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REALITY CHECK PART II: THE IMPACT OF EPA'S PROPOSED OZONE STANDARDS ON RURAL AMERICA

HEARING

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED FOURTEENTH CONGRESS

FIRST SESSION

APRIL 29, 2015

Serial No. 114–17

Printed for the use of the Committee on Science, Space, and Technology

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REALITY CHECK PART II: THE IMPACT OF EPA'S PROPOSED OZONE STANDARDS ON RURAL AMERICA

WEDNESDAY, APRIL 29, 2015

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to call, at 2:37 p.m., in Room 2318 of the Rayburn House Office Building, Hon. Jim Bridenstine [Chairman of the Subcommittee] presiding.

LAMAR S. SMITH, Texas
CHAIRMAN

EDDIE BERNICE JOHNSON, Texas
RANKING MEMBER

Congress of the United States
House of Representatives
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Subcommittee on Environment

Reality Check Part II:
The Impact of EPA's Proposed Ozone Standards on Rural America

Wednesday, April 29 12, 2015
2:00 p.m. – 4:00 p.m.
2318 Rayburn House Office Building

Witnesses

The Honorable Jim Reese, Secretary and Commissioner of Agriculture, Oklahoma State Board of Agriculture

Ms. Cara Keslar, Monitoring Section Supervisor, Wyoming DEQ - Air Quality Division

Dr. Paul J. Miller, Deputy Director and Chief Scientist, Northeast States for Coordinated Air Use Management

Mr. Kevin Abernathy, Director of Regulatory Affairs, Milk Producers Council; Vice Chair, Dairy CARES

The Honorable Todd Hiett, Commissioner, Oklahoma Corporation Commission

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON ENVIRONMENT

HEARING CHARTER

Reality Check Part II: The Impact of EPA's Proposed Ozone Standards on Rural America

Wednesday, April 29, 2015
2:00 p.m. – 4:00 p.m.
2318 Rayburn House Office Building

PURPOSE

The Environment Subcommittee will hold a hearing entitled *Reality Check: The Impact and Achievability of EPA's Proposed Ozone Standards* on Wednesday, April 29, 2015, at 2:00 p.m. in Room 2318 of the Rayburn House Office Building. The purpose of the hearing is to examine the scientific basis of the Environmental Protection Agency's (EPA) proposed National Ambient Air Quality Standards (NAAQS) for ozone. In addition, witnesses will discuss impacts of these proposed national standards to rural and agricultural sectors of our country in order to meet such standards.

WITNESSES

- **The Honorable Jim Reese,** Secretary and Commissioner of Agriculture, Oklahoma State Board of Agriculture
- **Ms. Cara Keslar**, Monitoring Section Supervisor, Wyoming Department of Environmental Quality - Air Quality Division
- **Dr. Paul J. Miller**, Deputy Director and Chief Scientist, Northeast States for Coordinated Air Use Management
- **Mr. Kevin Abernathy**, Director of Regulatory Affairs, Milk Producers Council; Vice Chair, Dairy CARES
- **The Honorable Todd Hiett,** Commissioner, Oklahoma Corporation Commission

BACKGROUND

Ozone (O_3) is a gas that occurs both in the Earth's upper atmosphere as well as at ground level (troposphere). Ozone in the upper atmosphere helps protect the Earth from the sun's harmful rays such as ultraviolet radiation. Ozone at ground level is not directly emitted into the air, but instead is created by chemical reactions between precursor emissions, specifically

nitrogen oxide (NOx) and volatile organic compounds (VOC).[1] Ground level ozone is commonly referred to as smog.

The Clean Air Act of 1970 (P.L. 91-604, with major legislative updates in 1977 and 1990) directed EPA to set NAAQS for pollutants considered harmful to public health and the environment.[2] EPA has set standards for six criteria pollutants, including carbon monoxide, lead, nitrogen dioxide, ozone, particle pollution (particulate matter), and sulfur dioxide. The Clean Air Act specifies two categories of standards: primary standards for public health protection and secondary standards for public welfare protection.

The Clean Air Act requires EPA to review the NAAQS every five years to ensure adequate health and environmental protection is being provided. In 1997, EPA replaced the existing ozone NAAQS with an 8-hour standard of 84 parts per billion (using standard rounding conventions). In 2008, EPA issued a final rule revising the ozone standard to a level of 75 parts per billion.[3] Last February, EPA finalized[4] a new set of requirements that state, tribal, and local air quality management agencies must meet for areas where air quality exceeds the 2008 NAAQS.[5] In July 2011, outside of the normal five year review process, EPA submitted a rule for reconsideration of the 2008 ozone NAAQS that President Obama then subsequently withdrew in September 2011.[6]

Based on the advice of the Clean Air Scientific Advisory Committee (CASAC), the EPA proposed an updated ozone NAAQS which appeared in the Federal Register on December 17, 2014.[7] The proposal would set more stringent standards, by lowering the primary standard from the current 75 parts per billion (ppb) to a range of 65 to 70 ppb. Publication in the Federal Register begins the public comment period that ended on March 17, 2015. The agency must address significant public comments when it publishes the final standard. **[is there any news on when that might be published?]**

COMPLIANCE WITH THE NAAQS

When the EPA revises the NAAQS for ozone, it must designate areas in the US which meet *attainment* or *nonattainment* of the standard. Attainment refers to a state or region complying with federal regulations, while nonattainment is an area that exceeds the regulated limit. States must individually develop a plan to comply with the NAAQS, including proposals for bringing nonattainment areas into attainment. Reductions in ozone levels can be achieved by a variety of methods including pollution control technologies. Ozone control technologies generally target nitrogen oxides (NOx) and volatile organic compounds (VOCs). Control strategies focus on mission limits along with control equipment that may address specific industrial processes. State environmental agencies must then develop State Implementation Plans

[1] http://www.epa.gov/air/ozonepollution/basic.html
[2] http://www.epa.gov/air/criteria.html
[3] http://www.gpo.gov/fdsys/pkg/FR-2008-03-27/html/E8-5645.htm
[4] http://www.epa.gov/groundlevelozone/actions.html#feb2015i
[5] http://www.epa.gov/groundlevelozone/pdfs/20150213fr.pdf
[6] http://www.whitehouse.gov/the-press-office/2011/09/02/statement-president-ozone-national-ambient-air-quality-standards
[7] http://www.gpo.gov/fdsys/pkg/FR-2014-12-17/pdf/2014-28674.pdf

(SIPs).[8] Specifically, after each revised NAAQS is promulgated, both the EPA and states must undertake the following actions:

- **"Within two years after NAAQS promulgation:** With input from the states and tribes, EPA must identify or 'designate' areas as meeting (attainment areas) or not meeting (nonattainment areas) the standards. Designations are based on the most recent set of air monitoring data.
- **Within three years after NAAQS promulgation:** All states must submit plans, known as state implementation plans (SIPs), to show they have the basic air quality management program components in place to implement a new or revised NAAQS, as specified in Clean Air Act section 110.
- **Within 18-36 months after designations:** Due dates for nonattainment area SIPs are based on the area designation date and vary by pollutant and area classification. SIPs for Ozone, $PM_{2.5}$, and CO nonattainment areas are generally due within 36 months from the date of designation. Each nonattainment area SIP must outline the strategies and emissions control measures that show how the area will improve air quality and meet the NAAQS. In addition, the CAA mandates that areas adopt certain specified control requirements."[9]

After a state submits its implementation plan, EPA then reviews and either approves it in full, in part, or disapproves. The public has an opportunity to submit comments on EPA's proposed actions. If a state fails to submit a plan or if EPA disapproves of the plan, EPA is required to develop a federal implementation plan.[10]

SECONDARY STANDARD

In addition to issuing the primary standard, the EPA is required to issue secondary standards that protect the public welfare under Section 109 of the Clean Air Act. The secondary standard is intended to protect ecosystems and sensitive plants. Currently, the secondary ozone standard is equal to the primary ozone standard, based on short-term (8 hour) average concentration measurements. However, plants and foliage are more sensitive to long-term cumulative ozone exposure, causing stunted growth or injury. A cumulative index of exposure is better correlated with plant growth effects than the 8-hour average concentration used to measure human health effects. An appropriate cumulative index must consider not only ambient concentrations of ozone but also other relevant physiological processes.[11]

ADDITIONAL READING

- U.S. Environmental Protection Agency, National Ambient Air Quality Standards for Ozone, Proposed Rule. Available at: https://www.federalregister.gov/articles/2014/12/17/2014-28674/national-ambient-air-quality-standards-for-ozone
- U.S. Environmental Protection Agency, Regulatory Impact Analysis of the Proposed Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone. Available at: http://www.epa.gov/ttn/ecas/regdata/RIAs/20141125ria.pdf

[8] http://www.epa.gov/airquality/urbanair/sipstatus/overview.html
[9] http://www.epa.gov/airquality/urbanair/sipstatus/process.html
[10] Ibid
[11] pp 75316 of the Federal Register, Proposed Rule, National Ambient Air Quality Standards for Ozone

Appendix A:

Table of Historical Ozone NAAQS[12]

Final Rule/Decision	Primary/ Secondary	Indicator	Averaging Time	Level	Form
1971 36 FR 8186 Apr 30, 1971	Primary and Secondary	Total photochemical oxidants	1-hour	0.08 ppm	Not to be exceeded more than one hour per year
1979 44 FR 8202 Feb 8, 1979	Primary and Secondary	O_3	1-hour	0.12 ppm	Attainment is defined when the expected number of days per calendar year, with maximum hourly average concentration greater than 0.12 ppm, is equal to or less than 1
1993 58 FR 13008 Mar 9, 1993	EPA decided that revisions to the standards were not warranted at the time				
1997 62 FR 38856 Jul 18, 1997	Primary and Secondary	O_3	8-hour	0.08 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
2008 73 FR 16483 Mar 27, 2008	Primary and Secondary	O_3	8-hour	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years

[12] http://www.epa.gov/ttn/naaqs/standards/ozone/s_o3_history.html

Appendix B:

Percent Change in Air Quality[13]

	1980 vs. 2013	1990 vs. 2013	2000 vs. 2013
Carbon Monoxide (CO)	-84	-76	-59
Ozone (O_3) (8-hr)	-33	-23	-18
Lead (Pb)	-92	-87	-60
Nitrogen Dioxide (NO_2) (annual)	-58	-50	-40
Nitrogen Dioxide (NO_2) (1-hour)	-60	-46	-29
PM_{10} (24-hr)	---	-34	-30
$PM_{2.5}$ (annual)	---	---	-34
$PM_{2.5}$ (24-hr)	---	---	-34
Sulfur Dioxide (SO_2) (1-hour)	-81	-76	-62

Notes:
1. --- Trend data not available
2. Negative numbers indicate improvements in air quality
3. In 2010, EPA established new 1-hour average National Ambient Air Quality Standards for NO2 and SO2

[13] http://www.epa.gov/airtrends/aqtrends.html

Appendix C:

Percent Change in Emissions:[14]

	1980 vs. 2013	1990 vs. 2013	2000 vs. 2013
Carbon Monoxide (CO)	-67	-59	-42
Lead (Pb)	-99	-80	-50
Nitrogen Oxides (NO_x)	-52	-48	-41
Volatile Organic Compounds (VOC)	-53	-39	-18
Direct PM_{10}	-50	-20	-17
Direct $PM_{2.5}$	---	-24	-32
Sulfur Dioxide (SO_2)	-81	-78	-69

Notes:
1. --- Trend data not available
2. Direct PM10 emissions for 1980 are based on data since 1985
3. Negative numbers indicate reductions in emissions
4. Percent change in emissions based on thousand tons units

National and local air quality trends graphs showing the nation's progress towards clean air are available for: carbon monoxide (CO), ozone (O_3), lead (Pb), nitrogen dioxide (NO_2), particulate matter (PM), and sulfur dioxide (SO_2).

[14] http://www.epa.gov/airtrends/aqtrends.html

Chairman BRIDENSTINE. The Subcommittee on Environment will come to order. Without objection, the Chair is authorized to declare recess of the Subcommittee at any time.

Welcome to today's hearing entitled "Reality Check Part II: The Impact of EPA's Proposed Ozone Standards on Rural America."

Without objection, our colleague from California, Mr. Valadao, is authorized to participate in today's hearing.

I recognize myself for five minutes for an opening statement.

It is Congress' responsibility to provide oversight of the executive branch, and that means we must carefully review the impact and achievability of this proposed regulation. I am deeply concerned lowering the standards at this time will have a negative impact, particularly on rural America.

Ozone levels and emissions of volatile organic compounds have significantly decreased over the past few decades. Furthermore, according to EPA's own data, their "projections show the vast majority of U.S. counties would meet the proposed standards by 2025 just with the rules and programs now in place or under way." In other words, ozone levels will continue to decrease without doing anything else.

However, it is concerning that the EPA is moving the goalposts and proposing to tighten the standards without first fully implementing the existing 2008 standard. The guidance for state implementation plans was only released earlier this year by the EPA. States have not even been given a chance to comply with the existing standard.

Last month, the Full Committee held a hearing to examine this complicated and massive regulation that will impact almost every sector of the American economy and individual in the United States. According to Dr. Allen Lefohn, who testified in last month's hearing, it is his expert opinion that the EPA Administrator is relying solely on one 2009 study of 31 participants in order to scientifically justify the costliest regulation in the history of this country.

Just so everyone understands how massive this rule is, a February 2015 analysis by NERA Economic Consulting finds that GDP will be reduced by $1.7 trillion between 2017 and 2040, our economy will have 1.4 million fewer jobs, and households will lose an average of $830 per year.

Another troubling issue is one of natural or background ozone. With these low proposed standards, background ozone may become the main contributor to exceedances of the standard all across the United States. States will be held responsible for factors outside their control.

According to the Western States Air Resources Council, there are numerous national parks in the western United States with ozone monitors that regularly record concentrations which exceed the proposed range of 65 to 70 parts per billion, and some that even exceed the existing 75 parts-per-billion standard. As this figure shows—you can see up on the screen there—monitored ozone levels at rural sites in the West have stayed relatively flat. It is possible that all 11 of these areas would be considered in nonattainment under this new proposal. This would include Yellowstone National Park. There is no way this was Congress' intent when it passed the Clean Air Act over four decades ago.

Two sectors of the economy will be heavily impacted by this rule are agriculture and transportation. These are incredibly vital to my home State of Oklahoma, and I look forward to discussing more in detail with our witnesses.

Rural areas, like a lot of my state, will be especially hit hard by the Clean Air Act's transportation conformity requirements. A classification of nonattainment would mean that the Federal Government can withhold Federal highway funds for projects and plans if the individual projects do not meet specific emissions and air quality standards. They're talking about withholding Federal highway funds to my State of Oklahoma. Currently, we're in attainment, and while we're in attainment, we're still reducing our ozone. And now they're going to change the goalposts, move the goalposts, and then they're going to potentially withhold Federal highway funds.

Those who bear a regulation's compliance costs may also suffer a decline in their health status, and these increased risks might be greater than the direct benefits of the regulation. Unfortunately, but not surprisingly, the EPA did not include premature deaths and increased mortality caused by the loss of disposable income when considering this proposed rule.

Low-income Americans and senior citizens living on fixed incomes may be forced to choose between medications, food, or paying for heat and electricity. This is a continuation of this Administration's "war on the poor," to go along with the Clean Power Plan and other existing and proposed EPA regulations.

Supporters of the EPA's agenda will say opposition amounts to opposing clean air. This could not be further from the truth. My home state is in attainment, and has been for years, and even still, efforts are being made to further reduce ozone and other emissions. I am extremely proud of the work done by our state and local leaders. Even with their efforts, a new rule would plunge many areas into nonattainment.

This is all the more reason why any proposed rule should not be decided in a hasty and hurried manner, especially since the impact of this rule will be widespread and affect every American.

I want to thank each of the witnesses for coming this afternoon and I look forward to hearing from you.

