



# **Ozone National Ambient Air Quality Standards: Scope and Methods Plan for Welfare Risk and Exposure Assessment**

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Office of Air Quality Planning and Standards  
U.S. Environmental Protection Agency  
Research Triangle Park, NC 27711

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Office of Air Quality Planning and Standards  
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## **DISCLAIMER**

This planning document has been prepared by staff from the Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. Any opinions, findings, conclusions, or recommendations are those of the authors and do not necessarily reflect the views of the EPA. This document is being circulated to facilitate consultation with the Clean Air Scientific Advisory Committee (CASAC) and to obtain public review. For questions concerning this document, please contact Dr. Travis Smith ([smith.jtravis@epa.gov](mailto:smith.jtravis@epa.gov)) or Ms. Christine Davis ([davis.christine@epa.gov](mailto:davis.christine@epa.gov)), U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, C539-07, Research Triangle Park, North Carolina 27711.

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1   **1   INTRODUCTION**

2           The U.S. Environmental Protection Agency (EPA) is presently conducting a review of the  
3 national ambient air quality standards (NAAQS) for ozone. Sections 108 and 109 of the Clean  
4 Air Act (Act) govern the establishment and periodic review of the NAAQS. These standards are  
5 established for pollutants that may reasonably be anticipated to endanger public health and  
6 welfare, and whose presence in the ambient air results from numerous or diverse mobile or  
7 stationary sources. The NAAQS are to be based on air quality criteria, which are to accurately  
8 reflect the latest scientific knowledge useful in indicating the kind and extent of identifiable  
9 effects on public health or welfare that may be expected from the presence of the pollutant in  
10 ambient air. The EPA Administrator is to promulgate and periodically review, at five-year  
11 intervals, “primary” (health-based) and “secondary” (welfare-based) NAAQS for such  
12 pollutants. Based on periodic reviews of the air quality criteria and standards, the Administrator  
13 is to make revisions in the criteria and standards, and promulgate any new standards, as may be  
14 appropriate. The Act also requires that an independent scientific review committee advise the  
15 Administrator as part of this NAAQS review process, a function now performed by the Clean Air  
16 Scientific Advisory Committee (CASAC)

17           EPA’s overall plan and schedule for this ozone NAAQS review are presented in the  
18 Integrated Review Plan for the Ozone National Ambient Air Quality Standards Review (EPA,  
19 2011b), which is available at: [http://www.epa.gov/ttn/naaqs/standards/ozone/s\\_o3\\_cr\\_pd.html](http://www.epa.gov/ttn/naaqs/standards/ozone/s_o3_cr_pd.html).  
20 That plan outlines the Clean Air Act (CAA) requirements related to the establishment and  
21 reviews of the NAAQS, the process and schedule for conducting the current ozone NAAQS  
22 review, and three key components in the NAAQS review process: an Integrated Science  
23 Assessment (ISA), a Risk and Exposure Assessment (REA), and a Policy Assessment (PA). It  
24 also lays out the key policy-relevant issues to be addressed in this review as a series of policy-  
25 relevant questions that will frame our approach to determining whether the current primary and  
26 secondary NAAQS for ozone should be retained or revised.

27           The ISA prepared by EPA’s Office of Research and Development (ORD), National Center  
28 for Environmental Assessment (NCEA), provides a critical assessment of the latest available

1 policy-relevant scientific information upon which the NAAQS are to be based. The ISA will  
2 critically evaluate and integrate scientific information on the health and welfare effects  
3 associated with exposure to ozone in the ambient air. The REA, prepared by EPA's Office of  
4 Air and Radiation (OAR), Office of Air Quality Planning and Standards (OAQPS), will draw  
5 from the information assessed in the ISA. The REA will include, as appropriate, quantitative  
6 estimates of human and ecological exposures and/or risks associated with recent ambient levels  
7 of ozone, with levels simulated to just meet the current standards, and with levels simulated to  
8 just meet possible alternative standards.

9 The REA will be developed in two parts addressing: (1) human health risk and exposure  
10 and (2) welfare-related risk and exposure. This document describes the scope and methods  
11 planned to conduct the welfare risk and exposure assessments to support the review of the  
12 secondary (welfare-based) ozone NAAQS. A separate document describes the scope and  
13 methods planned to conduct quantitative assessments to support the review of the primary  
14 (health-based) ozone NAAQS. Preparation of these two planning documents coincides with the  
15 development of the first draft ozone ISA (U.S. EPA, 2011a) to facilitate the integration of policy-  
16 relevant science into all three documents.

17 This planning document is intended to provide enough specificity to facilitate consultation  
18 with CASAC, as well as for public review, in order to obtain advice on the overall scope,  
19 approaches, and key issues in advance of the conduct of the risk and exposure analyses and  
20 presentation of results in the first draft REA. NCEA has compiled and assessed the latest  
21 available policy-relevant science available to produce a first draft of the ISA and related Annexes  
22 (US EPA, 2011a). The first draft ISA has been reviewed by staff and used in the development of  
23 the approaches described below. This includes information on atmospheric chemistry, source  
24 emissions, air quality, exposure, and related welfare effects. CASAC consultation on this  
25 planning document coincides with its review of the first draft ISA. CASAC and public  
26 comments on this document will be taken into consideration in the development of the first draft  
27 REA, the preparation of which will coincide and draw from the second draft ISA. The second  
28 draft REA will draw on the final ISA and will reflect consideration of CASAC and public  
29 comments on the first draft REA. The final REA will reflect consideration of CASAC and

1 public comments on the second draft REA. The final ISA and final REA will inform the policy  
2 assessment and rulemaking steps that will lead to a final decision on the ozone NAAQS.

3 This introductory chapter includes background on the current ozone standards and the  
4 quantitative risk assessment conducted for the last review; the key issues related to designing the  
5 quantitative assessments in this review, building upon the lessons learned in the last review; and  
6 an overview introducing the planned assessments that are described in more detail in later  
7 chapters. The planned assessments are designed to estimate welfare risks that are associated  
8 with recent ambient levels and, if appropriate considering resource and data availability, with  
9 ambient levels simulated to just meet the current standards, and with ambient levels simulated to  
10 just meet alternative standards that may be considered. The major components of the  
11 assessments (e.g., air quality analyses, quantitative exposure assessment, and quantitative  
12 welfare risk assessments) briefly outlined in the Integrated Review Plan (U.S. EPA, 2011b) are  
13 described in more detail below in Chapters 2 – 6. The schedule for completing these  
14 assessments is presented in Chapter 7.

## 15 **1.1 Background on 2008 Ozone NAAQS Review**

16 As a first step in developing this planning document, we considered the work completed in  
17 previous reviews of the primary and secondary NAAQS for ozone and in particular the  
18 quantitative assessments supporting those reviews. EPA completed the most recent review of the  
19 ozone NAAQS with publication of a decision on March 27, 2008 (73 FR 16436). Based on the  
20 final criteria document (CD) (US EPA, 2006) published in March of 2006, and on the final Staff  
21 Paper (U.S EPA, 2007) published in July of 2007, the previous EPA Administrator decided to  
22 revise the level of the 8-hr average primary ozone standard from 0.08 ppm to 0.075 ppm and to  
23 revise the secondary to be identical to the primary. As discussed in more detail in the Integrated  
24 Review Plan, the current EPA Administrator decided to reconsider the March 27, 2008 decisions  
25 on the revisions to the primary and secondary ozone NAAQS.

