Biofuels and the Environment: First Triennial Report to Congress

Summary of and Response to Comments Received concerning the January 19, 2011 External Peer Review Draft

Prepared by the

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Background:

In December 2007, Congress enacted EISA, the Energy Independence and Security Act (Public Law 110-140) to reduce U.S. energy consumption and dependence on foreign oil, and to address climate change through research and implementation of strategies to reduce greenhouse gases. In accordance with these goals, EISA required the U.S. Environmental Protection Agency (EPA) to revise the Renewable Fuel Standard (RFS) program, created under the 2005 Energy Policy Act, to increase the volume of renewable fuel blended into transportation fuel from 9 billion gallons per year in 2008 to 36 billion gallons per year by 2022. Additionally, the U.S. Congress requested a report every three years (Section 204 of EISA) on the environmental and resource conservation impacts of increased biofuel production and use. This report is the first of EPA's triennial reports on the current and potential future environmental impacts associated with the requirements of Section 211(o) of the Clean Air Act. This report reviews environmental and resource conservation impacts identified under EISA, as well as opportunities to mitigate these impacts, at each stage of the biofuel supply chain: feedstock production, feedstock logistics, biofuel production, biofuel distribution, and biofuel use. This first triennial report represents the best available information through July 2010, including input from the U.S. Departments of Agriculture and Energy, with whom EPA consulted during development of this report.

Review Process and Response to Comments:

An external review draft of this report was publically released and a 30 day comment period announced through a *Federal Register* notice published on January 28, 2011 (FRL-9259-5; Docket ID No. EPA-HQ-ORD-2010-1077). At a public peer review panel meeting on March 14, 2011, eleven reviewers summarized their comments on the draft report. Oral and written comments from the public were also received at the March meeting and in the public docket. Overall, EPA received comments from 11 peer reviewers and 22 individuals and organizations representing academia, trade groups, industry, and public interest groups. All comments were evaluated and parsed into approximately 1800 separate comments which were then categorized into the following topic areas

- Air quality
- Climate change and greenhouse gases
- Ecosystem health and biodiversity
- Land use change
- Soil quality
- Water quality
- Water quantity

- Biofuel production
- Life cycle analysis

This document provides a summary of those comments along with how EPA responded to those comments. EPA's final draft reflects many of the suggestions provided by our reviewers. However, other suggestions were considered outside of the scope of this first triennial report to congress and will be used to inform the development of the next report.

The EPA acknowledges that the biofuels literature is growing quickly. This was confirmed by comments received from peer review panel members and the public who provided suggestions for additional literature that might be used to inform our assessment. For those references that met EPA's literature selection criteria (i.e., peer reviewed or from a government sources and were published prior to July 30, 2010), references were reviewed and where appropriate, new information added to the final draft.

General Comments from the Public and Peer Review Panel:

Overall the peer reviewers recognized the extent of the material presented in the report, recording a range of views from "adequate" to "encyclopedic." Reviewers thought the report was responsive to the mandate from Congress in EISA Section 204, although differing opinions were expressed with regard to the scope of the assessment, the particular approach used to organize and synthesize the information, and whether the views presented a balanced picture from the scientific community. The reviewers noted omissions in the report and offered recommendations for additional sources available in the peer reviewed scientific literature and elsewhere.
The summary tables and figures were recognized as an effective way to convey a great deal of information in a concise format. However, some of the reviewers recommended that the explanations of how the graphics were derived and what they represented should be made clearer and introduced earlier in the report.

While the qualitative nature of the assessment was accepted, several reviewers noted that EPA did not provide a comparison of biofuels with fossil fuels or made inappropriate comparisons of environmental impacts between rowcrops and non-rowcrops such as perennial grasses and algae. Additionally, several reviewers criticized the analysis of the land use change as inadequate and the subsequent conclusions made from that analysis as misleading. In support of their observation, more recent literature was cited in which investigators came to different conclusions on the magnitude of potential environmental impacts from land use change.

Many of the reviewers found the report comprehensive while remaining readable and accurate in its presentation. Several noted that it could be improved by a clearer explanation of the reports scope and the approach taken by EPA to respond to the congressional mandate.

To a large extent, the public comments reflected those received from the peer review panel as summarized above. In several cases, however, the public comments reflected valid but relatively narrow views of the organizations being represented. For example, organizations representing the corn and soybean growers complained of an unbalanced presentation that did not adequately consider the environmental benefits of growing corn and soybeans as feedstocks for biofuel in the report. In addition, they commented that EPA did not sufficiently acknowledge the improvements made over the last decades in implementing best management practices (BMPs) and more efficient technology in production systems to reduce environmental impacts. For some commenters, EPA neglected to point out the benefit of reducing GHGs through the use of biofuels. Others suggested that EPA did not go far enough in consideration of GHGs from many processes in the production of biomass feedstocks. They stated that there is some mention of GHGs from fossil fuel consumption for harvesting and planting, but very little detail about GHGs from soil processes (nitrification, denitrification, mineralization) and fertilizer manufacture and application.

