US EPA Science Advisory Board Integrated Nitrogen Committee (INC)
Public Meeting May 14-15, 2009

Committee: The SAB Integrated Nitrogen Committee (See Roster - Attachment A)

Date and Time: May 14, 2009, 8:30 a.m. to 5:30 pm and May 15, 2009, 8:30 a.m. to 12:45 p.m.

Location: Holiday Inn Georgetown, 2101 Wisconsin Avenue, NW, Washington, DC 20007

Purpose: The purpose of the teleconference is to discuss a draft report on an integrated strategy for managing reactive nitrogen

Attendees: Members of the Integrated Nitrogen Committee (INC)
Dr. James N. Galloway (Chair)
Dr. Thomas L. Theis (Vice-Chair)
Dr. Viney Aneja
Dr. Elizabeth Boyer (May 14, 2009 only)
Dr. Ellis Cowling.
Dr. Russell Dickerson
Dr. Otto C. Doering III
Dr. William Herz
Dr. Donald Hey
Dr. JoAnn S. Lighty (May 14, 2009 only)
Dr. William Mitsch
Dr. William Moomaw
Dr. Arvin Mosier
Dr. Hans Paerl
Mr. Paul Stacey

EPA SAB Staff
Dr. Angela Nugent [Designated Federal Officer, DFO)]
Dr. Vanessa Vu

Meeting Summary

(The meeting generally followed the agenda (Attachment C)

May 14, 2009:

Welcome

Dr. Angela Nugent, EPA SAB Staff Office, Designated Federal Officer, opened the public meeting and announced there were two public requests for oral comment. Dr.

Vanessa Vu, Director of the SAB Staff Office, thanked committee members for their participation and Drs. Galloway and Theis for their leadership. She noted that EPA looked forward to receiving the committee's advice on meeting the important environmental challenge of reactive nitrogen. She thanked the new DFO for planning the meeting and the expert review of the committee's draft report. She noted that the chartered SAB would be holding a public meeting on September 23-24, 2009 and expressed hope that the chartered SAB might hold a quality review of the committee's draft report at that time.

Review of agenda and purpose of meeting

Dr. James Galloway, Chair, noted that the meeting was planned as the final face-to-face meeting of the Integrated Nitrogen committee. The agenda for the two-day meeting will focus on developing a response to the comments received from external reviewers (See Attachment D for list of reviewers). A committee member asked how the reviewers were chosen. The DFO responded that the SAB Staff Office chose reviewers based on input from the committee, independent identification of experts, and use of the original short-list developed for formation of the committee. The SAB Staff Office sought technical experts on nitrogen exposure through air and water and those with expertise in risk management. Once the committee has revised the draft to respond to external reviewers' comments, the plan will be to hold two public teleconferences in July and invite EPA and stakeholder comments on that revised draft.

Public comments

Dr. Eladio Knipping from the Electric Power Research Institute (EPRI) provided brief remarks on EPRI's research involving Water Quality Trading in the Ohio River Basin and EPRI Nitrogen Research (see Attachment e)

Mr. Steve Dye of McAllister & Quinn, LLC made a brief presentation on behalf of the Ohio River Valley Sanitation Commission (see Attachment F)

General discussion of external review comments on the March 19th draft report

Dr. James Galloway initiated discussion of the comments received from seven external reviewers by asking committee members for their general reaction. He noted overall that the committee should respond to comments by indicating one of three responses: agreement and intent to change the report text; disagreement and rationale; and need to follow up with more investigation.

Members observed that comments were useful overall and provided information about what needed to be clarified in the report. One member observed two underlying themes, the role of climate change and energy use and implications for nitrogen in the environment. Another committee member noted that the report could address the energy and climate change comments by specifying the time frame of concern for the committee. If a time frame longer than 10 years is the perspective, there is much uncertainty

associated with the science. Yet another member noted that the committee could not conduct a full analysis of the interactions between the nitrogen cycle and climate. Instead, it could refer to the International Panel on Climate change scenarios and suggest research for future research to reduce nitrogen impacts, including research on climate change impacts on rainfall and intensity, which affect the nitrogen cycle. Members also discussed external comments calling for more discussion of biofuels and their implications for the nitrogen cycle.

Members then observed that several reviewers called for more discussion of the role of wetlands. Several members discussed adding text to the Executive Summary about wetlands, including a discussion of wetlands trading and text about wetlands at key points later in the report. Committee members also discussed ways in which the energy issue and wetlands interrelate. As more regulations dictate more wastewater treatment plants, more energy will be consumed. In his view, wetlands offer a less energy-intensive ways to address issues and the committee's report should address that issue.

Dr. Vu noted that the Executive Summary should communicate more clearly why the SAB is undertaking the topic of reactive nitrogen and the limitations of EPA's current management efforts. She suggested that the Executive Summary focuses too much on the nitrogen cascade and instead should discuss more of the policy context.

A member responded that the Executive Summary should highlight the concept of critical load assessments more clearly. Several member voiced concern about strengthening the discussion of the critical loads finding and locating that finding, recommendation, and justification in the right place in the report. Another member observed that the Executive Summary should quantify the problem presented by reactive nitrogen, i.e., how many people are dying because of nitrogen, effects on impacted lakes, and ecosystem services. Yet another member agreed that the committee could better explain how the current "stovepiped" approach is not adequate to address the real problem and therefore there is a need to address the issue in a more integrated way.

The chair summed up the discussion by identifying the major themes he heard in the conversation: 1) climate change; 2) energy use; 3) wetlands; 3) communicate the regulatory approach recommendations more clearly in the Executive Summary and give the rationale for them; 4) discuss the impacts on ecosystem services and build that thread through the existing structure of report; and 5) quantification of cost in terms of human and ecosystem health impacts.

Members then discussed how they should consider the timescale for report recommendations and the political dimension of the report recommendations. The committee chair and Dr. Vu spoke of the need for the committee to focus on the science of nitrogen to address how management of nitrogen could be better managed and not to focus on the politics associated with the issue. If there is variability or uncertainty associated with one or more risk management options, the report should identify that uncertainty.

Discussion of specific external review comments

The committee proceeded to discuss external review comments and plans for revision, chapter by chapter of the main body of the report and appendices. In response to the request of the chair, the committee developed a consensus response to each external review comment and also identified action items to assist in developing the next draft of the report. Attachment G contains a summary of the action items with responses to external review comments compiled by chapter/section and reviewer**.**

Summary

In concluding the work of the committee for the day, Dr. Galloway asked Dr. Andrew Manale (EPA, Office of Policy, Economics and Innovation) to provide the committee with a brief introduction to EPA's "Nitrogen Backgrounder," a set of Powerpoint Slides provided on March 13, 2009 to the DFO for posting on the SAB Web site. Mr. Manale noted that the slide presentation was developed to provide EPA managers with an introduction to integrated nitrogen issues and drew the committee's attention to the different definition of reactive nitrogen used in the "Backgrounder," as compared to the INC draft report. The chair asked INC members to read through the "Backgrounder" prior to committee discussion on May 15, 2009.

The committee recessed for the day at 5:15 p.m.

May 15, 2009

The DFO reconvened the meeting at 8:30 a.m. The chair expressed appreciation for the progress made addressing reviewers' comments. The committee discussed specific external reviewers' comments related to the Executive Summary and then turned to a discussion of

Committee members briefly discussed the "Nitrogen Backgrounder" provided by the Agency. The DFO noted that she had contacted Mr. Manale and his managers to enquire whether they would like formal advice from the SAB on the "Backgrounder." The SAB Staff Office has not received a response to this enquiry. Several committee members asked the DFO to ask Mr. Manale to articulate in writing EPA's rationale for initiating the "Backgrounder" and the key questions it was attempting to address. Members also expressed concern over the different definitions of reactive nitrogen used by the "Backgrounder" and the INC report. The chair noted that EPA's exclusion of nitrous oxides was problematic.

Discussion of schedule for developing the next draft of the INC report

At the request of the chair, the DFO provided an overview of the proposed schedule for revising the INC report for chartered SAB quality review September 23-24, 2009. She noted that the proposed schedule (Attachment H) required revisions of the document prior to two public teleconferences tentatively planned for July 8 and 9, which

would focus on providing opportunities for EPA and stakeholders interest in the reactive nitrogen issue to comment on the committee's draft recommendations. This schedule is ambitious and will require all revised sections of report to be provided to the DFO by June 15. Committee members agreed to meet this schedule. Dr. Galloway noted that if the committee did not complete drafts in time to prepare for the September meeting of the chartered SAB, the INC report could be sent for quality review at a later date.

Discussion of publication of INC findings in a peer-reviewed publication

The committee agreed that it would be desirable to publish the INC findings in a peer reviewed publication. The committee discussed several options and agreed to seek publication of a review article in a journal with wide distribution. Options discussed were: *Frontiers in Ecology*, *Environmental Science & Technology*, or *Science*.

At the request of the chair, the DFO adjourned the meeting at 12:45 p.m.

Respectfully Submitted:	Certified as True:
/Signed/	/Signed/
Angela Nugent Designated Federal Official	Dr. James N. Galloway, Chair SAB Integrated Nitrogen Committee

List of Attachments

Attachment A: Roster of the SAB Integrated Nitrogen Committee

Attachment B: Federal Register Notice

Attachment C: Meeting Agenda

Attachment D: List of External Reviewers

Attachment E: Presentation by Dr. Eladio Knipping of the Electrical Power Research Institute on Water Quality Trading in the Ohio River Basin and EPRI Nitrogen Research

Attachment F: Presentation by Mr. Steve Dye of McAllister & Quinn, LLC on behalf of the Ohio River Valley Sanitation Commission

Attachment G: Action Items from May 14-15, 2009 SAB Integrated Nitrogen Committee Meeting with responses to external review comments compiled by chapter/section and reviewer for the 3/19/09 Draft Report, *Reactive Nitrogen in the United States: An Analysis of Inputs, Flows, Consequences, and Management Options*

Attachment H: Proposed schedule for completing the INC report

Attachment A:

U.S. Environmental Protection Agency
Science Advisory Board
Integrated Nitrogen Committee

CHAIR
Dr. James Galloway, Professor, Department of Environmental Sciences, University of Virginia, Charlottesville, VA

VICE CHAIR
Dr. Thomas L. Theis, Director, Institute for Environmental Science and Policy, University of Illinois at Chicago, Chicago, IL

MEMBERS
Dr. Viney Aneja, Professor, Department of Marine, Earth, and Atmospheric Sciences, School of Physical and Mathematical Sciences, North Carolina State University, Raleigh, NC

Dr. Elizabeth Boyer, Associate Professor, School of Forest Resources and Assistant Director, Pennylvania State Institutes of Energy & the Environment, and Director, Pennsylvania Water Resources Research Center, Pennsylvania State University, University Park , PA

Dr. Kenneth G. Cassman, Professor, Department of Agronomy and Horticulture , Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln, NE

Dr. Ellis B. Cowling, University Distinguished Professor At-Large Emeritus, Colleges of Natural Resources and Agriculture and Life Sciences, North Carolina State University, Raleigh, NC

Dr. Russell R. Dickerson, Professor and Chair, Department of Meteorology, The University of Maryland, College Park, MD

Dr. Otto C. Doering III, Professor, Department of Agricultural Economics, Purdue University, W. Lafayette, IN

Mr. William Herz, Vice President for Scientific Programs, The Fertilizer Institute, Washington, DC

Dr. Donald L. Hey, President of The Wetlands Initiative and Director , Wetlands Research, Inc, Chicago, IL

Dr. Richard Kohn, Professor, Animal Sciences Department, University of Maryland, College Park, MD

Dr. JoAnn S. Lighty, Chair and Professor, Chemical Engineering, University of Utah, Salt Lake City, UT

Dr. William Mitsch, Professor, Olentangy River Wetland Research Park, The Ohio State University, Columbus, OH

Dr. William Moomaw, Professor of International Environmental Policy and Director of the Center for International Environment and Resource Policy, The Fletcher School of Law and Diplomacy, Tufts University, Medford, MA

Dr. Arvin Mosier, Visiting Professor, Agricultural and Biological Engineering Department, University of Florida, Mount Pleasant, SC

Dr. Hans Paerl, Professor of Marine and Environmental Sciences, Institute of Marine Sciences, University of North Carolina - Chapel Hill, Morehead City, NC

Dr. Bryan Shaw, Commissioner, Texas Commission on Environmental Quality, Austin, TX

Mr. Paul Stacey, Director, Bureau of Water Management and Land Reuse, Planning and Standards Division, Connecticut Department of Environmental Protection, Hartford, CT

SCIENCE ADVISORY BOARD STAFF

Dr. Angela Nugent, Designated Federal Officer, 1200 Pennsylvania Avenue, NW 1400F, Washington, DC, Phone: 202-343-9981, Fax: 202-233-0643, (nugent.angela@epa.gov)

Attachment B: Federal Register Notice

Science Advisory Board Staff Office; Notification of a Public Meeting of the Science Advisory Board Integrated Nitrogen Committee
PDF Version (2 pp, 73K, About PDF)

[Federal Register: April 15, 2009 (Volume 74, Number 71)]
[Notices]
[Page 17482-17483]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr15ap09-74]

ENVIRONMENTAL PROTECTION AGENCY
[FRL-8892-6]

Science Advisory Board Staff Office; Notification of a Public Meeting of the Science Advisory Board Integrated Nitrogen Committee

AGENCY: Environmental Protection Agency (EPA).
ACTION: Notice.

SUMMARY: The EPA Science Advisory Board (SAB) Staff Office announces a public meeting of the SAB Integrated Nitrogen Committee (INC) to discuss the committee's draft report.

DATES: The SAB INC will conduct a public meeting on May 14-15, 2009. The meeting will begin at 9 a.m. Eastern Time on May 14, 2009 and adjourn no later than 5:30 p.m. The meeting will begin at 8:30 a.m. on May 15, 2009 and adjourn no later than 3 p.m.

ADDRESSES: Holiday Inn Georgetown, 2101 Wisconsin Avenue, NW., Washington, DC 20007.

FOR FURTHER INFORMATION CONTACT: Any member of the public wishing to obtain general information concerning the public meeting may contact Dr. Angela Nugent, Designated Federal Officer (DFO), via telephone at: (202) 343-9981 or e-mail at nugent.angela@epa.gov. General information concerning the EPA Science Advisory Board can be found on the EPA Web site at http://www.epa.gov/sab.

SUPPLEMENTARY INFORMATION: The SAB was established by 42 U.S.C. 4365 to provide independent scientific and technical advice, consultation, and recommendations to the EPA Administrator on the technical basis for Agency positions and regulations. The SAB is a Federal Advisory

Committee chartered under the Federal Advisory Committee Act (FACA), as amended, 5 U.S.C., App. The SAB will comply with the provisions of FACA and all appropriate SAB Staff Office procedural policies.

Background: The SAB INC is studying the need for integrated research and strategies to reduce reactive nitrogen in the environment. At the global scale, reactive nitrogen from human activities now exceeds that produced by natural terrestrial ecosystems. Reactive nitrogen both benefits and impacts the health and welfare of people and ecosystems. Scientific information suggests that reactive nitrogen is accumulating in the environment and that nitrogen cycling through biogeochemical pathways has a variety of consequences. Information about the committee's previous

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meetings is available on the SAB Web site at http://yosemite.epa.gov/sab/sabproduct.nsf/fedrgstr_activites/Nitrogen%20Project.

The purpose of the meeting is for the SAB INC to discuss the committee's draft report addressing the environmental problems presented by reactive nitrogen and providing recommendations related to an integrated nitrogen management strategy.

Availability of Meeting Materials: Agendas and materials in support of the meeting will be placed on the SAB Web site at http://www.epa.gov/sab in advance of each teleconference.

Procedures for Providing Public Input: Interested members of the public may submit relevant written or oral information for the SAB INC to consider during the advisory process. Oral Statements: In general, individuals or groups requesting an oral presentation at a public face-to-face meeting will be limited to three minutes per speaker, with no more than a total of one hour for all speakers. Each person making an oral statement should consider providing written comments as well as their oral statement so that the points presented orally can be expanded upon in writing. Interested parties should contact the DFO, in writing (preferably via e-mail) at the contact information noted above, by May 7, 2009 to be placed on the list of public speakers for the meeting. Written Statements: Written statements should be received in the SAB Staff Office by May 7, 2009 so that the information may be made available to the Committee members for their consideration. Written statements should be supplied to the DFO in the following formats: one hard copy with original signature, and one electronic copy via e-mail (acceptable file format: Adobe Acrobat PDF, MS Word, MS PowerPoint, or Rich Text files in IBM-PC/Windows 98/2000/XP format). Submitters are requested to provide versions of each document submitted with and without signatures, because the SAB Staff Office does not publish documents with signatures on its Web sites.

