to help evaluate and improve emissions inventories and CMAQ model performance. NH_4 measurements are currently available from the CASTNET and (urban) CSN networks, and could conceivably be added to IMPROVE. NH_3 measurements are currently much sparser and are more critically needed, not only for implementing the currently proposed secondary standard but also for better understanding sources and trends of $PM_{2.5}$, regional haze, and sources and effects of N deposition on nutrient enrichment.

20. What are the Panel's views on having a subset (e.g., 3-5 sites) of monitoring stations in different airsheds that measure for the major NO_y species; nitric acid, true NO_2, NO, PAN and p-NO_3?

As suggested in the response to question 18, a slight modification to the proposed calculation of the deposition transfer ratio (currently expressed as T_{NOY}) for oxidized nitrogen deposition, might allow the use of a modestly expanded version of the existing CASTNET network to determine compliance with the proposed secondary SO_x/NO_x NAAQS. Disadvantages of this approach include the loss of valuable temporal resolution in the weekly aggregated CASTNET filter pack data, as well as the neglect of important NO_y components like NO, NO_2 and PAN, which better reflect the sources of oxidized nitrogen emissions, which eventually contribute to N deposition downwind, and/or which may represent important components of total deposition at some locations.

For these reasons, it is important for implementing this secondary standard that the CASTNET network be expanded by adding sites in different kinds of sensitive areas, and refined by adding more detailed supplemental measurements at a small subset of these sites. Valuable supplemental measurements would include continuous NOy and trace SO_2, PAN, true NO_2, and possibly continuous nitric acid, p-NO_3, and NH_3. Possibly there will be opportunities to add CASTNET filter pack and supplemental measurements to several of the existing or planned rural NCore sites. Such measurements would not only help respond to the multiple objectives for this secondary standard outlined on page 8-1 of the PA, they would also be of great value for improving data analysis and modeling assessments of sources, atmospheric chemistry, transport of and the effectiveness of control strategies for ozone, $PM_{2.5}$ and regional haze.

Chapter 9: Conclusions

21. What are the Panel's views on the overall characterization of uncertainty as it relates to the determination of an ecologically-relevant multi-pollutant standard for NOx and SOx?

EPA has done a good job of qualitatively evaluating uncertainties in Chapter 7. As noted in response to charge questions 14-16, CASAC would like to see further progress on quantitative analysis of sensitivity or, preferably, uncertainty, for key components of AAPI, for the combined effect of multiple uncertainties on AAPI, and implications for specification of the trade-off between NOy and SOx allowable concentrations. In Chapter 9, EPA should provide a concise summary of those key uncertainties that are most likely to lead to bias, imprecision, or both, in AAPI, and the implications of such uncertainties when translating an ANC target into an associated AAPI level. For example, given biases, should the selected AAPI be higher or lower than implied by a specific target ANC? Given imprecision, what range of AAPI might be consistent with a particular target ANC? EPA should conduct a more complete evaluation of the CMAQ predictions for the deposition transfer coefficients and consider additional processes, such as internal sulfur sources, in the AAPI.

22. What are the Panel's views on the following:

a. The insights that can be gained into potential alternative additional secondary standards (using the AAPI form) by considering:

- *i. Information from studies on the relationship between mortality in aquatic organisms and pH and ANC?*
- *ii. Information from studies on the relationship between fish health and/or biodiversity metrics and pH and ANC?*
- *iii. Information on the relationship between pH, Al, and ANC?*
- *iv. Information on target ANC levels identified by states and regions, as well as other nations?*

Each of the sources of information mentioned in the charge question both separately and taken together provide a compelling case on the relationships between ANC and other water quality metrics that are associated with biotic health of waters, and provide insight regarding target ANC values. Text should be provided on the validity of spatial survey data when applied to infer temporal relationships. Different states and nations have identified different target levels. Some use pH, others use ANC. It will be helpful to explain and comparehow these values were developed. Chapter 9 could clearly and briefly summarize possible co-benefits and unintended consequences of various alternatives for the standard. For example, to what extent might a standard focused on aquatic acidification also be protective of terrestrial acidification or aquatic nutrient enrichment? Would higher levels of target ANC provide more protection for these other effects? These points can be made while still placing emphasis on the sufficiency of the scientific evidence supporting the need for a revised standard to protect from aquatic acidification..

b. The appropriate role of qualitative and quantitative characterizations of uncertainty in developing standards using the AAPI form?

Conceptually, the AAPI approach is compelling and appropriate. There are uncertainties associated with the practical use of AAPI that should be more fully evaluated. The sensitivity and uncertainty characterization of the AAPI needs to include not only statistical analyses associated with

specific model parameters individually, but also consider their joint effect (taken into account covariance and dependencies) and an evaluation of possible omissions (e.g. reduced nitrogen inputs, contribution of sulfate sources and sinks in soil). To the extent possible, biases and imprecision in values of AAPI associated with a target level of ANC should be quantified, and these uncertainties should be used to inform specification of ranges of AAPI associated with a target ANC that may be more or less protective within the range of scientific uncertainty. This would lead to a family of NOy-SOx trade-off curves associated with each target ANC for a given geographic location. A specific standard would be set by choosing an AAPI within the range of scientific uncertainty, which would then be associated with just one NOy-SOx trade-off curve per region. EPA staff are encouraged to offer reasonable judgments about the range of uncertainty in AAPI for a given ANC target based on factors difficult to quantify within the time period of the assessment, such as the preindustrial cation weathering, the deposition transfer ratios, unmodeled factors, ancilliary benefits, and unintended consequences.

c. The role of considerations regarding the relationship of the standard to:

i. the time trajectory of response, e.g. when specific ANC levels are likely to be realized given a specific level of the AAPI?