Environmental Impacts in General	
Comment	**EPA Response to Comment**
Some reviewers suggested that every potential environmental impact was treated with equal weight in the report. Reviewers suggested the report be recast to evaluate which problems are both more likely to emerge and also to cause the greatest environmental damage if they do occur.	EPA believes the report's scope is responsive to the charge from Congress. While writing the first triennial report, there was insufficient information to predict the probability of many particular environmental impacts discussed. However, in response to this and similar comments, EPA made changes to the qualitative assessment in Chapter 6 so that plausible outcomes were highlighted.
Several commenters claimed EPA was not taking a balanced view -- some claimed we overlooked beneficial results (i.e., GHG reductions) while others challenged the notion that certain biofuels would meet the mandatory GHG threshold.	EPA disagrees that we had overlooked beneficial effects and reiterated that consideration of GHGs were outside the scope of the Section 204 report and that this had been done as part of the RFS2 Regulatory Impact Analysis (RIA). Since EPA had certified that the biofuels in question would meet the GHG thresholds, we included the following language: "Because of the inherent uncertainty and the state of the evolving science on this issue, EPA is basing its GHG threshold compliance determinations for this rule on an approach that considers the weight of evidence currently available."
For cellulosic feedstocks, one of the primary comments from the peer reviewers was the draft report inappropriately compared cellulosics with row crops.	EPA acknowledges that, based on its initial reading of the literature, it did make these comparisons without a full estimation of the likelihood of crop conversions and recognizes that the replacement of row crops with cellulosic feedstocks is not likely because of market factors. EPA has modified the text to reflect the emerging consensus that much of the literature has focused on land use conversions that are not likely to be commonplace. This altered some of the conclusions with respect to the question, "How will cellulosics affect the environment?" because whereas replacement of row crops generally would improve the environment, replacement of currently unmanaged areas likely would not. EPA has modified the report to reflect this thinking.

Environmental Impacts in General	
Comment	**EPA Response to Comment**
EPA neglects the EISA requirement to assess environmental impacts of the RFS "to date," choosing instead to focus on highly speculative potential future impacts.	EPA paid considerable attention to the current, principal feedstocks being grown for biofuels as well as those thought to be most probable future feedstocks. With respect to emerging feedstocks that are not currently commercial produced, discussion necessarily focused on future impacts specified in EISA Section 204. In revising the report, EPA has added additional information that supports the conclusion of modest, but negative impacts from the current principal feedstocks (see Chapter 3 and 6).
The mandate provided to the EPA included a requirement to consult with USDA and DOE on this report. These departments have broad missions that would indicate that Congress intended issues such as social impacts, national security, economic development, especially in rural areas, and climate change should be included. A detailed statement of scope should be included in the introduction to define those issues that EPA included and those that EPA intentionally did not include. This report only purports to address one of the relevant issue areas and as such should not be used as the sole basis for discussions on biofuels policy.	EPA used the scope given by Congress (e.g., no social or economic impacts); EPA also worked with USDA and DOE. The report's introduction makes clear that the document is not intended to be the sole basis for discussions on biofuels policy, but rather as a starting point for future assessments and a complement to the previously published RFS2 RIA.
Figures show net effect of EISA only. Although I understand this is Congress requirement, I believe it is wrong to try to separate between incremental impacts caused by EISA from existing impacts.	EPA appreciates the difficulty in attributing environmental impacts to biofuel feedstock when they exist as a part of the much larger environmental impacts from agriculture, in general. However, Congress specifically requested that EPA focus on EISA.
The report could have more geographic specificity, drawing on what is sometimes termed "resource analysis" to determine where growing each feedstock is feasible and then summarizing potential regional effects where possible.	EPA agrees that a regional approach would provide more robust analyses. For this report, EPA focused largely on regions of the U.S. where current and future production is and is predicted to be greatest, but future reports will both expand the breadth of regions considered and the depth with which each region is discussed.

Environmental Impacts in General	
Comment	**EPA Response to Comment**
There is not adequate discussion of the difference in workable versus optimized systems and steady-state versus dynamic systems. The importance of how to address the issue of multiple objectives and how to resolve/balance risk management practices at various stages to achieve minimized overall system level risks to the environment needs to be stressed. It may be worthwhile considering developing a platform that will allow near real-time, concurrent assessment of risk management practices since the biofuels research, development, and implementation activities are moving at a very fast pace.	EPA agrees that this approach would provide very useful management tools, but it is well beyond the scope of this report and the congressional mandate.
Many statements in summary areas have no scientific basis and data seem to be inappropriately and selectively used.	This comment was directed to the Executive Summary which the commenter thought was too broadly stated. EPA has revised the executive summary and conclusions to better mirror the content of the report. All conclusions were based on information from the scientific peer-reviewed literature.
I have a hard time agreeing with the conclusions in chapter 6 and the summary information in figures 6.1 and 6.2. This is for four reasons: (1) methodology used to create figures 6.1 and 6.2 is not transparent (2) preferred to see numbers instead of qualitative evaluations (3) the comparison would be more meaningful if it were in terms of biofuel units and not area units. Crop yields and ethanol yields are very different across crops. When those yields are factored in the picture changes completely. (4) assumptions used in creating best- and worst-case scenarios don't seem realistic. For instance, non-irrigated soybean will never substitute irrigated corn.	EPA received comments on the figures that both criticized and supported them. To address this particular comment, EPA has more explicitly described the approach for developing assumptions and impact magnitudes and uncertainties. A quantitative assessment was beyond the scope of this report, but EPA will consider such an assessment for a future report(s). While feedstock production impact assessment on a per volume of biofuel basis could be informative, EPA believes its assessment on a per area basis is equally valid and conveys useful information to the reader. EPA considered the reviewer's suggestion as an alternative or additional way to communicate impact magnitude, but was not convinced it added sufficient value to warrant such a change in this report. EPA has changed the assumption that non-irrigated soy replaces irrigated corn, given this assumption is highly unlikely.