Accessibility: For information on access or services for individuals with disabilities, please contact Dr. Angela Nugent at (202) 343-9981 or nugent.angela@epa.gov. To request accommodation of a

disability, please contact Dr. Nugent preferably at least ten days prior to the teleconferences to give EPA as much time as possible to process your request.

Dated: April 9, 2009.
Vanessa T. Vu,
Director, EPA Science Advisory Board Staff Office.
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Attachment C: Meeting Agenda

U.S. Environmental Protection Agency – Science Advisory Board (SAB) Staff Office
Science Advisory Board (SAB)
Integrated Nitrogen Committee
Public Meeting
May 14-15, 2009
Holiday Inn Georgetown, 2101 Wisconsin Avenue, NW.,
Washington, DC 20007

Meeting Agenda

Purpose: to discuss plans for revisions to the committee's draft report. The goal of the report is to address the environmental problems presented by reactive nitrogen and provide recommendations related to an integrated nitrogen management strategy.

May 14, 2009

8:30 a.m.	Welcome	*Dr. Angela Nugent, EPA SAB Staff Office, Designated Federal Officer* *Dr. Anthony Maciorowski, EPA, SAB Staff Office*
8:40 a.m.	Review of agenda and purpose of meeting	*Dr. James Galloway, Chair*
8:50 a.m.	Public comments	*To be announced*
9:00 a.m.	General discussion of external review comments and the March 19th draft report	*Dr. James Galloway, discussion leader* *Committee members*
10:15 a.m.	Break	
10:30 a.m.	*Chapter 1 Introduction* : discussion of external review comments and plans for revision Lead for revisions: Dr. James Galloway	*Dr. Thomas Theis, discussion leader* *Committee members*
11:00 a.m.	*Sections 2.1 and 2.2: Sources of reactive nitrogen (Nr) new to the environment*: discussion of external review comments and plans for revision Co-Leads for revisions: Drs. Viney Aneja and Kenneth Cassman	*Dr. William Moomaw, discussion leader* *Committee members*
12:00 p.m.	Lunch	

1:15 p.m.	*Section 2.3: Nr Transfer and transformation:* discussion of external review comments and plans for revision Lead for revisions: Drs. Russell Dickerson and Arvin Mosier	*Dr. Elizabeth Boyer, discussion leader* *Committee members*
2:15 p.m.	*Section 2.4: Impacts, metrics, and current risk reduction strategies:* discussion of external review comments and plans for revision Co-Leads for revisions: Drs. William Moomaw and Thomas Theis	*Dr. Viney Aneja, discussion leader* *Committee members*
3:15	Break	
3:30 p.m.	*Chapter 3: Integrated Risk Reduction Strategies:* discussion of external review comments and plans for revision Lead for revisions: Dr. Thomas Theis	*Dr. Otto Doering, discussion leader* *Committee members*
4:45 p.m.	Appendices: discussion of plans for revision	*Dr. Hans Paerl, discussion leader* *Committee members*
5:15 p.m.	Discussion of plans for May 15, 2009	*Dr. James Galloway*
5:30 p.m.	*Adjourn for the day*	

May 15, 2009

8:30 a.m.	Reconvene the meeting	Dr. Angela Nugent
8:35 a.m.	Summary of discussions and identification of issues for further discussion	Dr. James Galloway
9:30 a.m.	*Executive Summary*: discussion of external review comments and plans for revision Lead for revisions: Dr. James Galloway	Dr. Arvin Mosier, discussion leader Committee members
10:30 a.m.	Break	
10:45 a.m.	Committee discussion of report revisions	Committee
11:30 a.m.	Working lunch	
12:30 p.m.	Identification of next steps	Dr. James Galloway
1:00 p.m.	Adjourn the meeting	

Attachment D: List of External Reviewers

List of External Reviewers for the March 19, 2009 INC Report

Dr. John W. Day, Jr.
Distinguished Professor
Department of Oceanography and Coastal Sciences
Louisiana State University- Baton Rouge

Dr. Elisabeth Holland
Scientist III and Leader NCAR Biogeosciences Program
The Institute for Integrative and Multi-Disciplinary Earth Studies
Atmospheric Chemistry Division
National Center of Atmospheric Research

Dr. Gregory McIsaac
Assistant Professor, Ecosystem Management
Department of Natural Resources and Environmental Sciences
University of Illinois -Urbana/Champaign

Dr. Jerry Mellilo
Director and Senior Scientist
The Ecosystems Center
Marine Biological Laboratory
Woods Hole, MA

Dr. Gyles W. Randall
Soil Scientist and Professor
Southern Research & Outreach Center
University of Minnesota

Dr. James J. Schauer
Professor
Civil and Environmental Engineering Department
University of Wisconsin-Madison

Dr. Stuart Weiss
Chief Scientist
Creekside Center for Earth Observations
Menlo Park, CA

Attachment E: Presentation by Dr. Eladio Knipping of the Electrical Power Research Institute on Water Quality Trading in the Ohio River Basin and EPRI Nitrogen Research

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Water Quality Trading in the Ohio River Basin and EPRI Nitrogen Research

May 14, 2009
Washington, D.C.

Eladio Knipping
Senior Technical Manager

Jessica Fox
Project Manager

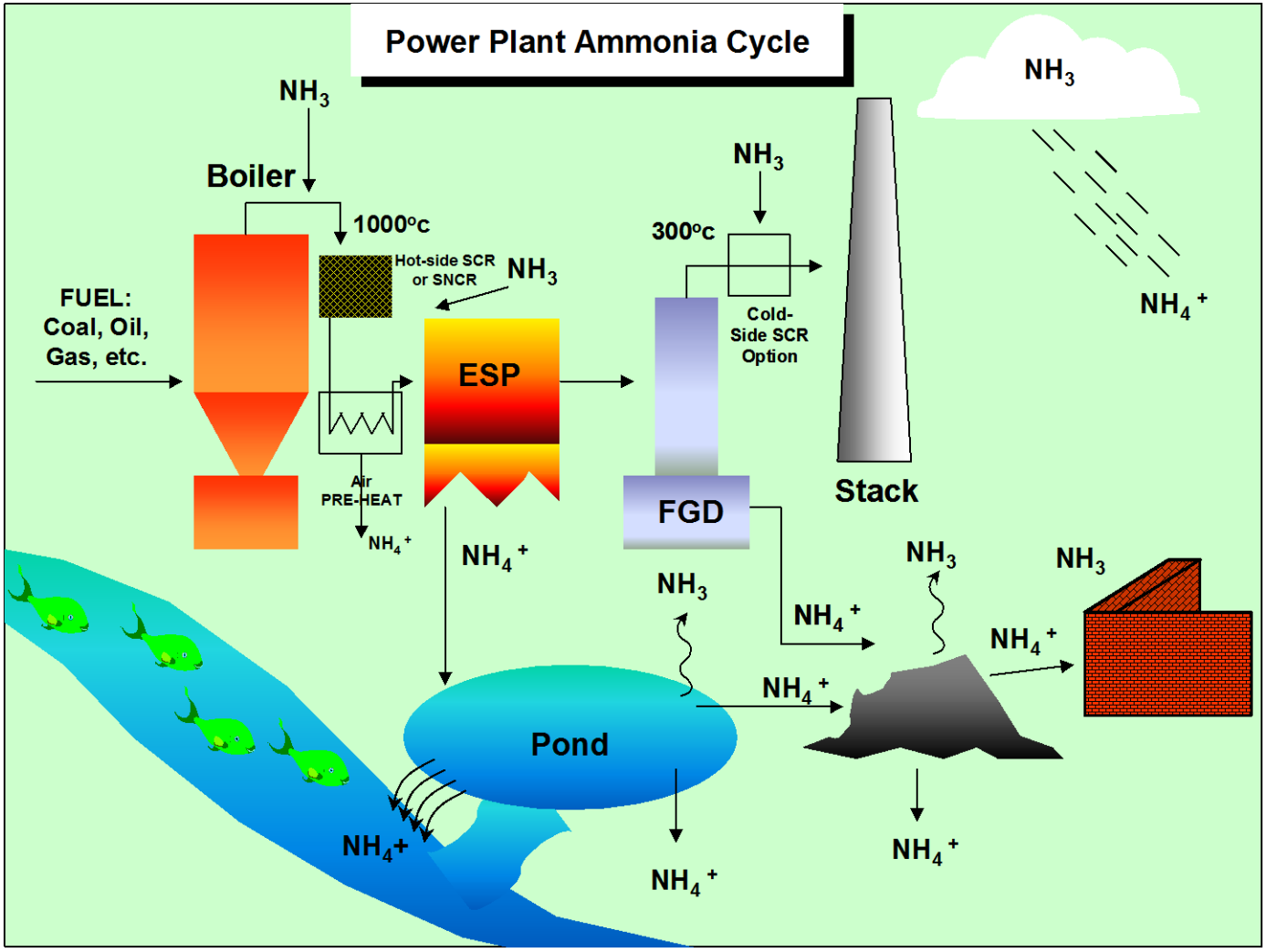
EPRI's Interest in WQT

- EPRI wants to establish a project where power companies will participate as buyers and/or sellers of nitrogen credits.
- Such a project will allow power companies manage their nitrogen discharge with WQT.
- Project will serve as a model for other trading programs in the U.S.

Rationale

- N load from power plants may increase in near future
  - Selective Catalytic (and Non-Catalytic) Reduction (SCR, SNCR)
  - Flue Gas Desulfurization (FGD)
  - CO_2 scrubbing (amine or ammonia based sorbents)
- New NPDES permits may have more stringent limits on N discharges
- Potential reduction in cost of compliance by trading N & P loads with other sources

Nitrogen in Power Plants



Power Plant Ammonia Pathways

Characteristics of Successful Water Quality Trading Programs

- Approximately 80 WQT pilot projects, feasibility assessments, and trading programs have been conducted throughout the U.S. in the last 15 years.
- Few have resulted in actual trades.
- These projects, assessments, and programs provide lessons regarding characteristics that may promote or hinder success of WQT.

- Considered WQT Pilot Programs in:
  - Ohio River Basin
  - Chesapeake Bay
  - Catawba River Basin

EPRI Report: Water Quality Trading Programs Pilot Project Review

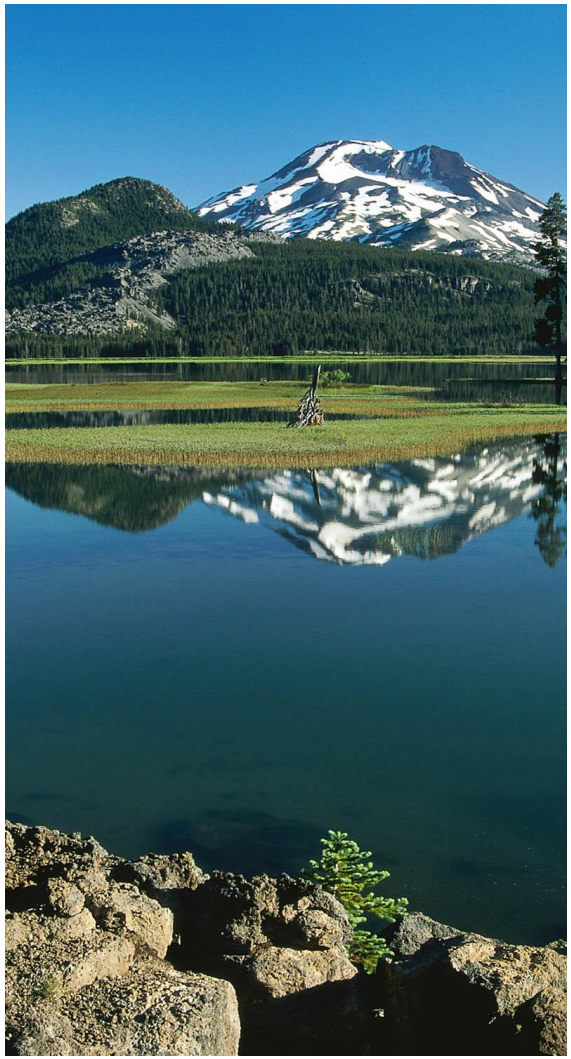
Screening Criteria	Ohio River	Chesapeake Bay	Catawba River Basin
Pollution cap - measurable and restrictive	□	□	○
Type	□	□	○
Timing	□	□	□
Nutrient discharge regulations	□	□	○
Nitrogen	□	□	○
Phosphorus	□	□	□
Permitting cycle	□	○	□
High Compliance Costs	□	□	□
High variability in pollution control costs	□	○	□
PS - Facilities with high impending treatment costs	□	□	□
NPS – Reduction costs	□	○	○
Basis for strong credit supply and demand	□	○	○
Baseline for PS and NPS (% reduction for all sources)	□	□	□
Industry mix	□	○	□
Seed funding (multiple potential funding sources)	□	○	□
Program champion	□	□	□
Lead identified	□	□	□
Supporting organizations identified	□	○	○
Conducive regulatory environment	□	○	○
Interstate Coordination	□	○	○
Organizations	□	○	□
Regulatory authority	□	□	○
Stakeholder Willingness	□	○	○
Buyers	○	○	○
Sellers	□	○	○
Public	○	□	○
Methods for calculating pollutant equivalency	○	□	○
Modeling for load allocations	○	□	○
Modeling	□	□	○
WQ Data	□	□	□

Prepared By Shaw Environmental

Ohio River Basin Chosen

- High nutrient loading
- Pending regulatory program will create potential
- WQT credit demand
- Presence of multiple sources of N & P
- Regulatory climate favorable to WQT
- Presence of numerous coal-fired power plants with potential or actual N loads
- Many stakeholders: Farmers, WWTP, Power Industry
- Links to Gulf of Mexico Hypoxia issues

Project Collaboration



Electric Power Research Institute

Kieser & Associates

Ohio River Valley Water Sanitation Commission (ORSANCO)

American Electric Power

Duke Energy

American Farmland Trust

Miami Conservancy District

UC Santa Barbara

Hunton & Williams

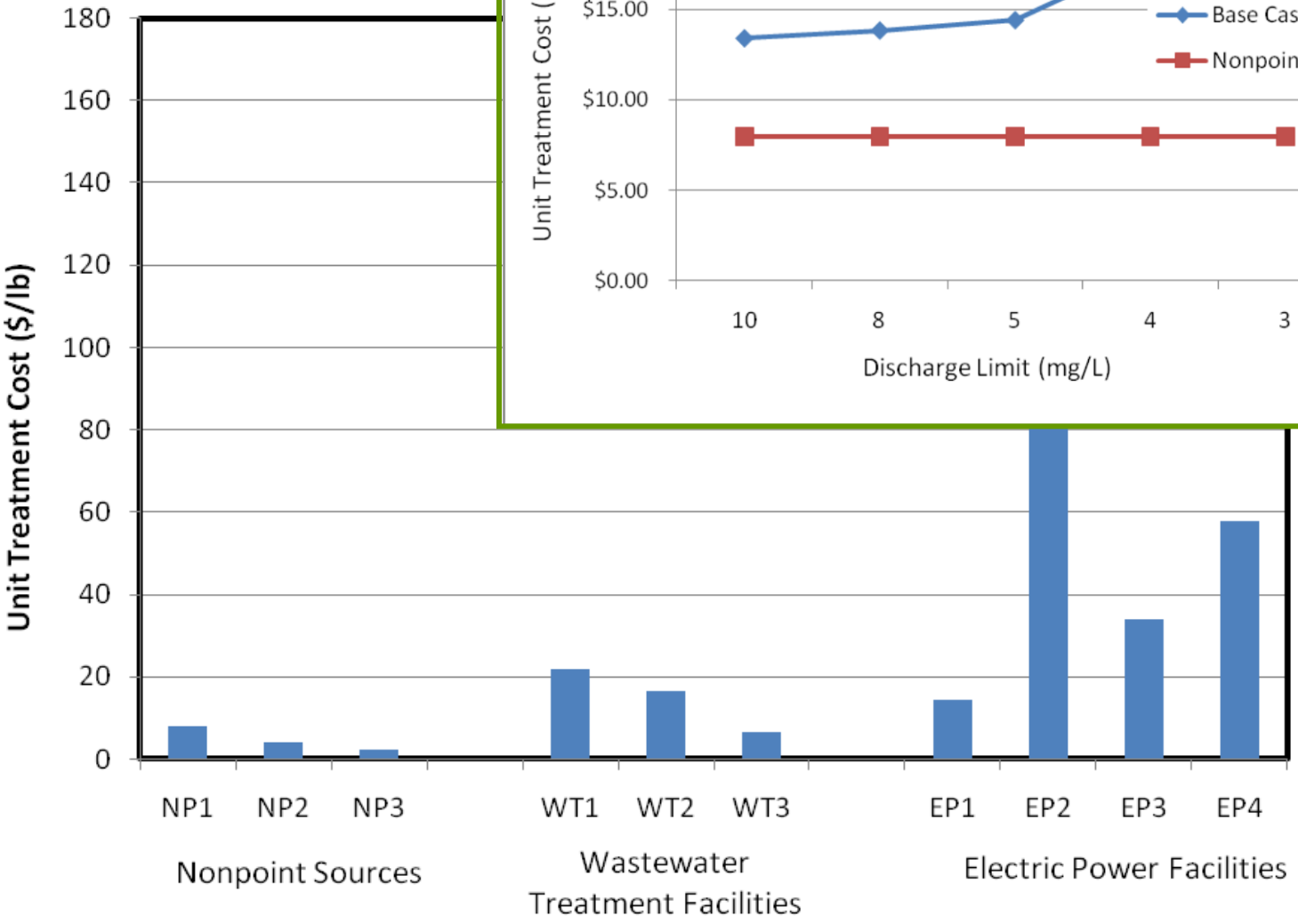
Ohio River Trading Program Goals

- Participants will achieve cost-effective outcomes
- Add WQT trading to the toolbox of large set of stakeholders
- Ecosystem Service Benefits
- Regional Effort
- Collaborative process
- 3-5 years to established program (trading in 1-2 yrs)

