U.S. Environmental Protection Agency
Science Advisory Board
Integrated Nitrogen Committee
Public Meeting – April 9-11, 2008
Minutes

Date and Time: Wednesday, April 9, 2008, from 9 a.m. to 5:30 p.m. through Friday, April 11, 2008, from 9 a.m. to 3 p.m. (Eastern Time), as announced 73 FR 54 – 14802, March 19, 2008.

Location: Latham Hotel Georgetown, 3000 M Street, NW., Washington, DC 20007; telephone (202) 726 - 5000.

Purpose: The purposes of this meeting are (1) to learn about policies and programs, past and present, directly or indirectly affect how reactive nitrogen is managed, and (2) to draft additional portions of the INC's study report.

Materials Available: Materials made available for the INC's earlier meetings and teleconferences teleconferences are identified in the minutes for those meetings. The additional materials made available for this meeting are listed on Attachment 1.

Attendees: Drs. Galloway and Shaw were unable to attend any of the meeting; chartered SAB member Dr. Theis chaired the meeting. All other members were present for the first two days of the meeting. Dr. Moomaw was unable to attend on April 11 and Drs. Dickerson and Mitsch were only able to attend part of that day.

SABSO DFO Kathleen White, of the Science Advisory Board Staff Office was present all three days. Deputy Director Dr. Anthony Maciorowski was present April 9 and 10. Director Dr. Vanessa Vu was present April 10 and 11. DFO Kyndall Barry was present on parts of April 9 and 11.

Speakers present during part or all of the meeting on April 9 were: Dr. Stan Daberkow, Economic Research Service, US Department of Agriculture; Dr Roger Claassen, Economic Research Service, US Department of Agriculture; Mr. Craig Cox, Soil and Water Conservation Society; and Mr. John Davies, Transportation Analyst, Transportation and Climate Division, Office of Transportation and Air Quality (OTAQ), Office of Air and Radiation, USEPA.

Speakers present during all or part of the meeting on April 10 were: Dr. Paul Fixen, International Plant Nutrition Institute; Mr. John Sheehan, LiveFuels; Dr. John Miranowski, Iowa State University; Mr. Rudolph Kapichak, Environmental Engineer, Transportation and Regional Programs Division, OTAQ, Office of Air and Radiation, USEPA; and Dr. Alan Hecht, Director for Sustainable Development, Office of Research and Development, EPA

Sarah Mazur of EPA was present on April 9 and 10.

Tamara McCann Thies of the National Cattlemen's Beef Association was present on April 9 and 10.

Cindy Langworthy of Hunton and Williams was present on April 9.

Kate Winston of Inside EPA was present April 9-11.

Summary: In terms of content, the meeting went according to the agenda, with minor re-ordering of a few agenda items. The following actions and decisions resulted from the meeting:

1. Cassman, Hey & Mitsch, Lighty & Moomaw, and Stacey developed "one-pagers" on risk reduction options. Aneja & Kohn subsequently prepared one on animal agriculture.

2. The INC will form a risk reduction options integration team to prepare material for the consideration by the full committee at a later date.

3. The INC will form a workshop planning team to plan and prepare for a workshop at which the INC will present their preliminary findings and conclusions, emphasizing those on risk reduction options for integrated nitrogen management, and seek the input of decision-makers, managers, and practitioners.

4. The DFO will follow-up with the presenters from USDA to see if their slides could be made available to the committee and the public. (Done)

5. Cassman and Stacey developed written summaries of the risk reduction options developed by the breakout groups. The DFO distributed these to the members for refinement.

6. Various proposals were made for the organization of the recommendations. Three suggestions were: the use of the project objectives; avoid, minimize, mitigate; conserve, reuse, control outputs.

7. The chair, leads and co-leads will assign various tasks resulting from this meeting to working groups. The working group leads and co-leads then will assign the tasks within their groups. (Done April 24.) When that work is done, it should provide the intellectual basis for the workshop.

8. Dr. Cassman will include at least a footnote on the regulatory structure in Nebraska with NRE and districts.

Further Information on Matters Discussed:

This section of the minutes is more detailed and only partially chronological. For the convenience of the reader, related presentations and activities are described together here although they may not have followed immediately one after the other on the agenda.

After the DFO opened the meeting on April 9, Dr. Maciorowski, Deputy Director of the Science Advisory Board Staff office welcomed the members and asked them to briefly introduce themselves for the benefit of those who had not met with the Committee before.

Chartered SAB and INC member Dr. Thomas Theis chaired the meeting as Dr. James Galloway, chair of the INC, was unable to attend this meeting. Dr. Galloway was receiving the Tyler Prize. For these minutes, "the chair" refers to Dr. Theis.

Dr. Theis stated the purpose of this meeting, the Committee's fourth, and reviewed the agenda. The dominant for this question is, "What is a manager to do about reactive nitrogen in the environment?" There were no questions about the agenda.

The Leads and Co-Leads then briefly summarized the activities of the working groups.

Dr. Viney Aneja & Dr. Kenneth. Cassman lead the Producers Working Group which also includes Boyer, Doering, Herz, Kohn, Lighty and Shaw. The PWG had worked on reactive nitrogen fluxes for the contiguous USA. (See overheads.) Dr. Boyer added that one of the highlights was the need for good nitrogen accounting at the national scale. Dr. Paerl asked Dr. Boyer whether it was possible to regionalize some of this analysis; she answered, "yes". The PWG has compiled the data by state already and may organize it by major watersheds.

Dr. Russell Dickerson & Dr. Arvin Mosier lead the Environmental System Working Group which also includes Boyer, Hey, and Mitsch. (See overheads.) Dr. Hey expressed concern over the lack of information on risk management in the current draft Section 3.2. Dr. Theis noted that the INC has set aside time for committee discussion on these issues at this meeting and will defer further discussion to that time. Dr. Cassman noted that sections 3.2 and 3.3 are supposed to be descriptive.

Dr. William Moomaw & Dr. Thomas Theis lead the Impacts & Metrics Working Group which also includes Cowling, Doering, Paerl, and Stacey. (See overheads.) INC member Dr. William Moomaw spoke about economic impacts. He noted that we cannot manage what we do not measure and what we measure determines what we manage.

A variety of metrics can be used in the context of nitrogen, including: tons of reactive nitrogen fluxes and stocks; dollar cost of damage to human health and/or environment; human mortality and morbidity, and mitigation costs of each form of reactive nitrogen.

Where mass fluxes are greatest determines where the most effective control points for reactive nitrogen are located. This varies by location. In the Mississippi valley the greatest flux is from agricultural runoff, whereas, for the Chesapeake Bay, fluxes for energy and agriculture are about equal.

He noted that protecting human health is a major goal of legislation and air emissions have the greatest impact per ton on health. In the Chesapeake Bay, mortality costs are about ten times that of morbidity.

The damage costs also cascade. Cost puts a lot of different things on a common valuation and it reflects societal values on various ecosystem goods and services. The damage costs track the cascading tons of reactive nitrogen. However, not all damage costs can be monetized and it is difficult to see how some of them could ever be monetized. In their Chesapeake Bay study they had nine non-monetized damages.

Their analysis showed that the air emissions cause more damage and the damage costs are higher, partly because they cause health problems and partly because they cascade so much further. Costs of mitigation are different again.

Looking at different endpoints provides different messages. Dr. Moomaw plotted total damage costs associated with anthropogenic nitrogen fluxes in the Chesapeake Basin.

Integrated management of nitrogen needs to use a more integrated management approach that is region specific AND should use multiple metrics. This will provide more information for selecting effective policies and action. Optimizing nitrogen in each subsystem sub-optimizes the reduction of nitrogen in the total system.

Dr. Thomas Theis leads the Risk Reduction Working Group which also includes Aneja, Boyer, Dickerson, Doering, Herz, Lighty, Moomaw, Mosier, and Stacey. He briefly summarized the current draft of Chapter 4 then reminded the Committee that this meeting would identify risk reduction options and research needs and also address integration. By doing so, it would provide material for Chapters 4 and 5.

Invited Presentations: Agriculture

Dr. Stan Daberkow and Dr. Roger Claassen of the Economic Research Service at the Department of Agriculture gave the first of three presentations on agriculture. (See overheads.) Dr. Daberkow focused on the survey work while Dr. Claasen focused on economics. Daberkow's data is mostly field level from the ARM survey. Claassen's is at the farm level.

Dr. Daberkow provided an overview of private management practices and public policies affecting agricultural nitrogen use. In addressing commercial nitrogen use in agriculture, Daberkow looked at trends in selected nutrient management practices in corn production, policy effects on land use and crop mix. He focused on corn because it uses about 40% of the fertilizer used in the US. About 96-98% of corn acreage is treated with nitrogen and the nitrogen application rate is heavier than for other major crops. About 94 million acres of corn were planted last year, the highest number since 1944.

