

**Response to Compilation of Member Comments on the Integrated Nitrogen
Committee's
Draft Report on Reactive Nitrogen
SAB Teleconference of September 23, 2009**

A. Lead Reviewers:

1. Dr. Jerald Schnoor:

This is a comprehensive report on nitrogen dynamics in the United States by an excellent SAB Committee with considerable knowledge about the subject. The nitrogen cycling information in Chapter 2 alone is a benefit to EPA and to the research community as a major research report. Overall, the report is well written, although its organization into an Introductory chapter and two voluminous chapters on behavior of nitrogen (Chapter 2) and integrated risk reduction strategies for reactive nitrogen (Chapter 3) is a bit cumbersome. The report ends rather abruptly without a conclusions section.

Response: We will consider the addition of a Conclusion section.

At least the main recommendations should be assembled in a final section in a briefer format than that given in the Executive Summary (pp. 14-19). I liked the first three recommendations (A, B, and C) in the Executive Summary on page 15, but then the Summary seemed to devolve into bullets, sub-bullets, and numbered recommendations which were too disorganized for major impact on the reader. This could be revised.

The report has been extensively reviewed by distinguished scientists (but not policy makers). Looking at the review comments as editor of a journal, they are quite detailed and rather critical. It would lead one to conclude that the "paper" needs major revisions and that the outcome is in doubt. This is in part because the INC report is so ambitious, and the report is largely successful in its goal of identifying key points in the nitrogen cycle where problems exist. Thus, experts in the field on those separate points are critical of the exact conclusions and recommendations. But the report in its entirety is a very useful and comprehensive piece of work, and the authors of the report have responded to the questions in most cases. The reviewers would have liked to have seen still more information about the links of reactive nitrogen to energy and climate, to wetlands practices on a large scale, and to species losses and biodiversity concerns related to Nr (and the Endangered Species Act).

Response: It was our belief that we had responded to all questions from the external reviewers. Please advise if there are specific ones that we did not respond to.

Specific Comments:

- a) I wonder if it would increase the report's credibility if a section were added on "the positive effects of the anthropogenic nitrogen cascade". Are there any that the literature has identified? In any management scheme, they should be considered, and the report would seem more balanced if the positive effects were considered.

Response: The positive effects of the N cascade are when N enters agro-ecosystems; this point has been stated in several places.

- b) The recommendations are many and varied, but I got the feeling that it will be difficult for EPA to really take advantage of them. From a policy viewpoint, I wonder if there are key management opportunities that could be emphasized? Could the recommendations be prioritized? How could the major pieces of legislation be made to work together through new rules to lessen the impacts of reactive nitrogen? Would it be better to have fewer recommendations and more focus on a few?

Response: Several reviewers have commented on the number and presentation of the Finding and Recommendations. We will review all of the F&Rs with an eye towards either grouping, sharpening, or eliminating some.

- c) Critical loads are advocated in the document, but many feel that critical loads have not resulted in better management in Europe. Perhaps a paragraph could be added on the experience gained by the critical loads approach in Europe, its successes and failures?

Response: It would be appreciated if we could be provided with documents that show that CL have not resulted in better management.

- d) The recommendation on moving towards a monitoring network of NO_y species rather than just nitrate and ammonium ions has cost implications and technical difficulties associated with it. It is not clear exactly what would be measured and how.

Response: This is beyond the scope of our report.

- e) I was confused about the recommendation to change the NO₂ criteria pollutant to include all forms of nitrogen oxides (NO_y). Does this recommendation compare "apples and oranges" from EPA's regulatory standpoint? Aren't the NO₂ criteria health based, and several of the other nitrogen species are not?

Response: We will clarify this.

- f) Enforcement of an integrated nitrogen management strategy has not been considered in the report and perhaps that should be stated.

Response: This is beyond the scope of our report.

- g) The list of management strategies (summarized on pp. 13-14) are excellent and should prove useful to EPA in responding to this important report.

2. Dr. Judith Meyer:

This is a most impressive compendium of the recent information on reactive N in the environment. It is clearly written. I particularly liked the fact that findings and recommendations were highlighted.

i) Were the INC objectives met?

1. Overall, yes. But ...
2. p. 7, line 18: The brief summary of what was addressed under objective 4 strikes me as not adequately addressing the objective. It may be that this is just a poor description of what was actually done. What is stressed in this paragraph is an application of existing technology and understanding to better address management objectives. But I read the objective to be asking for suggestions of NEW technologies and pathways to enhance understanding, i.e. research needs.

Response: The committee's view is that there are considerable opportunities to apply existing technologies, practices, and proven policy mechanisms to the Nr problem; these have been summarized in Chapter 3 of the report. At the same time we have acknowledged, in Chapter 3, that in the longer term it may well be necessary to implement a more ambitious undertaking, one in which new technologies are called for. We will clarify our statements to this effect in Chapter 3 and throughout the report.

3. 76, 20: No findings on Nr in aquatic environments? No recommendations? Nr has impacts on both marine and freshwater systems, but only marine is discussed. States and EPA are currently struggling to establish numeric nutrient criteria (e.g., for total N and total P), and the limited information on freshwaters is of concern. The document is exceptionally complete with respect to atmospheric Nr, as well as Nr in terrestrial and marine (especially estuarine) systems. It is much less complete with respect to freshwater, including rivers, streams, lakes, wetlands and groundwater. I was relieved to see some more discussion of freshwater in a later section, but it is much less detailed than for the atmosphere or marine systems.

Response: Good point; we will confer with the aquatic ecologists on our panel.

4. 85, 26: The recent EPEC evaluation of the Multi-year Plan for the Ecosystem Services Research Program in ORD (SAB 2008. *SAB Advisory on the Ecological Research Program Multi-year Plan*) should also be cited and mentioned here. All parts of the Agency reading this document need to be reminded that ORD has this active research program in measuring and monitoring ecosystem services, one component of which is specifically directed at understanding the ecosystem services associated with nitrogen. That should be noted in this report as it is directly relevant to its findings and recommendations.

Response: we agree.

ii) is the report is clear and logical?

In general yes. I have suggestions for improvement here and then several more specific suggestions below.

1. 1, 27: The nitrogen cascade is mentioned without having been defined. Introduction of that concept belongs early in the Exec Sum. This concept of the N cascade is finally defined on p. 3, but it needs to be introduced earlier in the Executive Summary, before the bulleted recommendations because it provides additional basis for some of the recommendations. I also think some explanation of the concept belongs in the Letter, again because as you say, it provides the framework for your analysis and your recommendations. For example, the statement on 11,25 is a very effective summary of the N cascade and belongs earlier in the Exec Sum and in the Letter. It provides a clear explanation of why an integrated N strategy is so important.

Response: Agreed. Revisions will be made.

2. A table listing the many forms of Nr is needed early in the executive summary. This should include the difference between NOy and NOx.

Response: Agreed. Will be done.

A footnote defining Tg in the Exec Summary also might be helpful as readers looking only at the Exec Sum may not be able to look in the glossary for a definition.

Response: OK.

3. Figure 2: treatment of freshwater environments is extremely confusing and needs to be changed. At the very least, change the label “terrestrial” to “terrestrial and freshwater”. Change the “surface water” to “estuaries” or “estuaries and oceans”. Without these or similar changes, the “riverine discharge” export is very confusing.

Response: Agreed. Will be revised.

4. p. 17: In the discussions around Gulf hypoxia, we said much about misplaced incentive programs (e.g., for corn-based biofuels). I don't see that here at all. There is some mention in the last section, but it deserves some acknowledgement here.

Response: The report contains a section on biofuels (2.2.3.5), and acknowledges, in the discussion of Target Goal #2, that biofuel development makes it more difficult to achieve the suggested target (by increasing the Nr release to the environment by an estimated 0.5 Tg). But the report stops short of recommending wholesale shifts in cropping practices.

5. 29, 7: This comment about deposition to the lower 48 states makes me wonder if the budgets and other calculations are ALL for the lower 48. If this is so, it must

be clarified up front including in Figures 1 and 2. I also think some justification for why this has been done is needed.

Response: we will clarify.

6. p. 31, 13: Where are aircraft in all this? I thought airplane emissions were significant.

Response: we will clarify.

7. Table 14: Given Finding 9 (which is a bit of a shocker), I think an additional column with loss as a % of input would make the finding more apparent.

Response: we will add a column.

8. 78, 15: Why a different C/N ratio than used in the previous calculations (on 77,9)? If it is because the previous ratio assumed some proportion of hardwood vs. softwood, that needs to be explained.

Response: we will clarify.

9. Chapter 2: I was surprised that there was no discussion of the relative proportion of denitrification end products (N₂O vs N₂) in different environments (e.g., aquatic vs. terrestrial). That would seem to be an important consideration. (I see that this is briefly mentioned on p. 121, but it seems worth discussing in terms of whether one should be promoting denitrification in terrestrial vs. aquatic environments.) I think we had something to say about this in the hypoxia report.

Response: Agreed. We will revise, adding new material as necessary, to address this comment.

10. 90, 18: That conclusion is also a result of focusing the analysis only on Chesapeake Bay. If the in situ (i.e.. local stream or reservoir) degradation were also included, the results may be different.

Response: we will clarify.

11. 98, 31: “affordable” is a value-laden word. I would take it out. Parties with different interests and values will have a very different definition of “affordable.”

Response: we agree.