[The prepared statement of Chairman Bridenstine follows:]

PREPARED STATEMENT OF SUBCOMMITTEE ON ENVIRONMENT
CHAIRMAN JIM BRIDENSTINE

Good afternoon and welcome to this afternoon's hearing entitled: "Reality Check Part II: The Impact of EPA's Proposed Ozone Standards on Rural America"

It is Congress' responsibility to provide oversight of the executive branch, and that means we must carefully review the impact and achievability of this proposed regulation. I am deeply concerned lowering the standards at this time will have a negative impact, particularly on rural America.

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According to the Western States Air Resources Council, there are numerous national parks in the western United States with ozone monitors that regularly record concentrations which exceed the proposed range of 65-70 parts per billion, and some that even exceed the existing 75 ppb standard. As this figure shows (FIGURE 1), monitored ozone levels at rural sites in the west have stayed relatively flat. It is possible that all 11 of these areas would be considered in non-attainment under this new proposal. This would include Yellowstone National Park! There is no way this was Congress' intent when it passed the Clean Air Act over four decades ago.

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Supporters of the EPA's agenda will say opposition amounts to opposing clean air. This could not be farther from the truth. My home state is in attainment, and has been for years, and even still, efforts are being made to further reduce ozone and other emissions. I am extremely proud of the work done by our state and local leaders. Even with their efforts, a new rule would plunge many areas into nonattainment. This is all the more reason why any proposed rule should not be decided in a hasty and hurried manner, especially since the impact of this rule will be widespread and affect every American.

I want to thank each of the witnesses for coming this afternoon and I look forward to hearing from you.

Chairman BRIDENSTINE. I now recognize the Ranking Member, the gentlewoman from Oregon, my friend, Suzanne Bonamici, for an opening statement.

Ms. BONAMICI. Thank you very much, Mr. Chairman, and thank you to all of our witnesses for being here today to discuss the EPA's proposal to lower the current ozone standard to somewhere in the range of 65 to 70 parts per billion.

I do want to apologize in advance; I'm going to need to step out of some point for a meeting. I thought I had things perfectly timed and then they called votes and we're getting a late start, so my apologies. It does not indicate a lack of interest in this important issue.

At a hearing last month on this very topic, one of the witnesses before the Committee, Dr. Mary Rice, stated that, "the scientific evidence available seven years ago . . . has been supplemented by an even greater understanding of the health effects of ozone exposure, including greater exacerbations of respiratory disease in infants and children, worse lung function in healthy adults and those with lung disease, . . . and increased mortality in adults."

In addition to the adverse public health effects of ozone, we'll also hear today about how high levels of ozone negatively affect vegetation and ecosystems. For example, more than 40 years of research shows that long-term ozone exposure results in decreased forest productivity and diminished crop yields. Representing a state where agriculture is a critical economic driver, I take very seriously the negative effects of ozone on forest and crops.

Specifically, an analysis by the EPA states that high levels of ozone may reduce the value of a whole tree such as Christmas trees. Now, Oregon is the number one producer of Christmas trees in the Nation. All in all, agricultural production accounts for over $5 billion towards Oregon's economy.

Furthermore, the Clean Air Act, as passed by Congress, explicitly prohibits EPA from considering cost when setting at ozone standard. Congress purposely put the health and well-being of Americans first. Now more than ever the American people need a strong EPA to protect their right to clean air and water.

Some will argue today that implementing a lower ozone standard is not worth it, that it will kill jobs and the economy. Now, there is much more evidence showing that on balance, jobs are created and the economy expands following the passage of major environmental reforms. For example, in a report to Congress on the cost and benefit of Federal regulations, OMB estimated that major rules promulgated by the EPA between 2003 and 2013 in that decade had benefits between $165 billion and $850 billion compared to costs of $38 billion to $46 billion. Such a significant return on investment should prove the obvious, that when the environment is healthy, the economy is healthy.

Let me be clear. I'm sensitive to the concerns we'll likely hear today. In fact, my home State of Oregon, we recognize the challenges associated with implementing a more stringent standard. Wildfires and the long-range shifting of ozone from Asia will need to be addressed if we're to achieve a lower standard.

That said, comments submitted by my home State indicate Oregon's support for the EPA's proposal. A letter from David Collier, the Air Quality Manager at the Oregon Department of Environmental Quality, our DEQ, states that "Oregon welcomes EPA's proposal to lower the ozone NAAQS based on advice provided by the Clean Air Act Science Advisory Committee in order to provide adequate protection to human health and welfare."

Although significant progress has been made in the past 40 years, it is our job to build upon this legacy and ensure that we continue to improve the quality of our air. A strong economy and help the environment are not mutually exclusive. We can have both.

The Clean Air Science Advisory Committee recommended in 2008 lowering the ozone standard to between 60 to 70 parts per bil-

lion. They disagreed with the standards set previously of 75 parts per billion, stating it was not sufficiently protective of public health. We should listen to our scientists and our public health professionals and set a standard that is based on the best available science. I'm confident in the ingenuity of Americans to address these challenges. We can and must do better for current and future generations.

Thank you very much, Mr. Chairman. Again, thank you to our witnesses for being here this afternoon. I look forward to your testimony, and I yield back the balance of my time.

[The prepared statement of Ms. Bonamici follows:]

PREPARED STATEMENT OF SUBCOMMITTEE ON OVERSIGHT
MINORITY RANKING MEMBER SUZANNE BONAMICI

Thank you, Mr. Chairman, and thank you to our witnesses for being here today to discuss the EPA's proposal to lower the current ozone standard to somewhere in the range of 65 to 70 parts per billion.

At a hearing last month on this very topic one of the witnesses before the Committee, Dr. Mary Rice, stated that "the [scientific] evidence available seven years ago . . . has been supplemented by an even greater understanding of the health effects of ozone exposure, including greater exacerbation of respiratory disease in infants and children, worse lung function in healthy adults and those with lung disease . . . and increased mortality in adults."

In addition to the adverse public health effects of ozone, we will also hear today about how high levels of ozone negatively affect vegetation and ecosystems. For example, more than 40 years of research shows that long-term ozone exposure results in decreased forest productivity and diminished crop yields.

Representing a state where agriculture is a critical economic driver, I take very seriously the negative effects of ozone on forests and crops. Specifically, an analysis by the EPA states that high levels of ozone may "reduce the value of a whole tree such as Christmas trees." This is important to my constituents because Oregon is the number one producer of Christmas trees in the nation. All in all, agricultural production accounts for over $5 billion dollars toward Oregon's economy.

Furthermore, the Clean Air Act, as passed by Congress, explicitly prohibits the EPA from considering cost when setting an ozone standard. Congress purposefully put the health and wellbeing of Americans first. Now, more than ever, the American people need a strong EPA to protect their right to clean air and water.

Some will likely argue today that implementing a lower ozone standard is not worth it—that it will kill jobs and the economy. There is much more evidence showing that on balance, jobs are created and the economy expands following the passage of major environmental reforms. For example, in a report to Congress on the costs and benefits of federal regulations, OMB estimated that major rules promulgated by the EPA between 2003 and 2013 had benefits between $165 billion and $850 billion, compared to costs of just $38 billion to $46 billion. Such a significant return on investment should prove the obvious: that when the environment is healthy, the economy is healthy.

Let me be clear, I am sensitive to the concerns we will likely hear today. In fact, in my home state of Oregon we recognize the challenges associated with implementing a more stringent standard. Wildfires and the long-range shifting of ozone from Asia will need to be addressed if we are to achieve a lower standard. That said, comments submitted by my home state indicate Oregon's support for the EPA's proposal. Specifically, a letter from David Collier, the Air Quality Manager at the Oregon Department of Environmental Quality states that "Oregon welcomes EPA's proposal to lower the ozone NAAQS [pronounced NACKS], based on advice provided by the Clean Air Act Science Advisory Committee, in order to provide the adequate protection to human health and welfare."

Although significant progress has been made in the past 40 years, it is our job to build upon this legacy and ensure that we continue to improve the quality of our air. A strong economy and a healthy environment are not mutually exclusive. We can have both.

The Clean Air Scientific Advisory Committee recommended lowering the ozone standard to between 60 and 70 parts per billion in 2008. They disagreed with the standard set by the Bush Administration of 75 parts per billion, stating it was not

"sufficiently protective of public health." We should listen to our scientists and our public health professionals and set a standard that is based on the best available science. I am confident in the ingenuity of Americans to address these challenges. We can and must do better for current and future generations.

Thank you, Mr. Chairman, and again thank you to our witnesses for being here this afternoon. I yield back the balance of my time.

Chairman BRIDENSTINE. I would like to thank the Ranking Member for her opening statements.

We'll now introduce the witnesses. I will yield to the gentleman from Oklahoma, Mr. Lucas, to introduce our first witness, the Hon. Jim Reese, Secretary and Commissioner of Agriculture for the Oklahoma State Board of Agriculture.

Mr. LUCAS. Thank you, Mr. Chairman. I appreciate the opportunity to introduce my old colleague from my state legislative days.

The Secretary acts as Governor Fallin's Chief Advisor on Policy Development and Implementation related to agriculture, food, and forestry issues. Reese grew up on a wheat and dairy farm—you never mentioned that in the past, Jim is still a wheat farmer near Nardin, Oklahoma, to this very day, a fellow who has a lifetime of experiences in dealing with the issues that we're talking about here.

He served in the Oklahoma House of Representatives from 1987 to 2001. After that, he was Executive Director of the USDA Farm Service Agency in Oklahoma, a bachelor's degree from Oklahoma State University in engineering technology, a fellow who lives it, does it, understands it, and I appreciate that, and it's a pleasure to have him here today, my old mentor from legislative days.

And, Mr. Chairman, if you would indulge me for one further moment, without objection, I'd like to introduce the following ten documents into the record, including comments from the California Cotton Ginners and Growers Association, the California Farm Bureau Federation, the Georgia Farm Bureau, the Iowa Farm Bureau, the Kansas Farm Bureau, the Michigan Farm Bureau, Pennsylvania Farm Bureau, South Dakota Farm Bureau, and the Texas Farm Bureau. And I'd also like to submit comments from Mr. Howard Pearl, who's a small business and farm operator in New Hampshire who runs Pearl & Sons Farm, LLC.

As a former Chairman of the House Agriculture Committee, I am very sensitive to what's going on in this area and would note if nothing else perhaps we should have finished implementing the 2008 standards before we moved on to something else.

With that, Mr. Chairman, without objection, I'd like to submit these letters to the Committee.

Chairman BRIDENSTINE. Without objection, they will be included in the record.

[The appears in Appendix II]

Chairman BRIDENSTINE. Does the gentleman yield back?

Mr. LUCAS. The gentleman yields back.

Chairman BRIDENSTINE. Roger that. The gentleman yields back.

Our next witness is Ms. Cara Keslar, Monitoring Section Supervisor for the Wyoming Department of Environmental Quality's Air Quality Division. Ms. Keslar has 18 years of experience in the environmental field, including 13 years in the Air Quality Division. Ms. Keslar has a bachelor's degree in chemical engineering from

Clarkson University and a master's degree in environmental and occupational health from the University of Illinois at Chicago.

Our next witness is Dr. Paul Miller, Deputy Director and Chief Scientist for Northeast States for Coordinated Air Use Management, NESCAUM, a nonprofit association providing scientific, technical, analytical, and policy support to the air quality and climate programs of eight Northeast States.

Before joining NESCAUM, Dr. Miller was a senior fellow at Princeton University's Center for Energy and Environmental Studies and a National Research Council Associate at the Joint Institute for Laboratory Astrophysics at the University of Colorado at Boulder. Dr. Miller has a Ph.D. in chemical physics from Yale University and a J.D. from Stanford University.

I will now yield to the gentleman from California, Mr. Valadao, to introduce our next witness, Mr. Kevin Abernethy, the Director of Regulatory Affairs for the Milk Producers Council, and the Vice Chair of Dairy CARES.

Mr. VALADAO. Thank you, Chairman. I appreciate the opportunity to come and spent some time in your committee and introduce a personal friend.

As many of you know, I am a dairy farmer from Hanford, California, and I've watched the industry struggle for many years trying to survive under these regulations. And the frustrating thing is when you see how the impact has really changed the dairy world. It's forced all the smallest of our producers, those who are just starting out, those who are trying to get into the business, it's basically prevented them from actually ever being successful because of the cost. It's typically the larger farmers who've been around a lot longer that have the ability and the financial ability to actually hire the engineers, hire the consultants, and hire all the crews they need just to survive.

But Kevin Abernathy I've known for long time as my time at California Dairy Campaign. I was actually the Vice Chairman. And through that whole process of watching all these regulations start to be implemented, Kevin has always been someone that's spent a lot of time not just in an office pushing papers but actually out in the field working with the dairymen, looking for ways to make sure that we do our job for the environment but at the same time do it in a way that actually makes sense, that is actually doing what it's supposed to do on the environmental side but also have the ability that's feasible that a business owner can do it, and to make sure that the regulators understand what they're doing.

He's on the USDA Agriculture Air Quality Task Force, San Joaquin Valley Air Pollution Control Districts, Dairy Producer Advisory Group. He's on the Central California Ozone Policy Committee, California Department of Food and Ag. He's got a few committees that he sits on as well, and obviously, like you mentioned earlier, Chairman, the Dairy Community Alliance for Responsible Environmental Stewardship.

His background, animal husbandry over at Fresno State, so a good local Central California school, and he's been an expert that we've always leaned on to make sure that we have great representation in the dairy business so that our farmers have a fair shot at survival in producing food for our nation.

So again, thank you, Kevin, for being here, and thank you, Chairman. And I yield back.

Chairman BRIDENSTINE. I'd like to thank the gentleman from California for his great introduction.

Our final witness is Hon. Todd Hiett, Commissioner of the Oklahoma Corporation Commission. I know Todd personally. He's a friend of mine from the great State of Oklahoma, born in Kellyville, Oklahoma, graduate of Oklahoma State University, first elected to the Oklahoma House of Representatives at age 27, served six terms, including his final term as the first Republican Speaker of the House in Oklahoma in eight decades.

After eight years in the private sector experiencing the hardships put on business by excessive regulation, Todd was elected to be one of three Commissioners of the Oklahoma Corporation Commission, which is responsible for regulating fuel, oil and gas, public utilities, and transportation industries. He and his family still live on a ranch south of Kellyville near my hometown of Tulsa, Oklahoma.

In order to allow time for discussion, please limit your testimony to five minutes each. Your entire written statement will be made a part of the record.

I'd like to now recognize Secretary Reese for five minutes to present his testimony. Mr. Reese, you are recognized.

Mr. Reese, could you turn on your mike, please? There's a button there.

Mr. REESE. To talk? Okay. I'm sorry.

TESTIMONY OF THE HONORABLE JIM REESE, SECRETARY AND COMMISSIONER OF AGRICULTURE, OKLAHOMA STATE BOARD OF AGRICULTURE

Mr. REESE. Good afternoon, Mr. Chairman and Members of the Committee. I've presented my written testimony so I will try to summarize quickly.

My visual presentation—my only visual presentation is a picture of my farm near Nardin, Oklahoma. My daughter took that on Easter Sunday of last year and it just happened to cover the beautiful sky in the background. There are skies all over Oklahoma and the rest of America that look exactly like this, but there are some things we cannot control.

We cannot control the heat in the summer of 2011. Oklahoma had the highest average maximum temperature during the three summer months of any state since records began in 1895 at 100.4 degrees. It was also our third driest in history with four inches of rain over those three months.

We had numerous exceedances of 75 parts per billion that summer because of the heat and drought and circumstances that were beyond Oklahoma's control. Despite that beautiful sky on the screen, it may be very difficult for Oklahoma to meet the ozone standard of 65 to 70 parts per billion. In fact, that picture is in a county that EPA currently estimates to run above the 65 to 70 parts per billion average standard.