### 26 **1.1.1 Overview of 2008 Review**

27 The assessments conducted as part of the last review focused on national-level O<sub>3</sub>-related  
28 impacts to sensitive vegetation and their associated ecosystems. The vegetation exposure  
29 assessment was performed using an interpolation approach that included information from

1 ambient monitoring networks and results from air quality modeling. The vegetation risk  
2 assessment included both tree and crop analyses. The tree risk analysis included three distinct  
3 lines of evidence: (1) observations of visible foliar injury in the field linked to monitored O<sub>3</sub> air  
4 quality for the years 2001 – 2004; (2) estimates of seedling growth loss under then current and  
5 alternative O<sub>3</sub> exposure conditions; and (3) simulated mature tree growth reductions using the  
6 TREGRO model to simulate the effect of meeting alternative air quality standards on the  
7 predicted annual growth of mature trees from three different species. The crop risk analysis  
8 included estimates of crop yields under current and alternative O<sub>3</sub> exposure conditions. The  
9 associated changes in economic value upon meeting the levels of various alternative standards  
10 were analyzed using an agricultural model. Key elements and observations from these exposure  
11 and risk assessments are outlined in the following sections.

### 12 **1.1.2 Exposure Characterization**

13 In many rural and remote areas where sensitive species of vegetation can occur,  
14 monitoring coverage remained limited. Thus, the 2007 Staff Paper concluded that it was  
15 necessary to use an interpolation method in order to better characterize O<sub>3</sub> air quality over broad  
16 geographic areas and at the national scale. Based on the significant difference in monitor  
17 network density between the eastern and western U.S., the Staff Paper further concluded that it  
18 was appropriate to use separate interpolation techniques in these two regions: The Air Quality  
19 System (AQS; <http://www.epa.gov/ttn/airs/airsaqs>) and Clean Air Status and Trends Network  
20 (CASTNET; <http://www.epa.gov/castnet/>) monitoring data were solely used for the eastern  
21 interpolation, and in the western U.S., where rural monitoring is more sparse, O<sub>3</sub> outputs from  
22 the EPA/NOAA Community Multi-scale Air Quality (CMAQ) model system  
23 (<http://www.epa.gov/asmdnerl/CMAQ>, Byun and Ching, 1999; Byun and Schere, 2006) were  
24 used to develop scaling factors to augment the monitor interpolation. In order to characterize  
25 uncertainty associated with the exposure estimates generated using the interpolation method,  
26 monitored O<sub>3</sub> concentrations were systematically compared to interpolated O<sub>3</sub> concentrations in  
27 areas where monitors were located. In general, the interpolation method performed well in many  
28 areas in the U.S. This approach was used to develop a national vegetation O<sub>3</sub> exposure surface.

1 To evaluate changing vegetation exposures under selected air quality scenarios, a number  
2 of analyses were conducted. One analysis adjusted 2001 base year O<sub>3</sub> air quality distributions  
3 using a rollback method (Rizzo, 2005, 2006) to reflect meeting the current and alternative  
4 secondary standard options. For “just meet” and alternative 8-hr average standard scenarios, the  
5 associated maps of estimated 12-hr, W126 exposures were generated. Based on these  
6 comparisons, the following observations were drawn: (1) current O<sub>3</sub> air quality levels could  
7 result in significant cumulative, seasonal O<sub>3</sub> exposures to vegetation in some areas; (2) overall 3-  
8 month 12-hr W126 O<sub>3</sub> levels were somewhat but not substantially improved under the “just  
9 meet” current (0.08 ppm) scenario; (3) exposures generated for just meeting a 0.070 ppm, 4th-  
10 highest maximum 8-hr average alternative standard (the lower end of the then proposed range for  
11 the primary O<sub>3</sub> standard) showed substantially improved 3-month cumulative, seasonal O<sub>3</sub> air  
12 quality when compared to just meeting the current 0.08 ppm, 8-hr average standard.

13 A second analysis described in the Staff Paper was performed to evaluate the extent to  
14 which county-level O<sub>3</sub> air quality measured in terms of various levels of the current 8-hr average  
15 form overlapped with that measured in terms of various levels of the 12-hr W126 cumulative,  
16 seasonal form. While these results also suggested that meeting a proposed 0.070 ppm, 8-hr  
17 secondary standard would provide substantially improved vegetation protection in some areas,  
18 the Staff Paper recognized that this analysis had several important limitations. In particular, the  
19 lack of monitoring in rural areas where sensitive vegetation and ecosystems are located,  
20 especially at higher elevation sites, could have resulted in an inaccurate characterization of the  
21 degree of potential overlap at sites that have air quality patterns that can result in relatively low  
22 8-hr averages while still experiencing relatively high cumulative exposures (72 FR 37892).  
23 Thus, the Staff Paper concluded that it is reasonable to anticipate that additional unmonitored  
24 rural high elevation areas with sensitive vegetation may not be adequately protected even with a  
25 lower level of the 8-hr form. The Staff Paper further indicated that it remained uncertain as to  
26 the extent to which air quality improvements designed to reduce 8-hr O<sub>3</sub> average concentrations  
27 would reduce O<sub>3</sub> exposures measured by a seasonal, cumulative W126 index. The Staff Paper  
28 indicated this to be an important consideration because: (1) the biological database stresses the  
29 importance of cumulative, seasonal exposures in determining plant response; (2) plants have not  
30 been specifically tested for the importance of daily maximum 8-hr O<sub>3</sub> concentrations in relation

1 to plant response; and (3) the effects of attainment of a 8-hr standard in upwind urban areas on  
2 rural air quality distributions cannot be characterized with confidence due to the lack of  
3 monitoring data in rural and remote areas.

4 The Staff Paper also presented estimates of economic valuation for crops associated with  
5 the then current and alternative standards. The Agriculture Simulation Model (AGSIM) (Taylor,  
6 1994; Taylor, 1993) was used to calculate annual average changes in total undiscounted  
7 economic surplus for commodity crops and fruits and vegetables when then current and  
8 alternative standard levels were met. Meeting the various alternative standards did show some  
9 significant benefits beyond the 0.08 ppm, 8-hr standard. However, the Staff Paper recognized  
10 that the modeled economic impacts from AGSIM had many associated uncertainties, which  
11 limited the usefulness of these estimates.

### 12 **1.1.3 Assessment of Risks to Vegetation**

13 The risk assessments in the last review reflected the availability of several additional  
14 lines of evidence that provided a basis for a more complete and coherent picture of the scope of  
15 O<sub>3</sub>-related vegetation risks, especially those faced by seedling, sapling and mature tree species  
16 growing in field settings, and indirectly, forested ecosystems. Specifically, new research  
17 available at the time reflected an increased emphasis on field-based exposure methods (e.g., free  
18 air exposure and ambient gradient), improved field survey biomonitoring techniques, and  
19 mechanistic tree process models. Highlights from the analyses that addressed visible foliar  
20 injury, seedling and mature tree biomass loss, and effects on crops are summarized below.

21 With regard to visible foliar injury, the Staff Paper presented an assessment that  
22 combined recent U.S. Forest Service Forest Inventory and Analysis (FIA) biomonitoring site  
23 data with the county level air quality data for those counties containing the FIA biomonitoring  
24 sites. This assessment showed that incidence of visible foliar injury ranged from 21 to 39  
25 percent of the counties during the four-year period (2001-2004) across all counties with air  
26 quality levels at or below that of the then current 0.08 ppm 8-hr average standard. Of the  
27 counties that met an 8-hr average level of 0.07 ppm in those years, 11 to 30 percent of the  
28 counties still had incidence of visible foliar injury.