Trading Types

- **Point/Point** - Point source pays another point source for reduction credits
- **Point/Nonpoint** - Permitted and non-permitted sources with voluntary (market driven) credit generation
- **Non-point/nonpoint** - Regulated nonpoint source such as municipal storm water permittees and unregulated nonpoint sources such as agriculture

Treatment Costs



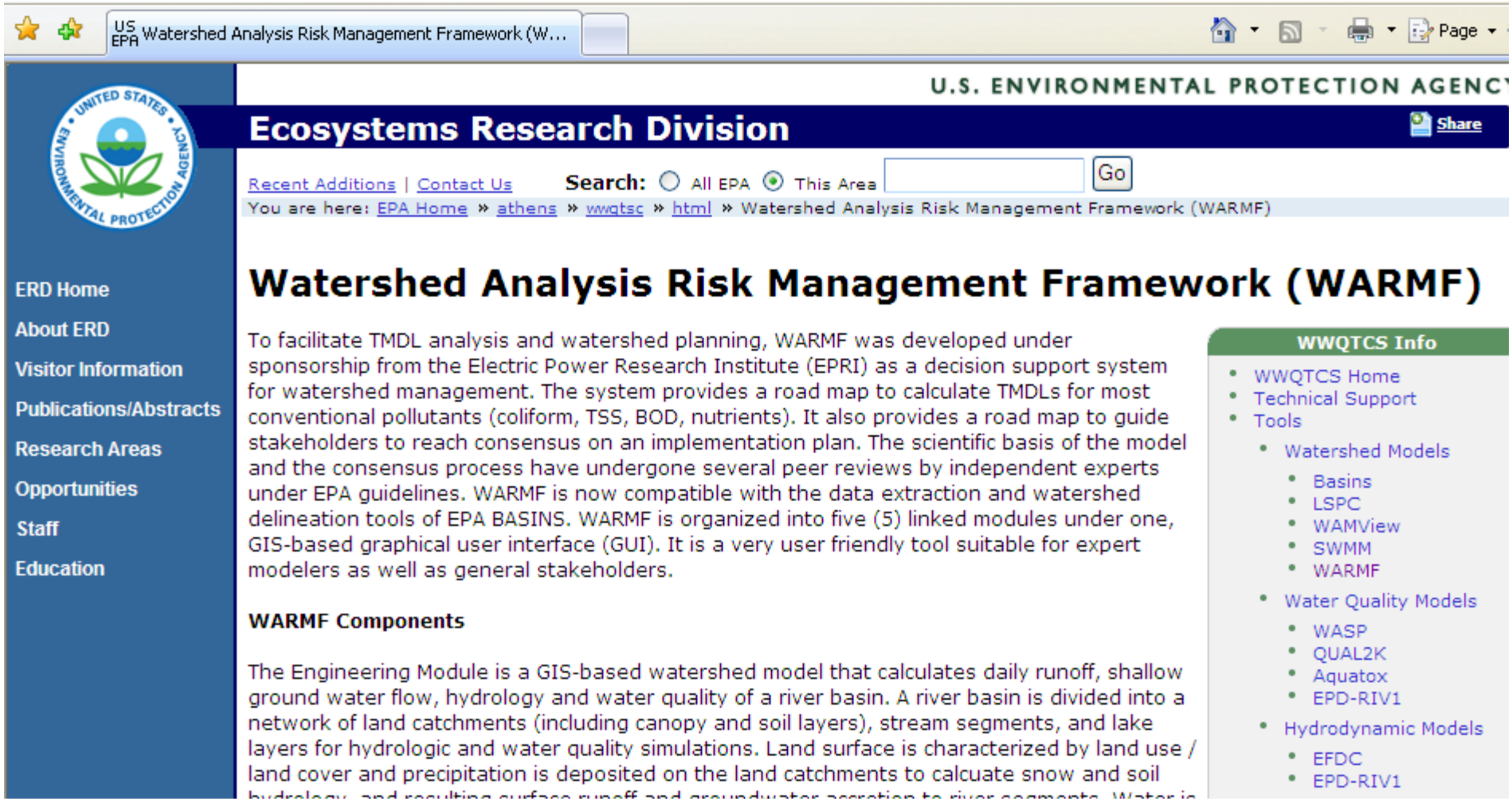
Source: EPRI Business Case, Prepared by Shaw Environmental and Kieser & Associates

Watershed Modeling

Watershed Analysis Risk Management Framework (WARMF)

Dr. Arturo A. Keller, Ph.D.
Bren School of Environmental Science & Management
University of California, Santa Barbara

Download WARMF from EPA



Types of Analyses

- Modeling nutrient fate and transport within the basin
- Evaluating effectiveness of BMPs at different scales
- Studying the effects of specific nutrient trades
- Evaluating different "what if" scenarios that the stakeholders would like to try
- Informs key technical questions (trading ratios, discounting)
- Helps to evaluate potential ecological benefits of trading programs
- Helps to develop and inform a water quality monitoring program

Investigating Credit Stacking with GHGs

Adam Diamant, EPRI Global Climate Program

- Demonstrating the potential to achieve large scale, cost-effective GHG emissions offsets by reducing N_2O emissions from agricultural crop production.

- EPRI developed this project in collaboration with one of the world's foremost experts on non-CO_2 GHG emissions from agriculture:

  Dr. Phil Robertson,
  Professor of Crop and Soil Sciences
  Michigan State University (MSU).

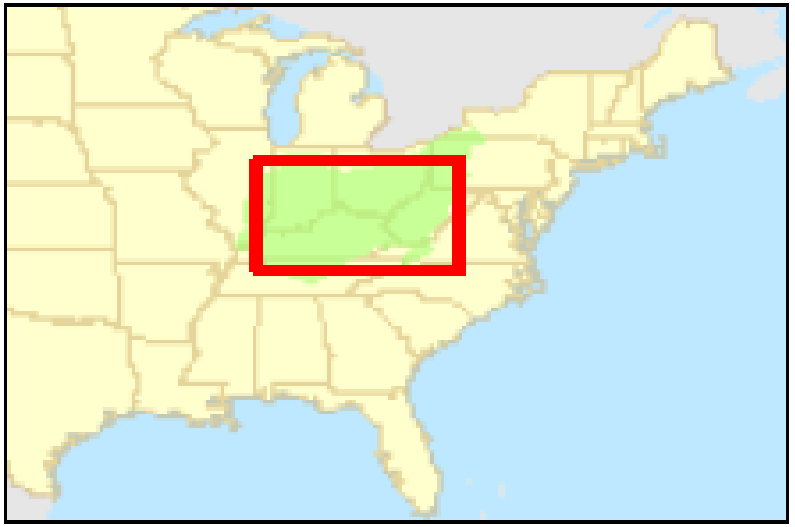
Benefits of Regional WQT Program

- Save millions of dollars in future start-up and program costs (compared to many small, localized trading programs)
- Allow point sources with multiple discharges to manage compliance needs under one primary trading framework
- Incentivize non-point source load reductions
- Provide uniformity in credit calculations across basin
- Legal framework for interstate trading
- Support nutrient standards development with modeling applications and flexible compliance tools
- Centralize trading debate/program design efforts to facilitate multi-state communication

Flexible, cost-effective compliance options with greater net environmental benefits

Project Summary

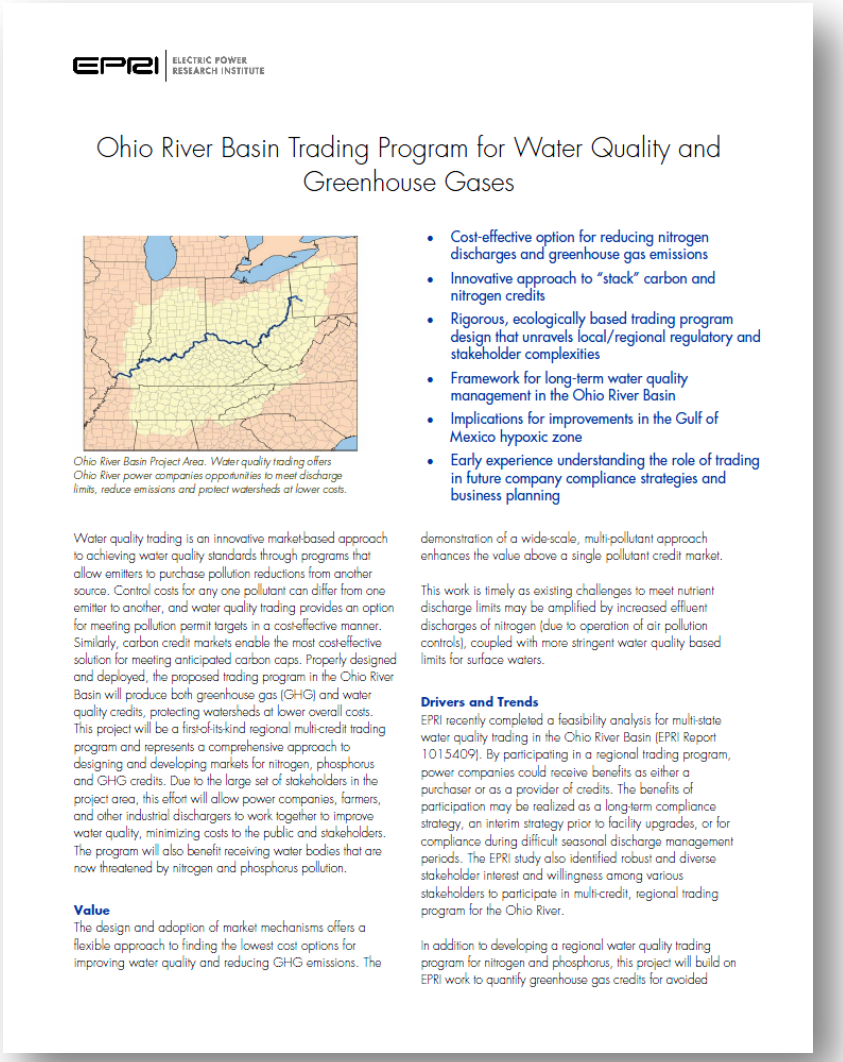
- Due to the large set of stakeholders in the project area, this effort will allow **power companies, farmers, and other industrial dischargers** to work together to improve water quality, minimizing costs to the public.



- This project will be a regional multi-credit trading program and represents a comprehensive approach to designing and developing markets for **nitrogen, phosphorus and potentially GHG credits**.

Supplemental Project (1018855)

- Organization and Facilitation of Stakeholder Group
- Support Trading Program Design
- Continue Watershed Modeling (WARMF)
- Evaluation of Credit Stacking with Carbon and Water quality credits



EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Ohio River Basin Trading Program for Water Quality and Greenhouse Gases

Ohio River Basin Project Area. Water quality trading offers Ohio River power companies opportunities to meet discharge limits, reduce emissions and protect watersheds at lower costs.

- Cost-effective option for reducing nitrogen discharges and greenhouse gas emissions
- Innovative approach to "stack" carbon and nitrogen credits
- Rigorous, ecologically based trading program design that unravels local/regional regulatory and stakeholder complexities
- Framework for long-term water quality management in the Ohio River Basin
- Implications for improvements in the Gulf of Mexico hypoxic zone
- Early experience understanding the role of trading in future company compliance strategies and business planning

Water quality trading is an innovative market-based approach to achieving water quality standards through programs that allow emitters to purchase pollution reductions from another source. Control costs for any one pollutant can differ from one emitter to another, and water quality trading provides an option for meeting pollution permit targets in a cost-effective manner. Similarly, carbon credit markets enable the most cost-effective solution for meeting anticipated carbon caps. Properly designed and deployed, the proposed trading program in the Ohio River Basin will produce both greenhouse gas (GHG) and water quality credits, protecting watersheds at lower overall costs. This project will be a first-of-its-kind regional multi-credit trading program and represents a comprehensive approach to designing and developing markets for nitrogen, phosphorus and GHG credits. Due to the large set of stakeholders in the project area, this effort will allow power companies, farmers, and other industrial dischargers to work together to improve water quality, minimizing costs to the public and stakeholders. The program will also benefit receiving water bodies that are now threatened by nitrogen and phosphorus pollution.

Value

The design and adoption of market mechanisms offers a flexible approach to finding the lowest cost options for improving water quality and reducing GHG emissions. The demonstration of a wide-scale, multi-pollutant approach enhances the value above a single pollutant credit market.

This work is timely as existing challenges to meet nutrient discharge limits may be amplified by increased effluent discharges of nitrogen (due to operation of air pollution controls), coupled with more stringent water quality based limits for surface waters.

Drivers and Trends

EPRI recently completed a feasibility analysis for multi-state water quality trading in the Ohio River Basin (EPRI Report 1015409). By participating in a regional trading program, power companies could receive benefits as either a purchaser or as a provider of credits. The benefits of participation may be realized as a long-term compliance strategy, an interim strategy prior to facility upgrades, or for compliance during difficult seasonal discharge management periods. The EPRI study also identified robust and diverse stakeholder interest and willingness among various stakeholders to participate in multi-credit, regional trading program for the Ohio River.

In addition to developing a regional water quality trading program for nitrogen and phosphorus, this project will build on EPRI work to quantify greenhouse gas credits for avoided

Project Website: www.epri.com/ohiorivertrading

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Overview | Ohio River Basin Trading Pilot Project

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Water and Ecosystems Research

>> Water and Ecosystems

2009 Research Offerings

>> View the 2009 Water and Ecosystems Research Portfolio

2008 Research Summaries

>> Water Quality Criteria Development and Assessment - Program 53 (110KB PDF)

Ohio River Basin Trading Pilot Project

Control costs for any one pollutant can differ from one emitter to another. Water quality trading (WQT) is an innovative market-based approach to achieving water quality standards that allows emitters to purchase pollution reductions from another source. A trading program enables facilities facing high pollution control costs to buy reductions from another facility with lower pollution control costs. The net effect is the same water quality improvements at lower, more efficient costs. Today, a few states have trading frameworks in place or in development but none operate on an interstate or regional basis. EPRI recently completed a feasibility study for a regional water quality trading program in the Ohio River Basin and is currently working with stakeholders and trading partners to develop a working pilot project. EPRI leads this effort with support from Kieser & Associates, LLC, American Farmland Trust

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Attachment F: Presentation by Mr. Steve Dye of McAllister & Quinn, LLC on behalf of the Ohio River Valley Sanitation Commission

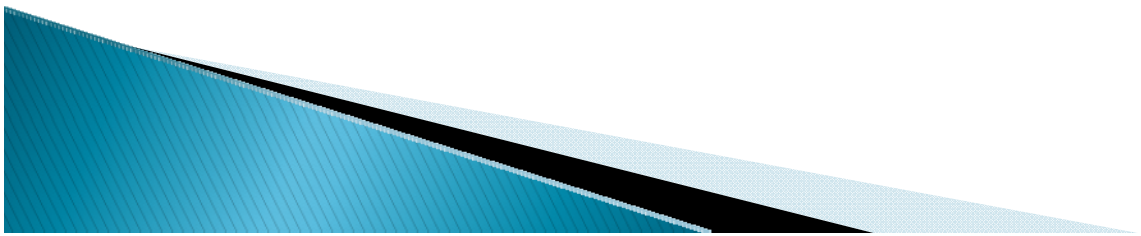
ORSANCO


OHIO RIVER VALLEY
AN INTERSTATE AGENCY
ESTABLISHED JUNE 30, 1948
WATER SANITATION COMMISSION


Ohio River Basin
Locks & Dams
NY
PA
OH
MD
IL
IN
WV
VA
KY
NC
TN

Ohio River Facts

- 981 miles long
- Formed in Pittsburgh, PA at the confluence of the Allegheny & Monongahela rivers
- Meets the Mississippi River at Cairo, IL
- Drainage basin covers 204,000 square miles



Ohio River Facts

- More than 25 million people live in the Ohio River Basin…almost 10 percent of the U.S. population
- Approximately 5 million Ohio River Basin residents get their drinking water from the Ohio.
- Over 150 species of fish live in the Ohio River and lower reaches of its tributaries.
- Over 155,000 square miles within the Ohio River watershed.