Environmental Impacts in General	
Comment	**EPA Response to Comment**
In its section on algae, the draft report again devotes considerable attention to potential concerns, but under-represents potential benefits. EPA has determined under RFS2 that, on a lifecycle basis, algae-based diesel represents at least a 50 percent reduction in GHG emissions relative to petroleum diesel. As such, EPA has already determined that algae-based fuel has a net positive impact on GHG emissions. Additionally, there is no evidence to support the assertion that open-water pond cultivation adversely impacts air quality any more than closed systems. In fact, open pond systems allow algae to absorb significant amounts of atmospheric carbon dioxide, thus positively impacting air quality. Likewise, many algae-based fuel companies utilize brackish or saline water, rather than fresh water, so as not to compete with precious agricultural water resources. Since algae uses water as a medium for growth, the only water use associated with algae's cultivation is evaporative loss in an open pond system.	EPA limited its discussion of algal biofuels because it is not yet reached commercial production and is unlikely to do so in the next few years. Additional environmental impacts--both positive and negative--will be appropriate when more specific and more complete data become available.

Air Quality	
Comment	**EPA Response to Comment**
There were a number of comments that noted specific impacts were not included in the report. These included: agricultural burning, detailed discussion of atmospheric chemistry, especially with respect to PAN, NO and ethene, direct impacts of biofuel production on climate (e.g., through water vapor and surface albedo effects), and emissions from soils (CO2, CH4, N2O, NO, NH3).	Where specific sentences were pointed to, EPA added a sentence or two to address the issue. For more details on atmospheric chemistry and emissions, the report referred to the RFS2 RIA for details. For agricultural burning, the report noted that while burning of crop residues is a serious issue, EPA was unable to find literature that evaluated how agriculture burning would be affected by the EISA mandate. Below is the text added to page x of the report to respond to this comment. : "We decided not to include emissions from agricultural burning in this report for several reasons. First, the crops most likely to be impacted by EISA 2007 do not tend to be ones for which residue burning is used. Second, those crops affected by EISA 2007 that might otherwise have their residue burned are also much more likely to have that residue harvested and used as cellulosic feedstock in a biofuel plant. Third, there is a great deal of uncertainty in determining the differential between agricultural emissions with and without EISA 2007. We are unaware of studies that have examined the impact of agricultural burning associated with biofuels compared to a baseline of agricultural burning that is already occurring independently of biofuel production. We agree that the direct impact of biofuel production on local climate (e.g., through changes in water vapor, surface albedo, etc.) is an important issue. The following text was added to Section 3.3 "Changes in evapotranspiration with the cultivation of perennial grasses could either increase or decrease field-level or local water supplies. Higher cumulative evapotranspiration for Giant Miscanthus and switchgrass over corn (Hickman et al 2010) suggests growing perennial grasses may decrease surface runoff and subsurface infiltration, and increase evapotranspiration (Van Loocke et al 2010). These impacts, along with albedo effects from a longer growing season, may lead to increases in local and regional humidity and cooling (Georgescu et al 2009)." While it is beyond the scope of this report to have an extended discussion of this effect, it would be important to include in future assessments.

Air Quality	
Comment	**EPA Response to Comment**
Section 3.2.5.2 - Section should also note nitrous oxide and methane emissions from soils via organic vs. inorganic fertilizer use.	EPA has added text noting that the application of inorganic and organic fertilizers can increase NOx and CH_4 emissions from the soil (Section 3.2.5.2). And EPA also notes that NH_3 emissions are expected to increase with increased fertilizer usage (Section 4.3.2). As described on section 2.3.4 Impacts Discussed in This report (page 2-6), this report does not include an extensive evaluation of carbon dioxide or other greenhouse gas emissions and readers are referred to EPA's RFS2 RIA. The level of detail suggested by the comment is beyond the scope of the report.
The report clearly notes that the potential emissions of aldehydes and higher emissions of nitric oxide are recognized as a potential issue, and enhanced ozone production is noted for biofuels primarily during combustion. However, a few key species and issues are missing in air quality. These include ethene (ethylene) emissions from ethanol and that the higher levels of acetaldehyde with higher nitrogen oxide emissions will lead to the production of peroxyacetyl nitrate (PAN) as well as ozone. While ozone is recognized for its plant and human health impacts, both PAN and ethene also have significant biological impacts and should not be neglected in assessing biofuel impacts. Ethene is a very potent plant growth hormone, and use of high levels of ethanol, such as E85 now being used in Minnesota and Illinois, could lead to increases in regional ethene that could also have impacts on crop yield.	EPA's RFS2 RIA air quality assessment accounts for the emission impacts of numerous compounds and atmospheric reaction pathways in addition to those explicitly discussed (including methane, ethene and PAN), and EPA has added text to the report to clarify this point.
The air quality discussion here relies almost exclusively on the RIA analysis rather than on the peer-reviewed literature (that other sections rely on). It might be helpful to include some peer-reviewed literature where results may not be included in the National Emissions Inventory. The assumptions of the RIA analysis might make a good appendix table.	The air quality assessment in the RIA is the only 3-D modeling study that has been performed which uses realistic future emissions scenarios and a full upstream and downstream inventory. Results are consistent with findings of others (e.g., Jacobson) on ethanol impacts. In addition, the RIA analysis has been published in the peer reviewed literature.