(i) Based on dynamic model calculations the time response to recovery from decreases in acidic deposition is very slow. Because of accumulation of sulfur in soils, it is likely that the timescale for recovery of watershed in the Southeast would likely be even longer. Factors such as changes in climate and CO2 concentration in the atmosphere could affect the time trajectory, and the effects may be substantially different between aquatic and terrestrial ecosystems.

ii. the likelihood of damages to aquatic ecosystems due to episodic acidification events given a specific target for chronic ANC?

(ii) Based on studied in the Northeast decreases in ANC associated with snowmelt is approximately 50 µeq/L.

iii. the levels of co-protection for terrestrial ecosystems against acidification effects and the for aquatic and terrestrial ecosystems against effects of excess nutrient enrichment?

(iii) There will be co-benefits to terrestrial and coastal ecosystems, and with respect to mercury methylation associated with decreases in sulfur dioxide and nitrogen oxide emissions. Aquatic ecosystems may not be more sensitive to acidic deposition that terrestrial ecosystems. Many soil time series studies suggest ongoing soil acidification while surface waters are recovering from acidic deposition. This may also suggest that soil is more “sensitive” to inputs of acidic deposition than surface waters

23. What are the Panel’s views on Staff’s conclusion that the existing secondary standards for NO_x and SO_x should be retained to provide protection against direct adverse effects to vegetation due to gas phase exposures?

Based on the information presented in the PA, the science has not changed appreciably since the standards were set. While the indicator for the proposed standard is relevant, the averaging times, form and level for the proposed standard are not relevant to providing protection to vegetation due to

gas phase exposures. Therefore, in order to provide protection to vegetation, the existing standards should be retained.

24. In light of the Panel's views on what constitutes adverse effects to public welfare (see Chapter 3), what are the Panel's views on:

a) the degree to which current levels of NO_y and SO_x deposition are adverse to public welfare based on evidence and risk information, and information on adversity provided in Chapters 2,3, and 4?

Current and cumulative levels of NO_y and SO_x deposition have been shown to result in environmental damage to an extent that is adverse to public welfare. The effects include acidification of aquatic and terrestrial ecosystems and nutrient enrichment. However, the panel felt that descriptive information about that adversity and its significance could be better and more comprehensively articulated.

b) target values for ANC that protect against adversity to public welfare in light of the information presented in Chapter 5 concerning levels of ANC and the ecosystem effects associated with those target ANC levels?

ANC is an appropriate environmental indicator. The case is well supported for a target of at least 50, and perhaps even higher (75-100) since a greater degree of protection for aquatic, and some terrestrial ecosystems is likely with higher ANC targets.

c) factors relevant in selecting target percentages of waterbodies to protect at alternative target ANC levels to protect against adverse effects to public welfare, and weights to place on those factors?

The justification, logic and necessity of the spatial grouping classifications was not clear to the panel. It is not clear what is gained by the added complexities of going beyond the two groups of sensitive and not sensitive, although there is inherent appeal to taking into account available information about variations across eco-regions. Because there is large variability in inherent sensitivities of water bodies to acidification effects among different regions and even within regions, protecting a target percentage of lakes from the populations which are potentially susceptible to acidification seems logical, however. It seems that the target should be higher than the current percentages of sensitive water bodies that are below the target ANC.

d) alternative standards for NO_x and SO_x that would protect against adverse effects to public welfare based on the AAPI form, and taking into account

- *consideration of target levels of ANC (chapter 5),*

The panel concurred that ANC levels from 20 to 100 were appropriate to consider, and that 50 is most defensible based on the information presented.

- *target percentage of water bodies to protect (chapter 5),*

The panel felt that this choice was a value judgment and somewhat arbitrary, however, the panel also felt that protecting only half of sensitive surface waters was not enough. The panel notes

that the target percentage will also be influenced by whether the filters discussed earlier (naturally acidified systems, for example) are applied.

- *consideration of relevant uncertainties in AAPI components (chapter 7),*

The Panel spent considerable time discussing how and what is necessary to characterize in regard to relevant uncertainties in AAPI components in order to answer this, and other questions about the PA. In general, the panel would like to see the following [give list here such as application of the AAPI to observed changes in ambient concentrations over the past 20 years to see if predicted changes in ANC are credible, etc. OR, TED, SHOULD THIS LIST GO ELSEWHERE] analyses, verifications, and comparisons performed on the components of the AAPI. The goal of these syntheses and analyses would be to lend defensibility to the approach, provide broad bounds on uncertainties, or, in some cases to provide reality checks on the components of the AAPI.

- *any other potentially relevant factors, such as levels of co-protection against terrestrial acidification and nutrient enrichment (chapter 6)?*

That a standard that reduces acidifying deposition to ecosystems might provide co-protection against terrestrial acidification was considered interesting, but perhaps not possible (see Dale Johnson's comments?). Expected co-benefits may bolster comfort with selected targets, but are not strong enough to justify more stringent targets.