The Clean Air Act directs the Administrator to set a standard based on criteria requisite to protect the public health. Biology teaches us the most important ingredients to support human life are air, water, and food. One of those three most important ingredi-

ents are to protect public health is food, not only public health but human life. Many may think food just appears in grocery stores but it does not.

Providing the safest, most affordable food supply in the world requires a great deal of commerce that both cleans the air and also contaminates the air. Agriculture and forestry on one hand are among the greatest assets in improving air quality in that growing plants consume carbon out of the air. Growing agricultural crops consume carbon from the air. Those crops are fed to livestock, which then is turned into protein and delivers to your grocery stores and to your homes.

But it does require fertilizer inputs, transportation inputs, diesel fuel inputs, food processing inputs, food shipment inputs, until finally it is on the plates of Americans supplying the third-most important necessary ingredient to sustain human life and public health.

This proposed standard means greater cost to our producers, retrofitting engines, increased energy costs for dairy barns, poultry houses, possibly curtailing pesticide applications and fertilizer applications. One of the most critical issues in agriculture today is timing, planting, harvesting, applications of fertilizer and pesticides. These critical decisions cannot be made timely with EPA prescribing the formula. American agriculture has never been more efficient but it must continue to grow more efficient if it is going to continue to feed a growing world.

Agricultural engines are more efficient and more air friendly than ever before. We are making great strides and great progress cooperatively. Much has been said about the prevalence of asthma and its sensitivity to ozone. In Oklahoma, we have an invasive nuisance that is also a major health risk, and that is eastern redcedar. Pollen from eastern redcedar causes itchy eyes, runny nose, congestion, migraines, and many more. The solution to the health problems associated with redcedar is effective land management, which does include prescribed burning, prescribed burning that would be prevented in Oklahoma counties if they are in nonattainment status.

Now, I would suggest—I would not suggest that we rate one health concern over another, but many times a solution to one health concern aggravates another. When does government finally decide that it cannot know all of the answers? Our ozone levels are moving in the right direction and they have for the past 20 years. Prescribed burning is a technique that prevents wildfires. It manages smoke contributions to the atmosphere. It saves lives and property. It improves grassland and forest health. All of these things are beneficial to the health of the environment, the economy, and human health. Being in nonattainment because of these EPA proposed rules can prohibit these beneficial aspects of prescribed fire.

Americans working together these past 20 years have resulted in lower ozone levels. I'm grateful for the efforts of EPA and of Americans who have invested in protecting and improving our precious air and water resources. However, at some point we have to stop and consider competing interests in protecting human health, and

protecting natural resources, and in protecting our food supply and our economy that are all equally important.

Thank you, Mr. Chairman and committee members, for the opportunity to provide this testimony.

[The prepared statement of Mr. Reese follows:]

REALITY CHECK PART II: THE IMPACT OF EPA'S PROPOSED OZONE STANDARDS ON RURAL AMERICA

Testimony by
Jim Reese
Secretary and Commissioner of Agriculture
Oklahoma State Board of Agriculture

Before the
Committee on Science, Space, and Technology
Subcommittee on Environment
U.S. House of Representatives

April 29, 2015

2800 N. Lincoln Blvd., Oklahoma City, OK 73105 (405) 522-5719
Jim.reese@oda.state.ok.us

Good Afternoon, Mr. Chairman and members of the committee.-

I had the great pleasure to listen to this committee's last hearing on this issue, and humbly come to you not as a scientist or a doctor or an economist. I am a farmer, with an Engineering Degree from Oklahoma State University. I was raised on a wheat and dairy farm near Nardin, Oklahoma. I continue to farm today and am Governor Mary Fallin's Secretary of Agriculture for the State of Oklahoma.

My only visual for my presentation is this picture of my farm near Nardin, Oklahoma on Easter Sunday, 2014. While this picture of a pristine sky- is clearly in attainment, there are skies all over Oklahoma and the rest of America that look exactly like this. But there are some things we cannot control. We cannot control the summer of 2011, which in Oklahoma was had the highest average maximum temperature during the three summer months of any state since records began in 1895 at 100.4 degrees in 2011. It was also our 3rd driest with 4 inches of rain those 3 months.

We had numerous exceedances of 75 ppm that summer (and the following) because of heat and drought and circumstances that were beyond Oklahoma's control. Despite that beautiful Oklahoma sky on the wall, it may be very difficult for Oklahoma to meet an ozone standard of 65 to 70 ppb. That picture is in a county currently estimated to run between the 65 to 70 ppb average standard.

I want to start with the premise that the most important ingredients to support human life are air, water, and food. Our human bodies can live approximately 3 minutes without air, 3 days without water and 3 weeks without food. While life can extend longer than those limits in many cases, the 3-3-3 generality is a memorable guide. Much has been previously said about economic impact, asthma impact, jobs impact, but I think more should be focused on the biology of human life. God has given us a great wonderful world with abundant air, abundant water and we should be grateful, thankful, and do what we can to protect and sustain those wonderful God given resources. The third most necessary ingredient is food and while many think food just appears in grocery stores it does not.

Providing the safest, most affordable food supply in the world requires a great deal of commerce that causes a great deal of NOx, SOx, and VOCs. Agriculture and forestry, on one hand are among our greatest assets in improving our air quality, in that growing plants consume carbon out of the air. Agriculture grows crops that consume carbon, that is then fed to livestock, which is then turned into protein and delivered to your grocery stores. But it does take fertilizer inputs, transportation inputs, diesel fuel inputs, food processing inputs, food shipment inputs and until finally it is there on the plates of Americans supplying that third most necessary ingredient to sustain human life.

This proposed standard means greater costs to our producers and for smaller operators who operate on a very thin margin that is already impacted by unpredictable forces such as Mother Nature; those increased costs can result in the decision to quit farming. Having to retrofit a combine, or tractor or generator is expensive and for a farmer who never knows for sure what price they will receive for their commodity, it is challenging to take on more expense to work towards a standard that may be unattainable.

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Years ago, some Yale researchers suggested returning the Great Plains into the Buffalo Commons. That is all fine and good, but what are we going to do with people, and how are we going to feed them. American Agriculture has never been more efficient, but it must continue to grow more efficient if it is going to continue to feed a growing world. It is estimated agriculture may have to double its current food supply by 2050. And again to remind you, Food is not an option.

Food is a necessity for survival but it is also a necessity for the stability of a nation. When you look across the world and find countries with food insecurity you also find a lack of stability in the government and the security of the nation and many times you find war and unrest. When people are working to find a way to feed their children every day, they have no time to focus on other aspects of the community or economy. Increased regulations that impact farmers and ranchers daily operations have a direct impact on food availability and the cost of food to consumers. The United States is very blessed to have had food security for its entire existence.

In the previous hearing much was said about the prevalence of asthma and its sensitivity to ozone. I am not a scientist or a doctor, but in Oklahoma we have another invasive nuisance in Oklahoma that I would point out is another major health risk and that is eastern redcedar. Eastern redcedar is an invasive species gobbling up thousands of acres a year in Oklahoma. It's pollen causes itchy eyes, runny noses, congestion, migraines and more. I am not comparing the two in severity, but the solution to the health problems associated with redcedar according to every conservation and environmental group I know is effective land management which includes prescribed burning. Prescribed burn that would be prevented if Oklahoma counties are in a non-attainment status. Now I would not suggest we rate health concerns as the one that affects your loved ones is the one you are most likely to care about, but many times a solution to one health concern aggravates another, and when does government finally decide it can't know all of the answers. Our responsibility is to do the best with this earth that we can. Evidence shows that our Ozone levels are moving in the right direction and approaching background levels.

Oklahoma is one of the most diverse states in the U.S. both geographically and ecologically with more eco-regions per square mile than any other state. We have a large amount of grasslands and forests. Prescribed burning is a technique that prevents wildfires, manages smoke contributions to the atmosphere, saves lives and property, and improves grassland and forest health. All these things are beneficial for the health of the environment, economy, and human health. Being in non-attainment because of this EPA proposed rule can prohibit these beneficial aspects of prescribed fire.

Working together these past 20 years has resulted in lower ozone levels. I am thankful for the efforts EPA and Americans have invested in protecting and improving our precious air and water resources.

However, at some point we have to stop and consider competing interests in protecting human health, in protecting natural resources and in protecting our food supply and our economy that are equally important.

Thank you Mr. Chairman and committee members for the opportunity to provide testimony on this very important issue.

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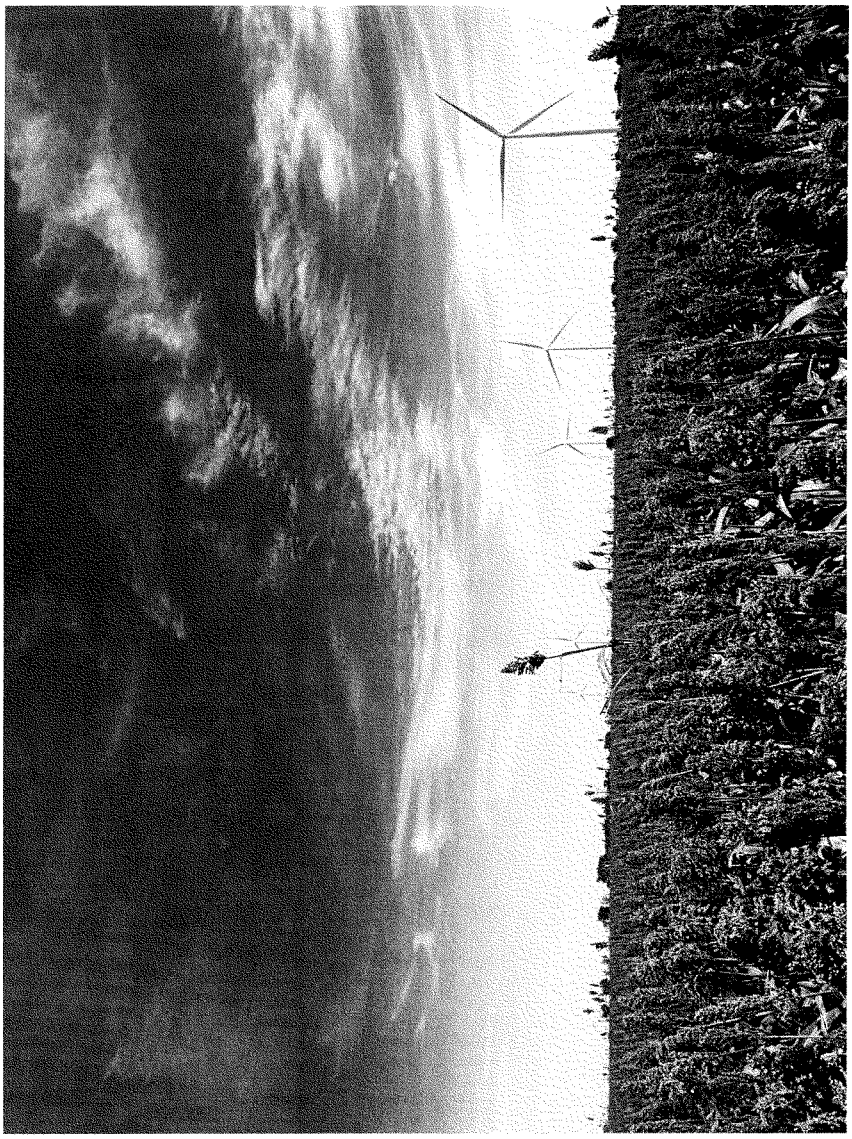
Jim Reese was appointed by Governor Mary Fallin as the Oklahoma Secretary of Agriculture and sworn into office on January 10, 2011. He acts as Governor Fallin's chief advisor on policy development and implementation related to agriculture, food, and forestry. Reese serves concurrently as the Oklahoma Commissioner of Agriculture and is a member of the Board of Regents for the Oklahoma Agricultural & Mechanical Colleges, the Commissioners of the Land Office and the Oklahoma State Board of Equalization.

Secretary Reese is a graduate of Northern Oklahoma College, where he earned an associate's degree in drafting and design. He later earned a Bachelor of Science degree in Engineering Technology from Oklahoma State University. Since 1978, he has managed a farm in Nardin, Oklahoma.

In 1986, he was elected to the Oklahoma House of Representatives and served in this office from 1987 to 2001. Reese was then selected to serve as the Oklahoma State Executive Director for the United States Department of Agriculture (USDA), Farm Service Agency under the administration of U.S. President George W. Bush. In 2008, Reese was appointed as the Oklahoma Policy Advisor to the Speaker of the House.

Secretary Reese has been married to Margaret Lynn Lobmeyer Reese since 1985 and has four children--Joanna, Drew, Lainey, and Spencer.



Chairman BRIDENSTINE. Thank you, Mr. Reese.

I now recognize Ms. Keslar for five minutes to present her testimony.

TESTIMONY OF MS. CARA KESLAR,
MONITORING SECTION SUPERVISOR,
WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY,
AIR QUALITY DIVISION

Ms. KESLAR. Thank you, Mr. Chairman.

Lower ozone NAAQS with design values influenced heavily by background ozone leaves Wyoming and Intermountain West States faced with new challenges in implementation.

This testimony will focus on the implementation issues with the proposed ozone NAAQS that are of particular concern to rural Intermountain West States like Wyoming and specifically the effects of background on rural areas and the available policies for addressing nonattainment issues, in particular, exceptional events.

At ground level, ozone is formed by complex reactions of pollutants in the atmosphere. Because of this, every geographical area has a unique mix of sources and meteorology that can govern its formation. Additionally, at high elevations like in Wyoming, ozone can be injected into our atmosphere from the ozone layer. This is called stratospheric ozone intrusion. This makes ozone exceedingly complex to understand and control. So far, EPA has focused on urban areas with highest ozone concentrations to protect public health and their tools and planning policies reflect that.

As the ozone standard is lowered, rural and mountainous areas will also have difficulty attaining and implementing the ozone NAAQS but have fundamentally different issues to contend with such as more transported and natural pollution.

In the NAAQS proposal, background ozone refers to components of international transport, transport into rural areas, and ozone from natural sources, including wildfire and stratospheric intrusion. This can account for a significant portion of measured ozone in the Intermountain West and is usually beyond a state's ability to control.

In its proposal, EPA suggests that these background contributions can be addressed by existing regulatory relief mechanisms, including the exceptional event rule. While we appreciate the efforts to retain these mechanisms in their current state they require extensive resources to document uncontrollable pollution. It is imperative that EPA make improvements to these mechanisms and streamline the demonstration and approval process so states and EPA resources are properly allocated to reducing emissions rather than performing paperwork exercises.

The DEQ has extensive experience in implementation of the exceptional event rule since its promulgation in 2007. We have produced several demonstrations showing that fire, high wind, and stratospheric intrusion have clearly caused exceedances of the NAAQS for PM 10, PM 2.5, and ozone. Specifically for ozone we've submitted five demonstrations to EPA Region 8 for stratospheric intrusion and we're the only agency and the Nation that has received a concurrence on intrusion event.

Based on this experience, each stratospheric intrusion demonstration takes between four and eight months to produce. The effort to produce those demonstrations use internal staff expertise, as well as assistance from federal, state, and academic staff focused on researching and diagnosing these intrusion events.

While we've not produced a demonstration to show ozone exceedances caused by wildfire, we're familiar with those demonstrations that EPA has concurred with. And to prepare comparable demonstration, it requires 15 months and contractor assistance of $150,000 per event.

In order for states to implement the exceptional events rule in the practical fashion, EPA must update and streamline the process. A key to this is developing workable technical tools to help states analyze these exceptional events. The EPA and other governmental agencies already have several online systems to provide data and analyses. There should be a concerted effort by EPA to consolidate these tools into a workable system to provide the necessary technical products.

Concurrently, EPA needs to follow through on their plans to provide clear requirements to demonstrate an exceptional event and produce very specific guidance for wildfire and stratospheric intrusion demonstrations for ozone. Furthermore, EPA needs to commit well-defined timelines for the region's review and decision on exceptional event.