Several nutrient management practices can influence nitrogen in the environment, such as:

- Application rates
- Soil testing
- Crop rotation

Manure and nitrogen inhibitor use
Nitrogen broadcasted with and without soil incorporation
Yield monitoring and yield mapping
Application timing

More farmers have adopted precision agriculture. And the relationship of corn yields to nitrogen application rates suggests there is an increase in nitrogen efficiency in corn. On the other hand, there seems to be less soil testing done. The share of planted corn acreage on which a yield monitor was used or a yield map produced has increased to 40%. If farmers map the data, they can use the geo-referenced data to guide planting later on. This may be the fastest growing technology.

Dr. Claassen talked about how federal policy affects practices and crop mix at the "10,000 foot level". Standard practices are things that are relatively easy to adopt. The technologies are mature, farmers are familiar with them such as conservation tillage, crop rotation and resistant seed. Dr. Daberkow talked about decision aids; soil/tissue test, pest scouting, and soil mapping are other decision aids. The decision aids are inputs to management-intensive practices such as variable application, nitrogen management and pest management.

Practice adoption reflects farm and operator characteristics. For the standard practices it is useful to consider four different kinds of farms:

Retirement/rural lifestyle farms run by people who rely on other income

Low sales farms run by people who are trying to make a living farming and earning less than $100k/year

Higher sales farms that earn $100-250k/year

Commercial sales farms.

Commercial sales farms are more likely to use decision aids than the higher sales farms, higher sales farms are more likely to use decision aids than the low sales farms while the retirement/rural lifestyle farms make the least use of decision aids. Penetration is not as high for any kind of farm as for the standard practices. The same pattern, with even less penetration is true for management-intensive practices.

Energy markets and energy policy are the driving factor in commodity markets right now. Oil prices, ethanol mandates and tax subsidies cause ripple effects in commodity markets. Commodity programs protect some producers against low prices. Commodity programs are complex.

Insurance and disaster programs protect producers against production or revenue loss. About 2-3 million acres are affected. Research suggests crop insurance has small land use effect (2-3 million acres).

USDA environmental programs retire land and encourage nutrient management. About 34.7 million acres have been retired. About 88% of the acres are fields and whole farms. USDA gives a priority to capturing nutrient run-off to water. High priority practices are mostly buffers, such as grass waterways and filter trips. This accounts for 8% of the acreage, but more of the costs. CREP targets specific environmental issues with the states. EQIP assists with nutrient management for livestock and crops. EQIP focuses heavily on livestock and manure nutrients – fencing cattle out of streams, for example. Over the long term, the bulk of Federal Conservation spending goes for land retirement. Participation reflects farmer and operator characteristics. Those who farm full time, but rent land, and get commodity programs are more likely to participate in EQIP.

He identified some publications that can be downloaded from www.ers.usda.gov/AmberWaves/july06special issue

Conservation Compatible Practices and Programs: Who Participates?
www.ers.usda.gov/publications/err14
www.ers.usdea.gov/publications/arei

Customized data summaries from ARMS are available at
www.ers.usda.gov/Data/ARMS/CropOverview.htm

Mr. Herz noted Dr. Claassen stressed the importance of energy prices on commodity. He wondered to what extent other factors such as increased population, increased per capita meat production, etc. were important. Dr. Claassen responded that they do come into play, but one quarter of the current corn crop is going to ethanol production and that is expected to rise to one third. It is huge.

Dr. Boyer spoke of INC's work on the assessment, recognizing that assessment and management will need the cooperation of multiple agencies. She asked about what they learned from the census of agriculture and also asked about funding difficulties affecting frequency of data collection and needs. Drs. Classen and Daberkow said they used to collect annual data by commodity through 2000 when they began a four-year funding cycle. The surveys are jointly funded with NAS, which looks at chemicals. ERS piggy-backs the information on practices on the survey. They do not have a way to address production practices in the census of agriculture which is highly structured. They will not do the corn survey again until 2010, but in 2008 there will be an energy related field level survey that can provide some data about corn. They have already seen a shift to corn in 2007; now that other commodity prices are up, there is some shift back to other grains. They hope the 2008 survey will give them some idea on what land is being used and what the crop mix is. There's a lot of uncultivated land that could be used. The census shows 400 000 million acres of crop land of which about 50 000 acres is unharvested.

Mr. Herz spoke of the importance of the regular surveys and suggested that agricultural and environmental interests all want those surveys done every two years.

Dr. Claassen guesses that there are 80 – 100, 000 acres of uncultivated cropland (he will look it up and let us know).

Dr. Cowling observed EPA tends to make regulations, but do very little education whereas USDA tends to educate farmers to make management decisions that are in the nation's interest. Dr. Cowling noted the INC is an advisory board of the EPA. The advice and counsel of scientists at USDA would be useful on the issue of how EPA could comport itself to foster and encourage a good working relationship with USDA. There is an air quality advisory committee in USDA on which INC members Drs. Aneja and Shaw sit. Dr. Cowling understands that EPA is developing a new committee on air issues. Dr. Cowling asked, "From your perspective in the ERS, how could the INC best advise EPA on its comportment?"

Mr. Craig Cox, an invited speaker, offered to touch on those points in his presentation, but made these general observations first:

1. There are no national goals for any of the things we talk about.

2. Absent some decision in the White House, CEQ, or OMB that nitrogen management is a national goal comparable to global warming, it is very hard to drive these concerns down through the bureaucracies which are driven by other concerns.

3. These are failures at the political level, not at the career staff level.

4. Asking the career staff to do this is asking them to drive off a cliff.

Dr. Cowling replied that the government's job is to inform the nation to which Mr. Cox agreed. Almost no one knows what reactive nitrogen is. It is not primarily public education that is needed, but the education of selected audiences that make decisions or influence those who do. An effective strategy must have a very strategic communication strategy.

SABSO Deputy Director Dr. Maciorowski observed EPA is 19,000 people, USDA and USDOE are much larger. The current and former EPA administrators have sought collaboration with USDA and USDOE. There are 300 000 fewer feds than 15 years ago. This, too, has fostered collaboration. All agencies are beginning to look more critically at the problems they are addressing. Point sources were relatively easy. There is an agricultural liaison now at EPA. Dr. Maciorowski thinks EPA's relationships with agriculture are better than ever.

Mr. Craig Cox, Executive Director of the Soil and Water Conservation Society gave the second of three presentations on agriculture. (See his overheads.) He began with a couple of caveats. The Society is a scientific, technical, and professional society that operates on the borders of science and applications and science and policy. The membership has a growing sense of urgency about the role of agriculture in manipulating these fundamental

processes of the ecosystem. The INC needs to think about how this issue penetrates, in a meaningful way, the understanding of people who influence what happens.

There is reason to think that our problems with reactive nitrogen are getting worse. Not just the ramp up in commodity prices, but also in the context of climate change. A more variable climate and more severe storms effect what happens on agricultural lands. Erosion could double. We are not keeping up with the changes and may befalling behind faster than any of us want to think about. The Society tries to be objective, but is not disinterested.

Mr. Cox made these key points:

1. We need to move beyond nitrogen conservation to the loops in farming systems and landscapes

2. These farmlands are the most productive in the world and cannot be retired from production (with a few exceptions).

3. This is not a problem of a lack of technology: we have the right practices right now. We are using much less than we know. As documentation, he provided a copy of the book, *Environmental Benefits of Conservation on Cropland:The Status of Our Knowledge*, Max Schepf and Craig Cox, Editors, Soil and Water Conservation Society, 2006.

Mr. Cox made these four suggestions

1. Conservation Intelligence. We need too rebuild (reinvent) our capability to survey.

2. Scientific-Technical Assistance Networks. Most important practices and systems are knowledge-based. Targeting requires capability to analyze data at local scales. The infrastructure is fraying due to reductions in federal, state and conservation district staffs. These are content intensive activities

3. Policy and Program Reform. Current voluntary programs are poorly targeted, poorly focused, still using a 1930s model. They can be improved by targeting, using priorities, and focusing resources on multi-producer projects. He's worked with voluntary programs for 30 years and voluntary programs alone will not get the job done.

Regulatory programs are essential but need to be innovative. We need regulatory frameworks that don't rely on individual permits and work through local intermediaries. Water, energy, and climate change will drive agenda

4. Scientific and Technical Advances. Better science and technology will lower the cost of getting conservation intelligence, enable "precision conservation", and allow the design of voluntary/regulatory hybrids.

Drs. Cassman and Cox made different points about conservation tillage. The farming community used to think, you don't need to worry about tillage if you have level land, however tillage on level land IS a problem and a big part of the nitrogen problem. Tillage is more than avoiding erosion.

The main point of the INC strategy is that it is the use of systems (or lack of it) that could make substantial differences in a hurry.

During the Q&A, Dr. Cassman noted Cox had highlighted the issue of why technologies aren't being adopted. He thinks there are sound practical reasons for why farmers do what they do, like fall application of fertilizer. It's hard to dodge rain storms and get into wet fields in the springs. The investment in equipment and labor is high, but cheaper in the fall. So, some things that are obvious in terms of technology, but aren't happening for logistical reasons, are candidates for regulations. Mr. Herz noted that almost 60% of nitrogen applied in the US comes from foreign sources so the logistics are even more complicated than Dr. Cassman noted. It is questionable that you could apply all this nitrogen in a 2-4 week period in the spring. Bad timing in the spring can actually be more harmful. He spoke of a study by a Dr. Otto which suggests that a ban on fall applications could cost $1-2 billion per year. He was enthusiastic about soil testing and conservation tillage as inexpensive ways to achieve the goal. Dr. Cassman wants to take a new look at tillage. We do know tillage makes soil more permeable to water which would create a higher potential for nitrate leaching and has a higher potential for denitrification. We need to look at the whole matrix of what can be done and the barriers.