12. 107, 28: I don't know if this is a correct statement of what was concluded. The question was if critical loads were well enough understood to be used in management; the conclusion was that there was limited use of critical loads. That begs the question if the science is inadequate or if they are not being used for other reasons. If that is what they said, then so be it. If not, I think it deserves clarification, particularly given recommendation 16. Is the science adequate or not?

Response: we will clarify.

13. Section 2.4.7.2: One aspect of the possibility of reduced fertilizer use that is not even discussed here is changing the crop to one that requires less applied N. The

discussion in this section is all about grain (which I presume is primarily wheat), yet much of the excess Nr problem in the corn belt is corn to feed ethanol production. A change to switchgrass as a way of reducing fertilizer input is not mentioned. I realize this is touched on in a later section, but I think it is worthy of at least acknowledgement here as well.

Response: Section 2.4.7.2 was primarily to give a caution and illustrate unintended consequences of simply lowering application rates for N fertilizer. We identified elsewhere the alternative of crop substitution and land/crop matching for the most productive use of N. See the executive summary page 13 for switchgrass instead of corn and page 16 for matching of crops with land types (changing crops on a given piece of land to reduce excess Nr) The latter is also identified on page 155. We were unsure about the trade-offs between corn and switchgrass in terms of excess Nr. For switchgrass this will depend upon the intensity of production required to minimize transportation to processing as well as the type of land used for such production. We raise this issue on pages 45/46. Matching the crop to the land to the appropriate N application to reduce excess Nr is important, but we did not pursue it because of the site specificity involved which made generalizations difficult. (This strategy was part of the economic analysis in the 1999 National Hypoxia Assessment that is referenced in the report.)

14. p. 144: FINALLY a discussion of those “key points” in the N cascade. It would really help if there could be a reference to this section when “key points” are mentioned earlier in the document. It would make the earlier recommendation seem much less vague.

Response: we will provide the reference.

15. pp. 146-149: Much of this was discussed more extensively in the SAB’s Gulf hypoxia report. The findings in that report should be incorporated into this section (b, c, and d – also g).

Response: we will refer to the Hypoxia report.

17. 156, 26: One of the recommendations I recall from the Hypoxia report was that NOx controls be throughout the year rather than seasonal as they are now. I don’t recall this being mentioned in this report (maybe I remembered this wrong).

Response: we will check and if appropriate refer to it.

18. 159, 19: I question that improved tile drainage and riparian buffers and nonpoint controls are less proven. They may not work in all settings, but to call them less proven is not defensible (and not consistent with what is said about BMPs on the next page).

Response: Agreed. Although there is some disagreement among reviewers on the efficacy of these BMPs, the wording in the report will be revised to be consistent.

19. 159, 30: The marine bias is coming out again. A wastewater treatment plant in a populated area has an equally devastating effect on a river far from the coast. Take out “coastal.”

Response: we will clarify.

iii) Are recommendations and conclusions supported by the body of the report?

Yes, but...

1. p. 2, line 30: I presume that in the report you identify what these key points are. I have not yet seen that part of the report so don't know if that has been done. If not, it is needed because otherwise the recommendation is vague. For example, p.15, Rec. A: I sure hope that somewhere you have an example of management at key points; otherwise this is an extremely vague recommendation. Maybe one way to improve is to include the idea of "key points" for management intervention in Rec B. The idea is there, but use of the same phrase would improve recommendation A.

Response: We will review and revise Recommendation A to make it clearer.

2. p. 16, 7: What is the evidence that enlarging the surface area of streams and ditches will enhance denitrification? It could also have many negative consequences to aquatic biota. I strongly recommend taking this out of the recommendation. I also think that we really don't know all the ways to enhance ecosystem services resulting in denitrification, so research is needed. P. 155, 7-8: Here is that ditch widening recommendation again. Take it out because of likely consequences to other components of the ecosystem!

Response: We agree and will make it clear that ditch widening will not be done without regard to other factors.

3. 70, 2-3: The statement that NO₂ is inadequate as a criteria pollutant is a very strong statement and not very well substantiated by data. Unless I missed something, all that was said in support of it is that NO₂ is a small component of NO_y. To support a statement like that, I would have expected graphs or tables showing NO₂ vs. NO_y and that NO₂ is a variable fraction of NO_y. Just being a small fraction does not strike me as rendering it inadequate. A small fraction can be a reasonable indicator if it is a consistent fraction.

Response: This point will be addressed more fully in the technical appendix.

Text box 6: There is no discussion of the local effects of this strategy. Although one may be reducing total N_r load (and therefore load to the Gulf), the streams in Northern Illinois would still be carrying excess N (if most of the wetlands are in S Illinois). Hence this would have no (or very limited) impact on streams immediately downstream of wastewater treatment plants. This tradeoff has to be acknowledged.

Response: This is true, but it is not exactly a tradeoff because the N is already in the streams of Northern IL. Locating wetlands very near the source of new N (waste

water treatment plant outfalls) is not feasible.

Here are some suggestions for further improvements in clarity:

1. **Letter** p.2, line 18: Is this recommendation on emissions different than the more detailed recommendation contained in the next bullet? It seems redundant with that, but the level of detail in the emissions recommendation in the next bullet is not also given for the other actions listed in this bullet (e.g., decreases from ag sources).

Response: We are not clear what portion of the letter is being referred to.

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2. 1, 10-12: First the sentence talks about Nr introduced into the US environment, then says that Nr is lost to the environment – that is unnecessarily confusing.

Response: We will clarify.

3. 2,2: “introduced into the environment” is not clear. Does this include fertilizer application to fields – or is it just “introduced” when it runs off or is denitrified to N₂O? Do you really mean “lost to the environment”?

Response: We will clarify.

4. 2, 9: no target for increased crop use efficiencies? Or is that included in the 2.4 Tg/yr – unclear.

Response: Yes it is included in the 2.4.

5. 2, 17: NO_y needs to be defined for the less informed reader (see my previous suggestion for a table, which would resolve this).

Response: We will clarify.

6. 2, 23: Clearly EPA should not be developing this strategy alone. It should be done in conjunction with other federal agencies (USDA and USGS come to mind immediately).

Response: We agree, as is noted later in the ES.

7. 9, 28: clarify that here you are referring only to advection in the atmosphere from the US – confusing because you say “all sources” and then start with riverine export in the next paragraph.

Response: We will clarify.

8. 14, 8: but surely sludge application and burning is not really removal because there is transformation and leakage to the atmosphere and to surface waters.

Response: Excellent point; We will clarify.

9. 15, Rec C: Not my field, but are the human health implications of Nr adequately covered in that list of agencies?

Response: Please that this is not an exclusive list.

10. 16, 4: I was surprised not to see something about finding better metrics for assessing the impact of Nr on ecosystem services.

Response: Excellent point, we will add.

11. 17,36: I'm confused – who is doing the nutrient management? I normally think of it in agricultural systems, but it is not clear why a construction grants program would be appropriate for that.

Response: We will clarify.

12. 23, 26&27: eutrophication is not only in estuaries. Freshwater productivity is also impacted by nitrogen, and in fact many systems show dual limitation of both N and P.

Response: We will clarify.

13. 30, 23: Do your calculations on Haber-Bosch introductions include the Nr produced by generating the energy needed to make fertilizer?

Response: They are included in the fossil fuel number.

14. 51, 13: Doesn't NOAA also have fairly extensive deposition monitoring networks? What about USGS?

Response: We will clarify.

15. 54, 21: I was very pleased to see the mention of phosphorus in addition to N, as basing decisions only on N may lead to greater losses of P. However, the only mention of P that I recall in the previous sections was phytase in animal feed. Some additional information on how "P load issues" need to be taken into account or what concerns arise is needed for this recommendation to be based in science.

Response: The committee decided not to include this, over and above the statement that N management strategies should be developed in the context of nutrient management strategies.

16. 58, 18: the difference between NO_x and NO_y has to be explained early in the document.

Response: We will clarify.

17. 58, 31: state what these oxides are unless it has been done earlier.

Response: We will clarify.

18. 103, 19: how extensive are these decreases in emissions? How far do they go toward meeting the reduction called for in this document?

Response: We will clarify.

19. 104, 26: A reader might wonder why it matters if soils are N_r saturated. A one-sentence statement about why this is of concern would strengthen this statement (or perhaps just a reference to the later section where this is detailed).

Response: We will clarify.

20. 106, 7: Are you sure that Vitousek reference is correct? That research sounds much more like Tilman's experiments.

Response: We will clarify.

21. 108, 20: Links to Hg methylation have not been discussed previously (unless I missed it).

Response: This material is a quote from a document.

22. 114, 14: Additional releases of CO₂ should also be mentioned.

Response: We will clarify.

23. 131, 11: It is also essential that a critical load (or scientifically based cap) can be adequately determined.

Response: Agreed; We will clarify.

And here are some editorial comments

Response: Thank you for these comments which will be referred to the copy editor.

1. **Letter:** p.2, line 34: Take ecosystem services out of parentheses. “Utilize the ecosystem services concept to develop an integrated ...”
2. Sincerely yours does not belong in the Table of Contents.

Executive Summary

3. 1, 6: take out first “that”
4. 1,7: reactive nitrogen in there twice
5. 1, 16: has, not have
6. 2, 22: “them” not “it”
7. 6,9: citations of those other studies are needed.
8. 9, 18: “to the extent that” rather than “insofar”
9. 16, 21: this bullet makes no sense and is I think a phrase left over from a previous bullet.
10. 16, 22: unclear what is meant by “primary use”
11. 16, 32: I wonder about the use of the term “extending.” I think that raises an unnecessary red flag, when what is meant is better integrating N regulatory activities or designing regulatory activities that recognize the N cascade – or something like that.
12. 18, 10: take out second “of”
13. 18, 15: Given what is said in the previous sentences, I would think you would want this done in an “integrated and transparent manner.”