At this time, there are no timelines for EPA's review and decision. This leaves air agencies with uncertainty when making regulatory decisions that can be affected by the inclusion or exclusion of exceptional data.

We recognize that EPA's responsibility to protect public health is the driving cause of lowering the ozone standard. However, overburdening state resources with administrative exercises will not help to achieve this objective. In addition to protecting public health, it is also the EPA's responsibility as the promulgators of this rule to provide states with the tools and guidance necessary to implement its standards and commit to doing so in a timely fashion. Therefore, EPA needs to devote the necessary resources to this issue to resolve concerns of rural and Intermountain West States.

Thank you.

[The prepared statement of Ms. Keslar follows:]

WRITTEN TESTIMONY OF CARA KESLAR,

AIR QUALITY MONITORING SUPERVISOR

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

BEFORE

THE HOUSE ENVIRONMENT SUBCOMITTEE OF THE

SCIENCE, SPACE AND TECHNOLOGY COMMITTEE

HEARING ON:

"REALITY CHECK PART II: THE IMPACT OF EPA'S PROPOSED OZONE STANDARDS ON RURAL AMERICA"

APRIL 29, 2015

1. Introduction

To understand Wyoming's perspective one would first benefit from knowing the key characteristics of the state. Wyoming is a large state covering 97,814 square miles and has the smallest population of any state, at approximately 584,000. Much of the state, as with much of the west, is still unsettled and consists of many rural communities with large distances in between. There are only nine towns and cities in the state with populations greater than 10,000. More than half of the land in Wyoming is owned and managed by the federal government. The mean elevation of Wyoming is 6,700 feet. A lower-ozone National Ambient Air Quality Standard (NAAQS), with design values influenced heavily by background ozone, leaves the Wyoming Department of Environmental Quality - Air Quality Division (DEQ) faced with new challenges in implementation, considering Wyoming's nature as a high-elevation, largely rural state with the lowest population in the United States.

Ozone is a complex air pollutant that can exist naturally, such as the ozone layer in the upper atmosphere, or be formed at ground level by emissions from both anthropogenic (man-made) and natural sources such as wildfire and trees. At ground-level, ozone is not directly emitted

from sources, it is formed by complex reactions of other pollutants in the atmosphere. There are approximately 280 chemical reactions that describe ozone formation at ground level, where each area has a unique mix of sources and meteorology that govern ozone formation. Additionally, at high-elevations, ozone can be injected into our atmosphere from the ozone layer. This makes ozone exceedingly complex to understand and control. So far, EPA has focused on urban areas with high population density and the highest ozone concentrations in order to protect public health. The tools and planning policies that EPA has developed to control ozone have been developed for summertime ozone issues in urban population centers, in mostly flat terrain and low elevations. As the ozone standard is lowered, rural areas will have difficulty attaining the ozone NAAQS, due to fundamentally different characteristics such as terrain, meteorology, fewer nearby anthropogenic sources, and more transported and natural pollution.

Currently, Wyoming has one non-attainment area the 2008 ozone standard. This area, known as the Upper Green River Basin, encompasses more than one county, and has a population of approximately 10,000 people and is surrounded by mountain ranges on three sides. The area is also a prolific oil and gas production area. In 2005, the DEQ began to monitor ozone exceedances in wintertime, which at the time was a relatively new phenomenon. In wintertime, tight inversions can form in the Basin, trapping pollutants. This, coupled with ultraviolet light reflection off the snow, leads to ozone exceedances in this relatively remote and unpopulated area. The DEQ has worked with local governments, federal land managers, industry, and the public, spending approximately $9.5 million dollars over the last ten years, to lower ozone concentrations in the Upper Green River Basin. In coordination with these federal and private partners, we performed the majority of the research and work in advance of the area's official 2012 designation. Wyoming and its partners took the initiative to solve this unique issue in the absence of EPA regulatory tools for our situation. Since the designation, we have not had any further exceedances of the ozone NAAQS. The work that we have done will be useful for other states struggling to understand and control wintertime ozone formation in rural areas.

Wyoming recognizes EPA's statutory responsibility to research and propose revisions to the primary and secondary ozone NAAQS to provide requisite protection of public health, with an adequate margin of safety, and public welfare. This testimony focuses on implementation issues that are of particular concern to Wyoming, in inter-mountain west, and rural and agricultural states in general: background and transported ozone; rural area nonattainment; and the available policies for addressing nonattainment issues, in particular exceptional events.

Whatever level EPA chooses for the ozone standard, implementation in the west will require a much better understanding of the role of natural and transported ozone, and we are looking to EPA to provide the resources needed to advance our knowledge in these areas. In addition, we call on EPA to improve upon the tools states may use to address areas that exceed the standard due to sources over which they have little or no control. Wyoming has shown leadership in the past to solve a unique ozone issue that was locally generated. However, it will be difficult for Wyoming and other states in the inter-mountain west to tackle issues of naturally formed and transported ozone without a cooperative and concerted effort by EPA and western states.

2. Ambiguity and Implications of Background Ozone

The term "background ozone" has been used in many different contexts. In the NAAQS proposal, the background ozone discussion refers to components of international transport of ozone and precursors, ozone transported into rural areas from anthropogenic sources, and ozone from natural sources including wildfire and ozone from the stratosphere that has intruded into the troposphere. Background levels of ozone in rural and remote locations, including many inter-mountain west national parks, can exceed the range of the ozone NAAQS proposed by EPA (65-70 ppb). In many of these areas, very little of the ozone can be attributed to emissions from nearby sources. Depending on the level of the 2015 ozone standards, many of these areas could end up being classified as non-attainment areas. This will be a new challenge for rural inter-mountain west states because ozone nonattainment planning policies and strategies have historically been focused on solving urban ozone exceedances.

Ozone exceedances in areas like these remote western national parks originate from a mix of anthropogenic and non-anthropogenic sources. That source mix, transport of pollutants over the complex terrain common in western states, and the role of natural events such as wildfires and stratospheric intrusions are just a few examples of scientific issues that are not well understood. The Clean Air Scientific Advisory Committee (CASAC) recommended "that EPA facilitate research to better characterize background levels." In the NAAQS proposal, EPA does not adequately address data from rural, high-elevation sites when considering background concentration.

Because of this, EPA's analysis and conclusions of the influence of background on total ozone levels is incomplete and not representative of observed conditions in the inter-mountain West. Given the high fractional contribution of background to total measured and modeled ozone concentrations in the inter-mountain west, a lower primary standard would put an undue responsibility on Wyoming and other high-elevation rural states to address high ozone concentrations that are beyond the states' abilities to control. Without a better understanding of background and what the anthropogenic contribution to background is, it will be difficult and ineffectual for rural western states to develop plans that focus on controlling anthropogenic sources.

For these reasons, EPA should commit to developing timely implementation guidance specific to high-elevation rural areas to address the treatment of background ozone, and to provide supportive resources commensurate with the relative burden of the new standard on high-elevation rural states.

In the NAAQS proposal, EPA downplays the ongoing significance of background ozone in the west and overstates the capability of the tools available to address the regulatory requirements imposed on states. To address this issue, EPA must take a different approach than used for urban ozone issues. EPA must research and develop tools to determine the relative contribution of the elements of background ozone; streamline the efforts for states to document these contributions; and allow states to focus resources on pollution that can be controlled, thereby improving air quality.

In its proposal, EPA suggests that these background contributions can be addressed by existing "regulatory relief" mechanisms, including the Exceptional Event Rule. The tools available to states to account for non-anthropogenic or not locally generated ozone are administratively burdensome and require resources and technical expertise that may not be available to state agencies. The DEQ recognizes that EPA intends to make improvements to the regulatory requirements to make these mechanisms viable options. However, the timing on these elements is critical and EPA has not yet committed to firm deadlines to accomplish this work. Nonetheless, a fundamental lack of data and understanding of the components causing ozone in an area will continue to hamper efforts to improve air quality.

3. Regulatory Relief Mechanisms

In its proposal, EPA suggests that these background contributions can be addressed by existing "regulatory relief" mechanisms, including the Rural Transport Area designation, International Transport Area Designation and the Exceptional Event Rule. This section outlines the DEQ's suggested improvements and experience with these relief mechanisms.

Rural Transport Areas

In the preamble to the proposed rule, the EPA discusses the various methods of regulatory relief available that are associated with U.S. background ozone, including the classification of eligible nonattainment areas as Rural Transport Areas (RTAs). The DEQ commends the EPA for retaining and expanding these regulatory relief mechanisms in light of the increasing relative importance of background ozone to overall ozone levels in rural, high-elevation areas with a lower standard. However, the fact that this classification has only been approved for two areas since the RTA's inception calls into question the RTA's usefulness as a nonattainment regulatory relief mechanism.

Therefore, the DEQ recommends that EPA reexamine its criteria for the acceptance of nonattainment areas as RTAs, as outlined in 42 U.S.C. § 7511a (h) (1). The EPA should also review its 2005 draft guidance, Criteria for Assessing Whether an Ozone Nonattainment Area is Affected by Overwhelming Transport, which has not been updated for nearly a decade. As EPA

further researches the components of background it will be critical to update this draft guidance, with state-of-the science information.

International Transport Areas

The DEQ also considers the EPA's recognition of the influence of International Transport on ozone levels under Section 179B of the Clean Air Act (CAA) to be too limiting, with little to no effective applicability in non-border states. Section 179B allows a state to consider in its attainment demonstrations whether an area might have met the NAAQS' "but for" emissions originating from outside of the U.S. While the EPA does not preclude non-border states from invoking Section 179B of the CAA, the precedent set by previous rulings suggests otherwise.

While the DEQ agrees that "the influence of international sources on U.S. O_3 levels will be largest in locations that are in the immediate vicinity of an international border with Canada or Mexico," there is a growing body of evidence that long-range transport of international emissions impacts ozone levels in the Western U.S. The EPA should continue to conduct and review research in the area of long-range international transport, and translate its findings into a stronger regulatory framework.

Similar to the EPA's draft guidance on RTA demonstrations, the only existing guidance for the development of "but for" demonstrations of the influence of International Transport under Section 179B is extremely outdated (Criteria for Assessing the Role of Transported Ozone/Precursors in Ozone Nonattainment Areas, May 1991). The EPA should update its 1991 guidance to include technology and tools developed in the past 24 years and reflect current research on international transport.

Exceptional Events

The EPA identifies several natural sources of ozone including wildfire and stratospheric intrusion. The EPA relies on the Exceptional Event Rule to account for these natural sources. The DEQ agrees with the premise that these events are natural and should allow for flags under the Exceptional Event Rule for these occurrences. Without this mechanism, areas could be

designated non-attainment due to natural sources beyond their control, and any required implementation actions would not result in an improvement to air quality. However, there are several implementation challenges associated with the Exceptional Event Rule that the EPA should consider.

As stated in the preamble, the extent to which ozone related to wildfire and stratospheric intrusions contributes to a measured ozone concentration on a given day can be uncertain and requires a detailed investigation and analysis to determine. This analysis serves as a basis for the demonstration that is required when requesting concurrence from the EPA Region under the Exceptional Event Rule. The demonstrations for both stratospheric intrusion and ozone from wildfire that the EPA has concurred with are lengthy and complicated. With the frequency of these events, there will be an overwhelming amount of resources needed from both state agencies and the EPA in order to use the Exceptional Event Rule as a viable method of relief.

The DEQ has extensive experience in implementation of the Exceptional Event Rule, since the rule promulgation in 2007. We have produced several demonstrations showing that fire, high wind and stratospheric intrusion have clearly caused exceedances of the NAAQS for PM_{10}, $PM_{2.5}$, and ozone. Specifically, the DEQ has submitted five (5) demonstrations to EPA Region 8 for stratospheric intrusion of ozone causing exceedances of the NAAQS at Wyoming ambient monitors, with one (1) concurrence from EPA. The other four (4) demonstrations to date have not been acted on by EPA.

So far, we are the only agency in the nation that has received concurrence for a stratospheric intrusion event. Based on this experience, each demonstration took between four and eight months to produce. The effort to produce those demonstrations used internal staff with meteorological expertise as well as assistance from the EPA's stratospheric ozone intrusion workgroup, a group of state regulators, Federal regulators, and academics focused on researching and diagnosing stratospheric ozone intrusions.

While the DEQ has not produced a demonstration to show a clear causal relationship between a wildfire and ozone exceedance, the DEQ is familiar with the demonstrations that the EPA has

posted as examples for wildfire impacts and ozone. The DEQ has concluded that it would require 15 months and contractor assistance of $150,000 to produce one of these demonstrations and any future demonstrations will require comparable resource commitments.

Securing funding and additional staff resources for new NAAQS implementation is always a challenge, but this process will be even more difficult for low-population, rural states facing additional workloads under a more-stringent ozone NAAQS. Wyoming is a one half of one percent funded state based on the EPA's current allocations of state air grants (42 U.S.C. § 7405). Population-based grants made more sense at a time when air pollution workloads were more directly tied to population. However, a lower ozone NAAQS leaves states in the Intermountain West – specifically those that have large, rural tracts with low population – grossly underfunded and understaffed given the current funding formulas. The traditional EPA provided tool-kits for ozone attainment in densely populated urban areas are inappropriate for our situation, leaving the DEQ to develop the appropriate tools with no additional funding or staffing.

EPA needs to examine the current mechanism for federal funding through State and Tribal Air Grants (STAG) in order to find alternatives for states facing these challenges. The funding that inter-mountain west states require for addressing this important new challenge should not come from a reallocation of existing funds that are currently used to carry out other important air quality management programs, nor should it adversely impact ongoing air quality improvement efforts in other regions of the country.

Improvements to the EER

In order for states to utilize the provisions of the Exceptional Events Rule in a practical fashion, EPA needs to streamline the process, provide the tools and guidance required to prepare demonstrations, and respond to exceptional event demonstrations in a timely fashion.

The EPA has plans to revise the Exceptional Events Rule, and it is DEQ's understanding that the proposed Rule is ready to send to OMB, with an expected release in fall of 2015. It is

imperative that this rule contain solutions to streamline the Exceptional Event process with clear requirements to demonstrate an exceptional event, updated technical tools needed to produce strong scientifically based demonstrations, and clear approval processes.

The EPA needs to develop workable technical tools to streamline the investigation and analysis process. The EPA and other governmental agencies already have several different online systems to provide data and analyses of different events. There should be a concerted effort by the EPA to consolidate these tools into a workable system to produce technical work products and analyses. Concurrently, the EPA should follow through on plans to produce guidance for ozone occurring due to wildfire demonstrations and stratospheric intrusion events.

Furthermore, to streamline the Exceptional Event process, the EPA must commit to well-defined timelines for the EPA Region's review and decision on exceptional event demonstrations. At this time, EPA has no time schedule requirements for the review and decision-making, while the state, local and tribal air agencies have required deadlines for flagging and submitting demonstrations. This leaves air agencies with uncertainty when making regulatory decisions that can be affected by the inclusion or exclusion of event-affected data. It is imperative that the EPA follows through with these activities in the ongoing tool to appropriately characterize natural events.

4. Summary

Making the right choices about how to improve air quality in the inter-mountain west and rural areas in general will depend on how well we understand background and how we implement the tools to account for it. EPA must implement these streamlining efforts so states are not spending excessive resources documenting pollution outside of their control. If technically sound research and streamlining efforts are implemented by EPA in a timely fashion, states can use their limited resources to focus on appropriate improvements to air quality.

We recognize that EPA's responsibility to protect public health is the driving cause of lowering the ozone standard. However, overburdening State resources with administrative exercises will not be conducive to attaining this objective. In addition to protecting public health, it is also

the EPA's responsibility, as the promulgators of this rule, to provide the states with tools and guidance necessary to implement its standards. Therefore, we call on EPA to devote the resources to this issue for the inter-mountain west.

Attachment: Wyoming Department of Environmental Quality – Air Quality Division Comments on the Proposed National Ambient Air Quality Standards for Ozone.