Mr. Cox agreed and noted that decision making on rented lands is fragmented which makes things even more complicated. He referenced the different kinds of farms the USDA/ERS speakers had identified. Trying to find an institutional and policy structure is a big part to making progress.

Dr. Daberkow suggested Dr. Cassman include at least a footnote on the regulatory structure in Nebraska with NRE and districts. Dr. Cassman replied that there are 23 watersheds, each of which is a natural resource district with an elected board from those areas with taxing authority. They have the responsibility of meeting the regulations. They can restrict the ability of pumping water for irrigation, ban fall application of nitrogen, and more. Cox thinks the ability to tax is important to their success.

One of the other invited speakers, Dr. David McNaught of EDF, asked the speakers to elaborate on the conservation securities program and voluntary-regulatory frameworks. Does CSP provide the right platform? Mr. Cox responded it depends on which CSP you are talking about. The CSP we had after 2002 would not be the right platform. But, if the Farm Bill passes, the changes to the CSP could make it a good platform. Legislation is 10% of the battle; implementation is really key. It is not so much program design at the legislative level, but how the agencies decide they want these programs to work and what they want them to focus on. Dr. Daberkow said that, when corn is $5-6 a bushel,

that will drive farmers' decisions rather than the CSP. He also thinks that the farm structure issue is important and timing becomes more of a driver.

Dr. Aneja asked Mr. Cox to comment on the atmospheric component. Mr. Cox responded he has limited technical expertise in that area, but is aware of its importance. That's why he is emphasizing nutrient management instead of conservation so we don't just move the nutrients from one medium to another. We want to reduce the total amount of reactive nitrogen in the environment. However, this is not how we think about it, nor how the practice standards are written.

Dr. Aneja clarified that Mr. Cox included BMPs under voluntary programs. Mr. Cox doesn't question the use of BMPs, he questions what the incentives are for users to adopt BMPs. Relying on a financial benefit from the government to adopt the BMPs will not be sufficient to move practice fast enough. Dr. Aneja thinks they will run out of BMPs and there is need to think about additional engineered solutions. Mr. Cox agrees that they should be thought about, but does not find them to be a priority. We are way, way far below the technical frontier right now.

Dr. Paerl noted that not everything is like the upper Mississippi Valley in terms of management issues and asked, " How do you promote nitrogen management at a regional level?" He gave some examples of situations that are different, like Chesapeake Bay and the big sounds and estuaries on the East coast. Mr. Cox said that the institutional structure is in place and works to some extent. Whether nitrogen conservation, soil erosion, pollinators, etc is the top priority is a different issue. His ideal institutional structure is the engagement of producers with an intermediary, set some goals for N reduction with a deadline and money. If they don't meet the goal after X years, they have to start re-paying the money. This combines incentives and accountability to accelerate improvement.

Dr. Cowling noted that 60% of the land area of North Carolina is forest. He asked Mr.Cox to expand his presentation to address forests. Mr. Cox replied that we tend to look at diverse landscapes as a good thing. Forests tend to make a landscape less vulnerable, so agroforestry and more conscious integration of agroforestry with agriculture is a good thing. Pasture management, on the other hand, gets very little attention. Very little pasture management is done, but only 10-20% of pasture is well done. Overgrazed pasture can be a problem.

Dr. Moomaw sees a very rapid response of producers to a change in policy on biofuels. We need to find approaches to nitrogen management that can be rapidly adopted.

Dr. Paul Fixen, Senior Vice President, Americas Group Coordinator, and Director of Research of the International Plant Nutrition Institute, gave the third of three presentations on agriculture. (See his overheads.) IPNI is only 15 months old. It's parent, the potash institute goes back to the 1930s.
IPNI's mission is to develop and promote scientific information about the responsible management of plant nutrition for the benefit of the human family

He had five major points:
1. Today's market and the presence of new technologies provide a great opportunity to make improvements in integrated N management.
2. Agricultural productivity must increase and environmental nitrogen policy will be more effective if it facilitates that increase.
3. Nitrogen is managed as an integral component of a cropping system based on system objectives with performance assessed at a system level.
4. The average is the enemy of efficient and effective N management and policy
5. Research and education focused on improving nitrogen use efficiency in systems producing near genetic yield potential levels are greatly needed.

Dr. Fixen addressed decision support and risk management tools and identified these priority research needs:

1. Development of nutrient decision support systems
2. Participatory research with producers & advisors to test feasibility of integrated decision support tools that employ local weather monitoring.
3. Determination of the fate of nitrogen not recovered in the harvested crop in intensively managed systems & the impact of new nitrogen technologies.
4. More needs to be known about field scale nitrogen losses and greenhouse gas emissions
5. See page 21 of the IPNI GHG review for additional topics related to GHG emissions associated with N fertilizers.

In addition to copies of his slides, Dr. Fixen provided an literature review of Greenhouse Gas Emissions from Cropping Systems and the Influence of Fertilizer Management, December 2007 and the December 2007 IPNI newsletter INSICTS with the article, "Ecologically Intensify Your Corn Nutrition".

Invited Presentations: EDF's Nitrogen Activities

Dr. David McNaught of the Environmental Defense Fund spoke on Environmental Defense's Nitrogen Activities. EDF is a leading national nonprofit organization, representing more than 500,000 members. Since 1967, Environmental Defense Fund has linked science, economics, law and innovative private-sector partnerships to create breakthrough solutions to the most serious environmental problems. EDF has an emerging international presence with offices in China and India; they do a lot of work with the World Bank. EDF's scope is broad. It is organized into five areas: climate & air; environmental justice; health; land, water and wildlife; and oceans. In the land, water & wildlife area EDF is almost in unique in emphasizing the management of private lands. EDF is non-partisan, tries to be cooperative and non-confrontational in working with business and others to find new solutions. EDF has more than three times as many scientists as lawyers. He is a social scientist and may need to refer to Joe Rudek for some technical questions. (For more information, visit www.edf.org.)

Dr. McNaught recommended Michael Oppenheimer's approach to education on global warming as a model for education on reactive nitrogen. Oppenheimer knew the public wasn't ready to connect to global warming, so he tied the issue to acid rain. It would be great if INC could interact with Fred Krup who would have a more sophisticated answer to how to apply the lessons of Oppenheimer's approach to nitrogen.

He liked what he heard Craig Cox say. We do need to do something dramatically different. Nitrogen problems include dying reefs, fish kills, algal blooms, red ties & dead zones, groundwater, acid rain & biodiversity, Ozone/PM2.5, and global warming.

EDF has been active on nitrogen, but also looked at in bits and pieces such as: watershed pollution reductions trading, airborne delivery into estuaries, critical loads designations, acid rain and NOx, hog waste management, and USDA incentive programs. Nitrogen is everyone's problem: many lakes and estuaries, most large urban areas, most rural areas, most mountain areas, most coastal areas, and the biosphere. It needs to be approached more holistically and in an integrated level. Nitrogen is a global problem. You can't fix the problem by shifting the nitrogen from one medium to another.

The earlier fragmented projects helped prepare the EDF staff on nitrogen, but they came to feel that reactive nitrogen deserved an more holistic and integrated approach. Therefore they organized a Nitrogen Workshop in October 2007, which included some members of the INC among others, to address biogeochemistry, environmental economics/policy, and agricultural practices. The main thing that came out of the workshop is the need to better integrate their work and they developed a primer with flow charts.

The principles address all forms of N in air water and soil to control input, optimize use, and maximize denitrification to N2. Even though this problem is newer than atmospheric carbon, it is already clear that we need to do something. Like Craig Cox, EDF is putting an emphasis on optimizing use (Cox's "loops") because controlling input (conservation) will not be enough. The workshops first targets are aggressive NGO leadership, increase public awareness, nitrogen inventory, integrated nitrogen pilot projects, and international scale.

EDF sees that they have the following opportunities: leveraging the scientific consensus to lay the foundation for global nitrogen governance; campaign for nitrogen sustainability; Non-CO2 greenhouse gas reduction programs; expand conservation incentives programs; valuation of ecosystem services; and double-dipping and double-teaming using existing policies and programs to address nitrogen. For funding and educational reasons, they will start on the climate change front where people are already interested and engaged.

1. establish an expert advisory panel to build scientific consensus
2. improve the national inventory of non-CO2 greenhouse gases
3. broaden public awareness about the health effects
4. launch pilot projects

5. conservation partnerships and university collaborations to build the technological and economic case for reducing reactive nitrogen
6. coordinate emission reduction efforts.