1 With respect to tree seedling biomass loss, concentration-response (C-R) functions  
2 developed from Open Top Chamber (OTC) studies for biomass loss for available seedling tree  
3 species and information on tree growing regions derived from the U.S. Department of  
4 Agriculture's Atlas of United States Trees were combined with projections of air quality based  
5 on 2001 interpolated exposures, to produce estimated biomass loss for each individual seedling  
6 tree species. These analyses predicted that biomass loss could still occur in many tree species  
7 when O<sub>3</sub> air quality was adjusted to meet the then current 8-hr average standard. Though this  
8 type of analysis was not new to this review, the context for understanding these results had  
9 changed due to recent field work at the AspenFACE site in Wisconsin on quaking aspen  
10 (Karnosky et al., 2005) and a gradient study performed in the New York City area (Gregg et al.,  
11 2003), which confirmed the detrimental effects of O<sub>3</sub> exposure on tree growth in field studies  
12 without chambers and beyond the seedling stage (King et al., 2005).

13 With respect to risk of mature tree growth reductions, a tree growth model (TREGRO)  
14 was used to evaluate the effect of changing O<sub>3</sub> air quality scenarios from just meeting alternative  
15 O<sub>3</sub> standards on the growth of mature trees.<sup>1</sup> The model was run for a single western species  
16 (ponderosa pine) and two eastern species (red maple and tulip poplar). Staff Paper analyses  
17 found that just meeting the then current standard would likely continue to allow O<sub>3</sub>-related  
18 reductions in annual net biomass gain in these species. Though there was uncertainty associated  
19 with the above analyses, it was important to note that recent evidence from experimental studies  
20 that go beyond the seedling growth stage continued to show decreased growth under elevated O<sub>3</sub>  
21 (King et al., 2005); some mature trees such as red oak have shown an even greater sensitivity of  
22 photosynthesis to O<sub>3</sub> than seedlings of the same species (Hanson et al., 1994); and the potential  
23 for cumulative “carry over” effects as well as compounding should be considered (Andersen, et  
24 al, 1997).

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<sup>1</sup> TREGRO is a process-based, individual tree growth simulation model (Weinstein et al, 1991) that is linked with concurrent climate data to account for O<sub>3</sub> and climate/meteorology interactions on tree growth. TREGRO has been used to evaluate the effects of a variety of O<sub>3</sub> scenarios on several species of trees in different regions of the U.S. (Tingey et al., 2001; Weinstein et al., 1991; Retzlaff et al., 2000; Laurence et al., 1993; Laurence et al., 2001; Weinstein et al., 2005).

1 With respect to risks of yield loss in agricultural crops and fruit and vegetable species,  
2 little new information was available beyond that of the previous review. However, limited  
3 information from a free air field based soybean study (SoyFACE) and information on then  
4 current cultivar sensitivities led to the conclusion that C-R functions developed in OTCs under  
5 the National Crop Loss Assessment Network (NCLAN) program could still be usefully applied.  
6 The crop risk assessment, like the tree seedling assessment, combined NCLAN C-R information  
7 on commodity crops, fruits and vegetables, crop growing regions, and interpolated exposures  
8 during each crop growing season. The risk assessment estimated that just meeting the 0.08 ppm,  
9 8-hr standard would still allow O<sub>3</sub>-related yield loss to occur in some sensitive commodity crops  
10 and fruit and vegetable species growing at that time in the U.S.

## 11 **1.2 Approach for Assessing the Adequacy of the Current Standard**

12 The first step in reviewing the adequacy of the secondary O<sub>3</sub> standard is to consider whether  
13 the available body of scientific evidence, assessed in the ISA and used as a basis for the analyses  
14 presented in the public welfare-related REA, supports or calls into question the scientific  
15 conclusions reached in the last review regarding welfare effects related to exposure to O<sub>3</sub> and  
16 other photochemical oxidants (e.g., peroxyacetyl nitrate, hydrogen peroxide) in ambient air.  
17 This evaluation of the available scientific evidence will focus on key policy-relevant issues by  
18 addressing a series of questions including the following:

- 19 • To what extent has new scientific information become available that alters or  
20 substantiates our understanding of the effects on vegetation and other welfare effects  
21 following exposures to levels of O<sub>3</sub> found in the ambient air?
- 22 • To what extent has new scientific information become available to inform our  
23 understanding of the nature of the exposures that are associated with such effects in terms  
24 of biologically relevant cumulative, seasonal exposure indices?
- 25 • To what extent has new scientific information become available that alters or  
26 substantiates our understanding of the effects of O<sub>3</sub> on sensitive plant species, ecological  
27 receptors, or ecosystem processes?
- 28 • To what extent has new scientific information become available that alters or  
29 substantiates our understanding of exposure factors other than O<sub>3</sub> that might influence the

1 associations between O<sub>3</sub> levels and welfare effects being considered (e.g., site specific  
2 features such as elevation, soil moisture level, presence of co-occurring competitors,  
3 pests, pathogens, other pollutant stressors, weather-related factors)?

- 4 • To what extent has new scientific information become available that alters or  
5 substantiates conclusions regarding the occurrence of adverse welfare effects at levels of  
6 O<sub>3</sub> as low as or lower than those observed previously? What is the nature of the  
7 exposure-response relationships of O<sub>3</sub> for the various welfare effects evaluated?
- 8 • Given recognition in the last review that the significance of O<sub>3</sub>-induced effects to the  
9 public welfare depends in part on the intended use of the plants or ecosystems on which  
10 those effects occurred, to what extent has new scientific evidence become available to  
11 suggest additional locations where the vulnerability of sensitive species or ecosystems  
12 would have special significance to the public welfare and should be given increased focus  
13 in this review?
- 14 • To what extent do risk and/or exposure analyses suggest that exposures of concern for  
15 O<sub>3</sub>-related welfare effects are likely to occur with current ambient levels of O<sub>3</sub> or with  
16 levels that just meet the O<sub>3</sub> standard? Are these risks/exposures of sufficient magnitude  
17 such that the welfare effects might reasonably be judged to be important from a public  
18 welfare perspective? What are the important uncertainties associated with these  
19 risk/exposure estimates?
- 20 • To what extent have important uncertainties identified in the last review been addressed  
21 and/or have new uncertainties emerged?

### 22 **1.3 Overview of Current Assessment Plan**

23 Since the 2008 review, new scientific information on the direct and indirect effects of O<sub>3</sub>  
24 on vegetation and ecosystems, respectively, has become available. With respect to mature trees  
25 and forests, the information regarding O<sub>3</sub> impacts to forest ecosystems has continued to expand,  
26 including limited new evidence that implicates O<sub>3</sub> as an indirect contributor to decreases in  
27 stream flow through direct impacts on whole tree level water use. Newly published results from  
28 the Long-term FACE (Free Air CO<sub>2</sub> enrichment) studies provide additional evidence regarding  
29 chronic O<sub>3</sub> exposures in closed forest canopy scenarios including interspecies interactions such

1 as decreased growth of branches and root mass in sensitive species. Also, lichen and moss  
2 communities on trees monitored in FACE sites have been shown to undergo species shifts when  
3 exposed to O<sub>3</sub>. In addition, it is expected that as in the previous review, recent available data  
4 from annual field surveys conducted by the USFS to assess foliar damage to selected tree species  
5 will again be available. In light of this new scientific information, we will consider whether  
6 additional analyses are warranted, such as combining the USFS data with recent county level air  
7 quality data to determine the incidence of visible O<sub>3</sub> damage occurring across the U.S. at air  
8 quality levels that meet or are below the current standard, as was done in the last review. To the  
9 extent warranted, based on new information regarding O<sub>3</sub> effects on forest trees, both qualitative  
10 and quantitative assessments may be considered in an effort to place both the estimates of risk  
11 from more recent long-term studies and historic shorter-term studies in the context of ecosystem  
12 services.