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14. 21, 14: I don’t think we want to sustain “an ecosystem” rather “ecosystems”
15. 24, 18: why “both”? more than two challenges are listed.
16. 24, 28: I would add TMDLs under OW’s activities.
17. 24, 33: I think they have changed the name of the Ecological Research program to the Ecosystem Services Research Program.
18. 25, 4: Nr instead of N
19. 26, 10: ORD is mentioned twice and OW not at all – is that correct? No interaction with NOAA? Or USGS?
20. 27, 27: the first “system” should be “systems”
21. 31, 7: energy production in the U.S. I presume – “in the US” should be added.
22. 31, 14: “NH₃ emissions.”
23. 34, 40: to whom have they made these recommendations?
24. 35, 40: It is long after 2008 – did they do it?
25. Table 3: What are DAP and MAP?
26. 41, 36: a phrase is missing in this sentence.
27. 58, 12: take refs out of italics
28. 68, 23: “level of development”
29. 69, 4: “border”
30. 77, 8: “molar C/N ratio”
31. 82, 10: “needs” not “need”
32. 84,6: Take out “Since”
33. 101, 39: end quotes missing
34. 105, 36: I would add “with time and with climate change.”

35. 151, 11: this is redundant with the same information presented earlier in the report.
36. 158, 17-32: Much of this is a repeat of what I read in Chapter 2. Rather than repeating the statistics, refer back to that section.
37. Rather than having the findings and recommendations in an Appendix, why not make them Chapter 4. Having them in an appendix makes them seem less important. I think it is a good idea to summarize them, just highlight that summary.
38. Section 3.4.1: I had comments on several of these that appeared in the executive summary. I am not bothering to repeat the comments when the statements also appear here.

3. **Dr. Kathleen Segerson:**

General comments:

This is a comprehensive report that includes a wealth of information about Nr. It will certainly serve as a useful reference document. It includes a long list of recommendations, with varying levels of specificity. In addition, it includes four “Target” recommendations regarding specific Nr reduction targets.

- a) My main general comment on the report is that it sends a mixed message about the cost of achieving significant reductions in Nr. In several places, there is language suggesting significant improvements are possible by changing practices or technologies with little cost (e.g., lost crop yield). In other places, it suggests the cost of achieving significant reductions will be “real” (which I assume means “significant”). I think the report would be improved considerably if it provided a clearer picture of how much “low hanging fruit” is out there. In reading the report, it seemed to go back and forth between these two positions, which makes it hard to know how to interpret the recommendations. For example, when it comes to the Target Recommendations, are these achievable with little cost (the discussion in Chapter 3 seems to suggest this), or will they require significant sacrifices? The report doesn’t state this clearly. For example, there is repeated reference in the report to the fact that, although agriculture is a major user of Nr (through fertilizer), most (“essentially all” – p.20) of this is lost to the environment. This suggests that much of the Nr used in agriculture is “wasted”. If this is true, and there is the potential to reduce these losses without significantly reducing yields, then the report should say this explicitly. But then the discussion about NFUE in Chapter 3 suggests that the potential for increasing efficiency is limited, especially in the short run, and that major investments are necessary to go very far in reducing Nr from fertilizer use. A clearer message about what can be done cheaply and what cannot would be very helpful.

Response: To perform an exhaustive cost analysis of the various management options for Nr was beyond the scope of the project. In compiling the target goals, the principal criterion was that these could be achieved using existing technologies and

implementing known practices. In this sense these opportunities for Nr control represent “low hanging fruit”—a term that we will incorporate at appropriate places in the report—and the numerical” recommendations” are in fact goals that the committee suggests are achievable in the near term. Our use of the terms “recommendations” and “targets” has been inconsistent and these will be made uniform in reference to the numerical goals throughout the report.

Specific Comments:

Letter to Administrator:

- a) Line 23, 1st page: It is not clear what it means to “optimize” the use of reactive nitrogen. Optimization requires some objective function, and I don’t think the committee has addressed the question of what that objective function should be. So I’d suggest deleting this word (leaving it simply as “needed to manage the use of...”) or finding a different word (e.g., “reduce”).

Response: we agree.

- b) Line 35, 1st page: This begins a list of “Additional” key findings, but the paragraph before this is not a finding but rather a recommendation. If the key “finding” that comes before these additional ones is that the current approach is not sufficiently coordinated, comprehensive, or adaptive, then perhaps this should be stated explicitly as a “key finding”, followed by the recommendation about the formation of the task forces.

Response: we will clarify.

- c) Lines 1-3, 2nd page: Here, there are 3 “largest sources” listed, while in the Introduction of the Executive summary there are “four largest sources” listed. It is clear from the actual numbers given in the ES that #4, importation through grain and meat, is small relative to the other 3 sources, but it seems confusing to identify 3 largest sources in the letter and 4 largest sources in the ES.

Response: we agree.

- d) Line 5, 2nd page: Start a new sentence with “however”.

Response: we agree.

- e) Lines 7-13, 2nd page: The list of impacts here is similar to the list on p. 1 of the ES but differs somewhat from the list on p. 3 of the ES. For example, fish kills and loss of biodiversity are listed here (as separate impacts from hypoxia and harmful algal blooms) but not explicitly included in the list on p. 3 of the ES. Conversely, on p. 3 the ES lists GHG emissions/climate change and stratospheric ozone depletion (these are also mentioned other places in the report), which are not included in the list in the Letter. Why not just use the same list everywhere? I think this would be more consistent and less confusing.

Response: we will clarify.

- f) Line 17, 2nd page: I don't know what the precedent is for the SAB to recommend a specific quantity reduction in a pollutant (here 25%). But it seems that if we are going to make such a recommendation, we need to specify the basis for this recommendation. For example, are we saying we believe it is technologically feasible at a "reasonable" cost (defined somehow – not clear how)? Or are we saying that a 25% reduction balances benefits and costs? I am uncomfortable including a recommendation for a specific quantity reduction without providing some indication of the basis for choosing that amount over alternatives (more or less).

Response: As noted above, the numerical goals are targets that the committee suggests are achievable, and the wording of the report will be revised for improved clarity. These goals do two things: if followed they act to reverse the trend of increasing Nr released into the environment, and they will bring about measurable improvements. The report is clear that greater reductions in Nr may well be required in the future. For example the "Hypoxia Report" calls for a 45% reduction in Nr released into the gulf from the MRB.

Executive Summary

- a) The "Introduction" to the ES includes a summary of the recommendations. It seems to be almost a summary of the (executive) summary. Given that the ES is 18 pages long (very long for an executive summary), I see the need to have something shorter, but having a summary of the summary seems odd and calling that an Introduction also seems odd. In addition, later in the ES there is then an "Overview." Is there another way to accomplish the goal here? Perhaps the "Overview" should be part of the "Introduction." Some consolidation/reorganization here might also reduce what appears to be some repetition in the ES.

Response: we will condense the ES.

- b) p. 1, line 32: I don't think the task forces will "shift to" new policies. They might "develop" or "advocate" such policies, but the wording "shift to" doesn't seem right here.

Response: we will clarify.

- c) p. 9, lines 1-2: It states here that the amount of Nr imported in grain and meat products is small, so small that it is not included in Figure 1. Yet p. 1, line 8 of the ES lists this as one of the "four largest sources".

Response: we will clarify.

- d) p. 7-9: I wonder whether the level of detail provided here (in terms of all the numbers) is necessary in an executive summary. In reading this, I found it hard to keep track of all the different numbers. It might be more effective to focus here on the "bottom line" or messages that come out of these numbers and leave the specific details to the body of the report.

Response: we will condense.

e) p. 11, lines 7-10: There is a statement here that “there are opportunities for reducing the negative environmental impact from Nr use in agriculture *while also sustaining the capacity to increase food production...*” (emphasis added). This is a very important statement that should be in the Letter to the Administrator and should appear much earlier (and more prominently) in the ES. I assume it is the basis (at least in part) for the recommended 25% reduction. If, in fact, there are ways to achieve this reduction at low very low cost (in terms of reduced food output), for example, by increasing efficiency, this is an important part of the message. In particular, it implies a very different message than recommending a 25% reduction even though the costs (in foregone food production) would be very high.

Response: we agree.

f) p. 11, lines 20-24: Here again the list of negative impacts differs from the list in the Letter.

Response: we will clarify.

g) p. 12, lines 25-34: There is a discussion here about tradeoffs, which states that limiting nitrogen fertilizer applications *may* (emphasis added) reduce crop yields and increase food prices. This is a different message than the message at the end of the first paragraph on p. 11 (see comment above). If the committee, in fact, found that these crop yield losses are small (as suggested on p. 11), then this discussion of tradeoffs here should include that finding. As it reads, it is a general statement about potential tradeoffs, while the statement on p. 11 reads like a “finding” about actual tradeoffs.

Response: The losses of Nr from croplands are highly variable, but a median value of approximately 50% is a realistic estimate. The wording noted will be revised to bring these sections of the ES into better agreement.

h) p. 15, line 3: Is the reference to “these four implementation mechanisms” intended to refer back to the four “policy mechanisms for management of Nr” on p. 14? If so, this should be explicit. And it is not clear what the “recommendation” is here. Are we recommending that EPA use a combination of policy mechanisms? And, if so, by this do we mean multiple instruments to address a given Nr problem, or possibly different instruments for different Nr problems (i.e., we are recommending that the choice of instrument be context-specific)?