In response to a question from Dr. Moomaw, Dr. McNaught said he would like to see the INI be recognized like the IPCC. Dr. Cassman noted that, even with massive conservation, consumption is going to go up. To better manage nitrogen in the environment under those constraints is very difficult -- cutting back on fertilizer use while growing more grain and animals is not an easy proposition. Dr. McNaught has had some success getting North Carolina to think about where it is going. INC is asking the public to think differently about something than where they currently are. Even in EDF the desire to produce results competes with the desire to transform the culture into one that actively contemplates the consequences of its choices.

Dr. Lighty referred to Dr. McNaught's slides showing two gorillas (carbon and nitrogen). She has been thinking about energy, the impacts of CO2 regulations on nitrogen, and so forth. Some of what can be done for energy can be beneficial for nitrogen. Dr. Theis noted that, in some cases, the impacts can be adverse. Dr. McNaught spoke about efforts to wet soils in the southeast to reduce CO2 emissions with the unfortunate effect of increasing N2O. He observed that, "To get carbon right, you have to get nitrogen right."

Dr. Boyer commented that the coupled relationships between carbon-nitrogen- and water. She said INC needs to think about co-benefits of the strategies.

Dr. Cowling recalled that Mr. Cox had spoken of the need to set national goals and priorities. He asked Dr. McNaught how to aim information at an audience to affect nitrogen priorities. Dr. McNaught observed that the environmental community, while too compartmentalized, is one of the important audiences. For example, if the green community responded to meeting the social and economic rural poor, would that do more to protect the environment?

Dr. Dickerson likes a lot of what Dr. McNaught said and agrees that there is a danger that introducing a second "gorilla" into public thinking will create havoc. He likes the idea of setting nitrogen in the greenhouse gas setting. What areas have been successful for carbon and are there analogies for nitrogen? Dr. McNaught will talk it over with his colleagues and get back to us. Dr. Theis noted that an important step on carbon was determining that CO2 was a "regulatable" pollutant. Mr. Cox didn't think tinkering with legislation was the issue, but implementation. What do EDFs attorneys do? Dr. McNaught responded that, occasionally, they sue. EDF has built its reputation on developing win-win cooperative solutions. They do try to stimulate activity that leads to legislative reform. They've put a lot of effort into climate change legislation.

Mr. Herz asked what EDF's perspective is on the public's perception of global climate change. Mr. Herz thinks there is some low-hanging fruit to pick, but it will need some legislative support. At 80-90% of facilities, N2O can be converted all the way to N2. Dr.

McNaught doesn't think the complexity of global climate change has penetrated public thinking very far.

Invited Presentations: Transportation

Mr. John Davies a Transportation Analyst in the Transportation and Climate Division of the Office of Transportation and Air Quality (OTAQ) in EPA's Office of Air and Radiation gave the first of two presentations on transportation. He spoke on nitrogen emissions from U.S. Transportation Sources. (See his revised overheads, dated April 10.) He manages the "bean counting" aspects of the Greenhouse Gas (GHG) inventory for the US from transportation.

Transportation combustion emissions include NOx and N2O. He addressed the relative significance of activity trends and emissions controls on these emissions, factors affecting transportation fuel consumption and GHG emissions, and the relationship of NOx/N2O emissions controls to fuel consumption.

For the US, NOx emissions in 2005 from on-road vehicles generate 43% of the NOx, stationary fuel combustion 38%, and non-road vehicles 12%. For the US, 78% of N2O emissions come from agricultural and soil management, other sources contribute 14%, while 7% comes from on-road vehicles and less than 1% from non-road mobile sources. (In the context of this presentation and the following discussion, the term "non-road" means planes, trains, and ships.)

Dr. Dickerson pointed on that black carbon and ozone were not included in the inventory. Mr. Davies thinks their values are commonly reported but not inventoried.

Mr. Davies addressed change in US vehicle Movement from 1990 – 2005. During this period, population increased 19% and GDP increased 55% while light duty vehicle miles traveled increased 39%, freight truck ton miles increased 56%, and commercial aircraft passenger miles traveled increased about 68%. At the same time the on-road contribution to NOx decreased almost 38% and to N2O about 18%. Freight trucks reduced NOx, but increased N2O. Commercial aircraft greatly increased NOx but increased N2O only slightly.

Factors affecting mobile N2O and NOx tailpipe emissions include:

- vehicle activity,
- fuel consumption,
- fuel characteristics,
- air-fuel mixes,
- combustion temperatures, and
- emissions control equipment.

US NOx emissions from 1970 to 2006 from all sources (mobile and stationary) show an overall decrease, with only a slight increase recently in emissions from on-road vehicles

Mr. Davies slide #10 also lists the steps that were taken to lower nitrogen emissions over this period, such as:

Oxidation Catalyst - 1975 to 1980 (cars) and 1980 to 1985 (trucks)
EPA Tier O – Began early 1980s; common until 1984
Implemented in cars and LD trucks
3-way catalyst; on-board diagnostic computer and oxygen sensor
Reduced NOX to nitrogen and oxygen; 1.0 g / mil for cars
EPA Tier 1 – 1990
Added advanced emissions controls, including elec. Controlled fuel injection & ignition timing, EGR and air injection
NOx reduced 60 percent from Tier 0
Diesel truck and bus standards
Locomotive and Marine Rule
EPA Tier 2 - 2004
Added more advanced emissions controls, including improved combustion,
NOx reduced 90 percent from Tier 0
Nonroad Diesel Rule

The early emissions controls technologies, the oxidation catalysts, increased the emissions rate of N2O by about three-fold. The Tier 0 regulations were even worse from an N2O perspective, driving them up another 15% or so. Tier 1 was a better, returning N20 emissions to about what they were in 1970. It was only with Tier 2 that you begin to see reductions in N20. These vehicles are only now beginning to work their way into the fleet. N2O in particular can be formed by catalytic processes used to control NOx, CO, and hydrocarbon emissions

He placed GHGs from transportation relative to total US emissions. In 2005, transportation provided about 28% of US greenhouse gas emissions (not just NOx and N2O). Passenger cars and light duty trucks together contribute about 60% of the transportation sector's GHGs. From 1990 to 2005 transportation's portion of the GHG emissions has increased, contributing to an overall increase in GHG emissions.

Overall US CO2 emissions from fossil fuel combustion increased from 1990 to 2005 and transportation (including short-sea shipping and military vehicles operating within the US) is a larger portion of the total emissions. Per capital CO2 emissions from fossil fuel combustion has increased only very slightly from 1990 to 2005, in part because of the de-industrialization of the US economy.

There was a discussion of "bunkers". These are fuels that are sold for international purposes -- that is fuel that is sold to for transportation to other nations. Dr. Dickerson said it is called bunkers because it is low grade fuel kept near ships. Mr. Davies noted the same term is used for aviation, which is very high quality. Dr. Boyer didn't include bunkers in the inventory; she thinks that was right because they aren't used in the continguous states. Mr. Davies thinks they should be included because bunkers are part

of the economy and they are a significant portion of domestic. Dr. Boyer asked for further clarification. An airplane that takes off in the US contributes to air pollution here. Because GHG emissions affect us all, and these are from American sources, perhaps they should be included.

Mr. Davies created a couple of different frames of reference. One is the IPCC inventory. Another is what is needed for policy decision making. The IPCC inventory leaves out a lot of shipping and aviation GHGs. Mr. Herz spoke of the politics of GHG inventories, in places like the European Union where much of the travel is country to country, if you ignore GHGs from international flights, you are under-accounting for the GHGs. Mr. Davies elaborated on this with an example about Swiss bunkers (as an intermediate stop).

Dr. Hey asked where public transportation and transportation of people fit. GHGs from rail are less than 4% of transportation emissions and about 1% of total US GHGs emissions. A significant part would be freight rail. Mr. Davies is willing to prepare a passenger rail number.

Aircraft have invested heavily in fuel efficiency. Older inefficient airplanes were retired. Aircraft are also flying very, very full. But from 2004 to 2005 GHG emissions increased from aviation. We may be approaching a passenger load ceiling and the improvements may not be sustainable.

There are a lot more light trucks on the road (SUVs, pick ups and mini vans sold now outnumber passenger cars sold). When you consider all those light duty vehicles on the road, the future looks bleak.

Freight trucks are the seedy underbelly of the transportation world. Medium and heavy duty trucks have become less energy efficient since the mid-1990s. Possible explanations include the demand for more powerful engines, impact of congestion, and the elimination of mandatory speed limits.

There has been change in freight activity, energy efficiency and GHGs over the last 15 years. The early NOx controls actually hurt the energy efficiency of truck engines sold in the late 1990s. The party line is that trucks have not taken a fuel efficiency hit from the NOx standards, but there is evidence that there was. From a policy perspective, there's a lot of reasons to take trucks very, very seriously.

Mr. Rudolph Kapichak, an Environmental Engineer in the Office of Transportation Air Quality's Transportation and Regional Programs Division located in EPA's Office of Air and Radiation, gave the second of two presentations on transportation. He provided a basic overview of transportation conformity and state implementation plans.