Air Quality	
Comment	**EPA Response to Comment**
There are different types of data required; environmental monitoring data is one aspect, with needed air and water emissions from soil as a function of crop, soil type and agricultural practices. • Soil/plant level air and water emissions and soil quality as a function of many ag conditions and management practices needed to more sustainably produce crops • Remote sensing to identify land use changes • Crop planting, fertilizer, soils, pesticides, yields (~county and annual resolution needed) and as a consequence of changing prices (GIS overlays would help for future assessment) • Vehicle emission data at tailpipe and near vehicle congestion, by specific pollutants (not lumped impacts (VOCs))	EPA agrees that these are important details, but adding additional information on each would have been beyond the scope of this report.
Also, the emission of increased levels of ethene, ozone and PAN production will all have impacts on forests, grasslands, and wetland health – these impacts would likely be on the regional scale or larger due to the atmospheric lifetimes and transport aspects of these pollutants. This will need regional scale models to be used to address the impacts for each region.	EPA agrees that scientific information on the resource conservation and environmental impacts of biofuels is incomplete. This report however represents a compilation and synthesis of available scientific studies; new modeling, field studies and monitoring are therefore outside the scope of the report. Throughout the assessment we have identified key uncertainties and unknowns.
EPA's assessment indicates that corn starch ethanol is negatively impacting air quality but the extent of the harm is difficult to discern. We urge EPA to clarify the qualitative findings. It also appears that EPA's air quality impact projections would be worse but for the agency's optimistic assumptions about future practices.	EPA has recommended actions to mitigate future environmental impacts in the "Recommendations" section of Chapter 6, including developing processes to minimize exposure to air emissions.
Finally, the Draft Report overlooks direct and indirect environmental benefits from biofuel production. For example, ethanol production and use lowers carbon monoxide, benzene, and other toxic emissions; and increased use of distillers' grains reduces livestock methane emissions.	The reductions in CO and other emissions at end use are noted. However, EPA concluded that many emissions increased, especially if feedstock stages are included. The AQ results that are summarized do include fossil fuel emission reductions as well as distillers grain. The details are provided in EPA 2010b. The overall net changes in emissions and air quality tend to be negative, with the notable exception of CO which is highlighted in the report..

Climate Change and Greenhouse Gases	
Comment	**EPA Response to Comment**
The report did not include GHGs. Greenhouse gas emissions from many processes in the production of biomass feedstocks are inadequately addressed. There is some mention of GHGs from fossil fuel consumption for harvesting and planting, but very little detail about GHGs from soil processes (e.g., nitrification, denitrification, mineralization) and fertilizer manufacture and application. It is generally not clear where GHGs fit within the scope of this report, but it seems that this is an unacceptable oversight (see more below in detailed comments)	The topic area, GHG emissions, was not in the list provided in Section 204. This report notes that EPA had done a comprehensive and thorough Life Cycle Assessment of GHGs in the RFS2 RIA and readers are referred to it. The final report has been modified toclarify the scope of the report and a summary of the RIA results included in Section 2.1.1.

Ecosystem Health and Biodiversity	
Comment	**EPA Response to Comment**
On p. 3-25, line 812-817 discusses the effect of accidently intermixing genetic material from plant varieties originating in other countries during the process of developing new feedstock varieties by U.S. seed and biotechnology companies. Similarly, the report mentions indirect effects of glyphosate resistance on weed species. Neither issue seems to have any connection to biofuels and should be dropped from the report.	These issues have been identified and discussed in the peer reviewed literature. EPA has noted these as possible indirect effects of biofuels feedstock cultivation.
EPA reviewed its assessment of invasiveness issues with regard to perennial grasses. Commenters were in general agreement, suggesting that the tone of the discussion was too alarmist on the invasiveness of both grasses, but especially of Miscanthus.	EPA re-assessed the literature and determined that, although the potential for escape is not zero, the weight of evidence clearly suggests it is unlikely that giant Miscathus would present risk of invasion. EPA agrees that, giant Miscanthus (1) has no history of invasiveness (2) only produces sterile seeds, and (3) requires significant inputs (watering especially and herbicide) to establish, so even vegetative propagules are not likely to spread. EPA has modified the report to reflect this evaluation.
Ecosystem sections should mention potential for habitat fragmentation (i.e., that the pattern of landscape change is an important predictor of habitat and therefore biodiversity).	Sections 3.2.5 and 3.4.6.1 have been revised to include a discussion of fragmentation issues.
Sections dealing with invasiveness would be improved with a discussion of how improved cultivars of native plants could become invasive within their natural range. Likewise, the potential for genetically-modified dedicated biomass crops to outcross with native plants should be noted.	Text has been modified to discuss the possibility of escape of a crop in its native range and crossing between a crop and wild relatives. A reference has been added (Ellstrand et al. 1999).
Chapter 3, section 3.2.6.2: Consider revising the definition of “invasive plants” (Appendix A) to reflect the fact that several genotypes can be present within a single species, and that some may be more invasive than others. E.g. “Invasive plant: A novel species or genotype whose introduction does or is likely to cause economic or environmental harm or harm to human health.”	EPA has taken the reviewer's suggestion and edited our definition of "invasive species".