13 Additional information relevant to vegetation risk assessments expected to be available  
14 includes that regarding the interactions between elevated O<sub>3</sub> and CO<sub>2</sub> with respect to plant  
15 growth and how these interactions might be expected to be modified under different climatic  
16 conditions, and potential reactions of O<sub>3</sub> with chemicals released by plants to attract pollinators  
17 that could decrease the distance the floral “scent trail” travels and potentially change the distance  
18 pollinators have to travel to find flowers. To the extent warranted, staff also plans to consider  
19 any available information regarding potential risks to threatened or endangered species.

20 To the extent warranted, qualitative and/or quantitative assessments of ecosystem services  
21 impacted by O<sub>3</sub> will be considered to inform the current review. For example, the ecosystem  
22 services evaluation in this review may include tree biomass and crop analyses, and when  
23 possible include impacts on ecosystem services such as impacts on biodiversity, biological  
24 community composition, health of forest ecosystems, aesthetic values of trees and plants and the  
25 nutritive quality of forage crops. CO<sub>2</sub> sequestration is another important ecosystem service  
26 (regulating) that may be affected by O<sub>3</sub> damage to vegetation. New preliminary evidence of O<sub>3</sub>  
27 effects on the ability of pollinators to find their target is also of special interest with respect to the  
28 possible implication for ecosystem services. Impairment of the ability of pollinators to locate  
29 flowers could have broad implications for agriculture, horticulture and forestry.

1           If resources are available, we will consider using the Forest and Agricultural Sector  
2 Optimization Model (FASOM) to assess the economic impacts of O<sub>3</sub> damage to forests and  
3 agricultural crops jointly. FASOM is a dynamic, non-linear programming model designed for  
4 use by the EPA to evaluate welfare and market effects of carbon sequestration in trees,  
5 understory, forest floor, wood products and landfills that would occur under different agricultural  
6 and forestry scenarios. It may be possible to use FASOM to model damage by O<sub>3</sub> to the  
7 agriculture and forestry sectors and quantify how O<sub>3</sub>-exposed vegetation affects the ecosystem  
8 service of carbon sequestration.

9           A conclusion in the last review was that the science continued to support a change in the  
10 form of the secondary standard for O<sub>3</sub> to better reflect the effects of cumulative O<sub>3</sub> exposures on  
11 plants. The current form of the secondary standard may not protect sensitive species that are  
12 chronically exposed to elevated O<sub>3</sub> concentrations. In light of new information on exposures,  
13 risks, non-plant effects, and ecosystem services, we will consider whether additional analyses are  
14 warranted to evaluate the relative risks associated with both the current and potentially  
15 alternative secondary standards seasonal forms, including the impact of using different length  
16 diurnal windows (e.g., 12, 16 or 24 hrs) or different seasonal periods (e.g., 3, 5, or 7 months).

1 **2 AIR QUALITY CONSIDERATIONS**

2 Air quality analyses are necessary to inform and support welfare-related assessments. The  
3 planned air quality analyses for this review will build upon those of the ISA and will include  
4 consideration of: (1) summaries of recent ambient air quality data, (2) estimation approaches to  
5 extrapolate air quality values for rural areas without monitors as well as federally designated  
6 Class I natural areas important to welfare effects assessment, (3) estimates of Policy-Relevant  
7 Background (PRB) concentrations, (4) air quality simulation procedures that modify recent air  
8 quality data to reflect changes in the distribution of air quality estimated to occur at some  
9 unspecified time in the future when an area just meets a given set of NAAQS. In this review, air  
10 quality analyses are being planned to support quantitative exposure and risk assessments that we  
11 may consider in light of the new scientific information available for specific locations, as well as  
12 at regional and national scales.

13 In addition to updating air quality summaries since the last review, these air quality analyses  
14 will include summaries of the most currently available ambient measurements for the current and  
15 potential alternate secondary standard forms, and comparisons among them . These air quality  
16 analyses will use monitor data from the AQS database (which includes National Park Service  
17 monitors) and the CASTNET network. In addition, staff may explore the suitability of using  
18 other sources of O<sub>3</sub> concentration information that might be available, such as from portable  
19 monitors or satellites.

20 In the last review, the vegetation exposure analysis used a spatial interpolation technique to  
21 create an interpolated air quality surface to fill in the gaps in ambient monitoring data, especially  
22 those left by a sparse rural monitoring network in the western United States. In this review,  
23 additional approaches that potentially could be used to fill in the gaps in the rural monitoring  
24 network, as well as opportunities for enhancing the fusion of monitoring and modeled O<sub>3</sub> data,  
25 may be explored.

26 Estimates of the risks in excess of PRB remaining upon meeting the current or potential  
27 alternative standards require EPA to estimate PRB. EPA will be evaluating alternative  
28 definitions of PRB and the implications of those definitions for estimates of risk, and will use a

1 definition of PRB that is consistent with the health risk and exposure assessment. This type of  
2 risk estimate is considered relevant to inform the EPA Administrator’s decision on the adequacy  
3 of a given standard.

4 As part of the air quality analyses supporting the assessments, it will be necessary to adjust  
5 recent O<sub>3</sub> air quality data to simulate just meeting the current standard and any alternative O<sub>3</sub>  
6 standards. In the last review, EPA used a quadratic air quality rollback approach (U.S. EPA,  
7 2007), but staff may consider alternative air quality simulation procedures.

## 8 **2.1 National Ozone Exposure Surface**

9 Since the last review, little has changed in terms of the extent of monitoring coverage in  
10 non-urban areas. We are planning to consider both past and alternative approaches for  
11 generating estimates of national O<sub>3</sub> exposures in an effort to continue enhancing our ability to  
12 characterize exposures in these non-monitored areas. It is expected that any vegetation exposure  
13 assessments that may be conducted will again include assessments of recent air quality, air  
14 quality associated with just meeting the current standard and any alternative standards that might  
15 be considered.

16 In addition, given the importance of providing protection for sensitive vegetation in areas  
17 afforded special protections, such as in federally designated Class I natural areas, we may also  
18 consider alternative sources of O<sub>3</sub> exposure information for those types of sites. For example,  
19 portable O<sub>3</sub> monitors are being deployed in some national parks and a current exploratory study  
20 is underway to measure O<sub>3</sub> concentration variations with gradients in elevation.<sup>2</sup> Information  
21 from these monitors could potentially inform our understanding of uncertainties associated with  
22 assessing O<sub>3</sub> distribution patterns in complex terrain and high elevations. New exposure data  
23 that would inform this assessment will be considered where appropriate.