Cara Keslar is the Monitoring Section Supervisor in the Wyoming Department of Environmental Quality – Air Quality Division. She has 18 years of experience in the environmental field, including 13 years in the Air Quality Division. Ms. Keslar has spent 10 years specializing in ambient air quality monitoring and ozone and also has extensive experience in National Environmental Policy Act issues. Ms. Keslar has a bachelor's degree in Chemical Engineering from Clarkson University and a master's degree in Environmental and Occupational Health from University of Illinois at Chicago.

Chairman BRIDENSTINE. Thank you for your testimony.

I now recognize Dr. Miller for five minutes to present his testimony.

TESTIMONY OF DR. PAUL J. MILLER,
DEPUTY DIRECTOR AND CHIEF SCIENTIST,
NORTHEAST STATES FOR COORDINATED
AIR USE MANAGEMENT

Dr. MILLER. Good afternoon. My name is Paul Miller and I am Deputy Director and Chief Scientist of the Northeast States for Coordinated Air Use Management, or NESCAUM. I thank Mr. Chairman, Ms. Ranking Member, and the Members of the Subcommittee for providing NESCAUM with the opportunity to provide these comments today on U.S. EPA's proposed ozone standards.

NESCAUM is a regional association of state air pollution control agencies representing Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. NESCAUM provides policy and technical support for our state member agencies in furtherance of their air quality and climate programs. Our member state agencies have the primary responsibility for developing strategies that will attain and maintain current and potentially revised ozone standards in their states and in downwind areas affected by transport.

My testimony today reflects the majority views of NESCAUM as a state membership organization. Individual NESCAUM member states do hold separate views regarding issues specific to those states' circumstances, which may differ from NESCAUM states' majority consensus.

Over its 45-year history, the Clean Air Act has saved hundreds of thousands of lives and generated trillions of dollars in health and welfare benefits for our nation. Compliance with national ambient air quality standards have consistently proven less costly and more beneficial than either its critics or supporters predicted.

Within the NESCAUM region, states have successfully met the challenge of reducing air pollution over the years while their economies, populations, and energy use have grown. While air quality has improved markedly under the existing Clean Air Act framework, the science clearly demonstrates that adverse impacts continue to occur and more protective ozone standards are needed.

NESCAUM supports a health-based ozone standard within the range recommended by the Clean Air Act Scientific Advisory Committee, or CASAC, of .060 to 0.070 parts per million, eight-hour average. Ground-level ozone is a respiratory irritant that adversely affects both people with respiratory disease and healthy children and adults. It can cause premature death.

The science was sufficiently strong in 2007 to justify a more protective ozone health standard, but the standard set by EPA at that time fell short of what was needed. The science remained sufficiently strong in 2010 when EPA tried to reconsider its earlier vision but ultimately could not do so. It is now 2015 and the science has only become stronger. By extension, the current ozone NAAQS of 0.075 parts per million remains inadequate. Retaining this as a standard should not be an option.

As today's hearing encompasses impacts on rural and agricultural sectors of America, I would like to focus the remainder of my comments on EPA's proposal for the revised secondary standard. The main focus of EPA's proposal is to provide increased protection against vegetation-related impacts.

Ozone is the most important air pollutant affecting economically valuable agricultural crops and other vegetation in North America and elsewhere. Long-term exposure to ground-level ozone above natural background concentrations results in diminished crop yields and in decreased forest productivity. In the United States, studies of estimated crop losses due to ozone damage are in the billions of dollars annually.

In light of the existing science, NESCAUM supports a secondary ozone standard of the W126 index form, which is intended to better reflect biologically relevant ozone levels. EPA is proposing to revise the secondary ozone NAAQS to a level within the range of 13 to 17 parts per million hours average over three years, but setting the standard within the range of an eight-hour average, .065 to .070, which it asserts would provide equivalent protection.

We believe that the W126 basis of EPA's proposed secondary NAAQS is at and above the CASAC recommended range. As a result, EPA's proposed level is not entirely consistent with the existing science.

In achieving more protective ozone standards, mobile sources remain an important emissions sector. EPA needs to be forward-looking in addressing these as the full benefits of their emissions reductions take time to be realized due to fleet turnover rates and other factors. Strategies to reduce ozone forming nitrogen oxides or NOx from mobile sources such as lower emission standards for heavy-duty on-road diesel vehicles, updated federal aftermarket catalytic converter policies, diesel inspection and maintenance programs, and idling reduction measures are significant opportunities for lowering ozone pollution going forward.

In sum, NESCAUM firmly believes that science must drive the ozone standards. EPA's most recent proposal generally better aligns with the long-standing science but may not adequately reflect levels needed to protect farms and forests.

I thank you for your attention and I'm happy to answer any questions you may have.

[The prepared statement of Dr. Miller follows:]

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Comments from the Northeast States for Coordinated Air Use Management
Presented by Paul J. Miller, Deputy Director & Chief Scientist
Before the House Subcommittee on Environment,
House Committee on Science, Space and Technology on
Impact of EPA's Proposed Ozone Standards on Rural America
April 29, 2015

Good afternoon. My name is Paul Miller, and I am Deputy Director and Chief Scientist with the Northeast States for Coordinated Air Use Management (NESCAUM). I thank Mr. Chairman, Ms. Ranking Member, and all the members of the Subcommittee for providing NESCAUM with the opportunity today to offer the following comments on the U.S. Environmental Protection Agency's (EPA's) proposed ozone standards and potential impacts on rural America.

NESCAUM is a regional association of state air pollution control agencies representing Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. NESCAUM provides policy and technical support to our state member agencies in furtherance of their air quality and climate programs. Our member state agencies have the primary responsibility for developing strategies that will attain and maintain current and potentially revised ozone standards in their own states and in downwind out-of-state areas.

My testimony today reflects the majority views of NESCAUM as a state membership organization. Individual NESCAUM member states may hold separate views regarding issues specific to that state's circumstances, which may differ from the NESCAUM states' majority consensus.

Over its 45 year history, the Clean Air Act has saved hundreds of thousands of lives and generated trillions of dollars in health and welfare benefits to our nation.[1] Compliance with national ambient air quality standards have consistently proven less costly and more beneficial than either its critics or supporters predicted.[2]

Within the NESCAUM region, states have successfully met the challenge of reducing air pollution over the years while their economies, populations, and energy use have grown (see example of Massachusetts in Figure 1 below).

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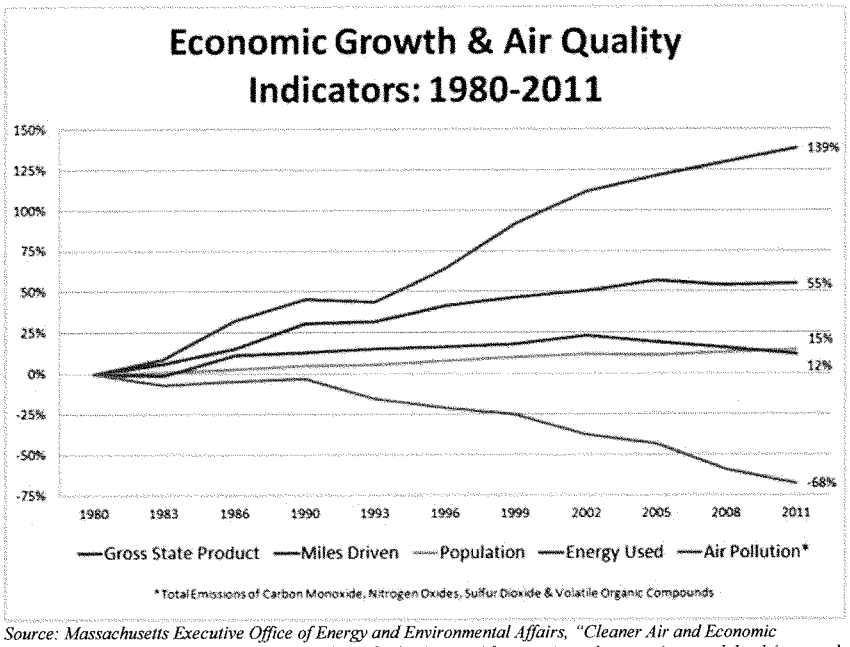
[1] U.S. EPA, *The Benefits and Costs of the Clean Air Act: 1970 to 1990*, EPA Report to Congress, EPA-410-R-97-002 (1997); U.S. EPA, *The Benefits and Costs of the Clean Air Act from 1990 to 2020,* Summary Report, U.S. EPA Office of Air and Radiation (March 2011).

[2] *See, e.g.*, NESCAUM, Environmental Regulation and Technology Innovation: Controlling Mercury Emissions from Coal-Fired Boilers, NESCAUM Report (Boston, MA), 2000. Available at http://www.nescaum.org/documents/rpt000906mercury_innovative-technology.pdf.

NESCAUM Members:
Connecticut Bureau of Air Management, Anne Gobin
Maine Bureau of Air Quality Control, Marc Cone
Massachusetts Bureau of Waste Prevention, Christine Kirby
New Hampshire Air Resources Division, Craig Wright
New Jersey Division of Air Quality, William O'Sullivan
New York Division of Air Resources, David Shaw
Rhode Island Office of Air Resources, Douglas McVay
Vermont Air Quality & Climate Division, Heidi Hales

Figure 1. Trends in Massachusetts Economic Growth and Air Quality Indicators: 1980-2011



Source: Massachusetts Executive Office of Energy and Environmental Affairs, "Cleaner Air and Economic Growth," http://www.mass.gov/eea/agencies/massdep/air/reports/cleaner-air-and-economic-growth.html (accessed April 24, 2015).

While air quality has improved markedly under the existing framework of the Clean Air Act, the science clearly demonstrates that adverse impacts continue to occur at current ozone levels, and more protective ozone standards are needed.

1. **NESCAUM supports a primary ozone health standard consistent with the science, consistent with the requirements of the Clean Air Act, and consistent with the Clean Air Scientific Advisory Committee's (CASAC's) recommendations.**

NESCAUM supports a health-based ozone standard within the CASAC-recommended range of 0.060 – 0.070 ppm, 8-hour average, that would ensure an adequate margin of safety as directed by the Clean Air Act.

Ground-level ozone is a respiratory irritant that adversely affects both people with respiratory disease and healthy children and adults. It can cause premature death. The science was sufficiently strong in 2007 to justify a more protective ozone health standard, but the standard set by EPA at that time fell short of what was needed. The science remained sufficiently strong in 2010 when EPA tried to reconsider its earlier revision, but ultimately could not do so. It is now 2015, and the science has only become stronger.

Lung function changes in healthy adults have been demonstrated to occur in controlled chamber studies at ozone levels of 0.070 ppm for up to 6.6 hours, the upper bound of EPA's proposed range.[3] These data do not account for increased sensitivities due to age or pre-existing respiratory conditions such as asthma. They also do not account for exposures that can occur for longer than 6.6 hours. Ozone exposure at 0.070 ppm has also been linked to cardiovascular effects.[4] These factors militate against the 0.070 ppm level being protective with an adequate margin of safety.

By extension, the current ozone NAAQS of 0.075 ppm remains inadequate. Retaining this as a standard should not be an option.

We recognize that Executive Order # 12866 requires EPA to conduct a regulatory impact analysis (RIA) for the proposed ozone NAAQS revisions. Such an analysis may include information about costs under various NAAQS scenarios, but must not come into play in EPA's decision on setting the level of the NAAQS. Only after the level of the NAAQS has been established should EPA consider issues on how to implement the standard efficiently in order to achieve health benefits as expeditiously as practicable. Implementation issues must not be considered in setting the level of the NAAQS.

2. NESCAUM supports a cumulative, seasonal standard in the form referred to as W126 for the secondary ozone standard to better protect agriculture and forests.

Ozone is the most important air pollutant affecting economically valuable agricultural crops and other vegetation in North America and elsewhere.[5,6] Long-term exposure to ground-level ozone above natural background concentrations results in diminished crop yields[7,8] and decreased forest

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[3] Clean Air Scientific Advisory Committee. CASAC Review of the EPA's Second Draft Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards. Letter to EPA dated June 26, 2014. See: http://yosemite.epa.gov/sab/sabproduct.nsf/5EFA320CCAD326E885257D030071531C/$File/EPA-CASAC-14-004+unsigned.pdf.

[4] Ibid.

[5] Mauzerall, D.L.; Wang, X. Protecting Agricultural Crops from the Effects of Tropospheric Ozone Exposure: Reconciling Science and Standard Setting in the United States, Europe, and Asia; *Annu. Rev. Energy Environ.* **2001**, *26*, 237-268.

[6] Ashmore, M.R.; Marshall, F.M. Ozone Impacts on Agriculture: An Issue of Global Concern; *Adv. Botanical Res.* **1998**, *29*, 31-52.

[7] Chameides, W.L.; Kasibhatla, P.S.; Yienger, J.; Levy, H. The Growth of Continental-Scale Metro-Agroplexes, Regional Ozone Pollution, and World Food Production; *Science* **1994**, *264*, 74-77.

productivity.[9,10,11] In the United States, studies have estimated crop losses due to ozone damage in the billions of dollars annually.[12,13,14]

In light of the existing science, NESCAUM supports a secondary ozone standard of the "W126 index" form. If the standard is based on a 3-year averaging period, then the level of the secondary standard should be set so that it does not exceed CASAC's recommended range of 7-15 ppm-hrs in an individual year.

EPA is proposing to revise the secondary ozone NAAQS to a level within a range of 13-17 ppm-hrs averaged over three years, but setting the standard in the 8-hour form within the 0.065-0.070 ppm range, which it asserts would provide equivalent protection.

The W126 basis of EPA's proposed secondary NAAQS is at and above the CASAC-recommended range. As a result, EPA's proposed level is not entirely consistent with the existing science and CASAC's recommended range.

As far back as 2001, ozone monitoring has indicated that much of the NESCAUM region may already be below 15 ppm-hours.[15] Documented forest damage, however, still occurs at these levels. Trained observers in the national Forest Health Monitoring program routinely observed foliar ozone damage symptoms in sensitive tree species in sections of the NESCAUM region and elsewhere in the eastern U.S. at levels comparable to or below 15 ppm-hrs.[16] This indicates that a secondary ozone standard of the W126 form towards the lower end of the CASAC-recommended range would provide better protection against current adverse impacts on forests in the NESCAUM region.

3. EPA and the states need to address interstate transport of ozone pollution and its precursors in a timely manner.

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[8] Fiscus, E.L.; Booker, F.L.; Burkey, K.O. Crop responses to ozone: uptake, modes of action, carbon assimilation and partitioning; *Plant, Cell, and Envt.* **2005**, *28*, 997-1011.
[9] Broadmeadow, M. Ozone and Forest Trees; *New Phytologist* **1998**, *139*, 123-125.
[10] Chappelka, A.H.; Samuelson, L. Ambient Ozone Effects on Forest Trees of the Eastern United States: A Review; *New Phytologist* **1998**, *139*, 91-108.
[11] Karnosky, D.F.; Skelly, J.M.; Percy, K.E.; Chappelka, A.H. Perspectives Regarding 50 Years of Research on Effects of Tropospheric Ozone Air Pollution on U.S. Forests; *Envtl. Poll.* **2007**, *147*, 489-506.
[12] Adams, R.M.; Crocker, T.D. The Agricultural Economics of Environmental Change: Some Lessons from Air Pollution; *J. Envtl. Mgmt.* **1989**, *28*, 295-307.
[13] Murphy, J.J.; Delucchi, M.A.; McCubbin, D.R.; Kim, H.J. The Cost of Crop Damage Caused by Ozone Air Pollution from Motor Vehicles; *J. Envtl. Mgmt.* **1999**, *55*, 273-289.
[14] Avnery, S.; Mauzerall, D.L.; Liu, J.; Horowitz, L.W. Global crop yield reductions due to surface ozone exposure: 1. Year 2000 crop production losses and economic damage; *Atmos. Envt.* **2011**, *45*, 2284-2296.
[15] EPA OAQPS Staff Paper, "Review of the National Ambient Air Quality Standards for Ozone: Policy Assessment of Scientific and Technical Information," EPA-452/R-07-003, January 2007 (Figure 7-6, p. 7-28).
[16] Smith G, Coulston J, Jepsen J, Prichard T. A national ozone biomonitoring program: Results from field surveys of ozone sensitive plants in northeastern forests (1994–2000), *Environ. Monit. Assess.* **2003**, 87(3), 271–291.