What is conformity? The last major revision to the CAAA was in 1990. It said that federal actions have to conform to the purpose of the state implementation plan (SIP). The purpose of the SIP is to eliminate/reduce violations of the national ambient air

quality standards (NAAQS). Congress added this because the environmental and transportation arms of the government were working at cross-purposes with one another.

The legislation applies to activities funded or approved by the Federal Highway Administration (FHWA) or the Federal Transit Administration (FTA) in non attainment areas for ozone, PM2.5, PM10, NO2, and CO.

Conformity links state air quality planning with state transportation planning. It is intended to help the state achieve its public health goals, create a forum for better long term decisions, ensure transportation and air quality coordination, and improve data and planning assumptions.

There are two types of conformity – transportation, which he has described, and general which applies to all other federal actions like airport expansion, DOD base realignment and closure, railroads, Army Corp Section 404 permits and so forth. General conformity applies to all the criteria pollutants, including SO2 and lead.

Transportation conformity only looks at air pollution from on-road mobile sources created by cars, trucks, and buses.

What SIPS and Air Quality Planning is about implementing ozone and PM2.5 standards A SIP is a legally enforceable plan for how a state or area will achieve better air quality. SIPS address specific CAAA requirements and deadlines and are prepared by a state or local air quality agency and a re submitted by the governor or his designee. Interagency consultation and public participation is required in preparation of a SIP.

SIP elements include an inventory of emissions estimates for each sector (stationary, area and mobile); air quality model to demonstrate SIP is achieving its purpose; specific list of controls, and contingency measures.

Multi-jurisdictional problems are addressed jointly. For example, the CT, NJ and NY ozone non-attainment areas do their air quality modeling for ozone together, then apply various controls to bring themselves into attainment.

National controls and regional controls, like the Clean Air Interstate Rule, get factored into SIPs.

The contingency measures kick in quickly if the regular controls are not successful in reaching attainment.

The Nonattainment and Maintenance areas for the 1997 8-hour ozone standard are clustered in California and the East with a few here and there elsewhere. About half of the areas now have 3 back-to-back years of successfully meeting the standard and are considered maintenance rather than non-attainment areas.

Dr. Lighty asked, when the PM2.5 standards are changed, will there be more nonattainment areas? Mr. Kapichak thinks there will be new nonattainment areas in the Rocky Mountain states and the Pacific Northwest. A lot of areas have been right around the new standard.

Dr. Aneja raised the issue of meteorology. How do the SIPS incorporate this? Mr. Kapichak replied that the models account for meteorology. When it comes to conformity, you are setting a ceiling on mobile source emissions. A number of ozone areas look at worst case meteorology in their modeling. EPA has developed a weight of evidence procedure that allows the state to use sensitivity analyses and other factor as well as the modeling results to determine whether they will meet attainment in every grid cell.

Dr. Boyer asked how the Clean Air Interstate Rule and power plants would fit in. Doering had a similar question about the dirty areas of Indiana. Mr. Kapichak says these get coordinated at the federal and state level. The feds do a regulatory impact analysis to examine how all the parts of the country can come into attainment. This brings all the EPA air offices together to work on the problem. Locally, it falls upon the agencies that are responsible for meeting the SIPs. Here's our problem, here's the magnitude of it, how are we going to get into attainment. They look at the benefits that will result from the federal requirements and see if that will suffice. If not, what else needs to be done.

Dr. Dickerson thought Dr. Aneja was speaking of the vagaries of the climate; Dr. Dickerson said that the models do not account for the impact of global warming. Mr. Kapichak says there is nothing to stop the areas from making a temperature adjustment, but doesn't think any have.

What is subject to transportation conformity?
All cities with a population of 50 000 or more have their own transportation or are part of a metropolitan planning organization that does. These develop transportation plans with a 20 year time frame. Transportation Improvement Programs (TIPs) have a four year timeframe and are the mechanism through which the organizations get their funding. "Federal" projects. Air quality impacts of regionally significant non-federal projects (like turnpike authorities) are also considered prior to approval, but no project-level conformity requirement is required.

Who is involved in transportation conformity?
Metropolitan planning organizations (MPOs) prepare transportation plans, TIPS and conformity determinations. Other transportation agencies, such as state DOTs and county agencies address projects outside MPO boundaries or, in the case of local transit agencies, address transit projects and consult on conformity determinations
At the regional level, EPA provides consultation on individual determinations; at the national level, EPA promulgates conformity rule and policy guidance. The FHWA/FTA make transportation plans, TIP and project conformity determinations; and they concur on national conformity rule and policy guidance. State and local air agencies develop SIPs/control measures/modeling and consult on conformity determinations.

When do you do conformity?
MPOs have to do conformity whenever they develop a new plan or TIP or adopt amendments (about every four years); within two years of a new SIP; at least every four years.

Transportation conformity is demonstrated by calculating emissions from the on-road sector out through the whole 20 years of the plan and showing that they are within the emissions budget established by the SIP. The federal agencies influence emissions limitations. States have authority over the emissions inspections and can also do things like lower the vapor pressure of gasoline. Areas can also get more people out of their cars through increased public transportation, rideshare parking lots, HOV lanes, etc. For areas that are not rich in mass transportation, the deadlines for attainment (which may be only a few years) make it difficult to solve the problem through public transportation infrastructure development.

What areas evaluate NOx in transportation conformity determinations?
The 8-hour ozone nonattainment and maintenance areas evaluate on-road NOx emissions as an ozone precursor. The PM2.5 nonattainment and maintenance areas evaluate on-road NOx emissions as a PM2.5 precursor. If the SIP establishes a NOx budget; and Before the SIP is submitted, unless on-road emissions of NOx are **not** a significant contributor to the PM2.5 problem in the area. Many larger PM10 nonattainment and maintenance areas evaluate on-road NOx emissions as a PM10 precursor. There is only one nitrogen dioxide area (The South Coast area in CA); it evaluates on-road NOx emissions.

What areas evaluated NH3 in transportation conformity determinations?
To date, no PM2.5 areas are evaluating on-road NH3 emissions in transportation conformity. PM2.5 non-attainment and maintenance areas evaluate on-road NH3 emissions as a PM2.5 precursor only if the SIP establishes an NH3 budget; or -- before the SIP is submitted -- if either EPA or the state air agency have made a finding that on-road emissions of NH3 are a significant contributor to the PM2.5 problem in the area

What happens if an area misses a deadline? The CAAA provides a 12-month grace period. If a new plan cannot be adopted in that period, then conformity lapses. During a lapse only three kinds of projects can proceed: exempt projects that are air quality neutral like replacing old buses; safety projects like eliminating railroad crossings; transportation control measures that are included in the SIP like HOV lanes and any project phase that was approved prior to the lapse, but not any subsequent phase.

Dr. Stacey asked whether there is much going on relating to outdoor wood burning. Mr. Kapichak replied that EPA's OAQPS worked with manufacturers to develop cleaner models that burn wood outdoors and heat your house.

Dr. Dickerson asked if states could consider NO emissions from soil, but Mr. Kapichak didn't know.

Dr. Hey asked about how MPOs do their planning. Mr. Kapichak thinks MPOs do more public outreach and input from local governments and citizens to understand how they want their transportation system to look in the future. Earlier the transportation people pretty much decided what would be done without consultation. EPA doesn't tell the MPOs how to evaluate their plans beyond working to achieve the standard.

Dr. Cowling said INC is always calling for more federal and state cooperation and coordination and observed that it now has a splendid example to cite. It took a nudge from Congress, but it looks like it is being implemented in the spirit that Congress intended.

Dr. Theis noted that many of the nonattainment areas are in or downwind from large agricultural areas, then asked, "Is there a connection?" Mr. Kapichak doesn't know but thinks population density and development are influences. While EPA as a whole is working more closely with USDA, OTAQ only has a small effort to get farm operators to improve their equipment to reduce their emissions.

Invited Presentations: Biofuels

Mr. John Sheehan, who had been at DOE's National Renewable Energy Lab (NREL) for 16 years and is now LiveFuels' VP Strategy & Sustainable Development, gave the first of three presentations on biofuels. LiveFuels is a mini-Manhattan Project including the core LiveFuels team, consulting engineers and scientists, and an alliance of DOE labs. He made his presentation in the context of the UN Comission's (1987) definition of sustainability and E.O. Wilson's from his book *Consilience*. For biofuels he prefers Wilson's because of the emphasis on ethics.

There are two energy outputs from generating biofuel from corn: liquid fuel and co-product electricity from burning the remaining biomass. More energy is produced than used, but not a lot. For soybeans the ratio of energy produced to energy used is much higher.

It is important to distinguish between reducing petroleum use and reducing the use of fossil fuels. When ethanol was first introduced to gas, it was to save petroleum, not fossil fuels. Some people see corn ethanol as a way of making liquid fuels from coal.

The land use issue has broken out in the last few months. Unfortunately, none of the existing LCAs have addressed it. The recent studies published in *Science* point out there is a question about what the real benefits of biofuels are, if you take into account the change in landuse. The issue needs to be analyzed.

Water use is the cousin to the land use question because biofuels needs land with available water.

If you get tunnel vision on nitrogen, you will miss other important issue.