24 To generate a national ozone exposure surface, staff plans to consider several interpolation  
25 methods. One option is to use a previously modeled ozone surface generated by the CMAQ  
26 model based on 2005 emissions at a 12 km grid resolution in conjunction with monitor data

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<sup>2</sup> For more information on portable ozone monitors in National Parks, please see  
<http://www.nature.nps.gov/air/studies/porto3.cfm>

1 (2004-2006) to create a fused surface with the Modeled Attainment Test Software (MATS).<sup>3</sup>  
2 Another option is to use the Voronoi Neighbor Averaging (VNA) interpolation method in the  
3 BenMAP model (Abt Associates, Inc., 2008) to create a national ozone surface from more recent  
4 monitor data (e.g., 2008-2010).<sup>4</sup> Staff will also evaluate alternate interpolation methods and  
5 sources of air quality data to assess which option is most appropriate given the analysis  
6 requirements, desire for consistency with the health risk assessment, and available resources.

7 In order to generate the national ozone surface in terms of a particular index, the monitored  
8 data and CMAQ model outputs that form the basis for the interpolation need to be characterized  
9 in terms of that index. At a minimum, staff plans to generate the national surface in terms of the  
10 current secondary standard. Staff recognizes that additional indices may be selected for further  
11 evaluation upon review of the information contained in the ISA and may perform additional air  
12 quality analyses based on those indices. Any expanded evaluation of additional indices would be  
13 contained and discussed in the Policy Assessment.

14 In conjunction with the health risk assessors, staff is currently considering various  
15 approaches to simulate just meeting the current and alternative standards, including the quadratic  
16 air quality “rollback” adjustment that was used in the last review (Johnson, 1997) and variations  
17 of the proportional adjustment method. In addition, staff is currently investigating methods for  
18 generating adjusted air quality in non-monitored areas.

19 The national ozone surface, depicted as a GIS layer, provides the exposures needed as  
20 input to the crop and tree seedling risk and ecosystem service assessments described in sections 3  
21 and 4.

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<sup>3</sup> More information on CMAQ is available at <http://www.epa.gov/amad/CMAQ/index.html>. More information on MATS is available at [http://www.epa.gov/scram001/modelingapps\\_mats.htm](http://www.epa.gov/scram001/modelingapps_mats.htm).

<sup>4</sup> More information on the VNA method in BenMAP is available at <http://www.epa.gov/air/benmap/models/BenMAPManualAugust2010.pdf>

1 **3 ECOLOGICAL EFFECTS OF EXPOSURE**

2 **3.1 National Scale Assessment**

3 **3.1.1 Tree Seedling Concentration-Response Functions**

4 Staff plans to analyze the 11 OTC tree seedling C-R functions identified and assessed in  
5 the 2007 O<sub>3</sub> Staff Paper in terms of the current exposure metrics. This analysis will enable staff  
6 to directly evaluate estimated seedling biomass loss values expected to occur under air quality  
7 exposure scenarios expressed in terms of the current and alternate secondary standards.  
8 Currently, the ISA does not provide any information that would substantially change these C-R  
9 functions, but Staff would evaluate any new information that becomes available in the ISA.

10 **3.1.2 Estimation of Biomass Loss for Tree Seedlings**

11 In the 2007 O<sub>3</sub> Staff Paper, information on tree species growing regions was derived from  
12 the USDA Atlas of United States Trees (Little, 1971). Staff plans to consider using more recent  
13 information from the USDA Forest Service FIA database in order to update growing ranges for  
14 the 11 tree species studied by NHEERL-WED. Staff plans to combine the national ozone  
15 surface (from section 2.1) with the C-R function for each of the tree seedling species and  
16 information on each tree species growing region to produce estimates of biomass loss for each of  
17 the 11 tree seedling species. From this information, staff plans to generate GIS maps depicting  
18 biomass loss for each species for each air quality scenario.

19 **3.2 Ecosystem Level Case Study Areas**

20 In order to assess the ecological effects of ozone staff will analyze ecosystem level effects in  
21 several case study areas. These areas will be selected to allow a more refined assessment of the  
22 extent of foliar injury, biomass loss and welfare related services. Criteria that may be used to  
23 select case study areas include:

- 24 • Occur in areas expected to have elevated levels of ozone where ecological effects might  
25 be expected to occur.
- 26 • Availability of vegetation mapping including estimates of species cover.

- 1 • Geographic coverage representing a cross section of the nation, including urban and
- 2 natural settings.
- 3 • Occurrence of ozone sensitive species and/or species for which ozone concentration-
- 4 response curves have been generated.

### 5 **3.2.1 Estimation of Vegetation Effects in National Parks**

6 The National Parks provide several potential case study areas. The United States  
7 Geological Survey (USGS) in conjunction with the National Park Service (NPS) is actively  
8 creating maps of the vegetation communities within the National Parks  
9 (<http://biology.usgs.gov/npsveg/index.html>). This provides a consistent vegetation map to  
10 compare across park units, which includes species coverage data. The NPS has also generated a  
11 comprehensive list of plant species that are known to exhibit foliar injury at ambient ozone levels  
12 (Porter, 2003).

13 Potential National Park units to be included are Great Smoky Mountains National Park,  
14 Rocky Mountain National Park, and Sequoia/Kings National Park. All three of these park units  
15 occur in areas with elevated ambient ozone levels, have vegetation maps, and have species that  
16 are considered ozone sensitive.

17 The NPS vegetation maps would be compared, using GIS, to the national ozone surface  
18 to provide an overall estimate of foliar damage and total biomass loss. The NPS units also have  
19 GIS data for park trails and recreational areas, which can be compared to the areas of foliar  
20 damage. Potential ecological metrics that will be calculated include:

- 21 • Percent of vegetation cover affected by foliar injury.
- 22 • Percent of trails affected by foliar injury.
- 23 • Estimate of species specific biomass loss within the case study area.
- 24 • Percent of wetland areas affected by foliar injury or biomass loss.

### 25 **3.2.2 Estimation of Vegetation Effects in Urban Areas**

26 Several urban areas nationally have extensive habitat management plans that include  
27 resource and vegetation mapping. These data are not as consistent or as readily available as the