Ohio River Facts

- 20 dams on the Ohio River maintain a nine-foot minimum depth for navigation.
- 49 power generating facilities are located on the Ohio River producing more than six percent of the total U.S. generating capacity.
- More than 230 million tons of cargo are transported on the Ohio.
- Coal and other energy products make up approximately 70 percent of the commerce traveling by barge.

THIS COMPACT, Made and entered into by and between the States of Indiana, West Virginia, Ohio, New York, Illinois, Kentucky, Pennsylvania, Virginia and such additional States as may join in its execution,

APPENDIX

Approval by the Congress of the United States of America

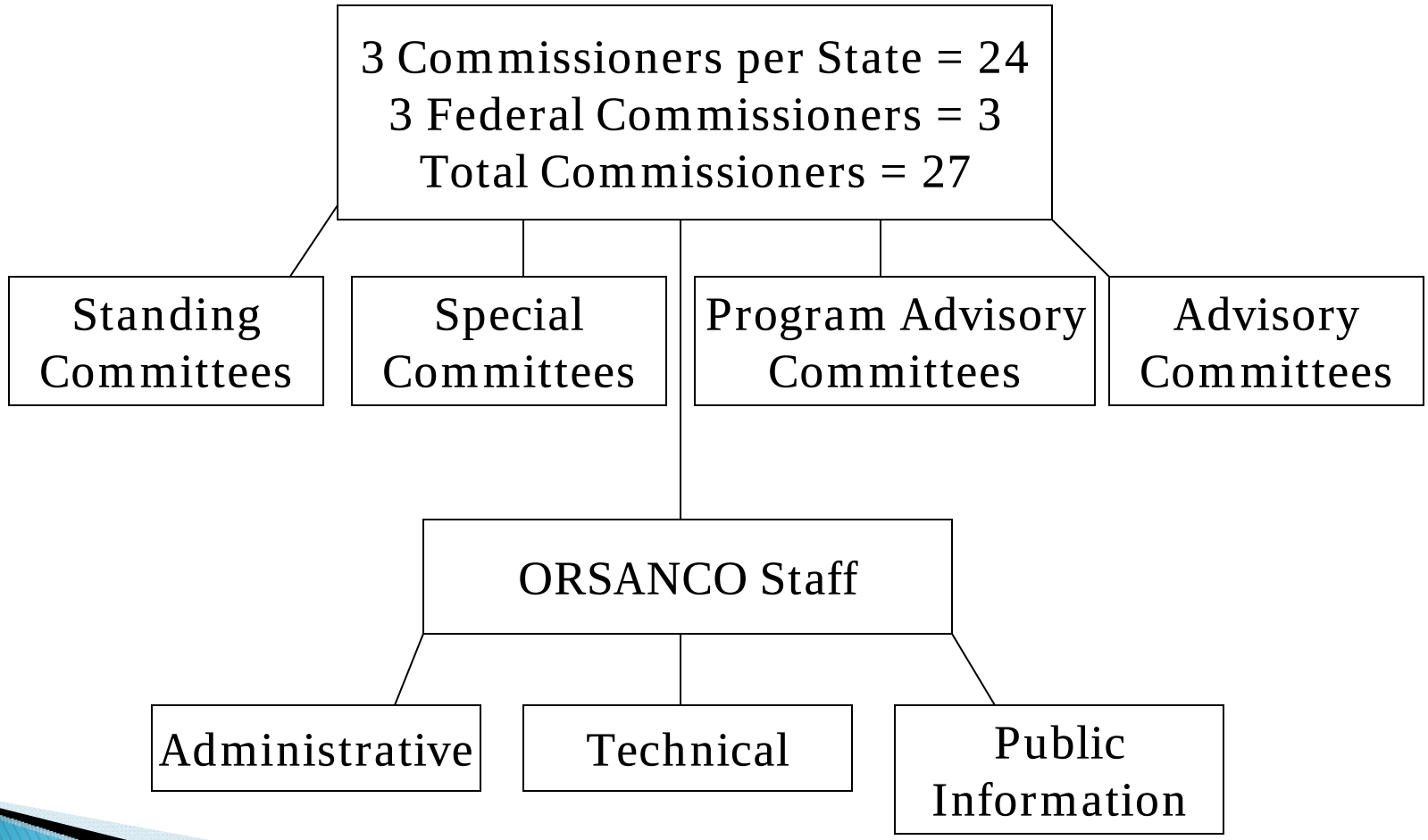
Authority to enter into the foregoing Compact was initially granted by act of the 74th Congress of the United States by Public Resolution No. 104, approved June 8, 1936, and subsequent consent to and approval thereof was expressly granted by the Congress of the United States by the following legislation:

Public—No. 739—76th Congress
Chapter 581—3rd Session
S. 3617, approved July 11, 1940

Mission of ORSANCO

- Direct action and coordination of state activities to improve water quality in the Ohio River Basin.
- Wastes discharged in one state shall not "injuriously affect" the waters of another state.
- Compact authorizes Commission to adopt rules, regulations and standards for interstate streams.

Commission Structure



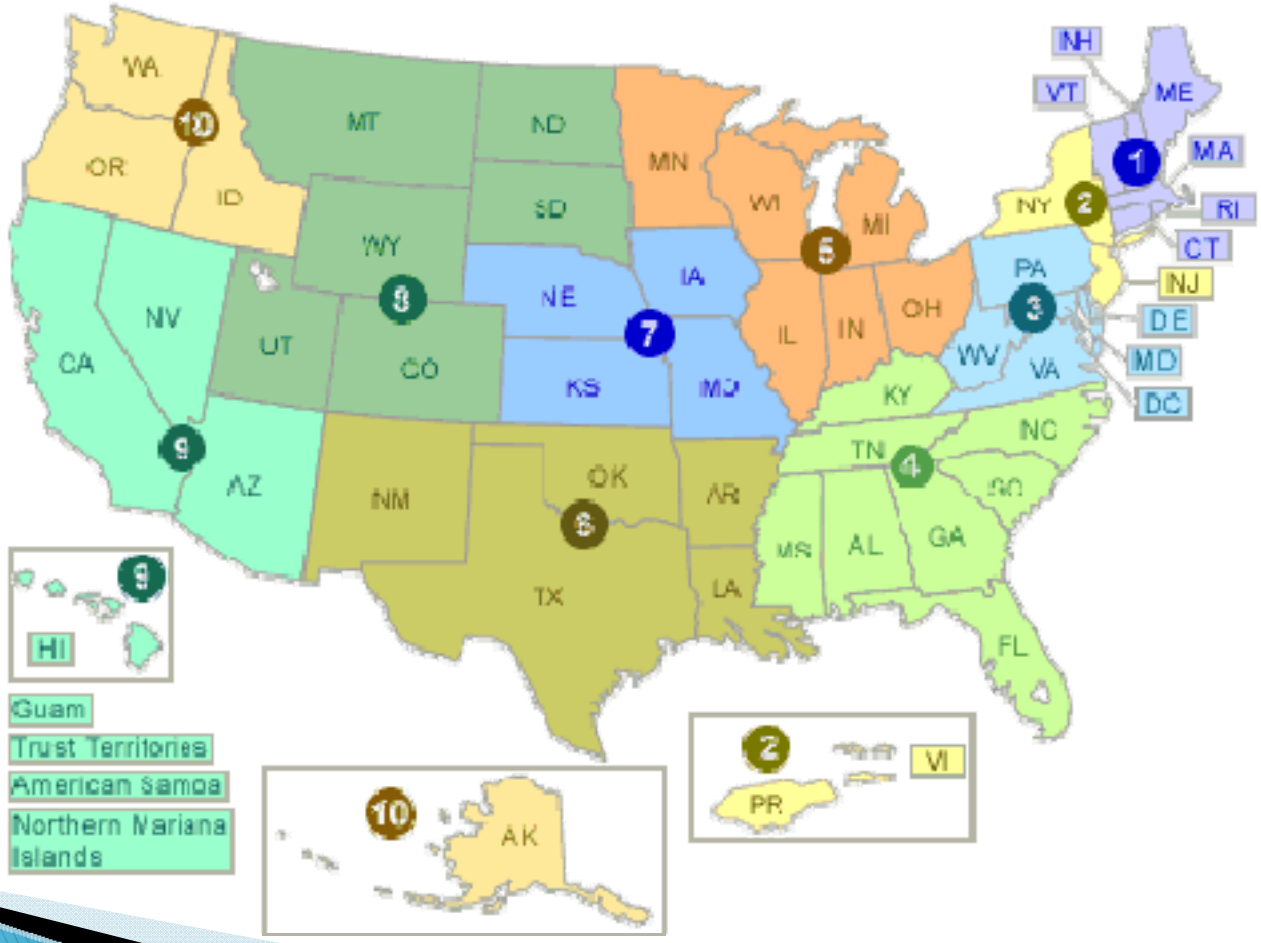
ORSANCO

- 27 Commissioners (3 from each state and 3 from federal government)
  - Each State's EPA Director is a Commissioner.
  - The other two state commissioners are appointed by the Governor.
  - Federal Commissioners are appointed by the President. Traditionally, one of the three is an EPA Regional Administrator from Region 3,4 or 5.
- Full time staff of 27

ORSANCO – cont.

- States and federal government share in operating expenses
  - $1.2 million annually from Clean Water Act Sect. 103 grant.
  - States contribute based upon amount of watershed in their jurisdiction
  - Total State contributions are about $1.3 million annually.

EPA Regions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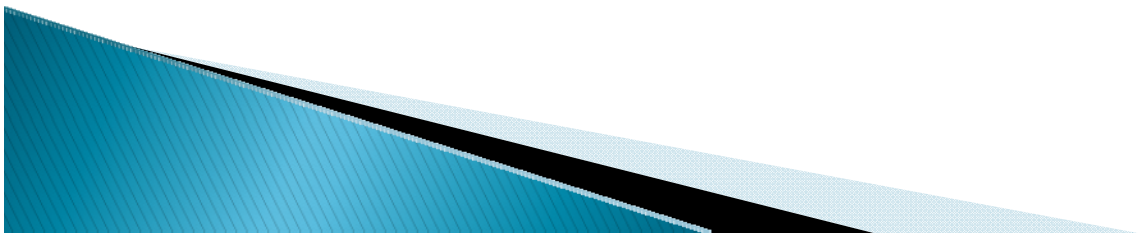
CT
NJ
DE
MD
DC
HI
Guam
Trust Territories
American Samoa
Northern Mariana Islands
AK
PR
VI

Nutrient and Algae Program

- Year round monitoring two times per month at 7 Ohio River locations
- Analyses for total Phosphorus, total Kjeldahl Nitrogen, Ammonia Nitrogen, Nitrate-Nitrite Nitrogen, Total Algae, Chlorophyl a, Turbidity
- Monitoring results are being used to develop numerical nutrient criteria for the Ohio River.



ORSANCO's Nitrogen Efforts

- In 2004 ORSANCO commits staff and resources to establish and support an Ohio River Sub-Basin Committee to implement the Action Plan to Control Gulf of Mexico Hypoxia in the Ohio River Basin.

- The U.S. EPA is the only federal agency that has provided funding towards these efforts thus far.

Sub-Basin Steering Committee

- Illinois Dept of Agriculture
- Indiana Dept of Agriculture
- Indiana Dept of Environmental Management
- Kentucky Dept of Environmental Protection
- Kentucky Division of Conservation
- Ohio Dept of Natural Resources
- Ohio EPA
- Pennsylvania Conservation Commission
- Tennessee Dept of Environmental Conservation
- West Virginia Conservation Agency
- West Virginia Dept of Agriculture
- West Virginia Dept of Environmental Protection
- ORSANCO

Attachment G: Action Items from May 14-15, 2009 SAB Integrated Nitrogen Committee Meeting with Responses to Compilation of external review comments by chapter/section and reviewer

1. INC members to review text in report and Appendix 2 (Acronyms and Abbreviations). If you think there should be more explanation for any term, send to Jim and Angela by May 22
2. Mitch,Hans, Bill M, Jim, Viney, Russ, and Ellis will send contributions to ES table by May 22 (see table below for assignments) to Jim, Tom, and Angela by May 22
3. Follow-up on responses to external reviewers' comments (see next page) so that leads/co leads (*Jim for the ES and chapter 1; Viney and Ken for sections 2.1 and 2.2; Russ and Arvin for section 2.3; Bill Moomaw and Tom for section 2.4; and Tom for Chapter 3*) will send revised drafts to Jim, Tom, and Angela **by June 15**

TABLE SHOWING EXAMPLES OF KEY DAMAGES
(for insertion in Executive Summary)

	Impact	**Cause**	**Location**	**Metric**	**Source**	**Reference**
Example	Mortality and Morbidity	Photochemical Smog	(insert location if relevant	(e.g., numbers of excess death, hospital emissions)	NO_x from fossil fuels	(insert key reference)
Mitch and Hans	Hypoxia		Gulf of Mexico			
Bill Moomaw	Hypoxia	Chesapeake Bay				
Jim		Acid Rain				
Hans	HAB	HAB				
Viney		PM				
Russ	Haze	Haze				
Ellis	Forest effects	Forests				
Mitch			**Iowa**			
Jim	Biodiversity	Biodiversity				

Response to external reviewers' comments discussed at the May 14-15, 2009 SAB Integrated Nitrogen Committee meeting with Action Items to implement those responses

General comments	Responses/Action Items
	Review revised document for use of term "loss" vs. transfer – Jim, Tom, and Angela
From Dr. John Day	
Review of EPA Nitrogen Report	
The report is a detailed treatment of reactive nitrogen in the US. It is comprehensive and a wealth of detail is provided. But the report suffers because different topics are treated in different detail. Many of the conclusions and recommendations are so general that they don't provide a clear idea of what should be done next.	No change required ES identifies overarching and 3 major recommendations
Climate change is dealt with very briefly in spite of the fact that climate will certainly have a dramatic impact on nitrogen dynamics. The loss of nitrogen from agricultural watersheds is strongly dependent on rainfall. Predicted increases and decreases in rainfall will likely have a dramatic impact on nitrogen export from ag fields. For example, precipitation is predicted to increase in the upper Mississippi watershed, and other factors being equal (but see below), N export should increase (e.g., Justic et al.). In the southwest, more winter precipitation is expected to fall as rain rather than snow. This may impact agriculture throughout the region and lower N export. The southeast may also have lower rainfall. Such topics should be dealt with in more detail because climate change may increase or decrease the need for dealing with excessive N in rivers. There is an extensive literature on this topic much of which is summarized in a series of PEW Center reports.	Russ will take lead for a new section of report for interaction of C and N. Committee will consider whether recommendations Russ will add sentence defining climate variability and providing short discussion (new text/section to go somewhere around 2.4.6)