Ecosystem Health and Biodiversity	
Comment	**EPA Response to Comment**
Overall, the biodiversity impacts noted in the Draft Report are purely theoretical, based largely on what the authors thought to be the impact of corn production in the US. This commenter was concerned that this Draft Report will mislead members of Congress by providing an un-balanced view of the impacts of corn production and an overstated optimism with regard to alternative biofuel sources.	EPA has substantially revised the ecosystem health and biodiversity sections under each feedstock, as well as the summary sections specifically addressing forests, grasslands, and wetlands in Chapter 3. These sections reflect the current state of knowledge on both benefits and negative effects of the different feedstocks considered in this Report.
Biodiversity sections should discuss vegetation diversity, including potential displacement of native vegetation or improvement of biodiversity on degraded lands. Vegetation diversity is discussed unevenly through the report. For example, displacement of vegetation diversity is not discussed with respect to corn or soy, but uses of native mixtures of grasses (i.e., positive impacts to biodiversity) are discussed a bit in 3.3.6.1 (and summarized in Table 3-6). Also, there should be research on SRWC plantations in the context of ecosystem restoration (e.g., mineland restoration) that addresses biodiversity issues.	EPA reviewed the additional literature and has modified the report to mention impact on plant germination sites and discuss the implications to understory plant diversity in Section 3.4.8 (Woody Biomass - Ecosystem Impacts - Biodiversity). Thomas et al. 1999, Scheller and Mladenoff, 2002, and Khanina et al., 2007 are added as new references in this section.
The potential impact of forestry residue removal on wildlife should be more thoroughly discussed in the report.	EPA added a paragraph in Section 3.4.8 (Woody Biomass - Ecosystem Impacts - Biodiversity) that discusses the impacts of residue/debris removal for wildlife, invertebrate species, and plants. New references in this section are Scheller & Mladenoff, 2002; Waddell, 2002 and Janowiak & Webster, 2010).

Ecosystem Health and Biodiversity	
Comment	**EPA Response to Comment**
One commenter pointed out that Eucalyptus species were discussed in too general a way, with invasion risk of one species being applied to others grown in different places under different conditions.	EPA has edited the text to be more specific about which Eucalyptus species have been grown without record of invasion and which have been suggested by the peer-reviewed literature to possess risk of invasion in certain regions.
Regarding invasiveness specifically, EPA should consider adding a recommendation for breeding programs that will decrease potential invasiveness in all feedstocks. This could range from complete sterility to "functional sterility," in which seeds are retained on the parent plant, etc. Also, because containment is mentioned, you could add containment of propagules at all stages of production (including transport to/from fields). It is good that this is mentioned in section 6.1.2.2., but it could be added for emphasis in the recommendations section.	EPA believes that this suggestion is too broadly stated for inclusion in the report and it is sufficient at this time to recognize the potential for containment strategies if and when deemed necessary based on environmental risk assessment.
Currently published, peer reviewed data does not exist to support the conclusion in EPA's draft that algal production has fewer biodiversity impacts than production of other feedstocks.	The Report does acknowledge that there is greater uncertainty associated with impacts to biodiversity from algal biofuel production, since this technology is not fully developed. However, the Report does cite published, peer-reviewed literature to support its findings for all feedstocks. Comparisons are made to row crops, both corn and soy, across feedstocks, for consistency. Impacts on biodiversity due to fossil fuel production are beyond the scope of this Report.