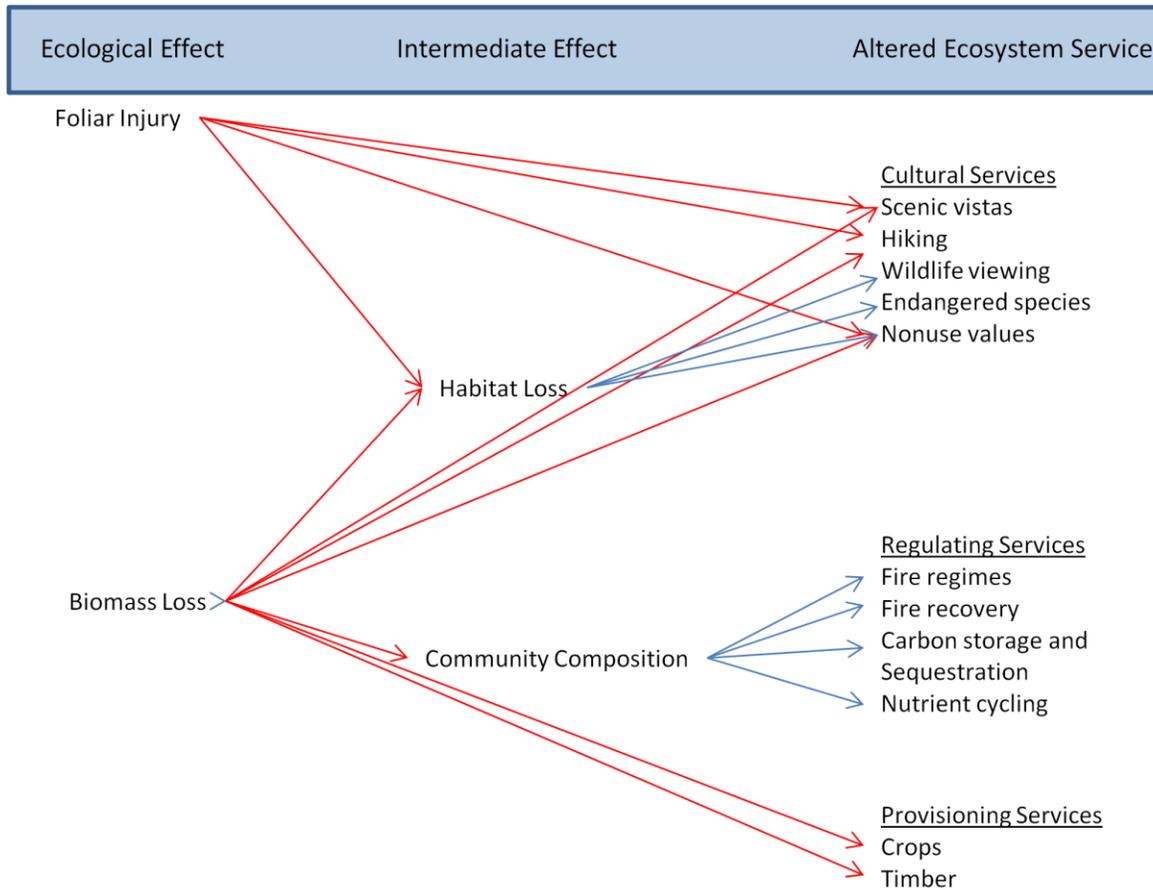
1 NPS units but in some cases can provide adequate vegetation maps in regions where ozone  
2 sensitive species occur. Two examples which are currently available are the city of Boulder,  
3 Colorado, which has a range of resource mapping available  
4 (<http://www.bouldercounty.org/find/maps/pages/gisldata.aspx>) and San Diego County, where  
5 there is a large scale Multiple Species Conservation Plan (MSCP) in place  
6 (<http://www.sandiego.gov/planning/mscp/>). Both urban areas occur in areas with elevated ozone  
7 and both have some species in common with species occurring on the NPS ozone sensitive  
8 species list (Porter, 2003).

9        Similar to the National Park case study areas, vegetation maps in urban areas would be  
10 compared, using GIS, to the national ozone surface to provide an overall estimate of foliar  
11 damage and total biomass loss. When available, GIS data for public trails and recreational areas  
12 will be compared to aerial extent of foliar damage. Ecological metrics that may be calculated for  
13 urban case studies will be similar to those calculated for National Parks depending on data  
14 availability.

1 **4 ECOSYSTEM SERVICES EVALUATION**

2 One of the requirements of the risk assessment for a secondary NAAQS is to quantify the  
3 risks to public welfare. The Risk and Exposure Assessment for Review of the Secondary  
4 National Ambient Air Quality Standards for Oxides of Nitrogen and Oxides of Sulfur (U.S. EPA,  
5 2009) has detailed discussions of how ecosystem services and public welfare are related and how  
6 a services framework may be employed to evaluate effects on welfare. We plan to identify the  
7 ecosystem services associated with the ecological effects described in Section 4 of this document  
8 for the national scale assessment and the more refined case study areas. These services may be  
9 characterized as: supporting services that are necessary for all other services (e.g., primary  
10 production); cultural services including existence and bequest values, aesthetic values, and  
11 recreation values, among others; provisioning services (e.g., food and timber); and regulating  
12 services such as climate regulation or flood control. Figure 4.1 illustrates the relationships  
13 between the ecological effects of ozone and the anticipated ecosystem services impacts. Specific  
14 services to be evaluated are discussed in the following sections.

1 **Figure 4.1 Schematic of Ecological Effects and Ecosystem Service Impacts\***



2

3 **\*Illustrative only. Not intended to be comprehensive.**

4 **4.1 National Scale Assessment**

5 Depending on data and resource availability, we will attempt to develop an estimate of  
 6 ecosystem service impacts broadly across the United States for selected cultural, regulating, and  
 7 provisioning services.

8 **4.1.1 Cultural Services**

9 We plan to use GIS mapping developed for the ecological effects analysis to illustrate  
 10 where effects may be occurring and relate those areas to national scale statistics for recreational  
 11 use available through the National Survey of Fishing, Hunting, and Wildlife-Associated

1 Recreation (U.S. DOI, 2007). The resulting estimates of service provision can then be scaled to  
2 the current population and values assigned using existing meta-data on willingness to pay from  
3 Kaval and Loomis (2003). We are aware that these estimates will be limited to current levels of  
4 service provision and will provide a snapshot of the overall magnitude of services potentially  
5 affected by ozone exposure. At this time estimates of service loss due to ozone exposure is  
6 beyond the available data and resources; however, estimates of the current level of services  
7 would have embedded within them the current losses in service due to ozone exposure.

#### 8 **4.1.2 Regulating Services**

9 The regulating services associated with ozone exposure include fire regimes, fire  
10 recovery, and carbon storage and sequestration due to ozone effects on community composition  
11 and diversity. Changes in community composition may increase fire frequency and/or intensity  
12 in certain ecosystems. Additionally, selection pressure due to ozone exposure may affect the  
13 timing of ecosystem recovery and the ecological succession as well as the composition of the  
14 succession communities. We will conduct a literature and data search for information available  
15 to estimate the impact of current levels of these services. There is data available through the  
16 U.S. Forest Service on fire incidence and expenditures related to wildland fires.

#### 17 **4.1.3 Provisioning Services**

18 The scope of the national-level provisioning services assessment will depend on data and  
19 resource availability. Below we outline potential methods for assessing the provisioning services  
20 associated with crop yield loss and tree biomass loss, which are consistent with the methods from  
21 the previous review.

##### 22 ***4.1.3.1 Estimation of Yield Loss for NCLAN Crops***

23 County-level crop planting data will be obtained from USDA-NASS (National  
24 Agricultural Statistics Service; <http://www.nass.usda.gov/>) for each NCLAN crop for the most  
25 recent year available. This information will be used to create GIS maps containing the planting  
26 data for each species/cultivar of commodity crop. Staff plans to overlay the national ozone  
27 surface (as discussed in section 2.1) with GIS maps of the crop growing regions and crop

1 specific planting and harvesting data to calculate yield loss using the relevant C-R functions.  
2 Staff will evaluate this data to calculate which months to use for the exposure of crops. This  
3 combination of data will result in an estimate of county-level percent yield loss for each NCLAN  
4 crop. Staff plans to create GIS maps of percent yield loss of each crop for the counties in which  
5 they were planted. This analysis will also be performed for just meeting the current standard and  
6 other alternative standards. The change in crop county-level percent yield loss estimates  
7 between ‚as is’ air quality and meeting various standards will serve as inputs to the AGSIM©  
8 agricultural economic impacts model.