General comments	Responses/Action Items
Energy is a topic that is not covered at all in the report but which will likely have dramatic impacts on both N dynamics and our ability to study them. There is a growing consensus that the world society is transitioning from a century of relatively cheap energy to a future where energy will be much more expensive and scarce. There is strong evidence that conventional world oil production has peaked or will peak soon. There is a quite robust literature on this subject that the report should refer to and analyze. In a time of energy scarcity, natural resource management will have to change to a less energy intensive approach. And the kinds of studies that scientists do will also be constrained by energy availability. For example, during the run up in oil prices last year, the price of fertilizer increased substantially. Although oil prices have fallen, the long-term trend is certainly for increasing energy prices. It is likely that in a decade or two, the price of fertilizer will be so high that farmers will be very efficient in its use resulting in greatly reduced fertilizer runoff from farm fields. When the economy of Eastern Europe collapsed in the 1990s, fertilizer use declined dramatically and Mee reported that hypoxic conditions in the Black Sea nearly disappeared in a short time period. It is likely that agriculture will return to what Boody et al. (Boody et al. 2005 BioScience) called multifunctional agriculture. The implication of this is that problems related to fertilizer runoff from ag fields (eutrophication of rivers, streams, and coastal waters, hypoxia, etc.) are likely to decrease. This information should be included in the report as possible future scenarios.	Hey, Mitch, Russ drafted text for ES, Introduction (send to Jim), and for latter part of chapter 2 not agriculture (latter text to send to Jim, Tom, and Angela)
I suggest that the role of wetlands in controlling N pollution should be treated more extensively and comprehensively in the report. There is some mention of this subject but in not much detail and it is scattered throughout the report. I suggest that it should be treated	Hey and Mitch provided text for ES, Introduction, and other sections of the report (send to Jim and Tom)

General comments	Responses/Action Items
in its own chapter and this could be referred to throughout the report. Mitsch and colleagues have proposed a comprehensive program for the Mississippi basin. This should be discussed as an example of what can be done.	
From Dr. Elizabeth Holland:	
The basic premise of moving towards a comprehensive holistic view of the environmental consequences of the ongoing dramatic increase in the use of nitrogen and the atmospheric-land-water exchanges of reactive nitrogen is one that I support enthusiastically. However, the draft report falls well short of its intended mark. Future versions of the report need to build more strongly on the published literature and must include a clearly articulated plan for integration of the work with strong emphasis on both models and data.	ES revised to describe more clearly how the cascade relates to drivers and effects
The report does not adequately take into account its ambitious holistic scope. Instead it comes across as series of research recommendations that interest the people who wrote the report. The report does not adequately build on the underlying science. Much of the science cited is old parts of the literature and has not been updated to the modern literature. Because agriculture is at the center of the problem, I suggest that subsequent versions of the report build strongly on interactions with the agriculture community laying the groundwork for the strong interactions with USDA called for in the report.	The INC respectfully disagrees that modern literature as not been used. Agree on importance of collaboration with USDA and have included it as overarching recommendation Revised executive summary expands on importance of collaboration.
A striking omission of the report is the connection between the climate system and the nitrogen cycle. The EU is currently funding Nitro-Euro, a multi-million dollar project that	Russ will develop new section and provide to Jim and Tom

General comments	Responses/Action Items
was motivated by this connection. A Science paper by Hungate et al in 2002, a series of ongoing studies by MIT (Sokolov et al. Journal of Climate 2008), Princeton (Levy, and others) and NCAR (Thornton et al 2008) underscore the importance of the links between the carbon and nitrogen cycle. The centrality of the carbon cycle to climate change and the impact of the N cycle on carbon uptake are the top of the list, followed by N_2O, NO and its role in tropospheric ozone production, and the increasing importance of N containing aerosols that play a role in global warming make a compelling case for addressing the connection between the changing nitrogen cycle and climate change in this report.	
Recent work suggests that the ongoing declines in fertilizer use throughout the mid-west are not sufficient to decrease the ongoing recurrence of hypoxia in the Gulf of Mexico. See particularly work by Laurie Drinkwater and Mark Davids of Cornell and a paper by Vitousek et al. submitted to Science (The manuscript may be available directly from Peter Vitousek at Stanford). The body of work suggests that years of excess fertilizer use may have sufficiently bolster soil organic nitrogen content to compensate for reductions in fertilizer use and provide an ongoing source of reactive nitrogen N to downstream ecosystems.	The INC respectfully disagrees. *Re: Drinkwater/David papers. They are modeling studies that show existing models do not do a good job of predicting nitrous oxide losses from agriculture. Nothing new here. The Vitousek paper mentioned is submitted to a journal, which means it has not completed peer review.* *The premise of the paper, however, as state by this reviewer, simply does not make sense. If we are prepared to accept a reduction in soil organic matter by "mining it down" from present levels as a source of N for crop production, this means a huge flux of CO2 to the atmosphere, which will accelerate climate change. Likewise, it makes no sense to replace N supply from mineralization of soil organic matter, which is relatively slow and synchronous with crop demand, with fertilizer N, which is more difficult to control in the environment—eventually the reduced soil N supply must be made up for with applied N, especially as there is a need to increase yields on*

General comments	Responses/Action Items
	existing farm land to avoid indirect land use change . Bottom line, no need to make revisions in response to this comment.
The report requires a strong editorial hand to remove redundancy, increase the precision of the wording in the findings, recommendations and executive summary, and standardize the report throughout is needed. The current report is quite variable across the sections and needs considerable strengthening.	Report will be edited.
From Dr. Gregory McIsaac	
General comments: The report compiles an extensive amount of information on Nr, which I consider to be largely accurate and the recommendations reasonable. I think the report could benefit from some thoughtful editing, with an eye towards organizing the technical information so that it most efficiently and effectively supports the recommendations. There are places where I found the text confusing or unnecessary, or providing potential for confusion.	Report will be edited and revised in light of detailed suggestions from this reviewer
I think this draft report represents a useful step in the process of improving understanding and management of Nr.	
From Dr. Jerry Melillo	
Preliminary review comments on *Reactive Nitrogen in the United States; An Analysis of Inputs, Flows, Consequences, and Management Option* (March 19, 2009 draft)	
General comments (to be supplemented by more detailed comments	

General comments	Responses/Action Items
by May 11th)	
• Overall, the report is terrific. It is valuable because it conveys the nitrogen cycle and its implications to the general public in an easy to grasp way – a difficult job well done.	
• The document frequently uses the verb "must," a word to be used carefully in science and science policy contexts. A careful examination of the entire document to ensure that the recommendations reflect exactly the committee's intentions would strengthen the report.	Document wlll be carefully examined for the use of this word.
• The report would benefit from copy editing to ensure standard usage(commas, hyphen use and so on) throughout the document.	Report will be copy edited.
<u>From Dr. Giles Randall</u>	
This was the most comprehensive, holistic document on nitrogen that I've read. It was quite well organized and for the most part was well written. After page 90, it did appear to be more hastily assembled with some sections repeated, poor agreement between figure citation in the text and the actual figure, incomplete sentences, unreferenced citations, etc.	Specific comments noted. Report will be revised
<u>From Dr. James Schauer</u>	
The subject report is well organized and well written. It contains excellent background material on the nitrogen cascade, sources of reactive nitrogen, and the flows and inventories of reactive nitrogen in the environment. The analysis appears sound and the recommendations are appear to be scientifically robust. As my expertise is in the atmospheric science and combustion related fields, my review and comments largely focused on these	

General comments	Responses/Action Items
components of the report. I do have several comments that should be addressed before the report is finalized and distributed. I do have several comments that should be addressed before the report is finalized and distributed. These commented are as follows:	
General Comments	
1) The framework for discussing the transport and inventory of reactive nitrogen across environmental compartments is somewhat deceptive in terms of the atmosphere. Due to the timescale of mixing across the global troposphere, it is not reasonable to view the US atmosphere as a well defined entity. It appears that the export of reactive nitrogen from the US via the atmosphere is considered in the analysis and mass balance but that the import of reactive nitrogen to the US via the atmosphere is not considered. I think the reader would greatly benefit from a clearer presentation of the atmosphere as only a global atmosphere, which provides a transport mechanism for deposition in other areas and transport to the stratosphere.	The INC notes that the charge was to examine fluxes among systems in US. Russ Will add sentence about Canada and Mexico to uncertainty characterization discussion
2) The inclusion of N2O in reactive nitrogen is understandable from a chemistry perspective but clearly the role of N2O in the context of the nitrogen cascade is very different from other species included in the report. N2O is basically inert until it reaches the largely isolated stratosphere, where it is an import species in stratospheric ozone depletion. The integration of N2O with all other reactive nitrogen species will be confusion to many readers. I think a separate section on N2O is needed to clearly explain N2O in the context of the nitrogen cascade and the report. This is particularly important in Figure 2 and 3, which implies that N2O has similar biogeochemistry to other species discussed in the report. As shown in Figure 2, the fate of NOy and NH3 are the same as N2O, which	Jim Will add footnote for figure 2 and 3 notes will discuss how N_20 is different from other Nr compounds (NOx and ammonia)

General comments	Responses/Action Items
is not correct. It is unclear how the recommendations on page 18 related to N2O.	
3) Throughout the report, one of the impacts of the nitrogen cascade is "global warming." I would strongly recommend to not use the term "global warming" as the impacts of the nitrogen cascade have important impacts on climate forcing that are positive and negative forcings. I would recommend the use of the term "climate change." As written, the report seems to use the term global warming with little explanation and some discussion of direct and indirect effects should be briefly discussed.	Comment accepted – change global warming to climate change (Jim will check for usage throughout report)
3) The discussion of mobile sources is a very stagnant perspective on emissions. The discussion of recommended reductions from mobile sources, and which feed into the overall recommendations, due not properly address the growth in mobile source VMT (Vehicles Miles Traveled) and already existing diesel engine emissions regulations that will go into place in 2010 for on-road engines and they are being phased in for off-road engines. The recommendations need to be placed into context of expected growth in emissions and existing regulations that are currently being implemented.	Some clarification will appear in the ES regarding a reference year. Report already acknowledges that EPA is moving toward a high level of NOx control will be more technologically demanding than addressing other sources. Russ will update section on diesel regulations to refer to 2010 regulations
From Dr. Stuart Weiss	
First, this document an excellent holistic view of the N-cascade and numerous negative environmental impacts of excess N in air, land, and water, and will be a foundation for finally addressing the issues in a comprehensive and effective manner.	
As a reviewer, my main area of expertise is the impacts of atmospheric N-deposition on biodiversity (mainly in California)	Will merge two recommendations on critical loads and will cite references provided (Jim)

General comments	Responses/Action Items
and the practical means to address the impacts in the short-term and long-term. I think a little more material on biodiversity impacts and policy responses would be a critical addition to the document, since the effects are a "1" in relevance. There is also some innovative processes, including Endangered Species Act consultations, underway that should be noted somewhere in the report (but I realize that I am providing far more background than could go into the document itself).	Jim will review recommendations for body report and to supplement materials in Introduction (including entry on biodiversity for table of impacts) Re ESA, Jim will identify place to address issue, including partnering with FWS.
Review work by Fenn et al. (2003) compiled numerous impacts of N-deposition on biodiversity in the western US. Some of these include:	
1) Loss of coastal sage scrub (CSS) in Southern California to invasions by annual grasses and subsequent changes in fire frequency, leading to losses of shrub cover and conversion to weedy annual grassland. CSS has already been reduced by ~90% due to urban and agricultural development and supports dozens of threatened and endangered species.	
2) Invasion of desert scrub by annual grasses that create fine fuel loads that can carry fire across miles of desert lands, in places where such fires were nearly unheard of until recent decades. These fires threaten life and property in addition to converting rich desert scrub to weedy annual desert grassland.	
3) Combined effects of ozone and N-deposition in Southern California montane conifer forests lead to changes in species composition, physiological disruption (needle lifetimes of < 1 year and continual buildup of litter), and increased fire risk, on top of climatic stresses.	
4) Groundwater and surface discharges from heavily polluted watersheds in the LA Basin have extremely high levels of	

General comments	Responses/Action Items
nitrate, including storm pulses and baseflow.	
5) Atmospheric deposition on the order of 8-20 kg-N/ha/yr in the San Francisco Bay Area leads to annual grass invasions of nutrient-poor serpentine soils (Weiss 1999) that lead to losses of biodiversity, most notably the threatened Bay checkerspot butterfly (*Euphydryas editha bayensis*).	
6) Montane meadows in Rocky Mountain National Park are losing wildflowers to native perennial grasses.	
7) Aquatic biodiversity in ultra-oligotrophic lakes in western mountains is affected by quite low levels of atmospheric deposition (1.5 kg-N/ha/year wet).	
A screening of the N-deposition exposure of listed (endangered, threatened, and rare) plants in California (Weiss 2006), suggests that a substantial fraction (~40%) of the listed flora in the state is exposed to > 5 kg-N/ha/year (from a 36 km CMAQ run for 2002). Many of these plants are on nutrient deficient soils such as serpentine. Many others are in vernal pools (seasonal wetlands). Grass and weed invasions are the primary mechanism of biodiversity loss. Many of the species are small annual forbs that are prone to being crowded out by increased grass and weed growth in many ecosystems.	
There are many other examples outside of the Western US that need to be compiled, and I would suggest as a recommendation that a national N-deposition/biodiversity screening and assessment are needed.	
Executive Summary	
	In chapter on procedures, add discussion of committee's approach for choosing data sets and literature for analysis,

General comments	Responses/Action Items
	including reference year. Also discuss assumptions for timeframe for analysis - Jim
	Bill Moomaw suggestion – will add more discussion of metrics in bullet on page 8; will provide draft text to Jim
From Dr. John Day	p. 8 – replace "losses" with "transfers" - Jim
	Otto – page 19 – will add bullet on land use for chapter 3 and Intro will coordinate with Jim and Tom
13, fig 2. Denitrification doesn't seem to be a pathway.	Jim – explore adding arrows from terrestrial and coastal boxes to circle/triangle with denitrification and storage with no number but pointer to note
16, Management strategies. Nutrient removal by wetlands should be specifically included in this list.	Agree - Bill Moomaw suggested revised text for Jim
18, Recommenation C. Academic scientists should be included in the task force. It is clear from the literature that the great majority of work done on Nr has been done by academic scientists and they should be integrally involved in all stages of the effort.	Add universities to recommendation A. (Jim) Add FEMA, FWS to recommendation C (Jim)
19. Wetlands should be included in best mgt practices.	Agree - Bill Moomaw suggested revised text (Jim)
From Dr. Elizabeth Holland	
The executive summary must refer to the correct section of the science portion of the report so that it is obvious to the reader where to find the supporting science. As written, it is not substantiated by the science.	Don't agree – ES should be a stand-alone document
While I agree with the intent of the N cascade framework—to	Bill Moomaw, Otto, Paul, Hans will provide draft

General comments	Responses/Action Items
integrate the various system components into a whole—I am unconvinced that continuing use of the term ***N cascade*** is useful to convey the importance and usefulness of a holistic N budgeting to the community outside of the relatively small community of scientists who are doing N cycling work.	sentences to Jim Revise text to relate science findings, especially on impacts, to cascade more consistently (e.g., climate, economic impacts) - beyond movement of chemicals through the system - diagram/text showing points to intervene to prevent impacts - modify figure 2 with internal boxes (Ag, vegetated, populated). Draft text will discuss impacts and interventions; possibly include example
From Dr. Gregory McIsaac	
Page 6, line 9 (and throughout most of the report): The report identifies combustion of fossil fuels as a source of NOx, suggesting that combustion of non-fossil fuels is not a source of NOx. There are only one or two places (such as page 112, line 32) where combustion of biomass is identified as a source of NOx.	Russ will revise text to clarify and update and provide to Jim.
Page 11, line 16: identifies stationary fossil fuel sources as power plants and industrial boilers. What about domestic heating?	No change, because it's a small piece of budget. Russ will confirm
Page 16, line 7: the claim is made that a "large part of the land surface in the northern hemisphere" has Nr deposition rates in the range of 10 to 20 kg N/ha-yr. This point could be made more explicit by estimating the proportion of land area in the US that receive deposition in this range.	Change to "large areas of the land surface in the contiguous US receives N deposition in that range" (Jim)
Page 19, line 32: refers to "other unregulated mobile and stationary sources". This is elaborated in the body of the report but I think it would be helpful to give examples of these sources here (e.g., off	Russ to provide Jim with brief new language describing examples

General comments	Responses/Action Items
road vehicles).	
From Dr. Jerry Melillo	
P13 – why not show delta of 5 Tg N/yr in veg., soil and groundwater, as well as denitrification estimate of 16 Tg N/yr in the figure to complete the mass balance?	Jim – explore adding arrows from terrestrial and coastal boxes to circle/triangle with denitrification and storage with no number but pointer to note
P14, L10-11 – by adding "fiver and fuel crops" the "issue" expands to "national energy security and a sustainable supply of fiber	Jim will make change, remove word "wholesome"
P15, L5 – hyphen needed, "service-based"	Jim will make change
P16, L15 – check punctuation sequence L22 – hyphen needed, "land use" L17 – hyphen needed, "risk-reduction"	Jim will make change Jim will make change
P17, L31 – change "must" to "will likely" – generally be careful about using the word "must"	Jim will make change
Comments from Dr. Giles Randall	
6-20 | all | The Executive Summary provides a good overview of the report. The sections dealing with "human activity creating reactive N", the "N cascade," and "sources of reactive N" were particularly helpful. The major findings and recommendations shown on pages 18-20 also set-the-stage quite well.	
Comments from Dr. James Schauer	