NESCAUM states are subject to significant ozone contributions from pollution sources in upwind states, in addition to pollution emitted within the NESCAUM region. Interstate transport must be addressed in order for states to meet more protective ozone standards.

4. EPA should consider ozone's contribution to climate change and methane's influence on ozone concentrations.

We note that ozone is a recognized contributor to atmospheric warming, and its global background levels have been rising due to increased anthropogenic precursor emissions. Addressing short-lived greenhouse gases (GHGs) helps mitigate near term climate change as ongoing deliberative processes proceed to address the longer-lived GHGs like carbon dioxide.

As an added co-benefit, an ozone standard that addresses its impact on climate change (as well as air quality) would include methane reduction strategies. Methane is a GHG in its own right, but is not typically considered in current ozone attainment strategies due to its relatively low chemical reactivity in the context of shorter term episodic peak ozone levels (e.g., 8-hour averages). In the global background context, however, methane can have a significant influence on ozone levels.[17] In our 2010 comments on the reconsideration of the 2007 ozone standards, NESCAUM provided a preliminary modeling assessment of methane's influence on broad regional ozone concentrations in the eastern United States. Our modeling indicated that elevated methane concentrations above pre-industrial levels are contributing to increased long-term ozone in our region.[18] This suggests that a methane reduction strategy will have "triple" benefits by reducing ozone as a GHG, reducing ozone as a criteria air pollutant, and reducing methane both as a GHG and ozone precursor.

5. EPA should be forward-looking in addressing mobile sources.

In achieving more protective ozone standards, mobile sources remain an important emissions sector. EPA needs to be forward-looking in addressing these as the full benefits of their emissions reductions take time to be realized due to fleet turnover rates and other factors. Strategies to reduce ozone forming nitrogen oxides (NOx) from mobile sources, such as lower emission standards for heavy-duty on-road diesel vehicles, updated federal aftermarket catalytic converter policies, diesel inspection and maintenance programs, and idling reduction measures are opportunities for lowering ozone pollution going forward.

6. Summary

In sum, NESCAUM firmly believes that science must drive the ozone standards. We have remained consistent with the levels and forms that we have supported in previous EPA ozone

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[17] Fiore AM, Jacob DJ, Field BD, Streets DG, Fernandes SD, Jang C. Linking ozone pollution and climate change: The case for controlling methane. *Geophys. Res. Lett.* **2002**, *29*,1919, doi: 10.1029/2002GL015601.
[18] Northeast States for Coordinated Air Use Management. *Comments to EPA on Proposed NAAQS for Ozone.* March 2010. http://www.nescaum.org/documents/nesc_o3_naaqs_reconsid_comments_20100322-final-all.pdf.

reviews dating back to 2007.[19] EPA's most recent proposal generally better aligns with the long-standing science, but may not adequately reflect levels needed to protect farms and forests.

I thank you for your attention, and I am happy to answer any questions you may have.

[19] See: 1) Northeast States for Coordinated Air Use Management. *Comments to EPA on Proposed NAAQS for Ozone*, October 2007, http://www.nescaum.org/documents/nesc_03_naaqs_comments-final-20071004.pdf; 2) Northeast States for Coordinated Air Use Management. *Comments to EPA on Proposed NAAQS for Ozone*. March 2010, http://www.nescaum.org/documents/nesc_o3_naaqs_reconsid_comments_20100322-final-all.pdf. For additional comments and oral testimony from NESCAUM on the NAAQS for ozone, see: http://www.nescaum.org/topics/ozone.

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Speaker's Bio
Paul J. Miller, Deputy Director & Chief Scientist
NESCAUM

Dr. Paul J. Miller is Deputy Director and Chief Scientist of the Northeast States for Coordinated Air Use Management (NESCAUM) in Boston, Massachusetts where he provides technical and policy coordination among the air quality agencies of eight northeastern states. Dr. Miller returned to NESCAUM in January 2006 after previously being with NESCAUM from 1995-1999 as Senior Science and Policy Advisor. He has contributed to state efforts on ozone transport, acid rain, regional haze, and other air issues.

From 1999-2005, Dr. Miller was the Air Quality Program Coordinator with the Commission for Environmental Cooperation (CEC) in Montreal, Quebec. The CEC is a trinational intergovernmental agency created by Canada, Mexico and the United States to promote environmental cooperation among the three NAFTA trading partners.

Dr. Miller has been a Senior Fellow at Princeton University's Center for Energy and Environmental Studies. Previous to Princeton, he was Senior Energy Fellow at the W. Alton Jones Foundation in Charlottesville, Virginia. He also was a National Research Council Associate at the Joint Institute for Laboratory Astrophysics, University of Colorado and the National Institute of Standards and Technology, in Boulder, Colorado.

Dr. Miller has a B.S. in Chemistry from Purdue, a Ph.D. in chemical physics from Yale, and a law degree from Stanford.

Chairman BRIDENSTINE. Thank you, Dr. Miller.

I now recognize Mr. Abernathy for five minutes to present his testimony.

TESTIMONY OF MR. KEVIN ABERNATHY,
DIRECTOR OF REGULATORY AFFAIRS,
MILK PRODUCERS COUNCIL;
VICE CHAIR, DAIRY CARES

Mr. ABERNATHY. Thank you, Mr. Chairman, distinguished Members of the Committee. I appreciate you holding this hearing today to discuss the EPA's proposed new standards on ozone.

I've lived in the San Joaquin Valley of California all of my life, and as you might already know, there's three things that make unique—that are very unique to California. We are the Nation's agricultural powerhouse. We're in the middle of a terrible drought and we remain one of the most challenging air basins in the Nation for meeting air quality standards.

While these things are true, there's much more to our story. Valley agriculture, business, and regulators have worked together to dramatically improve air quality while producing more crops in hopes of a stronger economy, and we can continue this if we act wisely, but we have to face the harsh reality. That reality is as the air gets cleaner, achieving further incremental improvements becomes technologically and economically challenging. As we move toward near background levels, it becomes almost impossible. A change in strategy is certainly needed.

As the current act monitors air quality agencies and bureaucracy and forcing them to implement multiple redundant standards for criteria pollutants, this wastes time and money. They're held accountable for these standards without regard to whether they're achievable. They're asked to literally do the impossible, control pollution and in some cases from sources they don't regulate, achieve reductions from technologies that don't exist today.

California dairy families produce nearly a fifth of the country's milk generating $63 billion in the economy, over 443,000 jobs, and agricultural production and processing accounts for 37.8 percent of the regional employment. It's to be said that for every dollar that comes onto the dairy farm, $8 are stimulated in the local community.

With the Valley's unique topography, temperature inversions, we face very tough challenges. With 10 times less pollution per square mile than Los Angeles with our stagnant air conditions, we struggle to meet ever-tightening air quality standards with pollution that's not only imported from the San Francisco Bay area but also from countries as far away as Asia. Slide one, please.

[Slide.]

We are very, very proud of this slide. It shows that we have had a 97 percent reduction in the 1-hour ozone standard with over 600 rules that have been implemented in the San Joaquin Valley, such as Rule 4574 stationary engines, Rule 4702 on stationary engines, 4570 for VOCs from CAFOs. 4570 is an interesting note from the standpoint that it's the San Joaquin Valley's most expensive individual rule ever passed on Central Valley dairy families. All told,

businesses have spent more than 40 billion in complying with these rules.

Slide #2.

[Slide.]

We've been committed. We made the comment that we would—we wanted rules that were based on sound science and guided by sound science that we would live with the results. With that, we have spent more than $50 million studying air quality in the Central Valley and in California. Now that the low-hanging fruit has been picked, our air quality in the San Joaquin Valley has the daunting task—we've reduced emissions by 80 percent but we have to find another 90 percent to meet the current standard, let alone a reduced standard.

Slide #3.

[Slide.]

What's interesting about the past slide that I missed on was the fact that we're potentially looking at shutting down all combustible sources of emissions in the Central Valley to meet the current standard. With that, Slide #3. Thank you.

[Slide.]

As you see here, with the potential lowering of the standard, we're potentially looking at having a lot of the country coming in to noncompliance.

Let me finish with, in summary, California dairy families are under the Nation's most strict environmental regulations from water quality to energy cost from the climate change regulations—and this is all happening during the middle of the historic drought in the Central Valley as farmers have been cut back between 65 and 100 percent of their water allocations.

We must ask the question: How long will California remain the number one agricultural state with nearly 500 dairy farms, as Representative Valadao noted, have closed in the past five years. As prominent states around us that have been luring our farmers out of California, they've actually made public comments thanking us for sending us "your best farmers." It may draw a chuckle but I would say beware; you possibly could be next. California is just the canary in the coalmine. We strongly urge leaders like yourselves to take careful considerations of the testimony provided today.

Again, thank you, Mr. Chairman and Members of the Subcommittee, for your attention and opportunity to provide testimony.

[The prepared statement of Mr. Abernathy follows:]

WRITTEN TESTIMONY OF KEVIN ABERNATHY

DIRECTOR OF REGULATORY AFFAIRS, MILK PRODUCERS COUNCIL [1]

VICE CHAIRMAN, DAIRY CARES[2]

MEMBER, USDA AGRICULTURAL AIR QUALITY TASK FORCE

BEFORE THE

COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
SUBCOMMITTEE ON ENVIRONMENT

HEARING TOPIC: "REALITY CHECK PART 2: IMPACT OF EPA'S PROPOSED OZONE STANDARDS ON RURAL AMERICA"

APRIL 29, 2015

Chairman Bridenstine, Vice Chairman Westerman, Ranking Member Bonamici and Distinguished Members of the Subcommittee:

Thank you for holding this hearing on the importance of the U.S. Environmental Protection Agency's proposed new National Ambient Air Quality Standards (NAAQS) for ozone and the potential for these standards to impact rural America.

I have lived in rural America all of my life, specifically in the San Joaquin Valley of California. If one were to rely only on news media descriptions of the Valley in recent years, one likely would conclude at least three things:

1) The Valley is the nation's agricultural powerhouse,
2) The Valley is struggling with historic drought, and
3) The Valley remains one of the nation's most-challenging air basins when it comes to meeting air quality standards.

All of these things are true, but they don't tell the whole story. In fact, the real story is one of tremendous good news – how agriculture, business and regulators in the San Joaquin Valley have worked together creatively and with ingenuity to dramatically improve air quality and increase efficiency in use of water, energy and other resources, even as they have dramatically

[1] www.milkproducerscouncil.org
[2] www.dairycares.com

increased productivity. That has been the story for decades and it could continue to be the story going forward if we act wisely.

But we are at a crossroads today. The federal Clean Air Act – born in 1963 and subject to major amendments in 1970, 1977 and 1990 – produced great strides forward in improved air quality across our nation. Because of these major improvements, the job of achieving even cleaner air is getting significantly more complex and difficult. And the Act as envisioned in 1990 is no longer up to the task.

Regional air pollution regulators, despite their success in actually cleaning the air, are mired in unnecessary bureaucracy related to implementing multiple and redundant standards for criteria pollutants. They are forced to waste time and money implementing measures they know won't help air quality, ironically diverting their attention from potential measures that could help. They are held accountable for meeting standards that cannot be met without controlling pollution from sources they have no authority to regulate. And in some cases, they are being required to meet targets that are unreachable with technology available today – and that could not be met even if major sectors of the economy were shut down.

This results in significant cost and uncertainty that not only increases costs for taxpayers – without benefits to those taxpayers – but places huge burdens on the economy in the form of increased business costs and uncertainty. The costs are passed through the entire economy, including agriculture and dairy.

In short, we might describe the Clean Air Act as implemented today as an airplane on autopilot; it has come a long way in the right direction, but now is headed straight toward a mountain. The impact of the coming catastrophe will definitely be felt in the San Joaquin Valley, but it will be also be felt in many other parts of America. I will try to share some ideas today about how we can get that airplane off autopilot, steer it in the right direction, and continue a safe flight that achieves both cleaner air and a stable economy in parts of rural America like the San Joaquin Valley.

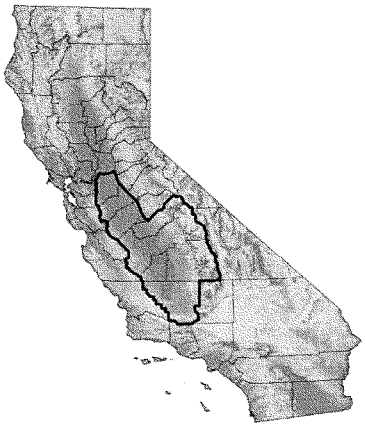

Figure 1. California's eight-county San Joaquin Valley. *Source: SJVAPCD*

The San Joaquin Valley: Air quality challenges, investments and successes

The San Joaquin Valley (see Figure 1) is home to 4.2 million people, about 11 percent of California's population. The valley has the largest agriculture-producing county in the nation (Fresno) and the nation's number-one dairy county (Tulare). In fact, seven of the valley's eight counties are in the nation's top 10 agricultural producing counties, and the valley contains 27,000 farms. Almost 18 percent of the *nation's* dairy

production comes from these eight counties. The California dairy industry is responsible for more than 443,000 jobs, while dairy farming and related industries generate $63 billion in economic activity[3]. Overall, agricultural production and processing industries in the Valley accounted for 37.8 percent of regional employment.[4]

While farming and agricultural processing are the lifeblood of the Valley, it is also home to 80 percent of the state's oil production and California's two major trade corridors, Interstate 5 and Highway 99.

The San Joaquin Valley has unmatched challenges in meeting NAAQS. The geography and meteorology of the valley, which is nearly completely surrounded by mountains, creates temperature inversions and stagnant air. To make matters worse, pollution is transported into the valley from the San Francisco Bay Area, and even as far away as Asia, creating high background levels. Goods movement – serving all areas of the state and neighboring states – relies on major routes through the San Joaquin Valley. These conditions combine to create an enormous challenge, even though the Valley generates substantially less pollution per square mile than other areas of California (6 times less than the Bay Area and 10 times less than the South Coast/Los Angeles area).[5]

Despite these huge challenges, by several measures, dramatic improvements in air quality have been achieved:

- Number of days of exceedance of the 1997 $PM_{2.5}$ standard have dropped dramatically since 1999 (Figure 2);
- Inventories of nitric oxides (NO_X, an ozone and particulate matter precursor) have dropped by more than half since 1990 (Figure 3);
- Combined NO_X and Volatile Organic Compounds (VOCs) inventories have dropped by nearly two-thirds since 1990 (Figure 4);
- Days over the 8-hour standard for ozone have dropped by 84 percent since 2003 (Figure 5); and
- Total hours over the 1-hour ozone standard have dropped by 97 percent since 1996 (Figure 6).

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[3] http://www.californiadairypressroom.com/node/289, accessed April 24, 2015.
[4] http://aic.ucdavis.edu/publications/moca/moca09/moca09chapter5.pdf; accessed April 24, 2015.
[5] April 16, 2015 presentation on the 2015 Plan for the 1997 PM2.5 Standard, San Joaquin Valley Air Pollution Control District.
http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2015/April/presentations/07.pdf, accessed April 24, 2015.