#### 9 ***4.1.3.2 Economic Valuation Associated with Crop Yield Loss***

10 The peer-reviewed AGSIM© model (Taylor et al., 1993) has been utilized recently in  
11 many major policy evaluations. AGSIM© is an econometric-simulation model used to calculate  
12 agricultural impacts of changes in O<sub>3</sub> exposure and is based on a large set of statistically  
13 estimated demand and supply equations for agricultural commodities produced in the United  
14 States. Initially, AGSIM© will be used to calculate the economic impacts of yield changes  
15 between the ‚as is’ and ‚just meet’ scenarios for a base year to be determined. This approach  
16 will also be used to calculate the economic valuation of alternative standards under  
17 consideration. If data are available, the same analysis will be performed using air quality data  
18 from other years.

19 In addition, as mentioned in a previous section, given sufficient resources we will  
20 consider using the FASOM model either as a complement to or in place of AGSIM©.

#### 21 ***4.1.3.3 Modeling of Tree Growth and Economics***

22 In the 2007 O<sub>3</sub> Staff Paper, the tree growth simulation model (TREGRO) was used as  
23 a tool to evaluate the effect of O<sub>3</sub> effects on mature tree growth. TREGRO (Weinstein et  
24 al, 1991) has been used to evaluate the effects of a variety of O<sub>3</sub> scenarios on several species of  
25 trees in different regions of the U.S. However, in order to examine tree growth rates over long  
26 time periods, competition among tree species must also be taken into account. Some researchers  
27 have linked TREGRO to the stand growth model, ZELIG (Urban et al., 1991), to simulate  
28 succession in mixed stands (Laurence et al., 2000; Weinstein et al., 2005). The linked TREGRO

1 and ZELIG modeling system can be modified to predict the effects of O<sub>3</sub> on basal area and other  
2 growth parameters of some species. As mentioned previously the FASOM model may be  
3 substituted for the above linked models provided resources are available.

4       There are many uncertainties and limitations in the modeling framework outlined above.  
5 For example, the TREGRO model is currently only parameterized for a subset of the 11 tree  
6 species for which seedling biomass C-R functions were available at the time of the last review.  
7 This subset includes ponderosa pine, loblolly pine, tulip poplar, red oak, sugar maple, and red  
8 spruce. Though TREGRO could potentially be parameterized for other tree species for which  
9 CR functions exist, this has not yet been done. Second, there is evidence that seedlings and  
10 mature trees may respond differently to O<sub>3</sub> exposure (Hanson et al, 1994). Third, when modeling  
11 growth of trees into the future, many simplifying assumptions must be used with respect to  
12 environmental factors that may be changing along with O<sub>3</sub> such as carbon dioxide  
13 concentrations, temperatures, and rainfall patterns. Consequently, these models provide only a  
14 framework for scientists and policy-makers to investigate questions about how factors such as O<sub>3</sub>  
15 may affect forest growth.

## 16 **4.2 Case Study Analysis**

### 17 **4.2.1 National Park Areas**

18       We plan to use GIS mapping produced for the ecological effects analysis to illustrate  
19 where effects may be occurring as a starting point to illustrate and, if possible, quantify the  
20 ecosystem services at potential risk. These are primarily, in national parks, cultural values that  
21 include existence, bequest and recreational values. Where we have data available we will overlay  
22 maps of critical habitat for threatened or endangered species and, if possible, assign values for  
23 the preservation of those species. We will also overlay the ecological effects maps with data on  
24 where hiking trails, campgrounds, or other park amenities are found to intersect potentially  
25 affected areas. We can then relate those areas to case study specific statistics for recreational use  
26 available through the National Park Service. In addition, we will, if possible, describe the other  
27 nonuse values associated with national parks including existence and bequest values. The  
28 resulting estimates of service provision values can then be assigned using existing meta-data on

1 willingness to pay from Kaval and Loomis (2003). We are aware that these estimates will be  
2 limited to current levels of service provision. At this time estimates of service loss due to ozone  
3 exposure may be beyond the available data and/or resources for many if not all ecosystem  
4 services listed above.

#### 5 **4.2.2 Urban Areas**

6 Where data are available, we plan to follow the same methodology for the urban case as the  
7 national park studies with the possible addition of the use of the i-Tree model to assess effects on  
8 ecosystem services provided by urban forests, including VOC emissions, building energy use,  
9 leaf area/biomass, pollution removal, and carbon storage and sequestration. The i-TREE model is  
10 a publicly available peer-reviewed software suite developed by the U.S. Forest Service and its  
11 partners to assess the ecosystem service impacts of urban forestry (available here:  
12 <http://www.itreetools.org/>). We will collaborate with the U.S. Forest Service to vary the tree  
13 growth metric in the model, which will allow us to assess the effects of ozone exposure on the  
14 ability of the forests in the selected case study area to provide the services enumerated by the  
15 model.

1 **5 UNCERTAINTY AND VARIABILITY**

2 **Table 5-1. Potential Sensitivity Analyses**

<b>Component of the Risk Assessment</b>	<b>Sensitivity Analysis</b>
Air Quality	A sensitivity analysis of the effect of different assumptions about background ozone levels on estimated risks associated with “as is” levels of ozone above background levels
Air Quality	A sensitivity analysis of the effect of different air quality adjustment procedures on the estimated risk reductions resulting from just meeting the current secondary standard and alternative standards
Concentration-Response	A sensitivity analysis of the effects of variability in the C-R functions on the estimates of tree and crop biomass loss.
Baseline Effects	A comparison of using larger-scale baseline ecological data (national, state, etc) versus more detailed community specific information in the case study areas.

3

4 **5.1 Differentiating Between Uncertainty and Variability**

5 An important issue associated with any ecological risk assessment is the characterization  
6 of uncertainty and variability. Variability refers to the heterogeneity in a variable of interest that  
7 is inherent and cannot be reduced through further research. For example, there may be  
8 variability among C-R functions describing the relation between ozone and vegetation injury  
9 across selected study areas. This variability may be due to differences in ecosystems (e.g.,  
10 diversity, habitat heterogeneity, and rainfall), levels and distributions of ozone and/or co-  
11 pollutants, and/or other factors that vary either within or across ecosystems.

1           Uncertainty refers to the lack of knowledge regarding both the actual values of model input  
2 variables (parameter uncertainty) and the physical systems or relationships (model uncertainty –  
3 e.g., the shapes of concentration-response functions). In any risk assessment, uncertainty is,  
4 ideally, reduced to the maximum extent possible, through improved measurement of key  
5 parameters and ongoing model refinement. However, significant uncertainty often remains and  
6 emphasis is then placed on characterizing the nature of that uncertainty and its impact on risk  
7 estimates. The characterization of uncertainty can include both qualitative and quantitative  
8 analyses, the latter requiring more detailed information and often, the application of sophisticated  
9 analytical techniques such as 2-stage Monte Carlo simulation.

10           While the goal in designing a quantitative risk assessment is to reduce uncertainty to the  
11 extent possible, with variability the goal is to incorporate the sources of variability into the  
12 analysis approach to insure that the risk estimates are representative of the actual response of an  
13 ecosystem (including the distribution of that adverse response across the ecosystem). An  
14 additional aspect of variability that is pertinent to this risk assessment is the degree to which the  
15 set of selected case study areas provide coverage for the range of ozone-related ecological risk  
16 across the U.S.