Land Use Change	
Comment	**EPA Response to Comment**
EPA makes assumption that land use changes will occur; changes that are not being observed.	EPA reported on the numerous modeling studies in the literature, particularly those by USDA, which project expanded cropland in the future. However, EPA has added language in several places (see Chapter 3) to clarify that the most damaging land use changes that could potentially occur have not taken place to date.
Land-use and ecosystem impacts of biofuels must be compared to petroleum impacts.	The decision not to include such comparisons was predicated on the limited utility of such comparisons with regard to environmental assessment beyond focused endpoints such as greenhouse gas emissions, particulate matter, and net energy balances. EPA reviewed and modified the introductory material in the report to make this clearer.
The dominant comment from the peer-review panel on soil quality and woody biomass was that perennial feedstocks such as short-rotation woody crops (SRWCs) should be compared to other land-cover/land-uses besides annual row crops. This is because woody biomass and perennial grasses may not replace row crops due to simple economics. Instead, peer-reviewers advocated for comparing the effects of perennial feedstocks to Conservation Reserve Program land, abandoned agricultural land and current forest land, among other land types.	EPA added a paragraph to the report noting that since the environmental impacts of row crops vs. perennial feedstocks are repeatedly compared in the scientific literature, it is legitimate to summarize this information. And EPA notes that this comparison does not imply that one feedstock is likely to replace another. The scientific literature comparing perennial feedstocks with other land-covers is generally lacking, but where available EPA added additional material on this subject. For example, EPA added material on the effects of growing perennial grasses on CRP in terms of soil quality (neutral to positive), and EPA added more discussion of the soil quality impacts of planting SRWCs on forest land (generally negative).
The report is quite muddled in how the specific issue of land use change is framed. AND Other thoughts for further likelihood analysis and/or reconsideration in Figure 6-1: Soy replacement of CRP is seemingly much more likely than soy replacing corn or perennials replacing soy/corn under increased biofuel demand	The state of science and rapid pace of change in policies and feedstock/biofuel production technologies does not permit a formal "likelihood" assessment of future land use and cultivation practices. EPA has, however, added information to the figures to reflect common sets of assumptions regarding land use and cultivation that are considered in the literature.

Land Use Change	
Comment	**EPA Response to Comment**
One of the major comments from the forestry industry, including Weyerhaeuser, was that EPA did not sufficiently acknowledge the strides made over the last decades in implementing forestry best management practices (BMPs) and the efficacy of these BMPs to reduce environmental impact.	EPA did acknowledge the importance of conservation efforts, but did not want to assume too much from such efforts when adherence to guidance is voluntary. With regard to forests, however, sufficient references were found that clearly indicated high implementation rates for BMPs. After a careful review, EPA agrees that researchers have found BMPs to be effective in reducing soil erosion and water quality degradation. EPA also noted that continued adherence to these BMPs may help mitigate increased woody biomass harvesting due to biofuel demand for this feedstock.
The report erroneously assumes soybean acres will expand or intensify in response to the RFS2 mandate for Biomass-based Diesel.	Revisions have been made to chapter 3 that clarify recent trends in soybean acres. Since 2008, total acres planted for soybeans annually have been greater than any other year for which data are available (i.e. since 1924).
Section 5.3 seems to be based on the premise that reductions in U.S. corn exports caused by ethanol production in the U.S. will cause land use changes in other countries to respond to that loss of corn imports.	EPA has reviewed and changed some language to take this observation into consideration.

Biofuel Production	
Comment	**EPA Response to Comment**
The draft report makes a few generalized conclusions about algae technology that do not reflect any industry or scientific consensus. [For example, this report fails to delineate between two distinct algae technologies – heterotrophic and photosynthetic which have vastly different environmental impacts. This broad generalization is made despite a clear reference in the Day et. al article cited earlier in the report that claims "Heterotrophic cultivation of micro-algae results in higher yields which allow economic production and downstream processing of microalgae".]	The report does delineate between heterotrophic and photosynthetic algae. However, EPA believes that a comparison of these technologies' respective yields is more appropriate for a different report and may be considered for future analyses when more data are available.
A recent 2008 national survey of dry mill corn ethanol facilities was conducted by Steffen Mueller. [Mueller, Steffen. "2008 National Dry Mill Dorn Ethanol Survey." Biotechnology Letters. DOI10.1007/s10529-010-0296-7.] This survey was completed at the Energy Resources Center at the University of Illinois-Chicago and represented 66% of the installed dry mill capacity and was recently published in a peer reviewed journal and incorporated into the GREET model at Argonne National Laboratories. The survey identified a decrease in thermal and electrical energy requirements for the dry grind production of ethanol from 2001 of 28% and 32.1%, respectively, and an increase in corn ethanol yield of 5.3% per bushel. This and other new research since EPA modeled the current corn-based ethanol pathway shows continued improvement.	EPA agrees and has incorporated the cited ethanol production efficiency gains into the report.
In Figure 6-1, the maximum potential range of environmental impacts for corn (starch) and stover production are not correct. EPA has not included potential positive environmental impacts from corn production which can be achieved. Therefore, the figure basically says that all corn production is bad for the environment. For example, the use of corn stover as a fuel source would result in less acreage needed to produce the same amount of ethanol, possibly resulting in improved water quality and air quality. If removal rates which are researched and approved by USDA technical standards are utilized, then the soil quality would actually be improved from conventional tillage. However, with this presentation format, these results are not credited.	EPA's estimate of the range of impacts did include direct benefits from practices used to produce feedstocks, as well as neutral practices. In response to this and similar comments, EPA has reviewed its analysis and has modified the figure and the explanation of its analysis to succinctly present the information and communicate the range of impacts.