Response: we will clarify.

i) p. 15, lines 30-32: The list here seems to be a list of things that the Task Forces should do. But then we seem to be recommending that the Task Forces enhance ecosystem services and implement BMPs. Is this what is meant here? Given that enhancing ecosystem services is described as things like reconnecting rivers and streams to their floodplains (see p. 16), it is not clear that this is something the Task Forces can do. Do we really mean that we want them to develop the science

to support programs to do these things? This seems clearer under the description of BMPs on p. 16, but there is still reference to establishing proactive extension approaches. The language on p. 15, line 29, suggests the purpose of the Task Forces is to generate knowledge to support policy decisions (by others?), not to determine policies. The basic question is whether the Task Forces are intended to be policy-making bodies or not. We should be clear on this when we recommend their formation.

Response: we will clarify.

- j) p. 17: The list of specific near term targets here gives no indication of the costs associated with these targets. Did the committee look at the costs and judge them to be “reasonable” (somehow defined) or “justified” (given large benefits), or are these recommendations based solely on technological feasibility? See my related comments above.

Response: this is that in the scope of our report but we will mention that his needs to be part of a further analysis.

- k) p. 18: It is odd for an ES to have an “epilogue.” This seems to again be a summary of the summary.

Response: we will clarify.

- l) p. 18: The question of costs is raised here in the epilogue, but it isn’t addressed in any real way in the summary. For example, as noted above, there are statements in the ES that suggest that much of the reduction could be achieved at very low cost. Even on p. 17 (lines 32-33), there is a statement that Nr can be reduced by up to 20% while increasing crop output, implying a “win-win” situation rather than a cost. Also, it is not just the tradeoffs “derived from the varying cost-effectiveness of different strategies” (line 13-14). There are at least potential tradeoffs in terms of, for example, food vs. health. The concept of cost-effectiveness doesn’t capture these types of tradeoffs.

Response: The wording will be revised to make clear that a comparative cost benefit analysis has not been done, and indeed will need to be a part of any set of implementation strategies.

- m) Finally, I’d suggest replacing Figure 2 in the ES with Figure 3 (the Nitrogen Cascade). Figure 3 is more general and easier to follow (at least for me). There is repeated reference to the cascade in the ES, so it seems that having a figure illustrating this idea in the ES would make sense (if we are going to have figures in the ES) – or maybe we need both.

Response: we agree.

Chapter 1:

- a) p. 22-23: Is all of the italicized text intended to be part of the Figure? If so, it makes for a very long legend. If it is just part of the text, should it be italicized? Also, on p. 3 it states that this report has been developed to identify a more comprehensive “analytical framework”. Is Figure 3, which was developed by the

committee, that framework? If so, the report should state that explicitly. If not, what is that framework?

Response: we will clarify.

- b) p. 24-25: The statement here about the fact that EPA is already using a wide variety of policy instruments or approaches to address Nr comes as a surprise to the reader, given Recommendation A on p. 15, which seems to basically state that EPA should use a variety of instruments (suggesting that the Agency isn't doing this). Perhaps some reference earlier on to what EPA is already doing (besides just the reference to NAAQS and TMDLs on p. 12) and a closer link between this and Recommendation A, would be helpful.

Response: we agree.

- c) p. 25, lines 13-19: It would be useful to have some example(s) of where focusing on a single aspect has been beneficial in some regard but led to larger-scale impacts on other systems. Again, since this is an important point made repeatedly, having an example or two earlier in the report would help make this point.

Response: we agree.

Chapter 2:

- a) There is a wealth of information in this chapter, as well as a long list of recommendations on various dimensions of the problem (e.g., data collection/monitoring, research, policy approaches). It is not clear to me how these many recommendations relate to the recommendations in the ES (either the general ones or those related to the specific targets for reduction of Nr). Were the recommendations here used to derive the recommendations in the ES, or are they separate? Also, some are very general (almost too general) while others are very specific. And it is surprising to see recommendations about management strategies (e.g., Recommendations 13 and 14) in this chapter, given that the next chapter is devoted to a discussion of risk reduction strategies.

Response: Several reviewers have commented on the number and presentation of the Finding and Recommendations. We will review all of the F&Rs with an eye towards either grouping, sharpening, or eliminating some.

Chapter 3:

- a) p. 132: I found Table 24 difficult to understand

Response: we will revisit the need for this table.

- b) p. 133-134: In the explanation of the CT program (Text Box 5), it might be useful to note that the sources buy and sell credits from the state. This means that the number of credits purchased does not need to match the number of credits sold (as would typically be true in a tradable permit system).

Response: we agree.

- c) p. 137-138: The Wetlands Reserve Program is not mentioned until after Recommendation 20. Since this recommendation relates to wetlands restoration and creation, it seems like the discussion in Text Box 6 should come before drawing a conclusion and making a recommendation about this

Response: This is a good point. We will reorganize this part of the report so that the flow of information is clearer.

- d) pp. 144-146: There is detailed discussion here about reducing Nr through changes in human diets. Are there specific things that EPA can do related to this?
- e) p. 147, lines 14-19: The discussion here suggests large losses of Nr from fertilizer applications to agriculture land (i.e., low NFUE), but it doesn't seem to suggest that "nearly all" Nr in fertilizer is lost to the environment, as stated elsewhere in the report (see comment above). If these two statements are referring to two different things, it would be useful to clarify. If they are referring to the same thing, they should be consistent.

Response: As noted above, the "wasted" Nr from fertilizer is about 50%. We will revise the text to bring different passages into agreement.

- f) p.148: Figure 6 is very useful. It would be nice to have some numerical scale on the vertical axis to indicate the potentials here.

Response: Figure 6 is intended as a general illustration; numerical values will of necessity vary from location to location. It is not possible to put numbers on the vertical axis.

- g) p. 154: In Recommendation A, the reference to "these four implementation mechanism" is even less clear here than on p. 15.

Response: Agree, will clarify.

- h) pp. 158-159: The end of Target Recommendation 2 seems to be identical to the first part of Target Recommendation 3. If there is a difference here, it is not clear. Also, Target Recommendation 3 doesn't seem to relate to the discussion preceding it (which deals with manure), and it doesn't track with the 3rd bullet on p. 2.

Response: We will examine and clarify.

- i) p. 162: The text here is repetition on text on the previous page.

Response: We will revise.

- j) p. 163: It seems odd to have a recommendation #21 follow the Target Recommendations 1-4. Perhaps this section on monitoring, along with recommendation 21, would fit better in Chapter 2.

Response: Agreed. As noted by other reviewers, the monitoring section needs to be moved to a more appropriate location. This will be done.

Appendix 3:

- a) p. 171: It states here that the Appendix gives the appropriate section headings for the listed recommendations but I don't see

Response: this will be corrected.

4. Dr. Rogene Henderson:

I was greatly impressed with the depth and breath of this document by the Integrated Nitrogen Committee (INC).. It is a complex area that was covered in detail. The major point of the document was to make clear the complexity of the problem and to recommend that the EPA participate in intra- and interagency task forces to begin to address the problems. But the group also made near-term target recommendations that gave specific goals to be achieved. The scope of their goals is visionary, and because of monetary constraints, we cannot expect immediate, rapid progress. However the document is a necessary beginning for addressing a major problem.

Did the INC address the 4 charges given it by the SAB? In my opinion, yes.

- a) Identify and analyze, from a scientific perspective, the problems N presents in the environment and the links among them; This is exhaustively addressed in Chapter 2.
- b) Evaluate the contribution an integrated N management strategy could make to environmental protection; This is addressed Chapter 3
- c) Identify additional risk management options for EPA's consideration; This is addressed in Chapter 3.3.
- d) Make recommendations to EPA concerning improvements in N research to support risk reduction. This is part of the recommendations in Chapter 3.4

Following are specific recommendations to improve the document:

a) The Letter

The document itself gives a balanced discussion of the benefits as well as the harmful effects of Nr, but the benefits did not get mentioned in the letter. For balance I suggest moving the sentence on page 11, lines 2-4, to be the second sentence in the letter. This sentence reads: "Because nitrogen is both a critically important natural resource and also a contributor to a number of environmental problems, it is imperative to understand how to decrease the risks to society while also providing the food, energy, and materials required by society."

Response: We agree.

The letter needs a clear definition of Nr. The definition at the bottom of page 1 of the Executive Summary might be a bit long for the letter, but couldn't you just say it is any nitrogen-containing compound other than diatomic nitrogen?. This would include nitro-aromatics, which do not seem to be in the definition given in the Executive Summary.

Response: We agree.

b) The Executive Summary

The definition of Nr at the bottom of page 1 does not seem to include nitro-aromatics. These compounds can be potent mutagens and should be included. In fact, the topic of nitro-aromatics is not mentioned anywhere in the report, as far as I could see.

Response: We will mention them as one of the Nr examples.

Be consistent in the use of reactive nitrogen vs. Nr. On page 1, line 3, is the first use of reactive nitrogen. You could put Nr in parenthesis after this first use, and then use Nr throughout the rest of the document.

Response: We agree.

Page 6, line 19: A reference is made to the nitrogen cascade and the wrong figure is cited (should be Figure 3). Since the nitrogen cascade is central to the arguments of the whole document, I suggest considering moving Figure 3 up to being in the Executive Summary. It would also need to remain in the Intro where it is now.