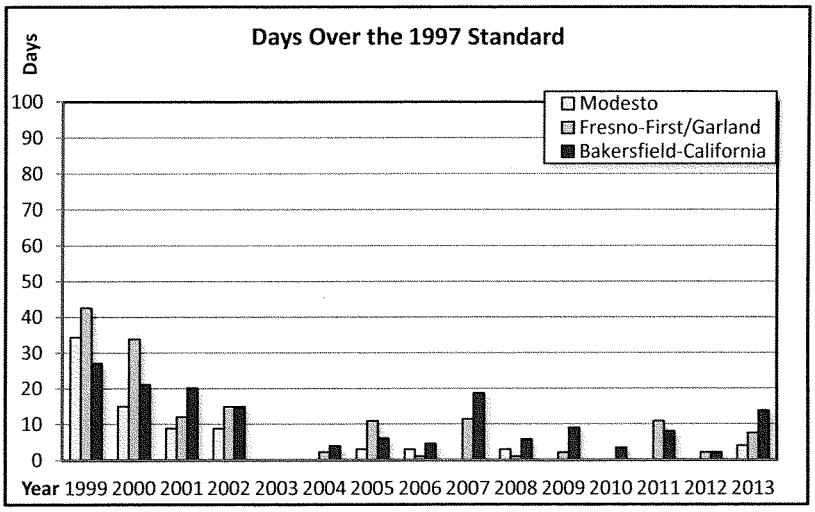


Figure 2. Number of days of exceedance of the 1997 $PM_{2.5}$ standard in the San Joaquin Valley Air Pollution Control District. *Source: SJVAPCD*

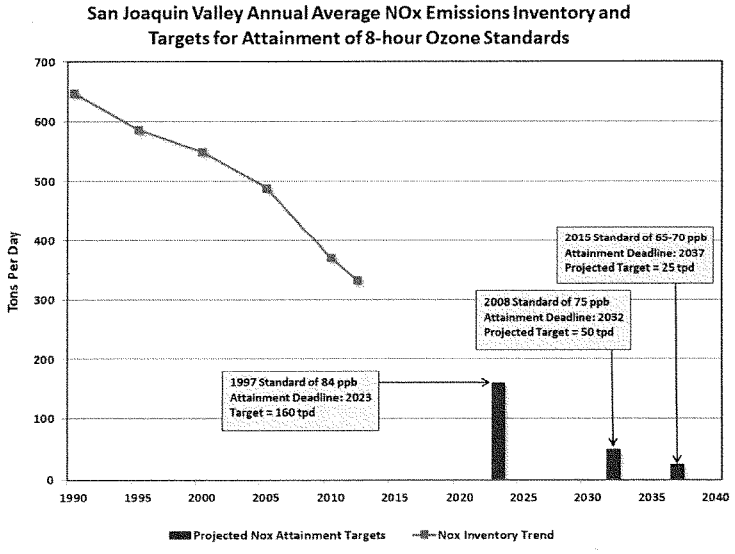


Figure 3. Inventories of nitric oxides since 1990. *Source: SJVAPCD*

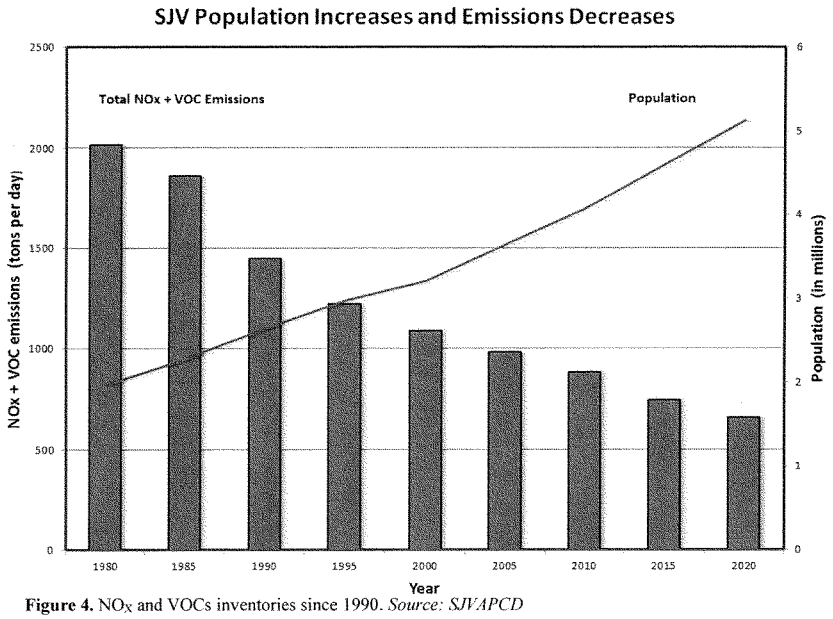


Figure 4. NO_X and VOCs inventories since 1990. *Source: SJVAPCD*

County	2003	2014
San Joaquin	2	0
Stanislaus	18	4
Merced	54	1
Madera	14	5
Fresno	97	22
Kings	15	4
Tulare	92	13
Kern	116	14
TOTAL	**408**	**63**

Figure 5. Days over the 8-hour standard for ozone since 2003.
Source: SJVAPCD

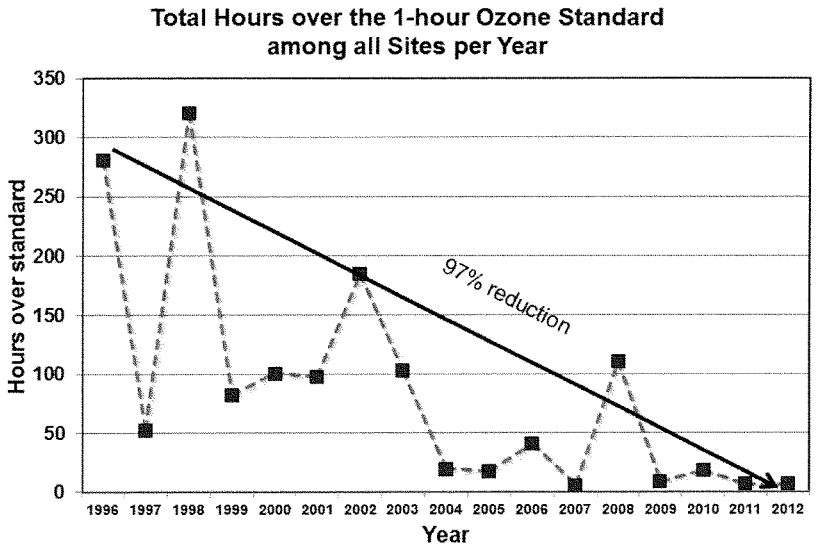


Figure 6. Total hours over the 1-hour ozone standard since 1996. *Source: SJVAPCD*

These reductions – an overall 80 percent reduction from stationary sources under the San Joaquin Valley Air Pollution Control District's (SJVAPCD's) jurisdiction – came via a "no-stone-left-unturned approach" that left no economic sector untouched. Beginning in 2003, the SJVAPCD launched major regulatory efforts to reduce emissions from agriculture, including but not limited to:

- Rule 4702 (stationary internal combustion engines);
- Rule 4570, the nation's strictest and most expensive regulation related to reducing emissions of VOCs from dairy farms; and
- Rule 4550, which targets reductions of fine particulate matter and fugitive dust from dairies and other farms.

Costs of improvements

The dramatic improvements in air quality have not come without cost. According to the SJVAPCD:

- The SJVAPCD and/or the state of California has enacted the nation's toughest regulations for cars and trucks, consumer products and farms and dairies;

- More than 600 rules have been implemented in the San Joaquin Valley for stationary and area sources since 1992;
- Rule 4570 for dairies and other confined animal facilities is the district's most expensive individual rule, with a price tag of $61.5 million, and this does not include costs to dairies related to complying with other rules;
- All told, business have spent more than $40 billion complying with these rules; and
- Another $1 billion of public and private funds have been invested in incentive programs.

It is also important to realize that these improvements in air quality were preceded by and supported by a significant cooperative agreement between governments and the private sector to carry out extensive air quality research programs, which began in earnest in 1990 and continue to this day. Under the auspices of the San Joaquin Valleywide Air Pollution Study Agency, and in cooperation with the Central California Air Quality Studies Policy Committee, more than $50 million in air quality research has been conducted since 1990. This work has included technical studies, data analysis and modeling at more than 400 weather and pollution monitoring sites in Central California, augmented by aircraft flights and weather balloons. Nearly $6 million of the research funding was provided by the private sector, about $16.7 million from the federal government, and about $28 million from air districts and state and local governments.[6]

Challenges moving forward

There is no question that in the campaign for cleaner air, the low-hanging fruit has already been picked. Having regulated virtually every stationary and area source, and with other agencies regulating mobile sources, the SJVAPCD today has reduced emissions by 80 percent – but "*need(s) another 90 percent reduction in emissions just to meet a standard that will soon be replaced with an even tougher standard.*"[7]

It is also clear that it will be extremely difficult if not impossible to meet current federal ozone standards – let alone more stringent proposed standards – without major advances in technology that are not currently available, and without shutting down major industries. In fact, analysis by the SJVAPCD (Figure 7) shows that meeting proposed ozone standards would require eliminating ***all existing emissions*** from:

- Stationary and area sources;
- Off-road equipment;
- Farm equipment;
- Passenger vehicles; and
- Heavy-duty trucks

[6] June 29, 2014 memorandum to San Joaquin Valleywide Air Pollution Study Agency, http://www.valleyair.org/Board_meetings/Study%20Agency/agendas/2014/June/final/04.pdf

[7] Quote from SJVAPCD Executive Director and Air Pollution Control Officer Seyed Sadredin, in presentation to "Workshop on Ozone NAAQS Science and Policy" on April 7, 2015.

Figure 3, while describing a rapidly declining ozone inventory between 1990 and 2015, also illustrates that NO_X reductions to near-zero levels will be needed to achieve the proposed standards, meaning that nearly every car, truck, tractor, boiler and other combustion sources in the valley would need to either be eliminated or produce nearly zero emissions within the next two decades.

Further complicating the matter is the issue of transboundary transport of pollution. According to the SJVAPCD, while the majority of emissions in the valley are generated locally, "policy-significant" levels ozone are transported into the valley from other areas, including areas as near as the San Francisco Bay area and as far away as Asia. Evidence suggests these contributions may add from between 35 parts per billion of ozone to more than 50 ppb, creating significant, uncontrollable (by SJVAPCD) baseline ozone levels. Given that a standard as low as 65 ppb is being proposed, this brings into question whether the standard would be attainable.[8] Even if these targets may be achievable with future technology advancements, it seems unlikely they would be achievable within the existing timelines prescribed in the federal Clean Air Act.

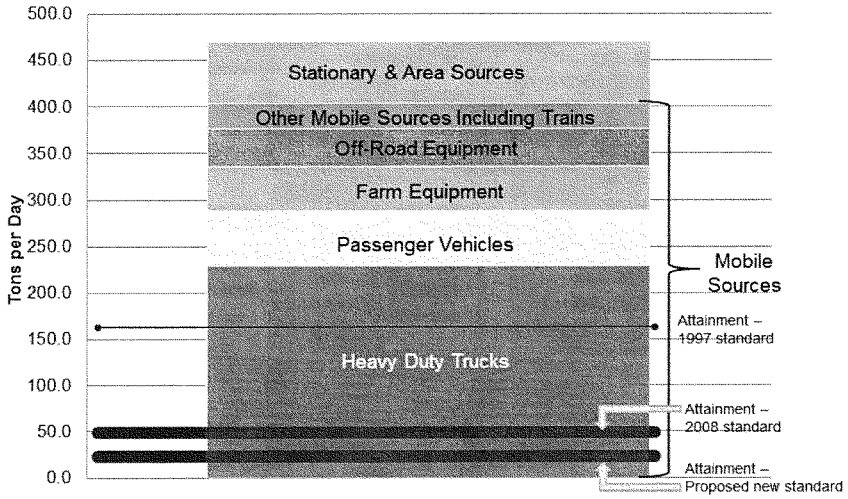


Figure 7. Meeting proposed federal ozone standards in the San Joaquin Valley would require eliminating the vast majority of existing sources. *Source: SJVAPCD*

[8] "Technology and Policy Options, The Search for Effective Solutions," Transboundary Ozone Pollution Conference, April 2, 2015 presentation, S. Sadredin. See Attachment A.

Is this problem limited to the San Joaquin Valley?

Those who think achieving a 65 to 70 ppb ozone standard will only be a problem in the admittedly unique San Joaquin Valley will be in for a rude surprise. As Figure 8 shows, at least 44 states are at risk of violating the proposed ozone standard.

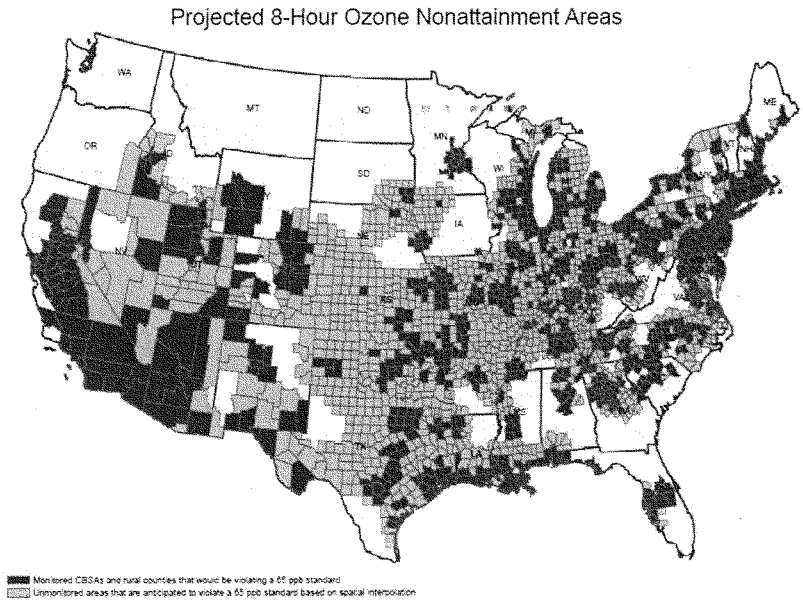


Figure 8. Projected 8-hour ozone nonattainment areas impacting 44 states. *Source: URS, July 7, 2014.*

Is implementation of the Clean Air Act structured to handle the coming non-attainment crisis?

Even with today's NAAQS for ozone, significant and unnecessary problems are occurring during implementation of the federal Clean Air Act. We can describe these problems and offer practical solutions, which do not force an unnecessary choice between protecting the economy and protecting air quality.

Problem 1 is implementing multiple NAAQS standards. Today, when a newer, more stringent standard is adopted, the older standard remains in place. This creates multiple, redundant planning timelines and public processes. For example, the SJVAPCD is currently addressing four pending standards for ozone and four additional standards for $PM_{2.5}$. In 2016 alone (after addressing the 1997 $PM_{2.5}$ standard during 2015) the district will be forced to report progress again on the 2006 *and* 2012 standards for, incredibly, $PM_{2.5}$. On top of that, SJVAPCD will also have to address the 2008 standard for ozone in 2016.

These multi-layered planning timelines exponentially increase the cost of implementing attainment plans and reporting on progress. They do nothing to improve air quality, because air quality could be protected by simply aligning the existing plans to newly adopted standards.

This additional administrative burden not only raises costs for taxpayers, but increases the costs of compliance for the regulated community, again without an air quality benefit. Businesses are also burdened with the substantial uncertainty associated with tracking multiple State Implementation Plans, associated rulemaking and permitting processes, and maintaining understanding about likely future requirements. This makes it that much more difficult to plan equipment retirement and replacement and potential future expansions or facility upgrades.

Specific recommendations on how to address this issue, without sacrificing air quality, have been put forward by SJVAPCD in its "2015 Federal Clean Air Act Modernization Proposal" (see Attachment B). We support these recommendations.