Biofuel Production	
Comment	**EPA Response to Comment**
We encourage EPA update its reports quantifying the energy sources such as electricity and natural gas that contribute to biodiesel production. The reports published by USDA in 2009 (USB 2009)[no reference] and USB in 2010 (USB 2010)[United Soybean Board. February 2010. Life Cycle Impact of Soybean Products and Soy Industrial Products.] are the most recent reports describing the energy required for soybean production and soybean crushing. The survey generated by the National Biodiesel Board in 2009 contains the most recent and complete data for energy consumption at biodiesel conversion facilities (NBB 2009)[National Biodiesel Board. June 2009. Comprehensive Survey on Energy Use for Biodiesel Production].	EPA acknowledges the view of this commenter, but many of points made were not supported by independent, peer reviewed literature.

Soil Quality	
Comment	**EPA Response to Comment**
We encourage EPA to fully incorporate the existing requirements of the Electronic Field Office Technical guide of the Natural Resources Conservation Service into its analysis, in order to assess the impact to date and likely future impacts of farming in America.	EPA has noted that the effectiveness of conservation practices depends upon their implementation rates. EPA cites the USDA-NRCS 2010 Conservation Effects Assessment Project (CEAP) report, entitled: "Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Upper Mississippi River Basin." This report found that erosion control practices are commonly used; however, there is considerably less adoption of proper nutrient management techniques to mitigate nitrogen loss to water bodies. EPA has also cited publications (e.g. the Keystone Alliance report) showing the improvements in environmental impacts made over the last two decades by corn and soybean production.
Page 2-8/Table 2-3: Grasslands – should acknowledge potential improvements to soil quality due to root matter improving texture and SOM and reducing erosion.	EPA has added text that growing switchgrass on degraded land can reduce erosion and increase soil organic matter.
We would like to see more discussion of the variability in soil quality and erosion potential with no-till vs. conventional till.	EPA has added text to specifically mention conservation tillage in Section 3.2.6, and added an additional paragraph on tillage practices and its effects on soil organic matter.
Flooding is an increasing concern in many agricultural landscapes. One possible benefit of perennial feedstocks relates to their capacity to reduce erosion and retain water on the landscape.	EPA agrees. EPA reports on the erosion control potential of perennial grasses in sections 3.3.4 and 3.3.6, and the potential for flood control by SRWCs in section 3.4.5.
We believe that the report should feature landscape scale biophysical models where scenario analysis can be performed; yet there is a surprising lack of discussion of models that can be used to undertake scenario analysis.	EPA agrees that these models are extremely useful. EPA has added this as a recommendation for the next report in 2013.

Soil Quality	
Comment	**EPA Response to Comment**
EPA should point out that without safeguards in place to protect against soil erosion, scaling up corn stover harvest for ethanol production may result in unacceptable losses of productive topsoil to erosion and declines in surface water quality due to increased sedimentation and eutrophication.	EPA has noted the potential for increased erosion, sedimentation and nutrient loss with high stover removal rates. Policy recommendations are outside of the scope of this report.
Page 3-35, line 1202. "Estimates … range from 20 to 40 percent" Note that this degree of carbon loss has been shown to occur after many years of cultivation (5-20), and this should not be used as a prediction for soil carbon loss from one-time site preparation for perennial bioenergy crops.	EPA agrees. EPA has removed the reference in this section (3.3.6) since it relates to row crops under continuous cultivation, not perennial grasses. Where we use the reference in section (3.2.6), we have clarified that the carbon lost is over a period of continuous cultivation (within the first 5 to 20 years).
Additional discussion about the current debate over whether conservation tillage increases soil carbon storage would be appropriate, especially given the importance of this parameter in the GHG analysis done for the RIA.	EPA has added an additional discussion on tillage effects on soil organic carbon, CO2, NOx, and CH4. EPA has also noted that the effects of tillage practices on NOx are highly variable. This report does not include an extensive evaluation of carbon dioxide or other greenhouse gas emissions, but readers are referred to EPA's RFS2 RIA.
The effects of management practices on soils (e.g. soil carbon) often take many years to be detected, such that predicting the effects of different levels of residue removal on soils will take a combination of modeling and thorough monitoring of the limited available field trials with long-term residue removal.	EPA agrees and has added a sentence regarding this in Section 3.2.6.

Soil Quality	
Comment	**EPA Response to Comment**
The general assumptions of increased fertilizer use and soil erosion due to stover harvesting are repeated throughout the report. It seems likely that as corn yields continue to increase, some stover removal will be required so as not to interfere with planting, and at least in northern states to allow the soil to warm sufficiently for planting.	The scientific literature supports the idea that stover removal may require additional fertilizer. EPA has added text to discuss the potential need to remove stover in colder, wetter locations to promote corn yield.
Chapter 3, lines 861-865: Regarding the phrase "[r]emoval of corn stover. . . ," it should be recognized that more research is needed to determine what this amount would be for different soil types.	EPA has rewritten this section to make it clear that conservation practices alone may not compensate for high stover removal.
There are several places in the report where EPA talks about "excess" removal of stover.	The use of the term "threshold" and "excess" removal are common terms in the literature. EPA believes that there is a common understanding that, in this particular case, there is a threshold below which soil loss can be tolerated and soil organic matter stocks can be maintained.