Response: We agree.

Page 15, line 35; as well as page 74, line 13 and 16; and page 154, line 36: The use of the term "budget" at these points of the report may be confusing to many readers. Most people will think of dollars spent on the program, but if I understand it correctly, you are talking about the Nr flux. Think about another word that would be less confusing.

Response: We agree and will use the term 'material budget'.

Page 17, line 4 and page 156, line 7: This recommendation seems weak compared to the others, because no expansion of the idea is given, as was done for the other recommendations.

Response: We will clarify.

Overall, I think the Executive Summary does an excellent job of summarizing the report.

c) Chapter 1-Introduction.

This section was very well done.

d) Chapter 2-Behavior of reactive nitrogen in the environment.

This was an excellent and exhaustive summary of all the many ways in which Nr impacts human health and the environment. I liked the idea of summarizing findings throughout the chapter, followed by recommendations based on those findings. It helped bring together the numerous areas covered by the chapter.

For recommendation 8a, I wonder how practical it is to change indicators for the NO_x standard to include NO_y. Are there adequate analytical procedures for all the components of NO_y?

| *Response: We will clarify.*

Pages 87-91: Here there is a drastic change from all the rest of the report. A large amount of detail is presented from one paper in a not-well-known journal (impact factor =0.77 in 2007). I think this may have been due to the first author being a member of the INC. This is understandable, but is not consistent with the rest of the report. The information could be greatly condensed.

| *Response: We believe that this material is central to the points made in the report.*

Page 103: The NO_x standard is about to change. Is there time to update Table 19?

Page 115, line 18-20: I do not think that the EPA assumes that NH₃ is not a PM_{2.5} precursor. I have certainly not heard that. In fact I have heard the opposite. You might want to check how you word this recommendation to be accurate.

| *Response: We will clarify.*

e) Chapter 3-Integrated risk reduction strategies for reactive nitrogen.

I thought this was an excellent summary of how the many impacts of Nr might be reduced. As pointed out in the chapter, it will require an integrated effort from within EPA and between EPA and many other government agencies. This is truly visionary but is worth the effort.

f) Appendix 3: Findings and Recommendations of the INC.

I think the appendix is helpful in summarizing all the Findings and Recommendations.

5. Dr. Terry Daniel:

My comments below must be taken in the context of the fact that training and a career in Psychology is not the ideal preparation for reviewing a document like this. I certainly cannot address the technical content with any authority! I will, none the less, journey on below.

First and foremost, this is overall an excellent and very impressive report of enormous scope—at least as wide in scope as it is long in pages. It mostly holds to a high professional level and makes a very compelling case for the recommendations presented. The committee is to be commended for an outstanding product and for what appears to have been a very substantial effort. Certainly for people like me, reading it is an educational experience. There are some variations in format and “style,” and perhaps even some conflict in the conclusions presented between the first

sections of the report and the later sections, especially toward the end of Chapter 2 (specific instances noted below). Perhaps it will all come together more clearly for me in Chapter 3?

If this report is only intended for a sophisticated scientific (and regulator) audience, it does an excellent job. However, the importance and complexity of the problem addressed suggests that here, or perhaps in some other document/process, these important points need to be packaged and effectively presented to a much broader audience—ranging from farmers to suburban homeowners to urban consumers. While the technical and scientific base is critical, the Nr problem will not be effectively addressed until there is broader recognition of the problems and support for policies to address it. This would no doubt require some simplification of the message, and simpler, smaller scale more concrete examples of the N cascade would certainly help. Presenting the key points in the context of a “simple” concrete story (about a farm field or a suburban lawn, for example) could convey the critical notion of the N cascade to a broader audience, and motivate greater appreciation of the need for protection/mitigation policies.

I did not try to be a text editor, but a number of items came to my attention as I read, so I thought it might be helpful to note them here. I was mostly consistent (I hope) in noting items that need to be deleted in red, and suggested changes in blue. My own comments/observations are presented below the copied texts in blue.

Response: we respond below to Dr. Daniel’s comments but not to his suggested editing changes, which we are in agreement with, unless otherwise noted.

P 1

7 nitrogen into 7.7 Tg of reactive nitrogen ~~reactive nitrogen~~ per year; 3) fossil fuel combustion resulting in

P 11

16 profitability of crop and animal agriculture ~~at~~, the nature and diversity of plant life, and vital ecological

P 15

Management efforts at one point in the cascade may be more efficient and cost effective than

8 control or intervention at another point.

[How many times does this exact sentence appear in the letter and executive summary?]

Response: We will clarify.

P 17

14 ... NOx controls for modern, on-road vehicles are effective and theses

15 technologies should be applied to off-road vehicles, locomotives, ships and other devices with

18 Tg N/yr) by a combination of BMPs and engineered solutions. This is ~~is~~-expected to decrease PM2.5

1.4

P 25

26 recommendations relating to Nr research **on** and control. Later, the SAB would consider the

P 30

Here and elsewhere, reports of contributions of Nr from different sources tend to mix together sources (because of some commonality, e.g., fertilizers) that differ greatly in their magnitude (e.g., 9.9 Tg from farms and 1.1 Tg from non-farms). This introduces a danger that readers (especially those not used to the Tg metric) will lump these sources together as being the “same problem” (e.g., “fertilizer” is the problem) or the same level of concern (not distinguishing between farm and non-farm sources viz. Nr reduction policies). This also occurs with cultivation induced (7.7 Tg) versus imports (0.1 Tg). Perhaps a simple table here could present the picture of the relative contribution from each of the major categories, with the individual contributions of specific sources within each category shown clearly as “subsets” that also vary in their magnitudes. The main point is what the relative contributions are from the various classes (and sub-sources), and this is a bit hard (for this reader) to fully sort out in the text.

Response: Since Table 1 and Figure 1 have this information, it would be helpful to know what additional information (or presentation) would be appropriate.

P 36 and preceding

Is all this “source of data” review relevant to the argument? Potentially it is (certainly so for other researchers in the field), but a sentence here and there to alert/remind the general reader of the purpose (in this report) of these details would be helpful.

Response: We believe that it is necessary.

P 38

28 effects on crop growth vigor and ability to acquire applied nutrients and **and** through losses of

P 41

36 *universities to help identify research and education priorities to support more efficient use and better mitigation*

37 *of Nr applied to agricultural systems.*

P 52-53

The comparisons of nitrogen consumed/excreted per produced unit seem to cry out for the conclusion that a shift in human meat preferences (from beef to chicken, for example) could have huge effects—but there is no such conclusion suggested. Are behavior-change policies “off the table” as potential mitigation strategies for this report?

Response: Beyond stating the dietary shift would decrease the amount of Nr introduced into the US, the committee did not go further because it was out of the area of our expertise.

P 58

35 concentrations. A recent ISA) evaluated the scientific foundation for the review of the

P 59

6 reactive nitrogen, it is appropriate to consider whether the existing criteria pollutants are

P 65

16 dry deposition, and spatial distribution, is provided in Appendix 4.C and will be only briefly reviewed

P 66

16 Ammonia emissions and ambient concentrations can be measured, but are not routinely

17 monitored. For Nr, the CMAQ numerical simulation employed inverse modeling techniques –

18 that is NH₃ emissions were derived from observed NH₄⁺ wet deposition (Gilliland et al., 2006;

19 Gilliland et al., 2003; Mathur and Dennis, 2003). Model determinations of NH₃ therefore do not provide

20 an independent source of information on NH₄⁺ deposition.

Is this right?

Response: we will clarify.

22 For NH_x, wet and dry are equally important, but for NO_y, dry deposition accounts for about 2/3

23 of the total deposition while wet deposition accounts for about 1/3. For NH_x, wet and dry are

24 equally important, but for NO_y, dry deposition is greater than wet.

This sentence seems redundant with the prior one.

25 eastern United States it is true for the United States as a whole; in arid southern California, for

26 example, dry deposition of Nr dominates. Based on CMAQ, total NO_y deposition is 2.79 times

27 the wet deposition and total NH_x deposition is 1.98 times the wet deposition.

Should this be "...Nr dominates: Based on CMAQ ..."

Response: we will clarify.

P 68

23 and numerical models of NO_y have reached a level of development to allow reasonable estimates of

P 69

2 United States. near major sources such as downwind of industrial Ontario and major cities of

3 Mexico, such as Tijuana, and San Diego, CA (Wang et al., 2009).

San Diego is NOT in Mexico, though some may with some justification think that it is.

P 70

3 pollutant “oxides of nitrogen,” is inadequate to protect health and welfare. NO_y should be

4 considered seriously as a supplement or replacement for the NO₂ standard and in monitoring.

9 deposition is known with much scientific certainty. Thus consideration should be given to

10 adding these chemically reduced and organic forms of Nr to the list of Criteria Pollutants.

These sentences both sound more like recommendations than findings—should they be moved into the recommendations?

| *Response: we will clarify.*

P 71

17 livestock and poultry Nr (~17 Tg total with 9.7 Tg from synthetic fertilizer and ~8 Tg from

P 72

15 unmanaged lands, atmospheric deposition and Nr from livestock manure that is deposited. The

16 livestock that is grazing within grasslands (Table 13) may lead to the N saturation of unmanaged

17 forest and grassland ecosystems (Galloway et al. 2004; Bobbink et al., 2009).

OR

Livestock grazing within grasslands (Table 13) may lead to the N saturation of unmanaged

17 forest and grassland ecosystems (Galloway et al. 2004; Bobbink et al., 2009).