General comments	Responses/Action Items
1) Page 11 lines 5-7 and Page 12 lines 1-3 – The text does not seem consistent with Figure 1. According to the Figure 1, Cultivated BNF seems to be the second largest sources and Fossil Fuel Combustion is the third largest source. This figure and associated text would gain from a clear discussion of the contributions by sector and process.	Jim will clarify the ranking in terms of total sources and be consistent – Jim Add to page 10-11 text discussing BNF (Jim)
2) Page 17, line 1 – I am not sure what is meant by "more efficient diesel engines" but I think this should be engines with lower emissions or after-treatment controls. Engine efficiency usually does not mean the degree of NOX emissions.	Change "more efficient" to "improved" - Jim
3) Page 19, line 31 – The term "passenger cars" needs to be checked. I assume that this is on-road vehicles or mobile sources.	Change "passenger cars" to "light duty vehicles (including passenger cars)" - Jim
Chapter 1: Introduction	
Comments from Dr. John Day	
22. An discussion of the role of cheap energy, especially oil, in the agricultural revolution is completely lacking. The globalized food system uses about 10 cal of oil (or its equivalent) to produce one cal of food. N pollution is likewise a result of cheap energy. Energy is central to understanding this whole problem and it must be dealt with.	Discuss extent to which nitrogen enters the cascade is partially due to the increase in price of energy. - Bill , Otto, and Russ to provide short paragraph
Comments from Dr. Gregory McIsaac	

General comments	Responses/Action Items
Page 25, Figure 3: All aquatic and terrestrial systems are identified as having some denitrification potential, except for oceans. But denitrification does occur in the oceans.	Insert sink symbol for open oceans (or just show symbol at the atmospheric, terrestrial, and aquatic levels) (Jim)
This seems to be an oversight because later on page 85, the report mentions that deposition of Nr to the oceans results in some N20 production, presumably from denitrification.	
Page 26, lines 11-14 and 20 -22: These statements identify "losses" of Nr from aquatic and terrestrial systems that do not include conversion of Nr to N2, and then indicate that there is "potential" for conversion of Nr to N2. But conversion of Nr to N2 occurs in these systems and it does represent an important loss from those systems. The language is potentially confusing. I'd recommend changing the word "losses" to "transfers" or "exchanges" of Nr from one system to another, and conversion of Nr to N2 be considered a loss of Nr.	Make change (Jim)
<u>From Dr. Jerry Melilllo</u>	
P23, L14 – change 'between" to "among"	Make change(Jim)
L24 – change "all" to "most"	Make change (Jim)
P24, L1-2 – punctuation "…molecule can, in sequence, contribute…."	Make change (Jim)
cascade, underscore…."	Make change (Jim)
L27 – punctuation "…and water, as exhibited in the n	
P25, figure –make it larger	Make change (Jim)
L4 – eliminate "popular"	Make change (Jim)
L11 – eliminate "important"	Make change (Jim)

General comments	Responses/Action Items
Comments from Dr. Giles Randall	
25-26 | all | Figure 3 and the accompanying text was well done.	
Chapter 2 Behavior of Reactive Nitrogen in the Environment	
2.1. Introduction	
2.2. Sources of NR new to the US Environment	
2.3. Nr Transfer and Transformation in and between Environmental Systems	
2.4. Impacts, Metrics, and Current Risk Reduction Strategies	
From Dr. John Day	
79-80. Recommendations. A comprehensive scientific program of the role of wetlands as sinks should be included in this list. For example, Mitsch and colleagues (refs cited in the report) called for a comprehensive research effort in the Miss basin on the use of wetlands. This could be cited here as an example of what needs to be done.	Insert finding and recommendation along these lines for section beginning at end of section 2.3.1.3 (beginning p. 83) before discussion of eutrophication on p. 84 and the Executive Summary (Bill Mitch and Don Hey to provide toArvin))
In a broader sense, these recommendations will require considerable funds (and energy). In an energy scarce future, hard decisions will have to be made about what is done. Study efforts should be directed at energy efficient approaches for controlling N pollution.	
89. Forests. The sentence on lines 22-23 “Changes in C…” is awkward. The statement is that the highest rate of tree growth is in the Pacific northwest. Is the rate of growth higher than cypress	Arvin will revise the sentence to say something like “…growth rate is among the highest”

General comments	Responses/Action Items
forests in the southeast. In addition, there is a climate aspect here. A recent study (van Mantgen et al. 2009. Science. 323:521) reported that tree mortality in the west had increased as a result of climate change. This is another way that climate may impact N dynamics if trees are dying more rapidly.	Russ, Jim, Bill M, and Tom will provide new section of report addressing relationship of N and climate change and weave in some of this discussion --
106. It is interesting to note that in fig. 21, the Everglades is treated as a separate unit while the Miss delta is grouped with arid south Texas. Likewise, the wet northwest is grouped with parts of arid southern CA.	Drop figure. Paul will revise text to reflect loss of figure.
From Dr. Elizabeth Holland	
The atmosphere land section of the report is one of the better substantiated portion of the report, but the section is characterized by an overreliance on unpublished and unevaluated runs CEMAQ. The section also overlooks key papers like the US N budget done by Holland et al. 2005, published in Ecological Applications. The section also overlooks a series of important studies linking N deposition/fertilization to increased NO and N_2O emissions published by Butterbach-Bahl and Papen in the European literature.	Russ will Cite Holland paper and Beth will provide published studies of CMAQ, specific to deposition analysis. Beth to provide to Russ and Arvin
From Dr. Jerry Melillo	
P31, L32 – would it be possible to add a column to indicate primary sources of this information?	Beth will do and provide to Viney and Ken
P42, L7-11 – at what spatial scale? Country or watershed suggested, but no actual area suggested, e.g., km^2	After line 8 “agricultural crops” add “in terms of timing and at a sufficiently small application scale to inform decision-making….”- Viney and Ken

General comments	Responses/Action Items
L12 – make it clear that NFUE discussion starts a new section – add section label "2.2.3.2"	Ken and Viney will add new subsection
P49, L16 – a more complete discussion of the Crutzen et al. discussion would be useful here. Also, see the results from Scanlon et al. 2003, where diode laser and eddy flux were used	No change. We note the discrepancy with other estimates, and then highlight the need for better predictions of N2O emissions from agroecosystems and the factors responsible for them. I looked at the paper by Scanlon et al. (2003) and it is based on measurements from intensive pasture systems in Europe where they apply heavy amounts of both N fertilizer and pig slurry. Such systems are not widespread globally, and they have a very small extent in the U.S. Bottom line, I do not recommend any changes to the text in question -
P51 – biofuels discussion should note that if biofuels feedstocks are going to be grown on marginal lands, additional N inputs and irrigation may be needed.	Otto will draft text addressing this point, updating literature references and provide to Viney and Ken Arvin will identify existing recommendation related to N20 and send reference to Ken and Viney. So there would be a cross-linkage to that page and recommendation
P64, L6 – why no finding for this topic? a big deal at the local level.	Paul and Bill Herz will send recommendation to Viney and Ken
P83, L21-23 – awkwardly stated – revise to read "EPA should work with USDAS, DOE and universities to ensure that …."	Make change (Arvin)
P87, L31-33 – recommendation is vague – make clearer	Paul and Hans will revise recommendation and send to Arvin
P94, L28 onward – section repeated	
P97, table – a better table can be taken from the Millennium Ecosystem Assessment	Tom will revise

General comments	Responses/Action Items
From Dr. Gregory McIsaac	
One of my main technical concerns involves the attempt to develop separate N budgets for Agricultural, Vegetated and Populated landscapes, discussed on pages 80-83. In this analysis manure and sewage N are treated as inputs, but they are really transformations of other inputs. Elsewhere in the report, claims are made about how much Nr is transported from agriculture to the environment but it is not always clear how these estimates were made.	Arvin will revise table notes
Page 35, figure 4: The horizontal scale is not arithmetic. The 20 years from 1970 to 1990 represents 5 units (four years per unit), but after 1990, each year represents a one unit on the horizontal scale. This appears to be an excel line graph. I'd recommend changing it and excel XY graph or some other format so that the horizontal scale is proportional to time.	JoAnn will revise figure and provide to Viney and Ken
Page 37, line 12: In discussing Table 2, the text refers to Louisiana even though data from Louisiana is not presented in Table 5.	Drop sentence starting "Louisiana and Texas…" - Viney and Ken JoAnn will investigate to see whether data can be updating beyond 2001. JoAnn to clarify title of table to show that it's meant to illustrate many different sources of nitrogen. Iniformation to go to Viney and Ken
Page 39, line 15: it would be nice to have a citation to the recommendations referred to.	Bill Herz will check file for communication from USDA for this information and provide to Viney and Ken
Page 42, line 3: the statement is made that 7.6 Tg of Nr is	Refer to Table 1, which explains source of number

General comments	Responses/Action Items
transferred from agriculture to aquatic and atmospheric systems. It was not clear how this value was calculated.	
Page 43, line 14: the statement is made that maize receives the largest share of fertilizer N in the US. It would be helpful to state this percentage.	Bill Herz will send percentage to Viney
Page 44, Figure 7: This figure is based on readily available USDA data, and could easily be extended from 2000 to include more recent years. This was apparently done to create Figure 25 on page 127.	Eliminate figure 25; refer to figure 7 instead - Viney and Ken
Page 46, lines 4-6: It might be helpful to mention here that many legume crops will tend to scavenge inorganic N out of the soil before investing resources in N fixation. This is why they have some potential to be more efficient than inorganic fertilizer. I am not sure if this is the best place to mention this but I think it should be somewhere in the report.	No change. It is true that legumes "prefer" to use available soil and residual fertilizer inorganic N before investing in the symbiosis, but this point provides additional detail not needed for our report. The statement by this reviewer that "this is why they (i.e. legumes) have some potential to be more efficient than fertilizer" does not make sense. Instead, he point currently made in the report is the key issue, namely, they can provide N input to cropping systems that can replace a portion of the total N requirement of a system.
Page 47, line 3: I think "prevention… of Nr applied to agricultural systems" is not the best word choice. Better choices might be "..prevention of unneeded Nr.." or "efficient use and mitigation of Nr…"	Change to "efficient use and mitigation of Nr - Viney and Ken
Page 51, line 28: there is an extra comma in this line.	Change - Viney and Ken
Page 51, line 29: "will be used … in 2008" should be "…was used…"	Otto will revise - Viney and Ken

General comments	Responses/Action Items
Page 57, lines 15-16: explain how are aerosol formation and neutralization of acids produced by sulfur and nitrogen oxides are adverse effects.	Russ will develop text to clarify language and provide to Viney and Ken
Page 59: a table that shows how the N excretion has changed per animal would be useful.	No change Per unit per animal not useful; what's important is per unit of milk. Report uses the right metrics. Otto will change Section 2.2.4.4 title should include the word "efficiency" and Table 6 should include term "efficiency" Total US chapter heading should be g/kg; all heading should include reference to N Changes to go to Viney and Ken
Page 60, line 18-19: the language describing the ammonia equilibrium is presented as if volatilization is either "allowed" above pH 7, or not allowed below pH 7. I think it is more accurate to present it as a continuous function, with very low quantities of NH3 available for volatilization below ph 7 and increasing quantities above pH 7. Also, there is a reference to Arogo et al (2006) here but no Arogo et al. citation appears in the reference list at the end.	Arvin will revise paragraph to clarify language and provide to Viney and Ken
Page 61, line 18: the "finding" is made that there are no regulations to decrease Nr losses from manure, but many states do have laws governing the management of manure from larger farms. The report recognizes this on page 124, lines 14-15.	Issue of consistency in section scope, labeling of table, and recommendations. Viney and Ken will clarify. Will consider the use of the term "transfer" rather than "loss"
Page 64, Table 9: It looks like the left column is messed up. I	Arvin will fix header and table.

General comments	Responses/Action Items
think the top left box should say "Type of turf fertilized" the second box should say "nominal fertilization", the third "Professional lawn care" and the fourth "high maintenance areas".	
Page 69, Figure 14: I think it is dangerous to presume a trend from two data points (the 1985 and 2005 maps). I have looked at the full series of maps available on the web, and I agree that there probably is a real trend, but I think it would be better to present and analyze the annual time series, as was done for nitrate.	Beth will Insert table showing time series and include contemporary figure showing spatial pattern, provide to Arvin and Russ
Page 72, lines 14-15: I don't understand what is meant by foliar resistance to NO, nor how it explains why dry deposition of NO3- is 39% off the total NO3- deposition.	Fix typo – "should be dry deposition of NO" Add text to explain foliar resistance (Russ)
Page 73, lines 8-21: I think an additional source of uncertainty in these estimates of Nr deposition is locally recycled NH3/NH4 and perhaps some other N compounds. Plants emit NH3 but they also absorb it from the surroundings. Similarly a dust storm may lead to some local deposition of particulate N, but also some local removal. The monitored deposition may include some of this locally derived Nr, or be replacing Nr that is being emitted and thus in may not necessarily represent a net of new Nr input to the region. It may also be worth repeating in this section that the sampling networks have not been tested for spatial bias (as stated on page 68). I believe most of the monitoring locations are in rural areas, and thus may under represent deposition in and near urban areas.	Add sentences to acknowledging complexity and sampling issues. (Russ)
Page 76, Figure 16. The legend on this graph is rather cryptic, and the graph basically provides only 4 percentages for each year, and there is not much difference between the two years. I think the essential information from the graph could just as easily be	Replace with one sentence in the text (Russ)

General comments	Responses/Action Items
presented in the text or a small table.	
Page 76, line 11: I think there is a need to insert after NHx the phrase "…emissions are…"	Change (Russ)
Page 76, line 21: delete "the" before 1985.	Make change (Russ)
Page 77, line 24: I think "within" should be changed to "with" and probably should be preceded with a comma.	Make change (Russ)
Page 78, line 9: "a fair fraction" ought to be changed to something more precise.	Russ – replace "fair fraction" with "significant fraction" – cite Neff fraction
Page 79, line 22-23: this statement comes out of the blue. There was no discussion of this in the preceding text.	Russ – could add sentence that NO2 is small proportion of nitrogen budget and NO2 is the only N compound monitored.
Page 80-83 issue of separate N budgets	Arvin Discuss relationship of table to table 1; revise notes
Page 80, lines 29-33: I think it is worth mentioning that much of the unharvested N is retained in the unharvested portions of the crop: leaves, stems and roots, which can protect the soil and contribute to soil organic matter, if properly managed.	Arvin – develop text
Page 81, table 13 and line 15: Animals don't manufacture Nr, but they transform it. Grazing animals consume N in the grasslands and a portion of that N becomes manure. So, it is recycled N and not a separate input. Humans and confined livestock are consuming grain and feed produced with fertilizer and BNF. To count manure and sewage as inputs involves double counting some of the Nr. Also, the portion of atmospheric deposition that is reduced may have derived from animal manure or fertilizer emissions, and thus would also be double counting. I can see the point of looking at transfers from one system to the other, but it seems that this analysis does not give enough attention to the difference between	Skip total Nr input; change legend to discuss recycled Nr (Arvin)

General comments	Responses/Action Items
new Nr and recycled Nr. Adding up the totals in the far right column certainly involves double counting.	
Page 81, line 8: I am not sure what the phrase "the remaining N" refers to. I am also not sure why 1.2 Tg of manure N in agricultural lands, and 3.8 Tg of manure in grasslands adds up to 6 Tg total. Maybe the difference is the "remaining" manure?	Arvin will clarify
Page 82, line 16: section 3.2.5.1 appears to be incorrect.	Change (Arvin)
Pages 82 and 83. I found this discussion rather confusing. Perhaps a diagram would help.	Arvin will consider how to address this comment
Page 83 (Wendy Powers) about Table 14 – table heading "Loss"	Table 14 uses term "Loss" – replace with "Transfers" to other systems and add footnote explaining transfers to other systems Change "products" to "Agricultural products" "Inputs to "Inputs to the System" and clarify term "storage" (Arvin)
Page 85, line 4: "higher ranked consumers"? Maybe "animals and aerobic microorganisms"?	Arvin will make change"
	Make change (Arvin)
Page 86, line 2: insert "of" after movement	
Page 87, line 34: ES = environmental system?	Make change (Arvin)
Page 88, lines, 27-39. The lengthy footnote found on page 91 that discusses this issue should be part of this section, rather than a footnote, except that the phrase "may need to	Make change (Arvin)
be reconsidered" should be changed to "need to be reconsidered". Also, consider the following paper that showed no change in soil C over the last 50 years in central IL:	
David, M.B., G.F. McIsaac, R.G. Darmody, and R.A. Omonode.	