Water Quality	
Comment	**EPA Response to Comment**
...nutrient leaching from fields is many steps removed from hypoxia in coastal waters. It is probably not a reasonable assumption that a report of this type can cover all of the transport, timing of releases, ocean mixing, etc., issues that impact hypoxia. There was an excellent section on hypoxia (pp. 3-12 – 3-14), but there is no real analysis of the impacts of biofuel choices on hypoxia other than amount of fertilizer used.	EPA agrees that additional data are necessary to judge the comprehensive water quality effects of biofuel production. When additional data become available, additional analyses on this issue will be possible.
It seems like it should be possible to come up with a back-of-the envelope analysis of how much hypoxia in the Gulf is associated with corn used for biofuels. This would be very crude, but it would give some sense of the magnitude of the issue.	EPA appreciates the commenter's suggestion and would welcome the opportunity to review additional peer reviewed analyses of Gulf hypoxia for inclusion, but it is not aware of such at present.
It is important to consider that many factors impact these monitoring results besides the production of biodiesel or even more broadly agriculture. Natural features such as geology, climate, hydrology, and soils result in geographic differences in concentrations in streams and groundwater, because they affect the transport of nutrients from the land to water and thereby make some areas more vulnerable to contamination than others. Human activities such as domestic, industrial, and animal waste, lawn maintenance, impervious surfaces, and other factors also impact the quantities and localities of nutrients that can affect surface and groundwater bodies. In addition, natural processes related to geochemical conditions can affect nutrient concentrations.	EPA believes it is outside the scope of this report to go into great detail on the contributions of non-anthropogenic sources to sedimentation, especially if these will likely remain unchanged by increases in biofuel production.

Water Quality	
Comment	**EPA Response to Comment**
Consistent with our comments concerning nutrient loading of surface water streams, EPA should be careful when describing sediment loadings in major watersheds containing farmland. Too often in the draft report EPA presents speculation that sediment within an agricultural watershed is most likely to come from cropland. As with nutrient loading, the majority of sediment load in many stream comes not from agricultural land, but from other types of land uses within those watersheds. It may be logical to describe watersheds by the primary land use type within those watersheds, but it cannot be assumed that the land use type occupying the largest area is necessarily the largest contributor to water quality problems caused by sediment.	There are significant challenges facing sediment attribution that preclude any sort of definitive assessment of impacts due to biofuels feedstock cultivation. EPA agrees this is an important issue and will consider methods to adequately address it in the future.
To separate the incremental impacts of feedstock production from current agricultural environmental impacts, at least three major pieces of information are needed: 1) field-scale research, preferably at the watershed scale, that measures many indicators (such as nutrients, water flow, biodiversity) in feedstock and reference areas. 2) modeling studies (e.g., using SWAT) to fill in the gaps (in feedstocks, scales, types of environments, types of management) for which field studies are not available. 3) causal analysis studies (of the sort that EPA investigates for impaired aquatic systems using CADDIS) to attribute probable cause of impacts among hypothesized causes.	EPA agrees that these are important considerations, but they suggest future work that would be included within the recommendations of this report..

Water Quality	
Comment	**EPA Response to Comment**
The report adequately described historical and current environmental impacts of agricultural and biofuel feedstock production on the basis of data from the literature. Unfortunately, the report does not distinguish between the environmental effects attributable to biofuel feedstock and those attributable to agricultural crops. This distinction is especially important because nutrient and sediment run-off into the water stream — a major cause of downstream accumulation of nutrient which could lead to hypoxia in certain water body — is directly linked to the management and practices common in agriculture production to which biofuel feedstock production belong. The way of farming a particular type of the crop remains unchanged regardless of its final use.	EPA agrees that the inability to distinguish between the impacts attributable to biofuels and other agriculture production is a limitation of this report. EPA looks forward to developing information to improve our understanding in future research.
The draft deport has analyzed the potential water quality (and other) impacts of each biofuel source one-by-one, in isolation, rather than taking an overall systems approach. The method chosen within the Draft Report does not allow one to consider the benefits of the innovative landscape designs mentioned above. It also fails to account for the overall risk-mitigation potential that comes from having a diversified portfolio of crop and bioenergy sources, with each crop or biomass feedstock positioned at the optimal place in the landscape and at the "right size" to meet the complicated nexus of economic, environmental, and societal demands. Such an optimization should also explicitly take into account the benefit of multi-purpose feedstocks like corn, which are extremely productive and benefit from multiple potential end uses — including feed and food. This versatility in the potential utility of the corn crop (grain and stover) is actually a benefit, rather than a mark against its use as a biofuel source, as so often alleged.	Future studies and additional data may permit the future reports to take a more systematic approach to assessing the environmental impacts of biofuels.

Water Quality	
Comment	**EPA Response to Comment**
Overall – I think that the synthesis of information in this report (conclusions or exec. summary) should really emphasize the geographic diversity of impacts and appropriate practices. Implementing biofuels in a manner to mitigate potential deleterious environmental impacts will look very different in different regions of the country. But in almost any situation, there will be trade-offs in the nature of the impacts. For example, Iowa and Illinois are good in terms of low irrigation needs, but because they have extensive tile drainage, corn production in these states results in significant water quality impairment. This could be worked into the discussion of needs for a comprehensive LCA approach to help identify and balance the pros and cons of each alternative feedstock.	Additional language about EPA's plans for a comprehensive assessment has been added to the report.