23 produced in the greatest amount. Using commodity N content data (derived from data used to

P 75

11 estimated that global atmospheric transport of Nr from land to sea accounts for the movement

12 of almost one third of the annual terrestrial Nr formation. Therefore, our understanding of marine

P 76

38 15,300 Tg of C and ~ 59 Tg N (estimated using a C/N ratio of 261), and 15,500 Tg of SOM-C,

P 78

24 surveys. For changes in C related to the rate of tree growth, Birdsey (1992) estimated that 52,500

P 83

32 Although N is among the most abundant elements on earth, only a small fraction, of Nr is

P 86-7

9 Ecosystem services considered to be regulating and supporting ecosystem services are

10 particularly difficult to fit into an economic metric. It is thus essential that a variety of

11 complementary metrics be used to assess the impact of anthropogenic Nr on the environment and

12 human well being.

I applaud this statement as it protects against one of the most important dangers of depending too much on economic valuation in these contexts. The use of economic/dollar metrics is very likely to tilt the Agency's regulatory/mitigation preferences inappropriately toward developed areas, marketed products, etc, that are more easily (and historically have been) incorporated into the metric.

The Chesapeake Bay box is a very compelling proof of the case against narrowing focus to a single metric, and a nice concrete example of many of the points the committee wishes to make about the N cascade.

P 94

2 Further field evaluations by EPA and state and university collaborators under the National

3 Coastal Assessment (NCA) using used probabilistic monitoring techniques.

Finding 13 seems to just repeat the text of the paragraph above it. You might change the text of one or the other, or better perhaps, just move the prior text to be the "finding."

| *Response: we will clarify.*

P 98

This section on water quality issues is good of itself, but the previous sections of the report seem to indicate that the sources/mechanisms focused on here are of relatively low impact at the national scale (contribute relatively low Tgs compared to other sources). Recommendation 15 seems not to include any acknowledgement of the lower importance of these concerns relative to the prior concerns and suggestions for mitigating Nr problems.

| *Response: we will clarify.*

P 100, lines 9-20

Have we abandoned the “Findings,” “Recommendations” format here? This seems like where that would have occurred based on the format followed in the prior sections of the report.

| *Response: we will clarify.*

100-101

Have we not read much of this in prior sections? There is at least the feeling of repeated material, which can be onerous in such a long document.

| *Response: we will clarify.*

P 103

4 The threshold for total Nr in the atmosphere **are** **is** yet to be fixed, but depends on its rate of

P 106

38 well as inorganic NO_y and NH_x forms of Nr) in the contiguous states of the United States. These

35 **Finding 16**

36 In this connection, the INC **notes**, and strongly commends EPA for its recently increased willingness to

[To make this a “finding” statement.]

It appears that we are back to the “Finding” format, albeit, this is an uncharacteristically long (and wide ranging) “finding.” This section could be improved, and made more consistent in format with earlier sections if much of the current text under “finding” were moved to the body above, and then a more concise, focused “finding” were stated to set up the recommendation that follows.

| *Response: we will move the material.*

P 109+

What appears to be a new section, or at least subsection, follows with little transition after Rec. 16, and goes on for pages of tables, etc. Is this something that is intended to elaborate Rec 16? This shifts considerably from the format practiced in the earlier

sections of the report. It seems more like an appendix, or perhaps a “box” than a continuation of the prior text. If it is central and important to the prior section, perhaps it should be brought up prior to what have formerly been the section-closing “Finding/Recommendation.” If not, perhaps a new section heading is needed.

Response: we will move the material.

P 115

10 most polluted areas of the United States. at most times.

P 118

Making

5 the assumption that without a concerted effort to improve N fertilizer application methods, yields

6 will decrease at 90% of the current PFP for N fertilizer (Cassman et al., 2003;

Dobermann and

7 Cassman, 2004).

Not a complete sentence (or thought).

2.4.7.2

This section seems in some places to conflict with at least the spirit of the earlier sections where more appropriate application of N fertilizers seemed to be recommended, and where it was my impression the losses in production and protein quality were minimal and relatively easily avoided. This is foreign material to me, and I do not have the time (or strength) to go back to those early sections now, but I do get a strong feeling of conflicting views here.

Also, there is again no “Finding” / “Recommendation.”

Response: The Committee's intent here was to give some illustrations of potential unintended consequences if nitrogen were simply reduced on crop production. This was intended as a caution about potential trade-offs rather than a finding for specific action. We did not go into the health and related issues for protein reductions in grain. We don't think we have a contradiction here.

P 119

23 exclusively as a result of the microbial processes of nitrification and denitrification.

P 123

The briefly stated finding/recommendation 18 provides little useful guidance to the agency—offering only a “motherhood and apple pie” statement about dealing with tradeoffs. Can you not provide some examples or other specific suggestions for research or policy approaches? Finding/recommendation 19 is similarly broad, but the recommendation breaks out some very specific suggestions for Agency response.

Response: we will clarify in the process of reviewing the F&Rs.

P 138

F 20/R 20 seem to return to a more optimistic view (relative to discussions toward the end of chapter 2) regarding the utility of wetlands for transforming and sequestering N. The concern about unintended production of N₂O is noted, but not dwelled on and apparently not of great concern.

| *Response: we will clarify in the process of reviewing the F&Rs.*

P 144

15 new Nr is derived from consumption of ~11 Tg of synthetic N fertilizer, ~8 Tg of N is fixed by 16 biologically by crops, and ~ 5 Tg is emitted from fossil fuel combustion annually). This N is used

20 Conservation of fossil fuel and resulting decrease in use of fertilizer in food and fiber production

How does conserving fossil fuel “result” in decreasing the use of fertilizer?

| *Response: we will clarify.*

P 145

7 day, respectively. In 2003, total protein consumption in the United States was 115 g person per 8 person per day (74 derived from animals and 41 from vegetable (FAOSTAT, 2003). In

This section focuses on the N-to-protein ratios for meat versus vegetable sources, but the argument would seem as relevant to the beef versus chicken comparisons that were not noted or addressed in a similar discussion on p 52-53 (see previous comment for those pages).

P 146

7 United States and globally. Additional Nr may be conserved by decreasing the amount of food 8 that is wasted.

This sentence begs for at least some statement of how much N savings could be had by reducing waste.

| *Response: we will clarify.*

P 147

4 production. The largest input of Nr in North America is N) fertilizer used for crop production.

36 Significant increases in NFUE are often achieved through reductions in N fertilizer use by 10 to

37 30 %, while increases in yield tend to be small (Giller et al. 2004).

I note first that this section returns to more optimistic views about the prospect of reducing N fertilizer use (see previous comments on section 2.4.7.2) as a mitigation measure. Regarding the particular sentence copied above, if it is intended as presented (decrease N fertilizer leads to small increases in yields), it could be stated more enthusiastically as "...10 to 30%, while still maintaining or even slightly increasing yields."

Note also that this section does not mention the changes in protein content of grains as a factor of concern, unlike the prior discussion in chapter 2.

| *Response: we will clarify.*

P 149

8 and one half in feces) is produced, there is often a much greater supply than can be efficiently or

9 economically used as fertilizer on crops. For large animal feeding operations (AFO's) there is

AFOs are referred to as CAFOs in the earlier texts—do we need both terms?

P 151 (section g)

Some reminder of the N₂ versus N₂O tradeoff issue, much discussed in chapter 2, needs to be repeated here.

The description of the 2003-04 workshop cries out for some statement of whether the recommended research/demonstration projects were actually started, and if so, what is the status of the studies.

| *Response: we will clarify.*

P 152

27 controlled by using a fuel-rich mixture versus fuel lean. In this case the reactions to take place at

28 lower temperatures.

P 162

12 Perhaps a more comprehensive framework has been developed by the Heinz Center as part of

Has it or has it not? Is it being reported as, or only being suggested as potentially a start toward a more comprehensive system?

| *Response: we will clarify.*

P 163

10 • Evaluation of the critical loads approach to air and water quality management

This whole set of recommendations seems to stray outside the "monitoring" topic, and mostly repeats recommendations made and substantiated more strongly in the

prior text. Indeed, this section leading up to F 21/R21 seems to back-track from what seemed to be the “Ta Dah!” conclusions presented in the just preceding presentation of large and important “target goals and recommendations.” Certainly monitoring is an essential operational need for implementing the recommendations of the committee. But so too are political, policy and legal changes and technical developments, etc. Can this section be shifted into a position prior to the targets/recommendations section? It seems a bit of an afterthought here, and it is rather an “anticlimactic” way to end the report.

| *Response: we will clarify as part of the process of reviewing the F&Rs.*

Letter

P 2, 2nd paragraph

This would seem to be a good place to include a short statement about the danger that regulation/mitigation of one form of N in one medium/system might inadvertently exacerbate other forms/effects of N in another medium/system (even though it is mentioned in the following pages).

This also might be a good place to put a number on the total amount of N at issue (e.g., the estimated input 40 years ago and today) to give more precise meaning to the findings/recommendations presented in the next two paragraphs (where references are made to “5x more” and “decrease by 25%,” for example).

| *Response: we agree.*

Executive summary

The summary should start with some statement of the N problem and its nature and magnitude. This is currently reserved for the “background” section that follows, but without this information up front, the reader not already very familiar with the “N problem” will have little idea why anyone should care about who/what contributes it in what amounts. A few sentences moved from the front of the “background” section might do the job, or a whole paragraph may be needed to state the nature and significance of the N problem.