17           We plan to more fully differentiate variability and uncertainty in the design of the risk  
18 assessment to more clearly address (a) the extent to which the risk estimates represent the  
19 distribution of ecological impacts across ecosystems, including impacts on more sensitive  
20 species, and (b) the extent to which risk estimates are impacted by key sources of uncertainty  
21 which could prevent a clear differentiation between regulatory alternatives based on risk  
22 estimates.

23           The remainder of this section discusses how we are planning to address variability and  
24 uncertainty within the ozone NAAQS risk assessment. The treatment of variability is discussed  
25 first (section 5.2) by identifying sources of variability associated with the modeling of ozone-  
26 related risk and noting which of those sources are reflected in the risk modeling approach  
27 presented here. Next, the treatment of uncertainty is addressed, which will include both a  
28 qualitative and quantitative component. The qualitative component is described first (section  
29 5.3.1), including plans for identifying and describing key sources of uncertainty, and noting

1 whether those sources of uncertainty are addressed quantitatively in the risk assessment model.  
2 A preliminary list of key sources of uncertainty for the risk assessment is provided as part of this  
3 discussion. The quantitative component of the uncertainty characterization approach, which is  
4 structured around single-factor and multi-factor sensitivity analysis methods, is then described  
5 (section 5.3.2).

## 6 **5.2 Addressing Variability**

7 Key sources of variability associated with the modeling of ecological risk associated with  
8 ozone exposure are presented below, including whether, and to what extent, we plan to address  
9 each source of variability:

- 10 • Spatial gradients in ozone concentrations: We plan to provide a national ozone surface  
11 that reflects the variation in ozone concentrations across the country. However, this  
12 source of variability is likely to be less well captured in the risk assessment primarily  
13 because the majority of studies providing effect estimates are themselves limited in  
14 reflecting more detailed patterns of ozone exposure among populations. More  
15 specifically, the studies typically use an average ambient concentration developed across  
16 regionally oriented monitors as a surrogate for exposure.
- 17 • Community composition (i.e., greater concentrations of sensitive species in certain  
18 locations): We plan to include multiple case study areas reflecting differences in species  
19 composition in different regions of the country to address this issue. In addition, we plan  
20 to provide a list the O<sub>3</sub> sensitive species by state and Class 1 area.
- 21 • Longer-term temporal variability in ambient ozone levels (reflecting meteorological  
22 trends, as well as future changes in the mix of ozone sources and regulations affecting  
23 ozone): This is more difficult to incorporate into the analysis and reflects a combination  
24 of variability as well as uncertainty.

## 1   **5.3   Uncertainty Characterization**

### 2   **5.3.1   Qualitative Assessment**

3           We plan to include a qualitative discussion of uncertainty in the risk assessment which  
4 will include: (1) identification and description of key sources of uncertainty, noting whether they  
5 are addressed quantitatively in the risk assessment model and (2) a qualitative assessment of  
6 those sources of uncertainty in terms of their potential impact on risk using a “high,” “medium,”  
7 and “low” designation. A preliminary list of potentially important sources of uncertainty has  
8 been developed for this plan and is presented below (note, some of these sources may be  
9 addressed in the quantitative uncertainty analysis, when feasible):

- 10       • Statistical uncertainty associated with the fit of the exposure or concentration response  
11        functions.
- 12       • Potential role of co-pollutants.
- 13       • Transferability of C-R functions from study locations to case study area locations: this  
14        reflects variation in (a) ozone distributions, (b) the possible role of co-pollutants in  
15        influencing risk, and (c) differences in population characteristics, (d) climatic or growing  
16        condition differences.
- 17       • Procedures for adjusting air quality to simulate alternate standard levels: There is  
18        uncertainty in developing the method for adjusting current ambient ozone levels (at  
19        individual monitors used in the risk assessment) to simulate just attaining alternative  
20        standard (methods available are likely to include both retrospective empirical monitor-  
21        based trend analysis and forward-looking model-based predictions.
- 22       • Estimates of policy-relevant background ozone levels in a particular location. There is  
23        uncertainty associated with characterizing PRB for individual locations.
- 24       • Limited monitoring coverage in rural areas. There is uncertainty associated with  
25        extrapolating a national exposure surface from limited monitoring sites, which is  
26        potentially greater in rural areas where the nearest monitor is often more distant.

1 **5.3.2 Quantitative Analysis**

2           The quantitative uncertainty analysis for the ozone risk assessment will be determined by  
3 the data that are available and used in the assessment. Staff will consider using a deterministic  
4 sensitivity analysis-based approach, Monte Carlo style analyses, and other methods that are  
5 relevant to the final data and analyses used in the assessment. The uncertainty analyses will  
6 provide the decision maker with a reasonable alternative set of risk estimates to supplement the  
7 set of core risk estimates that are generated. This set of additional risk estimates will provide  
8 insights into the impact of uncertainty on the initial set of core risk estimates.

1   **6   SCHEDULE AND MILESTONES**

2           Table 7-1 below includes the key milestones for the exposure analysis and  
3 welfare/vegetation-based risk assessment that will be conducted as part of the current ozone  
4 NAAQS review. A consultation with the CASAC Ozone Panel is planned for May 19-20, 2011  
5 to obtain input on this draft Scope and Methods Plan. Staff will then proceed to develop welfare  
6 risk estimates associated with recent ozone levels and levels adjusted to just meet the current and  
7 alternate ozone standards. These estimates and the methodology used to develop them will be  
8 discussed in the first draft ozone Risk and Exposure Assessment and in separate exposure  
9 analysis and risk assessment technical support documents. These draft reports will be released  
10 for CASAC and public review in conjunction with the release of second draft ozone Policy ISA  
11 in October 2011. EPA will receive comments on these draft documents from the CASAC Ozone  
12 Panel and general public at a meeting in November 2011. The revised exposure analysis and risk  
13 assessment reports will include estimates associated with just meeting any alternative standards  
14 that may be recommended by staff for consideration. The revised analyses will be released in  
15 May 2012 in conjunction with the first draft ozone Policy Assessment for review by CASAC and  
16 public at a meeting to be held in July 2012. Staff will consider these review comments and  
17 prepare final exposure analysis and risk assessment reports by October 2012.

18

1 **Table 7 1. Key Milestones for the Welfare Risk Assessment for the ozone NAAQS Review**

2

Milestone	Date
Release 1 <sup>st</sup> draft ozone ISA	March 2011
Release draft Scope and Methods Plan	April 2011
CASAC/public review and meeting on 1 <sup>st</sup> draft ozone ISA	May 19-20, 2011
CASAC consultation on draft Scope and Methods Plan	May 2011
Release 2 <sup>nd</sup> draft ozone ISA	September 2011
Release 1 <sup>st</sup> drafts of the ozone Exposure Analysis and Risk Assessment reports	October 2011
CASAC/public review and meeting on 2 <sup>nd</sup> draft ozone ISA and 1 <sup>st</sup> drafts of the ozone Exposure Analysis and Risk Assessment reports	November 2011
Final ozone ISA	February 2012
Release 2 <sup>nd</sup> drafts of the ozone Exposure Analysis and Risk Assessment reports and 1 <sup>st</sup> draft of the Policy Assessment	May 2012
CASAC/public review and meeting on 2 <sup>nd</sup> drafts of the ozone Exposure Analysis and Risk Assessment reports and 1 <sup>st</sup> draft of the Policy Assessment	June 2012
Final ozone Policy Assessment, Exposure Analysis, and Risk Assessment	October 2012

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