Some years ago, he did a controversial study on corn stover. Stover consists of the parts of plants that are left in the field after the grain has been harvested. Although it can be fed to animals, is typically goes unused. DOE tends to think of it as a waste that can be used freely; USDA thinks it is needed for the soil and should not be taken. They developed a systems approach to the problem. LCA lets you look at directional impacts of different choices. Its worst use is as a green labeling tool. Suppose we take the existing worlds of agriculture and petroleum and replace it with one where farmers collect corn stover, ship it to a facility that makes fuel, which is used by cars to drive a mile. The farmers also wanted to know what the LCA was per acre of farmland, which is a very different kind of analysis. They get some credit for reducing fossil fuel use in electricity generation as well.

They did a study in Iowa (that SAB/EEC member Susan Powers worked on) at the county level that showed that there was stover that could be harvested to use in this manner and areas where it should not be taken. Dr. Sheehan likes the integration of diverse models with different disciplines. They used Paustian's Century agroecosystem model. When they looked at nutrient management, they looked at the difference between a corn-soybean rotation to a corn-corn rotation. They had complex and detailed materials balance models that allowed them to track the flowed in the stover to ethanol model.

The reason that stover to ethanol model looks different than corn to ethanol is that there is a residual that can be used to generate electricity.

They thought about the difference between business as usual in farming in Iowa and two possibilities. One was new tilling practices that caused carbon sequestration in soil. The other was farmers recycling carbon.

When viewed from the car, going from gasoline through E10 and E85 to E100, the view is that N2O and methane increase. But when you add up N2O, methane, and other GHGs, the ethanol greatly reduces net GHGs. Dr. Cowling asked why the great increase in NOx is true. Dr. Lighty indicated that combustion turns N2 into NOx, it's not nitrogen in the fuel. Aneja noted that Sheehan is looking at NOx lost from the soil. It is not clear where it goes. Dr. Sheehan thinks the biofuels just move the NOx from urban to rural areas.

The difference is overwhelming. Dr. Mosier thinks that, if Dr Sheehan runs a different (daily) version of the model (instead of a century version), the N2O and methane from the agricultural part will be much higher.

Dr. Sheehan said that the century model gives you a look at effects yearly over a hundred years. The switch to no-till increases soil carbon. Sequestration (no till, but don't collect stover), instead of recycling, provides great benefits initially until equilibrium is reached. Recycling is easier to document and provides a steady and predictable reduction that is very close, after decades with the sequestration approach. About 86% of farm NOx emissions are from the soil to air and water.

Dr. Sheehan sees the biggest land use change is from corn-soy to corn-corn.

Dr. Sheehan returned to the Ethics Question. Technology, economics, politics, and ethics issues intersect and allow us to sort out what we think. Dr. Mosier's question on model selection is an example of this.

Quality of life issues are coming to the fore. Quality of life is improving in developing countries, which increases demand. An LCA process that addresses all sustainability issues and is accepted worldwide would be very helpful.

LCA can be a framework for dialog where stakeholder input contributes to setting the goal and scope, data is collected, models are constructed, draft findings get stakeholder input, and the final report provides input for a follow-up study.

There was a lot of discussion of the first bar on the sources of NOx slide. Dr. Sheehan thinks the issue is the order of magnitude of nitrogen load. Dr. Theis and the Committee were trying to sort out the nature of that burden and asked Dr. Sheehan what he meant by NOx. Dr. Sheehan used the IPCC calculations on nitrogen fate; he understands that accounts for reactive nitrogen that leaches into the water and ends up back in the atmosphere. The calculations do distinguish N2O from NOx. They think nitrates and nitrites remain in the water.

Because ethanol burns at a lower temperature than gasoline, emissions of reactive nitrogen from cars on E100 is less than from cars on gasoline. There is debate about the blends.

Dr. Sheehan thinks INC is raising the uncertainty issues in the science and technology areas that are co-mingled with the politics and ethics. The most valuable thing his group did was not coming up with numbers, it was sitting down with everyone from the beginning, getting the stakeholder input in setting the goals and scope.

Another issue is whether we need to raise the carbon content of soil, perhaps back to what it was 200 years ago.

Dr. Sheehan spoke briefly about his new job with LiveFuels. His report, *A Look at the US DOE"s Aquatic Specie Programs Biofuels from Algae* is now the #1 download on NREL's website (www.nrel.gov). Private sector spending in the last two years has exceeded what NREL spent in the 20 years they worked on it. NREL's production concept was a new kind of farming in open ponds. They also recycle CO2 from power plants by bubbling it through the ponds.

Dr. Paerl thought it would be great to take eutrophication and make it useful. Most of the algae they have trouble with are microscopic. He thinks the challenges are capturing them and how you get what you want out of them. Eutrophication problems aren't in the dessert, their in the Chesapeake Bay, the Gulf, etc. Dr. Sheehan responded that the

concentration is really critical. When you operate open pond systems you have less flexibility about where you put these systems. Ideally you would like to capture the nutrients upstream of the problems, but climate conditions make that difficult.

LiveFuels is acquiring 370 acres in the Imperial Valley, which is great algae growing country. The water used for irrigation down there is full of ag run-off which makes it a good fit for the algae. SeaFit has a facility on the Salton Sea that uses algae to remove nutrients.

Dr. Dickerson says that cars used to generate 3.6 grams of NOx per mile driven. Tier 1 regulations now get that down to 0.4 grams of NOx per mile driven. If ethanol driven cars effectively emit 1.9 grams of NOx per mile, it's not sustainable because every county in the Midwest will violate the ozone standard.

Dr. Moomaw says if you look at it globally and consider Brazilian sugarcane there are 122 countries in the world with sugarcane plantations. He thinks perhaps this should be done in the tropics because of the benefits to the rural poor. But the changes in land use are complicated. Sugarcane is replacing soy and soy is replacing the rain forest.

He used the analogy of the perfect storm of which biofuels is a piece.

Dr. Cassman says the reason sugar cane looks so good is that the Brazilians are using a number that can't be reproduced on sugar cane operations elsewhere. Because of transportation and storage issues for ethanol from biofuels, the advantages of corn ethanol aren't that far off.

Dr. Aneja asked Dr. Sheehan if his numbers were all model calculations. Dr. Sheehan said they were and noted that the NREL report gives all the details by county. It also describes the IPCC methodology for partitioning nitrogen in the environment.

Dr. Kohn spoke of the substitution of soybeans for corn and noted soybeans were for protein, but corn was for energy. He asked how you justify the corn-soybean substitution.

Dr. Doering knows of work to maintain traditional corn-soybean rotation which creates half as much stover. The economics of stover are much better than switch grass. In many instances you can afford to ship stover 100 miles for what it would cost to process switchgrass next to the farm.

Dr. John Miranowski of Iowa State University, who has written about the economic drivers of biofuels expansion, gave the second of three presentations on biofuels. Ethanol production has soared about 12 billion gallons since 1980. Because the plants are clustered in the Midwest while most people live on the coasts there are logistical problems. It would be cheaper for Brazil to land ethanol on the coasts than to ship it from the Midwest if the tariff were removed, but Brazil doesn't have enough available for export to meet the need anyway

He spoke about a long run equilibrium break-even price for corn as a way to see what will make an impact on corn ethanol. It works out to $4.25 per bushel. This was calculated using $60 per barrel price of crude oil or $2.07/gallon. There was more that I didn't get about a current tax credit of $1.40/bushel and FAPRI model. FAPRI looked at two scenarios with projections to 2016 and came up with about 15 million gallons of ethanol produced at about $3.50 per bushel, then used other values to get 29 billion gallons from corn grain. The FAPRI model includes increased livestock through 2016 because of the increased demands globally. While Dr. Miranowski sees 15 billion gallons as having many environmental impacts, 29 billion gallons has all sorts of impacts. We consume about 200 billion gallons of fuel in the U.S..

Experts in the area think $60/barrel is a good long-term number. Yesterday corn was $6/bushel and oil was $112 per barrel.

What does this mean for other agricultural commodities?
Corn price is related to ethanol price which is related to the oil price. Crops and livestock products competing for same domestic and global cropland base – all prices increase Growing global demand for oil, agricultural commodities, and nitrogen (and week dollar exaggerates impacts). Food, feed, fuel debate accentuated by all the above as well as short run shocks versus long run patterns. Growing opportunity cost of cropland and biomass fuels.

Is Biomass Feedstock the Answer?
There are significant economic and R&D challenges relating to the conversion process and biofuel form and questions about carbon and GHG emission reductions relative to corn ethanol. The anticipate reaching commercial scale about 2017.

Miranowski looked at the biomass processor's maximum willingness to pay for biomass at the plant gate and the producer's marginal willingness to accept. Market equilibrium would be reached when these two numbers equal each other or the difference is subsidized. The gap between willingess to pay and willingess to accept is about $50/ton. Will this provide the 80% reduction in carbon or not? If so, might it be worth subsidizing. The social benefit of biofuel may be greater than the social costs of subsidy

The implications for nitrogen are higher corn prices relative to other crop prices, more corn acres and higher nitrogen applications. The higher the price of corn, the larger the return to nitrogen, but higher nitrogen prices may reduce use.