The report does an excellent job of addressing the 4 charges. Indeed, it goes well beyond that to lay out a new integrated paradigm for research and policy regarding N.

The executive summary is 18 pages, including a large rather detailed table and two figures, the second of which is rather complex (for some readers, at least). This is perilously close to requiring an executive summary for the executive summary. The report is very substantial and addresses complex issues in a sophisticated way, so a long summary might be required. However, the authors should consider the goals for the executive summary and whether those goals might better be met by a shorter

presentation that leaves out many details and components from the report that are currently included.

Response: The ES will be revised in the context of this and other comments.

6. Dr. James Sanders:

INTRODUCTION:

This is a long, detailed, and very interesting report. I greatly enjoyed reading it. However, with one read, it is impossible to fully understand all the implications that are presented, nor can a reviewer have the luxury that comes from years of discussions and interactions. Please accept my comments in that context.

GENERAL CHARGE:

a) Were the INC objectives met?

In large part. I have a number of comments, which are listed below. In general, however, this was a large, complicated undertaking, and the committee should be congratulated for their efforts. I concur with the findings and recommendations as presented.

Objective 1. The report handles this task very well.

Objective 2. The report is less successful with Obj. 2. The report does lay out the opportunity that comes from an integrated assessment, but the details are greatly fragmented among the chapters. In addition, I believe that the authors missed an opportunity to provide guidance for how to actually promote and achieve such a strategy.

Objective 3. Well covered.

Objective 4. Well covered.

b) Is the report clear and logical?

The report is long and complicated. It suffers from repetition, and some sections contain greater detail than others (perhaps too much detail). However, except for comments below, the report accomplishes its goals, and presents information in a manner that should improve the agency's capabilities to respond to nitrogen issues in the future.

It is a long report. Not surprisingly, it suffers from many typographical errors, some of which are mentioned below. It was not our task to edit the document, and I have not done so. However, before publication, it will be

imperative that the document be carefully and more fully edited. I am happy to share my findings with the committee, if desired.

c) **Are recommendations and conclusions supported by the body of the report?**

Yes. Some specific comments can be found below.

SPECIFIC COMMENTS:

- a) The report handles objective 1 quite well. It suffers from some repetition, which may be expected in a report this long and detailed. If time exists, it would be helped by judicious editing to remove redundancies. This is most obvious as one moves from the Executive Summary to the body, and repetition there is to be expected. However, material in early chapters is often repeated, verbatim, in later chapters. Perhaps a strong editor can remove some of that repetition, without sacrificing the utility of the report. One of the most obvious examples of this deals with the overarching recommendations. It is clear that these should be repeated in the Summary and in the text. However, they can be found there, and in Section 3.4 (p. 153-), and then again in Appendix 3, p. 171-. Surely, they are not needed so close together?

| *Response: we will attempt to reduce the redundancies.*

- b) Numbers. I cannot always get the report numbers to jibe. Sources appear to vary from 28 to 35 to 48? Some of the confusion may arise from the complexity of the problem, however, I believe that there are also issues with presentation. For example, the beginning of the Summary (p. 1) is most confusing. Here, we learn that human activities produce 5 times more N than natural processes (but that is only in the US, correct? Globally it is 2 times?). Second, the four sources listed provide 70% of the total Nr, yet, further in the document, they seem to account for almost all of the Nr? Am I confused, or are the numbers here wrong? There are aspects of the document where numbers are quite precise, and other places where percentages don't even add up correctly (e.g., p. 55). This report will be, in large part, judged by its accuracy; it would benefit from a very careful review—from page to page—of the numbers of inputs and fluxes.

| *Response: the numbers will be carefully reviewed.*

- c) Ecosystem services. The report mentions the value of ecosystem services in several locations, and refers to ORD efforts that are beginning within the Ecological Research Program. This report could provide an important vehicle for bringing this important topic to the attention of the remainder of the Agency.

| *Response: we agree and do note the agencies plan to use Nr as a pilot for ecosystem services.*

- d) Overarching recommendations. Some suggested wording changes: For A, “EPA should develop an integrated...of Nr that uses a combination...”

| *Response: we will modify.*

- e) Figure 3. Font issue with “new” nitrogen. Also, shouldn’t the denitrification to N₂ be shown as arrows coming from the terrestrial and aquatic boxes?

| *Response: we will review.*

- f) Recommendation 15, p. 98. I understand that we are setting goals that may not be attainable; however, this recommendation seems to suggest the country step back and only attempt what is currently possible. I assume that the authors do not mean this.

| *Response: we will reword.*

- g) Text box 6. This appears to be based upon works that are in preparation, yet in some committee comments, work not yet published has been refused. Is this appropriate for an SAB publication?

| *Response: we will update.*

- h) Overarching Recommendations, p. 154-. See comments above about repetition. Note that Recommendation A here, and when repeated in Appendix 3, refer to nonexistent text (“...these four implementation...”, line 2-3). This needs to be clarified.

| *Response: we will modify.*

MINOR COMMENTS: I have only highlighted a few of many typos.

- a) P. 8. The second largest source is 5.7. The third largest source is 7.7?
- b) Figure 7, p. 39. The report discusses changes since 1980 or so. What happened from 1965 to 1980, to lead to the dramatic decrease?
- c) ‘There are a number of incorrect references, such as at line 35, p. 58 and line 37 on p. 77.
- d) There are repetitive sentences, such as lines 21-24 on p. 66.
- e) ml/l on p. 95, line 17 should be mg/l.
- f) p. 114, section 2.4.7.1. Is this section missing? I expected a discussion similar to the next section; however, there is only a short paragraph.
- g) Figure 36, p. 142. Not shown?

B. Other SAB Reviewers

7. **Dr. M. Granger Morgan:**

The letter to the administrator needs a bit more explanation of why Nr is a big problem. While adverse impacts are later elaborated (including table A), lines 19-23 on page 1 also seem pretty brief.

Response: we consider this comment along with the other comments on the letter.

It is unclear to me if it is appropriate for the SAB to recommend specific reduction targets. I would have thought that was a regulatory policy decision. Did EPA ask the SAB for targets?

Response: The EPA did not ask for targets; this is a SAB-initiated study.

If it determined that it is appropriate to make specific numerical recommendations for reduction targets (both the 25% and how it should be allocated across sources), there needs to be considerably more scientific justification. When I read sections 3.3 and 3.4 the numbers all seem to just appear. What does 25% get us that 20% does not? Why not 30%? What is the decision rule being employed?

Response: The 25% is the sum of the actions that we are proposing using current technologies.

It is fine for the SAB to advise the agency to create an "intra-agency" task force. The SAB needs to be a little cautious in how it words a recommendation for the creation of an "inter-agency" task force, since that is the prerogative of the EOP. However, it would be fine to advise the agency that they should work to get this set up. Just a matter of being careful about wording.

Response: we will reword.

The use of Ny in the letter to the administrator is confusing.

Response: we will reword.

The Swiss water lab EAWAG has worked for years on developing and demonstrating urine separation toilets and on strategies to convert the urine that is captured into fertilizer. See for example:

http://www.eawag.ch/organisation/abteilungen/eng/schwerpunkte/abwasser/abwasserbehandlung_haushalt/index_EN

I can find no mention in the report of human urine as a contributor to the Nr problem nor any discussion of this technology.

Response: human urine is included in 'sewage'.

8. **Bernd Kahn:**

The report is interesting and well prepared, to the extent that I can judge it. Some minor problems in the Letter and Executive Summary are:

Letter: where is page 1?

Letter, p.2, l.7: If the word ‘anthropogenically’ is used in the sense of ‘created by humans’, then the word ‘created’ that follows it is redundant. This coupling of words is used repeatedly in the Executive Summary.

Response: we will reword

Letter, p.2 l 8-10: ‘problems’ ... ‘human problems’ does not read well; possibly the latter should be ‘adverse human health effects’. Same in ES p.1, l.20-22..

Response: we will reword

ES p.1, l.14-17. The sentence is too involved, note ‘that is’ ... ‘that have’ refer to two different subjects.

Response: we will reword

ES p.1, l.19: ‘anthropogenically’ (sp.)

Response: we will correct.

ES p.4-5, Table A: A central question – whether the impacts listed in the first column are defined by current programs through measurements data analyses or require the integrated approach described here – should be addressed in connection with the Table. For example, can the measured levels in air and water be related to the effects listed last three items in Table A or is the magnitude of the effects currently a mystery?

Response: This table is not meant to be an exhaustive and integrated list of negative impacts of Nr. Rather it is meant, at an early stage in the report, to give an overview of many of the important impacts of Nr.

ES p.10, Figure 2: ‘Riverine discharges’ and the associated value are ambiguous. This does not seem to be an output such as the shown release of molecular nitrogen to air from water. Is the difference between transfer from ‘Terrestrial’ and molecular nitrogen output ‘stored’? Does ‘stored’ as shown in ‘Terrestrial’ mean forever?

Response: we will reword.

9. Dr. Duncan Patten:

This report is comprehensive, understandable and well documented. Extensive use of figures (visuals) gives the report potential for much wider use and understanding. Although I find nitrogen dynamics within and across media and ecosystems extremely important in human and ecosystem “health”, it is not an area I’m expert in

so I decided to emphasize an concept which is critical to most of the documents and reviews EPA SAB undertakes: that is, integration.

One area which I feel strongly about is integrating what we do and learn whether it is internal or between management and research agencies (or other entities).