General comments	Responses/Action Items
2009. Long-term changes in Mollisol organic carbon and nitrogen. Journal of Environmental Quality 38:200-211.	
Page 94, line 28, through page 95, line 15 is a duplication of section 2.3.4.	Remove recurring text. Move figure 18 on p. 95 needs to be moved to Appendix, 182 Beth will provide citation (e.g., using data from…) changes to go to Arvin and Russ
Page 96, line 20: " the ideal framework" seems overly promotional for a scientific document. I think it would be better to state that it provides "a comprehensive framework"	Make change (Tom)
Pages 97-8, section 2.4.2.2: I did not see much value or relevance to this section. I think it could be deleted.	Insert text discussing EPA using N as a focus for research on ecosystem services.(Tom)
Page 99, line 28: refers to Figure 20 should be Figure 19. From this point on, the figure numbers identified in the text does not match the actual figure number.	Correct figure references (Tom)
Page 106, Figure 21. I did not see much value in reproducing this figure.	Delete figure (Tom)
Page 109, Table 18: I think it should be more clear what the percentages in the Nitrogen Management Target column represent. They seem to be percent reductions of current or recent Nr loadings, but it would be helpful to make that more explicit.	Change column title from "Nitrogen Management Target" to something like "Goal of N reduction by X% of current loadings" Paul will send Tom revised Table with title
Page 109, line 15: is "disproportionate" the correct word? I think they meant "disappointing"	Make change (Tom)
Page 110, lines 14-15: N causes "substandard levels of dissolved sewage treatment plants in LI Sound" ? Some words got deleted or mixed up there	Paul will provide changed language to Tom

General comments	Responses/Action Items
Page 119, line 14: I think there should be the word "at" inserted after "aimed".	Make change (Tom)
Page 121, line 9-12: This sentence is confusing. I suggest it should be modified as follows: "The only way to determine the extent that critical thresholds are limiting is by overlaying them for different regions and determining by monitoring data or by model exercises where and which sources contribute to exceeding the critical threshold ~~is the limiting factor~~,and then identifying the best methods for putting caps on ~~losses from~~ relevant sources."	Make change (Tom)
Page 123, Table 21: In the middle column several of the entries are "NR" and should be Nr.	Make change (Tom)
Page 125, line 4: delete "neither"	Make change (Tom)
Page 126, line 2: Danish cereal crop yields are described as remaining relatively constant in Figure 24, but Figure 23 shows cereal crop production over time, and there appears to be an increasing trend.	Check location of figure 23 and update text as necessary (Arvin to Tom) and check figures pp 125-128 Change figure title "Synthetic and livestock manure" to "Synthetic fertilizer and livestock manure" (Arvin) Change figure 22 and 23 units to Tg (Arvin) Changes to be provided to Tom
Page 127, Figure 25: the figure caption references a 2002 publication but the data in the figure go through 2005. Several authors have presented similar analysis based on USDA data. I think the report can simply cite USDA data.	Drop figure 25, revise text to reference Fig 7 (Tom)

General comments	Responses/Action Items
Figure 25 presents an updated version of a grain yield per unit of fertilizer input that was presented in Figure 7.	See above
Page 128: It could perhaps be mentioned that Duvick et al (2005) and Duvick (1997) have reported declining protein content of corn hybrids in the US.	Arvin will address for Tom
Duvick, D.N., J.S.C. Smith, and M. Cooper. (2005). Changes in performance, parentage, and genetic diversity of successful corn hybrids, from 1930 to 2000. In C. W. Smith, F.J. Betrán and E. Runge (eds). Corn: Origin, History, Technology and Production. John Wiley & Sons, Inc., New York.	
Duvick, D. N. (1997). What is yield ? In Proceedings of a Symposium for Developing Drought and Low N-Tolerant Maize (Eds G. O. Edmeades, B. Banzinger, H. R. Mickelson & C. B. Pena-Valdivia), March 25±29, 1996, CIMMYT, El Batan, Mexico. CIMMYT, Mexico, D. F.	

Comments from Dr. Giles Randall

38-41	all	Section 2.2.3.1 on "Nitrogen Fertilizer Use" was very informative and clearly sets the stage for Recommendation 1 on page 42. This is critical for enabling a better understanding of the cause and effects of N on a landscape scale.	
41	Table 3	The table heading and column heading (Tg/year) indicates or at least implies that these data are the amount of N fertilizer (sources) and not the amount of N coming from each source. Because	Change to Tg N/yr – Viney

		the N concentration in the sources ranges from <20 to 82% N, it is important to clearly indicate this is the amount of fertilizer N from each source. Changing "Tg/year to Tg N/year would help.	
42	12-22	This paragraph can be very confusing to the non-N-trained audience. The lead sentence highlights nitrogen fertilizer use efficiency (NFUE). The second sentence (i) defines NFUE in terms of recovery efficiency (RE) in kg N uptake per kg N applied. However, (ii) describes physiological efficiency (PE), which is kg yield per kg N uptake where yield and N uptake are from both N fertilizer and soil N. Thus, (ii) really does not relate to NFUE because soil N taken up by the corn plant may account for anywhere between 25 and 100% of the yield given in the numerator. This is important for a couple of reasons. First, the proportion of corn yield produced by soil N is affected substantially by previous crop and geographic location. In Minnesota when using an optimum rate of fertilizer N, about 60% and 76% of the corn yield is produced by soil N for corn that follows corn and soybeans, respectively. In Illinois, those values are 54 and 64%, respectively. The means across 271 corn after corn sites and 427 corn after soybean sites in Illinois, Iowa, Minnesota, and Wisconsin are 56% for corn after corn and 70% for corn after soybean. (Reference = Sawyer, John, Emerson Nafziger, Gyles Randall, Larry Bundy, George Rehm, and Brad Joern. 2006. Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn. Iowa State Extension	*Response: It will be difficult to go into a lot more detail about N fertilizer efficiency without adding several pages of text. However, this reviewer agrees that there are indeed few data on actual on-farm measurements of N fertilizer efficiency, and the publication he cites that gives soil N uptake data is based on field research conducted in replicated field studies in relatively small plots with uniform soil conditions compared to production fields. So, the only good, direct measure of N fertilizer efficiency from farmer's fields is the NFUE, which indeed is a surrogate. Still, there is a good point in this comment.* ***I suggest editing the following paragraph, which is currently on pg 42, lines 23-29, as follows (red text is new):*** In most cropping systems, RE is the most important determinant of NFUE. A recent review of RE for cereals based on field studies around the world, mostly conducted on "small-plot" experiments at research stations, reported mean single year RE values for maize, wheat and rice of 65%, 57% and 46%, respectively (Ladha et al., 2005). However, crop RE values based on actual measurements in production-scale fields are seldom greater than 50% and often less than 33%. For example, a review of RE in different cropping systems, estimated average recoveries of 37% for maize in the north central US (Cassman et al., 2002). It is also important to note that soil N provides the majority of the N taken up by most crops grown on soils with moderate to good soil fertility. For maize in the U.S. corn belt, for example, 45-77% of total N uptake was

		PM 2015 or on the web at www.extension.iastate.edu/Publications/2015.pdf). When RE is calculated, the N uptake in the corn from the zero fertilizer plots or area is subtracted from the total N uptake to get N uptake from the fertilizer. This is true NFUE and the term we need to address if we are to improve fertilizer N efficiency. In line 30, page 42, it states that "relatively few data that provide measurement of fertilizer N recoveries by our major field crops. . . .". This is because very few growers will leave an unfertilized area or two in their fields to provide this "zero fertilizer N" number. Also, few growers have the capability to measure N uptake; it is much easier for them to measure corn yield. Thus, a surrogate for NFUE can be kg yield per kg N applied. The confusing part of this surrogate is that it presents a yield value for only the fertilizer N per amount of applied N; whereas, PE described in (ii) presents a yield value for both soil N plus fertilizer N per amount of N. This is the second reason this distinction is important. This report (p.42 lines 12-22, p. 127 Figure 25, and p. 151 lines 4-15) and various reports in the literature have confused NFUE, which addresses efficiency of fertilizer N only, with NUE, which often addresses soil & fertilizer N.	estimated to come from soil N reserves based on experiments from research stations (Sawyer J, Nafziger E, Randall G, Bundy L, Rehm G, and Joern B. 2006. Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn. Iowa State Extension PM 2015, www.extension.iastate.edu/Publications/2015.pdf). Therefore highest N efficiency and economic return on N inputs are achieved when the amount and timing of applied N is synchronized with the availability of soil N throughout the growing season to minimize both the quantity of N input required and the N losses from soil and applied N sources. (Ken)
42	23-29	I have no problem with what is said in this paragraph as long as one recognizes that RE can be affected greatly by previous crop and that RE is dependent on the rate of N applied because that	No change needed

		term is in the demoninator. From a science perspective, it is always important to calculate RE and PE at the optimum rate of fertilizer applied (EONR) over a long period of time. Otherwise, one does not know if NFUE is truly being improved by management shifts or new genetic materials being planted.	
43	9	Insert “may” between “that” and “improve”. The technologies that we currently have available and mentioned in lines 10-13 perform best in very site-specific instances and will not show N improvement across the board.	Make change - Viney
44	6-18	This paragraph contains some generalizations that need comment. Even though I am not a big fan of fall fertilization, due to our highest consistent yields occurring for spring preplant N application, I do recognize the logistical and economic factors that drive fall N application, especially in the Northern Corn Belt. Fall N application in late October or early November in Minnesota where the soils are frozen from early December through the end of March is much different than N being applied in mid-October in southern Iowa, Illinois, Indiana, Ohio and Missouri when the period of frozen soils is much shorter or absent. The potential for improving NFUE for spring compared to fall application is much greater in the mid-to southern Corn Belt than in the Northern Corn Belt.	***Response: This is true. Modifiy Pg 44, lines 12-13 as follows (red text is new):*** This situation suggests substantial potential for improvement in NFUE and 13 an associated reduction in Nr losses from crop agriculture, especially for maize in the warmer portions of the Corn Belt and other southern and southeast areas where maize is grown. – (Ken and Viney)
44	14-18	The “smart” fertilizers work well when the risk of	Change jargon from “smart fertilizer” to “enhanced

		N loss is high. Unfortunately, weather, e.g. precipitation in the spring, has much to do with that risk; precipitation is an uncontrollable factor. These fertilizers are more expensive, which is huge factor reducing their acceptance among farmers.	efficiency fertilizer" - Viney
45	1-3	See the reference mentioned earlier (p. 42, lines 12-22). This is not true in the Corn Belt (see the Corn N Rate Calculator on the Iowa State Extension Web site).	*Response: No response required. The citation in question is based mostly on field experiments conducted at research stations and not in farmer's fields. As explained elsewhere in the text, it is crucial to rigorously validate N recommendations in farmer's fields – (Ken and Viney)*
45	8-18	This paragraph illustrates the confusion between NFUE or RE and NUE or PE. The first line says NFUE yet the values are NUE/PE.	Add NUE to Table of Abbreviations (Jim and Angela)
45	19-30	Hurricane Katrina had little to do with higher N costs. The greater N costs were due to higher natural gas prices and off-shore production and transportation. N prices are largely driven by energy costs.	Otto will work with Ken and provide to Viney
45 46	35- 2	Cassman, who has done very good work, is frequently cited in this report. However, much of his work has been done on irrigated soils which are much different than rainfed crop production. The in-season decision-making tools described have a much greater probability of being successful in irrigated production, where N can be combined with water and delivered to the root system, compared to rainfed conditions where one needs to depend on Mother Nature to deliver that "timely rain".	*Response: This is not true. While it may be more challenging to synchronize N applications with crop demand in rainfed systems, it is not impossible and our current text calls for development of appropriate techniques. No changes are needed.* (Viney and Ken)

46	29-32	Zero-N control areas need to be implemented in production-scale fields to really get a handle on long-term N management.	No change. *Response: The committee agrees, but other research approaches are needed as well. No need to stipulate how the research should be conducted. Therefore, no change to existing text is needed*
46	33	include "land-grant Universities"	Make change (Viney)
47	1-3	" " " "	Make change (Viney)
50	10-12	The values of 10% and 20% seem high to me considering the amount of each source that is incorporated during or soon after application.	No change. They may be high, but this is what the IPCC uses
51	9-12	include "land-grant Universities"	Insert language The committee recommends that EPA ensure that the uncertainty in estimates of nitrous oxide emissions from crop agriculture be greatly reduced through the conduct of EPA research and through coordination of research efforts more generally with other agencies such as USDA, DOE, NSF and with research conducted at universities. – Viney and Ken
51	32	"increasing corn acreage by millions of acres" seems to be pulled out of the air. There are resources available to document how many acres of corn are planted each year. This statement is clearly an exception to the rest of this report.	Otto will revise and provide to Viney and Ken
57	16	"neutralization of acids produced by sulfur and N oxides". Does this really occur to any significant amount?	Russ will revise – provide to Viney

57	20	I'm not aware of nitrate causing soil acidification.	Change nitrate to "HNO_3" (Viney and Ken)
58	28	NRC 2996?	Make change (Viney and Ken)
52 61	all- all	Seems like a lot of attention to devoted to animal agriculture. Maybe that is fine from an atmospheric perspective, but in my opinion not from a water perspective.	No change. Animal agriculture provides much of the sources overall
64	Table 9	Table 9 is incomplete. The "High Maintenance Areas" has been omitted from the left-hand column.	Arvin will update table
67	15	"in" Recommendation D	Russ will correct
80	25-33	This is the first place in the report where the mineralization of soil N is referred to as a source of N for plant use. This is a major source of non-controllable plant-available N, and it greatly affects NFUE. Thus, I feel that the concept should be introduced on page 42, lines 12-22 in addition to the few lines stated here.	Arvin will address after discussion with Ken
81	Table 13	6.4 Tg N/y from N fixation in vegetated grasslands seems quite high when comparing it to the millions of acres of very efficient N fixing plants (alfalfa and soybeans) in agricultural systems! What leads to this high value. I know there are lots of areas of grasslands, but one does not visualize a significant amount of N fixation occurring in these grass-based systems.	Table 13, revise the N fixation line to reflect table 1 (Arvin)
83	16-23	I endorse this finding, the recommendation, and	

		the inclusion of universities in the research effort.	
86	3-24	This is a tricky section. The document has solely been directed toward N. Now P is being co-mingled with N. We know that algal growth is dependent on both N & P; but my knowledge indicates that N tends to be the driver in marine waters and P in fresh waters. Therefore, I'd recommend more text defining these differences. For most citizens who don't live next to marine waters, P is assumed to be the reason for algal blooms and associated taste and odor problems. Furthermore, aren't most of the 303 (d) listings and WQ nutrient pollution impairments due to P? The issue of N vs. P causing algal blooms is a real contentious issue among many, depending on how it affects their particular situation. This section as presently written only feeds that contensciousness. The section should be rewritten in a manner that focuses on N as a contributor to algal blooms and not using P to make the point. In my opinion, using P only discredits the report.	The committee disagrees with the comment. The world is more complex than what he prescribes. There are important systems in which BOTH N and P inputs need to be controlled, and it doesn't dilute the take home message of our report to mention this (i.e. it doesn't minimize the overall importance of controlling N inputs to these and other estuarine and coastal waters). Recently, a paper by Schindler et al. (PNAS 2008; attached) fanned the flames of having to be absolute about P limitation being the be-all, do-all limiting nutrient in aquatic systems (based on a purely freshwater interpretation. There have now been two replies to help clarify the point of why BOTH N and P input constraints are needed in many estuarine, coastal (and even freshwater) systems threatened by the adverse impacts of eutrophication. The Conley et al. (2009) and Paerl (2009) manuscripts as examples..
85	9-13	This section is fine as it concentrates on marine systems. Thus, distinguishing between marine and fresh water systems seems important.	
86	2	sentence is unclear	Arvin will revise
86	18-20	For those of us who live in fresh water areas, chlorophyll *a* is always associated with P.	
88	33	Recent information from Minnesota questions the	Footnote for table 15 will be moved close to p. 88