Higher biomass (switchgrass and miscanthus) yields require more nutrients. If biomass is produced on poorer quality land, it may increase nutrient use on these lands.

There is no silver bullet for energy nor for environmental impacts.

Dr. Cassman reflected his own driving experience with E10 and all gas and finds no difference, yet much of the modeling is based on ethanol being 67% of the energy value

of gasoline. There may be some slush in the analysis if you can design engines that are about as efficient with ethanol as with gasoline.

With the expanded funding for renewable and bio energy, none has been given to how to build out the corn ethanol system in an environmentally responsible way. It all seems to be going to cellulosic, yet corn ethanol is being built out now. There are lots of ways to make it more environmentally acceptable if we start now. It seems like there is almost a purposeful avoidance of the consideration of the practical, logistical and environmental issues.

Dr. Alan Hecht, Director for Sustainable Development for EPA's Office of Research and Development, gave the third of the three biofuels presentations. (See his overheads.) He spoke about feedstock production, feedstock logistics, biofuels production, biofuels distribution, and biofuels end use. He focused on finding the roadmap rather than the science issues. The underlying scientific issues are huge.

The rapidly growing biofuels industry impacts all programs mission responsibilities and performance goals. EPA's NACEPT recommended that EPA develop a Biofuel Strategy. The Administrator accepted the recommendation. ORD, OAR, Region 7 and the Agricultural Counselor coordinated Strategy development. There are 85 people on the group from the regions and program offices. The National Biofuel Action Plan is under development. In 2007, EISA added new EPA mandates. The Action Plan will be revised and finalized for presentation to the Administrator in June 2008.

The Energy and Independence Security Act (EISA) which was passed and signed in December 2007 has major impacts on EPA. It requires EPA to develop new renewable fuel standard to achieve the goal of expanding biofuels to 36 billion gallons by 2022. It requires lifecycle assessments of different fuel types and blends in comparison to petroleum fuel. It requires that biofuel production does not adversely impact the environment or natural resources, which will be very challenging. EPA has to report to Congress on the environmental impacts of the biofuel system every three years. EISA gives particular recognition to impacts on water quality and EISA amends the CAAA integrate *water quality* into a fuel assessment analysis.

Before EISA, EPA undertook a renewable fuel standard 1(RFS-1) analysis which assessed first order impacts for GHG impacts of corn and soybean acres in the US. Following the passage of EISA, EPA is conducting a more complete assessment of domestic and international impacts which will address corn and soybeans plus other crops; land use changes; and international impacts of decreased US exports, such as increased crop production in other countries adding to GHG.

LCA is required to determine which fuels meet mandated GHG performance thresholds compared to petroleum fuel replaced. The LCA must include impacts on domestic and foreign land use. Because corn based ethanol was capped at 15 billion gallons by 2015 (probably because of Congressional concerns over food production) meeting the 36 billion gallons requirement by 2022, will require approaches other than corn ethanol.

EISA Section 232 promotes sustainable biofuel production. EPA is concerned how to meet this mandate and carry out its other responsibilities nationally. But corn is a commodity which is traded internationally, so EPA has to consider global complications. The question of how you measure the sustainability of biofuel production is hot, with the EU getting in on the act. Both definition and determining whether sustainability has been attained are unsettled.

The outline of the EPA Biofuel Strategy is:

1. Purpose
2. Environmental Benefits and Impacts
3. Role of EPA
4. International Impacts
5. Research Gaps and Challenges
6. Action Items

The aim of the strategy is to position EPA to strategically address biofuel issues in an integrated cross-media manner, ensure EPA environmental strategic goals can be met; advance the biofuel industry in a sustainable manner, respond to public and industry concerns, meet national biofuel goals, identify new research and technical opportunities and promote solutions to address environmental or health impacts.

Dr. Hecht believes this train has left the station. Even if you find adverse effects under the energy bill, nothing is going to stop. He's not sure anyone anticipated the impact of biofuels on food production. It can seriously impact EPA's other statutes.

Dr. Cowling spoke of the target audience for the INC's report. Another member noted that INC needs to talk about the development of national goals and strategies. It seems Dr. Hecht has already been directed to do that for biofuels. Dr. Hecht finds there is an enthusiasm to get on top of this issue. The National Action Plan has changed a lot over the last few months.

Dr. Aneja observed that EPA is charged with monitoring the environmental quality of our nation. If the biofuels train has left the station, there could be a dichotomy between these two responsibilities. What will happen if biofuels causes the nation to miss its environmental targets? Dr. Hecht responded that they don't know how Congress came up with these numbers. EPA has been charged with finding a way to do both right and on time. All this has to be done in the context of market forces. EPA is going to have to be quick and agile.

Dr. Doering observed that no agency is a monolith. Dr. Hecht said that there are several representatives from USDA who bring different perspectives to the issue. The Reports to Congress are operational targets. The big challenge is how to institutionalize the process.

Dr. Cassman said EISA mandates all biofuels, but corn-based ethanol is the only one available for the next three years. Why not focus on doing a good job on corn ethanol and then use that as a framework for analyzing the others as they come on line? Dr. Theis thinks that LCA is the framework. Dr. Cassman emphasized the importance of getting the best most up-to-date numbers. Dr. Hecht says the focus is on corn ethanol now because it's not capped until 2015.

Invited Presentations by INC Members. In addition to the briefings by the working group leads and invited presentations by the outside speakers above, three members of the INC had been placed on the agenda for briefings and presentations.

Dr. Boyer gave a presentation on the nitrogen budget she had developed for the United States using 2002 data, the latest released for the United States. She explained the sources and values she had developed and asked for the committee's assistance in making certain determinations. The members discussed the need to use a consistent metric, either Tg or million metric tons and to have internal consistency within the document.

Dr. Cowling provided an update on the nitrogen-related activities of CASAC. Dr. Cowling spoke of CASAC's NAAQS activities, the NAS advice on the form of secondary standards, and the recent article relating to the NOx secondary standard in Inside EPA by Kate Winston from which he read a few sentences. He believes it might be possible to make real progress on what is now called the nitrogen NAAQS in this decade.

SABSO Deputy Director Tony Maciorowski then clarified that CASAC is working on a combined NOx/SOx standard. Under FACA, CASAC and INC are advisory bodies chartered to provide scientific and technical advice. No advisory report has policy implications for EPA. The charge of these committees is to provide technical advice which is complete when the advice is submitted to the Administrator. Anything before that is not advice, it is deliberative. It's easy to slip from science to science policy to policy. FACA ethics obligations and training, which the members have all had, mean that you need to remain open minded during deliberations. The CASAC panel is having deliberations. Until CASAC's report has gone to the Administrator, it has no status. Similarly with the INC's report. Dr. Cowling agreed that CASAC does not make policy; it offers advice and counsel to the Administrator who makes the policy.

Dr. Moomaw, co-lead of the INC's Impacts & Metrics Working Group, spoke about economic impacts. He reminded the INC that the choice of metrics matters and noted that we cannot manage what we do not measure and what we measure determines what we manage.

In the context of nitrogen, what metrics can we use?

- Tons of reactive nitrogen fluxes and stocks
- Dollar cost of damage to human health and/or environment
- Human mortality and morbidity
- Mitigation costs of each form of reactive nitrogen

Considering tons of nitrogen as a metric, where mass fluxes are greatest will determine where the most effective control points are located. In the Mississippi Valley the greatest flux is from agricultural runoff, but for the Chesapeake Bay, energy and agriculture are about equal.

Protecting human health is a major goal of legislation and air emissions have the greatest impact per ton on health. In the Chesapeake Bay, mortality costs are about ten times that of morbidity.

Reactive forms of nitrogen cascade through the environment. The damage costs also cascade. Cost puts a lot of different things on a common valuation and it reflects societal values on various ecosystem goods and services. The damage costs track the cascading tons of reactive nitrogen. However, not all damage costs can be monetized and it is difficult to see how some of them could ever be monetized. In the Chesapeake Bay study he worked on there were nine that could not be monetized, including diversity loss due to eutrophication.

Their analysis showed that the air emissions, partly because they cause health problems and partly because they cascade so much further, cause more damage and the damage costs are higher. While the tons of nitrogen are about equal for land and water, the damages from air releases are much more than that for land. Costs of mitigation are different again.

Looking at different endpoints provides different messages. He plotted total damage costs associated with anthropogenic nitrogen fluxes in the Chesapeake Basin.

He stressed that how we measure reactive nitrogen determines what we manage. Different areas will have different

Integrated management of nitrogen needs to use a more integrated management approach that is region specific AND should use multiple metrics will provide more information for more effective policies and action, optimizing nitrogen in each subsystem sub-optimizes the reduction of nitrogen in the total system.

Public Comment

Ms. Tamara Thies of the National Cattleman's Beef Association made a brief public comment on ammonia which is a known precursor to fine particulate matter. EPA considered whether to regulate ammonia and decided not to because of its value in neutralizing acid rain. EPA told the states that, before they could regulate ammonia, they would have to consider that fact. The chair noted that we have to move on with the agenda, but those who wish to chat with her can do so after the meeting is over.