The following comments may seem nitpicking or repetitive but they pick up areas in the text where I think both management and research should be brought in.

Page 25. Integration. There is a need not only to integrate N management programs as mentioned in this paragraph but integrate research on N processes and effects across the various ORD and other research programs of EPA and other appropriate agencies (e.g., USGS). Using Figure 2 and perhaps more importantly Figure 3, various media through which nitrogen “flows” are identified and each of these has its own research constituency e.g., air, water, soils, etc.). These research constituencies should make greater efforts for cross discipline communication.

Response: this is an excellent comment and will revise the report accordingly.

Page 21. This page mentioned that researchers and managers should explore integrated strategies. Use of term research should be part of a “common phrase” wherever integration is mentioned (when appropriate) rather than limiting recommending in some places to pointing out that managers should consider integration. Granted, objective 2 was to evaluate the contributions that could be made by an integrated management strategy, but how can this be separated from information used for management which should arise from integrated research to make it useful?

Response: we agree.

Recommendation 18. (page 123). Agreed that integrated management is necessary and should be emphasized but that management should be based upon findings from integrated research programs.

Response: we agree.

10. Dr. Cathy Kling:

Comments on the Integrated Nitrogen Committee’s Draft Report on Reactive Nitrogen
This report does a great job of bringing together an enormous amount of interesting and useful data and of raising a number of important questions. The authors have done a great service in doing so. However, I am concerned that there are so many recommendations and so much detail in the report that the key conclusions and recommendations are going to be lost amongst the trees. Would it be possible to reorganize the report with a focus on the top 10 key points (or other, more focused number)? I wonder if the report could be organized into a number of shorter, more focused chapters with much of the supporting detail placed into appendices.

In addition, there are some conclusions and recommendations that the committee makes that need to be better supported by data and arguments contained in the report. While I

focus my comments on these and other concerns, I applaud the committee for the wealth of information they have collected and the important issues addressed.

Response: With respect to the number of recommendations, the committee will review this and try to achieve more focus.

1. I strongly concur with the overview comment of Dr. Segerson regarding the question of the trade-offs associated with reductions in Nr. There are two issues here. The first is whether and where reductions can be achieved with relatively low trade-offs (costs) and the degree to which costs have been considered in making the recommendations for the 25% reduction target or the specific sectors to which the targets are allocated (e.g., the 2.0 Tg N /year from mobile and stationary sources, etc.) . The report is confusing on the first issue as Dr. Segerson’s comments point out.

The second issue is also important (and raised by Kathy in a separate comment). Ideally, to make a case for a specific target reduction of 25% or any other number, one would like to know what the costs and benefits of such a reduction would be. I do not wish to imply that we should wait to take action until we know with certainty that such action will result in gains that exceed the costs, but there needs to be some understanding of the tradeoffs and their magnitudes before a compelling case can be made for a target.

Response: The committee was not able to look at the costs and benefits associated with those actions that might bring about a one quarter reduction of Nr. What was used was a judgment about potential reductions based on technology being available, institutions being in place, and that the reduction would not involve serious disruptions on current systems or economic disruptions.

2. I think the committee has made a good case in this report for their recommendation to establish an Inter-agency task force, but I wonder if some lessons learned from other such efforts would be helpful. For example, there is an interagency task force that has been charged with addressing concerns related to Gulf of Mexico hypoxia. This is a large committee with representatives from many “stakeholder” groups. As far as I can tell, this approach has produced little beyond a large number of meetings.

Response: The committee recognizes that the creation of an interagency committee in and of itself does not necessarily lead to success. Political will is the primary factor that will drive a strong attempt to achieve reductions in Nr.

3. In the discussion of approaches to address N from agriculture, I suggest that committee find a different term than “best management practice.” BMP is a specific term used by USDA and especially NRCS to refer to a specific set of

practices and specific ways of undertaking those practices. I think the committee wants to think about a more general term that encompasses all ways in which agriculture can reduce its environmental impacts. For example, most farmers would not think of idling land or adding a wetland as a BMP yet it could be a very cost-effective from society's perspective for addressing N. "Conservation practices," or "N Control Strategies," are two possible options, there may be other, better ones.

Response: The committee did consider both idling farmland (or shifting to less leaky farmland) as well as wetland creation. We will look at where BMP was used and see if we can clarify.

4. I also urge the committee to consider whether there is something more or different they can say on the topic of BMPs that goes beyond business as usual. The call to "develop the scientific understanding required for identifying BMPs ..." on page 16, lines 10-11 is fairly standard fare and there have been many reports for decades that have called for such actions. Most conservation programs in agriculture (which have been around for decades) are based on implementing these practices. It would be easy for those in the agricultural conservation community to read these recommendations and think that they are already being implemented.

Response: The committee did consider both idling farmland (or shifting to less leaky farmland) as well as wetland creation. We do not think there is enough effort placed on developing the understanding required for BMPs, even though some of this has been done for a long time. One concern we have here is the documented actual performance of given BMPs.

5. Rather than call for more research and understanding of the effectiveness of these conservation practices, the committee might consider whether research is needed whether the current, voluntary and incentive-based system is adequate to achieve society's environmental goals. Likewise, is the current outreach focused strategy the most cost-effective way to achieve adoption of practices? Finding #2 and the associated recommendations focus entirely on engineering or technology solutions with no discussion of economic analysis. Most of the conservation approaches considered are available, but not currently implemented. Why not suggest that EPA evaluated the likely effectiveness of alternative implementation policies: taxes, mandatory controls (e.g., banning fall fertilizer application, etc.). The report is suppose to represent an integrated approach, yet there are opportunities to call for integration of research across social, economic, and physical sciences that are not taken advantage of.

Response: This is not an either/or situation. An understanding of the technical effectiveness of the control actions is essential in the determination of the appropriateness of various approaches (command and control, subsidies and taxes, etc.) and in the subsequent adaptive management. We did not consider the effectiveness of the various institutional control approaches – which would have to be somewhat specific to location, intensity of Nr flows, and current activities causing Nr increases in the environment. We are not sure how much would be gained by generic investigation of the institutional approaches beyond what is already known for the application of specific policy actions.

6. I have not read all of the report in detail, but I have a general concern about the findings and recommendations provided. They seem uneven in how well the findings are developed and the degree to which the recommendations follow from the findings. Here are some examples, but as I said, I have not read them all in detail.
 - a. Finding #1 and its associated recommendation#1 are excellent examples of well considered and justified work.
 - b. Recommendation and findings 3 and 4 related to EISA do not show an awareness of EPA’s current efforts in this area. I understand that ORD and region 7 have work undergoing in this area. Likewise, the life cycle analysis work just completed by EPA related to biofuels would have relevant information. I am sure more is needed, but a recognition of EPA’s current work in this area would seem appropriate.

Response: We have a similar suggestion from a reviewer with respect to EPA work on ORD ecological research and will try to acknowledge this.

- c. Finding 6 and its related recommendation are not quite accurate. I am no expert, but farmers in many states are required to have “manure management plans” that, at least in theory, require them to demonstrate that they are applying manure in a sensible way. I think the committee is quite correct to target this as an area of needed improvement (and it is great to see the recognition of the needed incentive framework), but to say there are “no incentives or regulations” is probably not accurate (page 54, lines 18-19).

Response: We will change this to “very few”. Most of the state regulations are phosphorous based.

- d. Finding #7 indicates that fertilizer application to laws is not well understood. I do not think this necessarily leads to the recommendations

7a and 7b that emphasize the need to coordinate research and to promote improved efficiency and reduce N use. Why doesn't it lead to a recommendation that incentives need to be put in place to achieve the optimal amount of synthetic fertilizer use? This is a case where a tax would seem to be a very cost-effective approach.

- e. In some cases, the committee in some cases goes so far as to call for specific regulatory or programmatic approaches for which adequate justification has not been provided. For example, on page 17, the committee recommends that a "targeted construction grants program under the CWA" be assigned a high priority. This is a recommendation that not only addresses target level of reduction (0.5 – 0.8 Tg N/yr), but also a specific way to pay for it --- taxpayers via a grants program. This seems like an overly strong recommendation. Perhaps the committee really means to note that this is an example of an avenue through which these targets could be achieved rather than to suggest it as the only or right way to proceed.

Response: Items d and e above are symptomatic of the dilemma we faced about how far we should go into policy or specific actions from our findings through our recommendations. We will review these for consistency and welcome further comments from the SAB on how far we should go.

7. There is a lot of material at places in the report that appear to be unnecessary for the arguments made. The summary of USDA conservation programs and water quality trading programs are valuable information, but seem a bit secondary to the goals of the report. These seem like one example of topics that could be effectively placed in an appendix.

Response: We will look at this in terms of how germane these are to the context they are now in.

8. A pet peeve of mine. On page 12, the executive summary likens TMDLs to NAAQS which I believe to be very misleading. NAAQS provide the basis for enforceable standards, TMDLs are nothing more than an understanding of where the pollution comes from and is not an enforceable standard on their own.

Response: In the context here both provide standards and criteria – enforceable or not.

11. Dr. Taylor Eighmy:

Here are my brief responses to your request for comments. The report is an impressive piece of work. The INC is to be commended for their efforts and outcomes.

i) if the INC objectives were met;

I believe that the four objectives were met.

ii) if the report is clear and logical; and

Excellent report.

iii) if recommendations and conclusions are supported by the body of the report.

The recommendations and conclusions are supported.

12. Dr.

13. Dr.

14. Dr.