		role of conservation tillage as a factor for greater SOC accumulation.	
91	Table 15	Table 15 and footnote 7 are valuable	Addressed above
93	9-13	This is an important paragraph. There are volumes of this information in the scientific literature, but perhaps it is too detailed and site-specific for this report.	Panel concurs
94	2-27	A very important section!	Panel concurs
94 95	28-15	This section was repeated earlier on p. 94.	Remove repeated text (Arvin and Russ)
95	16	Fig. 18 is not very instructive. Also, I could not find where it fits in or where it was discussed in the text.	Will be moved to appendix (Russ)
98	2-20	Are cost: benefit ratios appropriate for measuring these impacts?	Section is about damage costs, a metric other than not cost-benefit. No change needed (Bill Moomaw to check) and provide to Tom
99 102	24-18	Text Box 2, its text, figures and tables was an excellent instructive section.	
125	15-18	"decreasing N fertilizer application rates 10 to 50% . . . . would decrease nitrate output to the river by 10 to 43%". Compared to what rate? One always needs to be careful when making these kinds of statements without defining the boundaries. We have data showing that when N application rate is reduced from 160 lb N/A to 120 lb N/A (a 25% reduction) that nitrate-N	Insert sentence, effects depend on starting point (Arvin)

		concentrations in drainage water are reduced by about 30% without losing crop yield. When reducing the N application rate to 80 l Make change (Tom)b/A from the Univ. of Minn. N recommendation of 120 lb/A, nitrate-N concentrations were reduced only about 10%, but crop yields were significantly reduced. Bottom line: one needs to state what the starting point or comparison value is to make these kinds of statements valid.	
125	30	Jaynes and Karlen (2005) not found in Reference section.	Arvin will provide to Tom
126	2	Fig. 24 should correspond to Fig. 22 or 23	Make change (Tom) Revise figure 24 to Tg; axis should say N (Bill)
	18	" 25 " " " " 24.	Make change (Tom)
	19	" 26 " " " " 25.	Make change (Tom)
127	Fig. 25	Fig. 25 shows how corn grain yield per kg N changes with time. This "kg grain per kg N" relates to both the N from the soil and from the fertilizer. Thus, it does not specifically relate to NFUE (line 17, p. 126).	Replace "NFUE" with "NUE" (TomP
128	1-3	What is the N rate starting point or N rate range starting point? (same concern as above for p. 125 lines 15-18).	Arvin will address and send to Tom; Hu reference cited twice.
128	5	Fig. 27 should be Fig. 26.	Make change (Tom)
129	14	" 28 " " 27.	Make change (Tom)

131	2 & 7 8	“ 30 “ “ 29. “ 32 “ “ ??.	Make change (Tom)
131	Fig. 28	no discussion found in text	Bottom of page 130, line 35 should reference figure 28 (Tom)

Comments from Dr. James Schauer	
4) Page 58, lines 10-12 - Recommendation 5 is really not a feasible recommendation. It is not really possible to measure trends in fugitive or areas sources. Networks like NADP are used as an assessment tool to study trends in emissions. A better recommendation may to be expand the locations or measurements of the NADP and STN networks.	Change to “be monitored and assessed utilizing a network of monitoring network” - Viney Insert mention of NEON in Finding 5. Note that EPA and NSF should work with USDA. Bill Moomaw to provide suggested language to Viney
Chapter 3: Integrated Risk Reduction Strategies for Reactive Nitrogen	
From Dr. Elizabeth Holland	
The recommendations as currently constructed are likely to result in a series of independent studies that do not make substantial progress towards solving problems on larger spatial scale. Careful thought and substantial revision of the current plan is required to ensure that the studies and integration achieve the desired environmental and policy outcomes.	Recommendation and Finding 19 should be moved to Thresholds and critical loads discussion 118-131. Galloway will merge Finding and Recommendation 16 and 19 (Jim) . Recommendations A-C are meant to be overarching recommendations to encompass both research and risk management recommendations. No change
From Dr. Gregory McIsaacs	

Page 143, line 14: delete "for the WRP" as this was mentioned at the beginning of the sentence.	Make change (Tom)
Page 151, line 11: The assessment of Cassman et al. (2002) was based on data collected from the 1995-1999 growing seasons, not the 2000 growing season as stated on line 12. It may also be relevant that Cassman was using a different definition of NFUE than was defined in this report on page 43 (footnote 5). As defined on page 43, NFUE has units of kg grain per unit of N fertilizer applied. Cassman et al. defined a recovery efficiency as the difference in above ground N between a fertilized and unfertilized crop divided by the quantity of fertilizer applied. A problem with this approach is the unfertilized baseline is an artificial condition influenced by the prior crop residues.	*Response: This reviewer seems to be confused. The values for NFUE are taken directly from the data presented in Fig 7 in Section 2.2. In fact, these values do transform into 0.8 to 1.0 bu of corn/pound of N applied as fertilizer. Perhaps we need to modify the text as follows to make the units for NFUE clearer (red text is new):* From 1980 to 2000, N-fertilizer use efficiency (NFUE, kg grain produced per kg applied N, hereafter expressed as kg grain / kg N applied as fertilizer) increased from 42 to 57 kg grain / kg N, a 35% efficiency gain during a period when average U.S. corn yields increased by 40% (Fixen and West, 2002).
Page 152, lines 15-17: some citations that describe the storage systems would be valuable.	Tom will consider citation to NRC report. Viney will provide addition
Page 152, line 21: "bemoaned" does not seem to be an appropriate descriptor of an NRC report.	Change language (Tom)
Page 153, lines 29-30: there appears to be some words missing in the sentence starting with "Sommer".	Arvin will revise – send to Tom
	Issue of developing finding and recommendation relating to manure or pointing to recommendation in section 2.2 (Arvin and Tom)
Page 153, line 34-36: This sentence states that all unused fertilizer plus some of the N fixed by soybeans moves to surface and groundwater and ignores denitrification and long term storage. This statement, and the entire report also ignores the fact that soybeans in much of the Midwest	See response to Randall. Header needs to be moved Tom will make the following changes: Move wetlands heading (line 34) prior to last sentence, beginning on line 40 and flowing into next paragraph

are a net sink of N. Like many legumes, soybeans can reduce their investment in fixation if there is an abundant supply of soil N, and much of the plant N is transferred to the bean. In most years, soybeans remove more N from the soil than they leave behind in crop residues.	Wetlands would begin new subsection Remove sentences lines 34-40 Line 41 wetlands should be "natural, created, or referred"
Page 156, line 2: "a side reaction for the … catalyst system is ammonia" probably should be "…produces ammonia"	Make change (Tom)
Page 157, lines 5-7 are duplicated by lines 8-10.	Make change (Tom)
Page 157, line 18, NR should be changed to Nr.	Make change (Tom) also in Exec Sum
Page 159, Target Recommendation 2 seems to fit with the text of Target Goal 3 (page 161), and Target Goal 2 fits with the text of Target Recommendation 3.	Make change (Tom)
From Dr. Jerry Melillo	
P125, L13 – confusing sentence, clarify	Tom will consider revisions to clarify
P131, figure – not very informative, clarify	Tom will add some text
P154, L26 – sentence does not make sense, re write	Insert word "to" after the word 'scale" (Tom)

From Dr. Giles Randall

142	27	Fig.29 should be Fig. 32.	Correct (Tom)
150	12	" the most leaky lands should be taken out of production ". I find this statement to be most	Otto will revise, provide to Tom

		interesting. In this whole document it is the only sentence that relates to changing from a row-crop (corn & soybean) system to a non-row crop system (perhaps a perennial grass or alfalfa system. Minnesota research has shown nitrate-N losses to drainage water to be reduced by 30 to 50 times when converting from a corn and soybean system to a perennial grass or alfalfa system. The effect of changing to a different cropping system has a greater effect on reducing nitrate losses to drainage water than combining all BMP factors for N management mentioned in this report.	
150	23-39	It is not surprising that watersheds of the MRB with the highest rates of fertilizer runoff had the lowest amount of land enrolled in federal conservation programs. Lands enrolled in conservation programs are usually highly erodible with significant sediment loss potential; whereas the MRB watershed with higher nitrate runoff are generally flat and "non-erodible". So this could be an issue of taking flat non-erodible areas out of production to minimize nitrate loss and then replacing corn production on to areas much more vulnerable to soil erosion. It would be exchanging nitrate loss for sediment and P loss. Not a good trade.	Report does not suggest that trade-off. Otto will revise (possibly by deleting quote), provide to Tom
151	7-10	This wording suggests that this is a NFUE calculation (kg grain produced per kg of N applied). However, the values of 42 to 57 kg grain/kg of N convert to 0.75 bu to 1.00 bu of grain per pound of applied N; these values far	*Response: This reviewer seems to be confused. The values for NFUE are taken directly from the data presented in Fig 7 in Section 2.2. In fact, these values do transform into 0.8 to 1.0 bu of corn/pound of N applied as fertilizer. Perhaps we need to modify the text as follows to make the units for*

		exceed NFUE values and lead me to suspect that they are merely NUE (PE) values, which combines the yield from soil N with that from fertilizer N. Thus, this is not an illustration of NFUE. It is a 35% yield efficiency gain but it cannot be specifically related to improved N fertilizer use efficiency (NFUE).	*NFUE clearer (red text is new):* From 1980 to 2000, N-fertilizer use efficiency (NFUE, kg grain produced per kg applied N, hereafter expressed as kg grain / kg N applied as fertilizer) increased from 42 to 57 kg grain / kg N, a 35% efficiency gain during a period when average U.S. corn yields increased by 40% (Fixen and West, 2002).
151	10-12	The next sentence relates this as NFUE and compares it to NFUE of 37%; it is like comparing apples and oranges. Furthermore, in Fig. 25 on page 127, Fixen and West did not subtract grain produced from soil N from the grain produced from soil + fertilizer N – a requirement for NFUE.	See above
151	10	Fixen and West (2002) was not found in References section.	See above
151	37-39	More than a "large investment in research, extension education, and technology transfer" will be needed to obtain substantial improvements in NFUE. In 1991, the State of Minnesota appointed a Nitrogen Fertilizer Task Force, which developed a N Management Plan for the state. This consisted of a 3-phase plan leading up to N regulations and the development of BMPs for N in six different areas of the state. Seven UM Extension bulletins (one for each of the areas and one for overall N mgmt) based on University research were published in 1993. Countless N management extension meetings were held and thousands of bulletin/fact sheets were distributed over the next 15 years with astonishing little implementation.	Otto will draft brief text, provide to Tom, refer to earlier text on market mechanisms. Discuss options (market base, taxes, performance measurement)

		The bulletins were revised in 2008. In my opinion one needs more than "volunteerism" before BMPs are widely practical. Incentives, disincentives and a "stick" approach is needed in conjunction with state-of-the-art research. The increased price of fertilizer N did more to change grower behavior with respect to N than did all of the extension bulletins distributed and meetings held.	
153	29	sentence unclear	Insert missing word (Tom)
153	32	BMPs to minimize NH_3 emissions were not found in section 3.2	Otto will revise, provide to Tom
153	34-41	More N is removed in harvested soybean grain than is fixed by the plant. Also nitrate leached into drainage under soybeans comes primarily from the soil N and from fertilizer applied to corn the previous year. Nitrate leaching losses in a corn-soybean system are more complex than described in this paragraph.	See immediately above
153	38-39	Del Grosso et al. (2006) not found in Reference section.	Add citation or edit out reference)
154	35-39	This is an extremely important statement.	
155	6	Section 3.3.1 did not address NO_X emissions declining in the U.S.	refer to is section 2.2.2 (Tom)
156	14	include "Universities"	Make change (Tom)
157	20-28	BMPs based on excellent research and vigorously	Otto will provide text, linked to new text on p. 161.

		extended are not enough to change grower behavior AND industry sales/marketing when it comes to N. Tradition and the strong role of the fertilizer dealer are powerful forces opposing the implementation of N BMPs. As stated earlier incentives and disincentives are needed to accompany the BMP process.	Paul will provide bullets on BMP on stormwater Bill will provide bullets on BMPs for wetlands Provide to Otto
159	6-7	There is lots of talk and enthusiastic, optimistic marketing for improved tile-drainage systems, but in my opinion, there are numerous practical and logistical obstacles that are not discussed. Reducing tile drain depth from 3.5' to 2.5' will be helpful due to the large area of drained soils where this kind of management is suitable. But, I am not that optimistic about significant nitrate mitigation across the landscape with controlled drainage, wood chips for denitrification in the tile lines, and riparian buffers in most Corn Belt land.	No change. Acknowledging difficulty, but approach remains part of the potential suite of BMPs to be considered.
159	10-11	Advances in fertilizer technology will be helpful in certain specific areas but in the big picture will have a limited effect on mitigating nitrate loss to water.	No change. Approach remains part of the potential suite of BMPs to be considered
159	22	Simpson et al. (2008) not found in Reference section.	Hans will provide to Tom
159	36-41	Target recommendation 2 text should be under Target recommendation 3.	Make change (Tom)
160 161	34- 10	Target rec. 3 text should be under target rec 2.	Make change (Tom)

161	7-9	Decreasing Nr by up to 20% may be possible on average but the range is likely 0 to 100%. Again, what is the starting or reference point for the 20% reduction?	Text does refer to "below current amounts". No change
170	12-18	Does not agree with Target Goal 2.	Tom will revise
170	20-34	Agrees with Target Goal 2.	Tom will revise)

From Dr. Stuart Weiss	
Policy responses:	
Overall, the ongoing critical loads process (CLAD) provides a means for addressing this problem in the long run. Note regional efforts like that at Rocky Mountain National Park to reduce emissions are starting, based on a finding of critical load for alpine lakes.	Report already addresses critical load
Impacts on threatened and endangered species fall under the jurisdiction of the US Fish and Wildlife Service. Since 1999, mitigation for impacts of powerplants, road widening, and urban development on Bay checkerspot butterflies and serpentine grasslands include land acquisition and management/monitoring endowments and the development of a regional Habitat Conservation Plan. The Endangered Species Act may be a powerful means for identifying and mitigating N-deposition impacts on protected species	Jim will identify place to address issue, including partnering with FWS.
It is the short-term mitigation and management needs of these	Biodiversity already mentioned, but this level of discussion not

ecosystems that desperately need attention, especially control of invasive species. In California cattle grazing has been effective in maintaining serpentine grasslands and vernal pools. Management of many ecosystems remains problematic- wildland weeds are hard to control and substantial resources are needed on the ground.	needed
The emissions of ammonia from vehicles (catalytic converters) along heavily traveled roads creates high deposition corridors. Vehicular ammonia may be one of the more readily controllable sources, and the call for ammonia to be considered as a regulated pollutant	Russ will write some text about possible ammonia effects in some corridors.
Measurement and modeling of N-deposition loads is critical for understanding highly local effects, such as roadsides, as well as regional plumes. Passive samplers provide inexpensive means for monitoring time-averaged concentrations. A 4 km CMAQ run for the California (Tonnesen et al 2006) has proven immensely valuable for N-deposition assessments at regional levels. Standards for project-based and cumulative impact assessments need to be developed.	This level of discussion not needed
Fenn, M. E., J. S. Baron, et al. (2003). "Ecological Effects of Nitrogen Deposition in the Western United States." Bioscience **53**: 404-420.	
Tonnesen, G., Z. Wang, et al. (2006). Assessment of Nitrogen Deposition: Modeling and Habitat Assessment. Sacramento, CA, California Energy Commission, PIER Energy Related Environmental Research CEC-500-**2006**-032.	
Weiss, S. B. (1999). "Cars, Cows, and Checkerspot Butterflies: Nitrogen Deposition and Management of Nutrient-Poor Grasslands for a Threatened Species." Conservation Biology **13**(6): 1476-1486.	

Weiss, S. B. (2006). Impacts of nitrogen deposition on California ecosystems and biodiversity. Sacramento, CA, California Energy Commission, PIER Energy- Related Environmental Research CEC-500-2005-165.	

Attachment H: Proposed schedule for completing the INC report

	Target Date	Key Milestones
1.	May 14-15	INC holds face-to-face public meeting to discuss and dispose of external review comments
2.	June 19	INC draft available for public teleconference
3.	July TBD	INC public teleconference discussion of June 19th draft. Opportunity for Agency/public comment.
4.	August 15	INC consensus draft available
5.	September 23-24	Chartered SAB Quality Review and approval
6.	Late October	Final INC Report available for formatting/editing
7.	Late November	Printing
8.	December	Transmittal to the Administrator