Committee Business

Dr. Theis and the Committee discussed existing and potential additional consensus points and where they should be placed in the report. Additional consensus points were drafted by individual members and provided to the INC for their consideration.

The Committee discussed whether additional input was needed before they could finish drafting their report.

To put the budget in context, Dr. Hey would like to hear about health effects, continental context of hypoxia, and eutrophication great lakes. Some members felt the health effects were already well understood and adequately described in the literature so that taking extra time now for presentations on the health issues would needlessly delay the report. Another suggested that the framework needs to be set forth early in the draft report. Another looked at Hey's comments in the context of a changing world and future effects. Dr. Cowling reminded the INC of Dr. Moomaw's presentation on impacts and metrics which suggested that, without health effects, action would be much harder to justify. He thinks the INC report is currently missing a regulatory perspective. He suggests that INC invite the Chair of NRC Committee Managing Air Quality in the US, Bill Chamiedes, to give INC a review of what his ideas on multiple pollutant, multiple effects; secondary standards different in form than primary standards.

Mr. Herz would like to hear about legal impediments under the CAAA.

Dr. Cassman provided an update from Dr. Mosier, *Energy and Environmental Aspects of Using Corn Stover for Biofuel*. Because Dr. Sheehan cited an unpublished draft *Is Ethanol from Corn Stover Sustainable*, Dr. Cassman suggested INC be cautious and check with Sheehan before making heavy use of his presentation.

Dr. Theis divided the INC into two groups -- Agriculture & Related Land Use , and Terrestrial, Transportation and Populated Centers--for a writing session. DFO Kathleen White supported the first group and DFO Kyndall Barry supported the second.

Dr. Cassman reported for the first group which includes Kohn, Herz, Doering, Cowling, Paerl and Aneja. He summarized the findings and recommendations related to mitigation of reactive nitrogen in both crop and animal agriculture. The approach they took might work for other sectors as well. (See his presentation file). Population is expected to increase by a third over the next fifty years, while better use of existing technologies and practices can improve nitrogen efficiency by 25%. The development of new technologies and their integration into sophisticated crop management systems, as well as policies to facilitate their adoption will be needed to keep nitrogen losses to the environment from increasing. He encouraged INC to think of risk reduction options relating to aquatic losses, in addition to nutrient management plans.

Dr. Stacey was the reporter for the second group which includes Boyer, Hey, Mitsch, Mosier and Lighty. (See his handout.) In his summary, Dr. Stacey adddressed nitrogen

management, noting that intervention to control Nr can occur by: (1) prevention or source controls; (2) physical, chemical or biological "dead ending" or storage within landscape compartments where it is rendered less harmful (e.g., long-term storage in soils or vegetation; denitrification; reuse); and (3) treatment using engineered systems such as STPs or best management practices (BMP) for storm water and nonpoint source runoff. There are opportunities for combining the three intervention approaches.

Dr. Vu advised the INC to make recommendations within its sphere of competency. Use science to inform policy and stay within your charge. Dr. Hey doesn't think they have gone off charge. Dr. Vu suggested INC be careful when it addresses social areas, such as those relating to the changing lifestyles of Americans. Dr. Boyer responded that they can use the science to show the harm nitrogen causes.

Dr. Theis asked the DFO to review the next steps in report preparation as she saw them:

Some conference calls on risk reduction – she invited their suggestions on areas where additional input was needed
Writing, editing and polishing
Additional consensus points on recommendations for an integrated strategy for managing reactive nitrogen.
Once the draft is ready and INC is comfortable with it, it becomes input to the workshop
Workshop
Revision
External Peer Review as input to Chartered Board
Charter Board
Revision
Transmittal to the Administrator
Written response from the Agency

After asking if anyone had any corrections, the DFO asked the SABSO Director for her advice on the workshop. Dr. Vu stressed the value of getting key policymakers to react to the INC's strategy. Getting the report from that point to finalized is pretty routine. The workshop needs planning. The public draft is important. She can support a workshop by the end of the year. If necessary she will support another meeting for workshop planning, but if INC can do it by conference call that would be fine.

Dr. Aneja asked how the ten page summary INC prepared for this meeting fits into this process. Dr. Theis responded that the ten-pager was originally intended as a primer for the workshop originally planned for this April meeting. The summary well describes what the INC has done so far, but it has almost nothing on risk reduction.

Dr. Cowling reported that he had talked with INC Chair Dr. Galloway last week. At that time, Dr. Galloway hoped to complete this report in September or October. He asked whether Galloway really meant he would be content to have it out in 2009. Dr. Vu responded that INC is still collecting information. She reminded the committee that, if

they are going to have a workshop they need to have things written down for people to react to. How soon the INC completes its report depends on how fast INC can get it done.

Dr. Vu said that, for the workshop, INC might involve another 20 people and invite top managers from EPA. The managers can address the legal and technical ramifications of the INC's draft recommendations; that might input may result in INC amending its thinking. INC should invite people who are managing programs to help it reformulate its thoughts.

Dr. Cowling is interested in timeliness, completeness, and wisdom. Dr. Vu recommended that INC form a workshop subcommittee, which could make September feasible. Planning a workshop takes a long time; the planners needs to address the format, what questions to address, and who to invite.

The DFO reviewed the steps again. Dr. Vu reinforced that, if the INC members are committed, they can it done this year. CVPESS has taken four years. This report deserves a beautiful presentation as well, with a section for the lay audience.

Dr. Mitsch questioned the importance of the workshop. He thinks getting the report done is their priority. Dr. Vu responded that the discussion at the workshop provides significant benefits. The INC will present their current thinking to the audience and receives feedback by sector, theme, or some other organizing principle. EPA has a workgroup of senior managers on the same issue. She would like the report out sooner than later. Dr. Doering added that the workshop is also an informal vehicle for transmitting the information that Drs. Cowling and Vu talked about. Dr. Cowling said a report must be good AND good for something. He would like this report to be influential.

Dr. Cassman asked about where the chief workload was. The DFO thinks it is in preparing the rest of the report and then the edits resulting from the workshop and external peer review.

Dr. Vu said the workshop is to react to your thinking. After the workshop you can refine the report. If INC wants the workshop in September or October, INC should be able to wrap up the bulk of the report by December, then maybe we can get it out in March.

Dr. Doering suggested INC might need a face-to-face meeting of a subgroup on risk reduction, particularly integration to bring back to the full INC. Dr. Vu thought this was a terrific idea because it doesn't have to be a public meeting which makes scheduling easier. She thinks a planning group is important as well.

Theis suggested that the chair, leads and co-leads will assign out various tasks resulting from this meeting. The leads and co-leads will assign the tasks within their groups. When that work is done, it should provide the basis for the paper needed for the

workshop. This should be possible by the end of the summer. It would be good to have a draft before the July 21-23 conference calls.

The chair thanked everyone for their contributions and adjourned the meeting at 3 p.m.

Respectfully Submitted:	Certified as True:
/s/	/s/
Ms. Kathleen E. White	Dr. Thomas L. Theis, Acting Chair
Designated Federal Official	SAB Integrated Nitrogen Committee

Attachment 1

List of Additional Materials Made Available for this Meeting

1. Federal Register Notice
2. Agenda
3. Roster
4. Draft Interim Summary, April 8
5. Overheads for presentations by invited speakers & related materials:
    - Craig Cox overheads, plus
        - Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge, Max Schepf and Craig Cox, Editors Soil and Water Conservation Society, 2006
    - John Davies
    - Paul Fixen overheads, plus
        - Ecologically Intensify Your Corn Nutrition by Tom Bruulsema in IPNI Insights, December 2007
        - Greenhouse Gas Emissions from Cropping Systems and the Influence of Fertilizer Management: A Literature Review, International Plant Nutrition Institute, December 2007
    - Alan Hecht
    - Rudy Kapichak
    - David McNaught overheads, plus
        - Nitrogen Workshop, Hosted by Environmental Defense In Washington DC, October 31-November 1, 2007, 10 pages
    - John Miranowski
    - John Sheehan
6. Overheads for presentations by Committee members:
    - Viney Aneja
    - Russell Dickerson & Arvin Mosier
    - William Moomaw
7. "One-Pagers" prepared by Committee members;
    - Findings and Recommendations: Terrestrial – Populated Component
        - From Stacey April 10
    - Atmospheric Emissions April 11
        - From Lighty & Moomaw
    - Opportunities to decrease Nr Losses from Livestock production Systems
        - From Kohn April 11
    - Recommendations from the Role and Benefits of Wetlands
        - From Hey April 10
    - Risk Reduction -- Wetlands for Controlling Reactive Nitrogen
        - From Mitsch and Hey April 11
8. Break-out Group Summaries
    - Findings and Recommendations: Terrestrial – Populated Component
        - From Stacey April 11
    - Findings and Recommendations: Nr Mitigation in Crop Agriculture

From Cassman April 11

9. The Future of Coal-Based Power Generation, James R. Katxer in CEP, March 2008 www.aiche.org/cep
10. Revised Agenda for Friday and INC Breakout Groups April 11