A second problem is the heavier reliance air regulators will need to make on new or transformative technologies to reach newly adopted standards. This is an increasing problem as the standards reach near baseline levels. There is substantial uncertainty about whether these technologies – sometimes called "black box" technologies because it is not yet understood even what the technologies will be – will be technically or economically feasible. The Clean Air Act today does not currently allow economic feasibility to be considered when considering a more stringent NAAQS; we believe it is time to revisit this issue because adoption of unattainable standards automatically leads to requirements that air regulators work to achieve those unattainable standards. As standards move closer and closer to baseline, the luxury of waiting until the future to find out if they can be met no longer exists. SJVAPCD has proposed very reasonable, narrow and specific amendments to the Clean Air Act that address this problem (Attachment B).

A third problem is rigidity in the requirements for reporting progress on reductions from sources of criteria pollutant precursors. Regulators have long recognized that not all precursors are created equal. For example, in the San Joaquin Valley, oxides of nitrogen have proven to be 20 times more powerful than VOCs in creating ozone. Yet regulators are handcuffed into achieving equal reductions of both VOCs and nitrogen oxides as they report Reasonable Further Progress in attaining a standard. Alternative strategies that achieve an equal or even greater amount of pollution reduction are not allowed. Again, SJVAPCD has suggested specific changes that would solve this issue without sacrificing achievable air quality goals (Attachment B).

There are additional technical changes that SJVAPCD has proposed related to when contingency measures should be required, and to clarify the role of vehicle pollution control measures in attaining standards after recent court rulings left this important program in question. In summary, SJVAPCD has suggested several specific, workable changes to the sections 172, 181, 182 and 189 of the Clean Air Act. We hope your subcommittee will take these under advisement.

State control on mobile agricultural equipment

The California Air Resources Board is considering new regulations for mobile agricultural equipment, potentially to be adopted in 2016, that would aim for reductions from this source toward meeting NAAQS in 2023 and 2032. CARB has identified most equipment with 25 horsepower or larger engines as targets for this regulation, including tractors, harvesters, combines, balers, swathers, sprayers, forklifts and all-terrain vehicles.

While these regulations have not been developed, it points to the continued burden placed on rural communities and agriculture as NAAQS are continually tightened down. Furthermore, it speaks to the need for alignment and conformity in state and federal rules regarding mobile agricultural equipment. Because of their nature and sometimes seasonal use, many mobile agricultural equipment types can have very long service lives and it will be important to carefully consider these special factors when making policy decisions.

Impacts to business and dairies

It is clear that past decisions related to NAAQS have had real-world unintended consequences, including generating unnecessary administrative and business costs that do not benefit air quality. Absent reform of the Clean Air Act, this situation will only worsen and become more prevalent across the United States.

California dairies already operate under the most stringent and expensive air quality regulations in the world. However, those regulations represent only a slice of environmental regulatory costs for California dairies, which also are meeting the nation's most stringent and expensive water quality protection regulations. The state's dairy industry, including processors and producers, are paying additional direct and indirect costs associated with California's Global Warming Solutions Act of 2006, which taxes large dairy processors for greenhouse gas emissions while increasing energy costs for other sectors, including dairy farms, who require fuel and electricity to operate. And all of this is occurring in the context of a several-years-long drought. Contrary to news media reports, agriculture, including dairies, has suffered dramatic cutbacks in water supplies (between 65 percent and 100 percent cutbacks in each of the past three years for contractors in the federal Central Valley Project and State Water Project).

Though California remains the nation's top agricultural and dairy state, some are wondering how long this will last. Nearly 500 of the state's dairies (about one-fourth) have gone out of business in the past five years. At least seven other states, including Texas, Kansas, Nebraska, Nevada, Iowa, Missouri, and North Dakota (Attachment C) are actively recruiting California dairy

operators to relocate to their states, and quite a few of our dairies have taken them up on the offer. In fact, a prominent dairy leader in Idaho recently thanked several visitors from California for "sending us your best dairy farmers."

However, it seems that if we continue to follow the current path, we are heading toward a place where California's loss isn't another state's gain. As Figure 8 shows, few states will be exempt from the types of regulatory pressures California faces today. We may just be the canary in coal mine, and when dairies run out of places to go, we may drive another industry completely out of the country. I, for one, do not think that needs to happen and hope that leaders like you will give careful consideration to the issues and potential solutions that we have presented today.

Again, thank you Mr. Chairman and members of the subcommittee for your kind attention and the opportunity to provide testimony to you on this important matter.

Attachment A – April 2, 2015 Presentation to Transboundary Ozone Pollution Conference: "Technology and Policy Options, the Search for Effective Solutions," Seyed Sadredin, Executive Director, APCO for San Joaquin Valley Air Pollution Control District

Technology and Policy Options

The Search for Effective Solutions

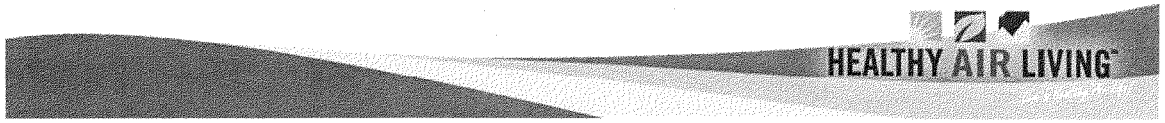
Transboundary Ozone Pollution Conference

April 2, 2015

Seyed Sadredin

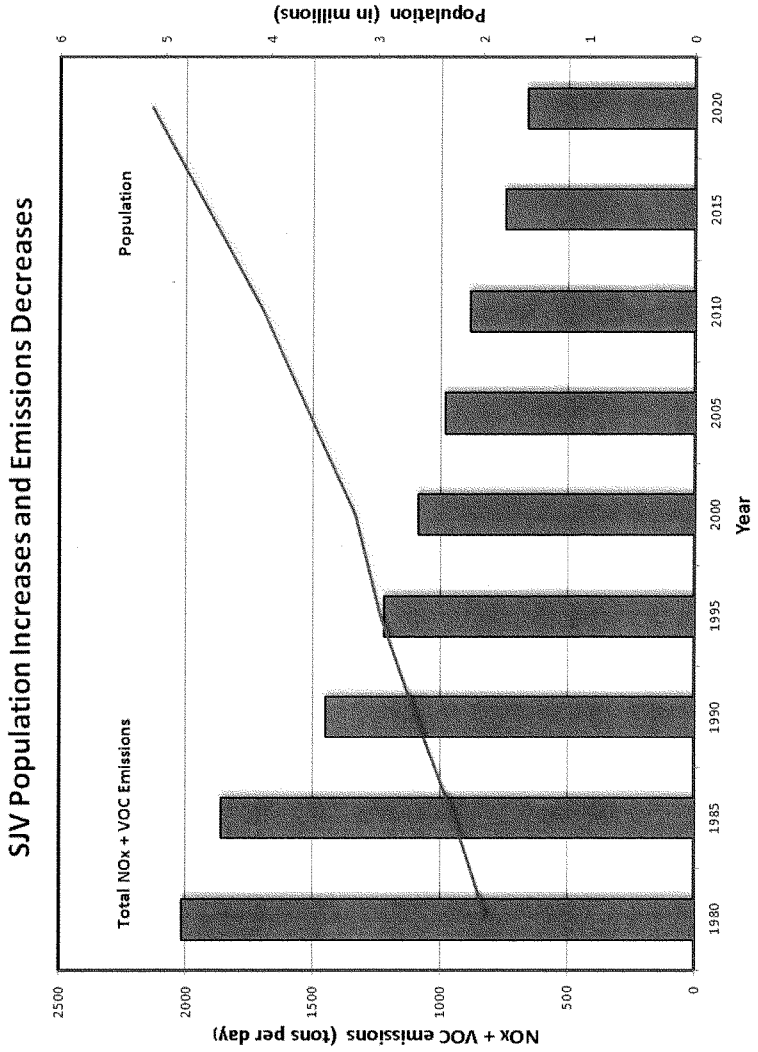
Executive Director/APCO

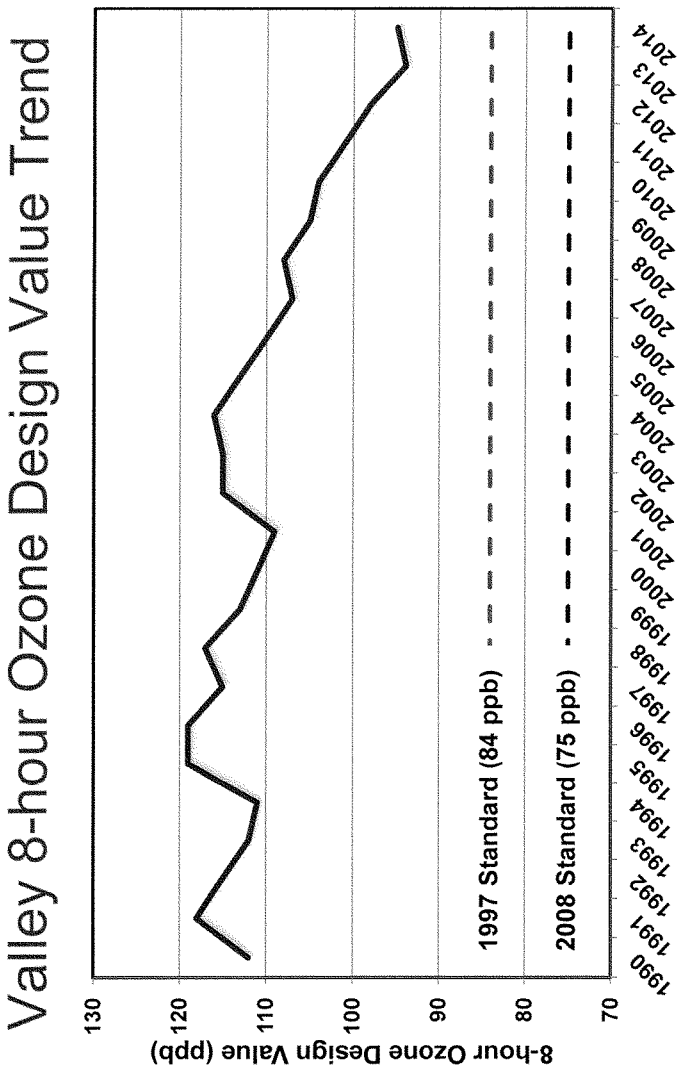
San Joaquin Valley Air Pollution Control District



What if a region did all of these?

- ✓ Toughest air regulations on stationary sources (600 rules since 1992)
- ✓ Toughest air regulations on farms and dairies
- ✓ $40 billion spent by businesses on clean air
- ✓ Over $1 billion dollars of public/private investment on incentive-based reductions
- ✓ Toughest regulations on cars and trucks
- ✓ Toughest regulations on consumer products
- ✓ Reduced emissions by 80% - *but need another 90% reduction in emissions just to meet a standard that will soon be replaced with an even tougher standard*

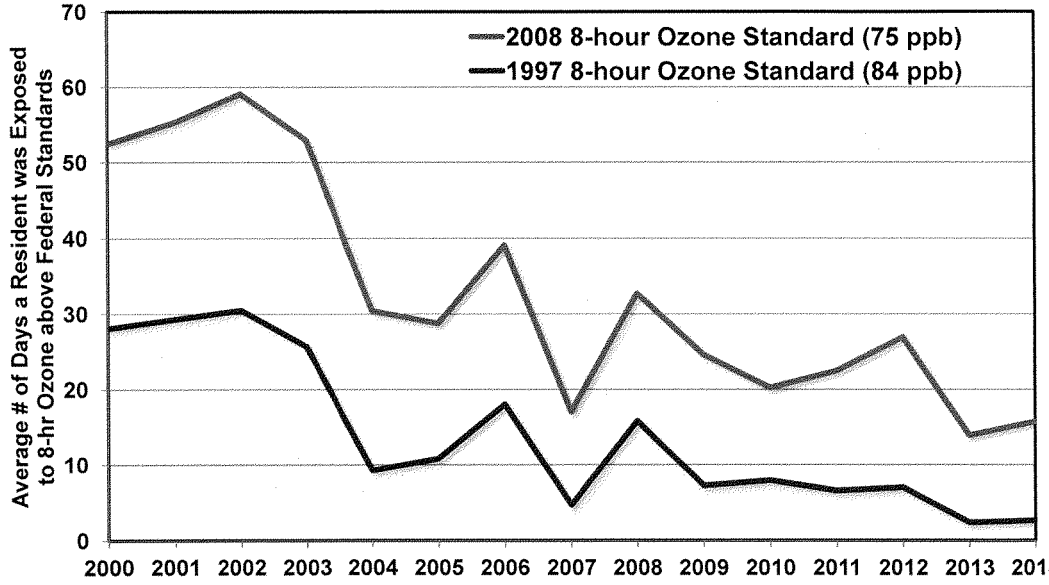

SJV Population Increases and Emissions Decreases
Total NOx + VOC Emissions
Population
NOx + VOC emissions (tons per day)
Population (in millions)
Year
0
500
1000
1500
2000
2500
0
1
2
3
4
5
6
1980
1985
1990
1995
2000
2005
2010
2015
2020


Valley 8-hour Ozone Design Value Trend
8-hour Ozone Design Value (ppb)
130
120
110
100
90
80
70
1997 Standard (84 ppb)
2008 Standard (75 ppb)
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

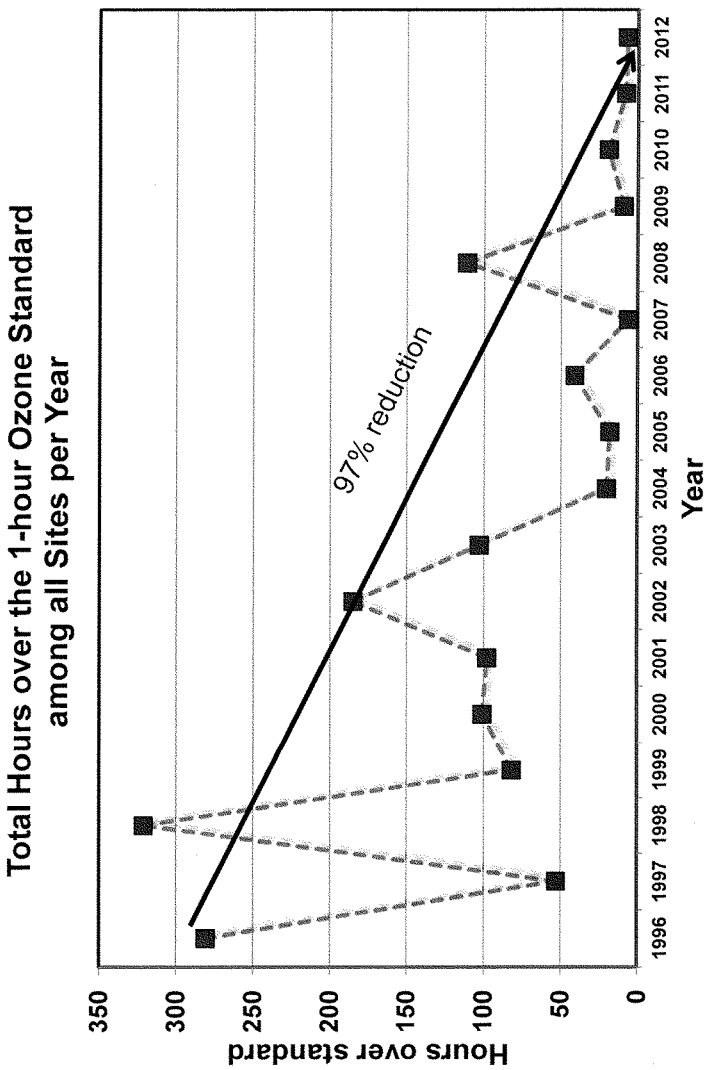
Days over 84 ppb 8-hour Ozone Standard by County (2003 and 2014)

County	2003	2014
San Joaquin	2	0
Stanislaus	18	4
Merced	54	1
Madera	14	5
Fresno	97	22
Kings	15	4
Tulare	92	13
Kern	116	14
TOTAL	**408**	**63**

Significant Reduction in Population Exposure

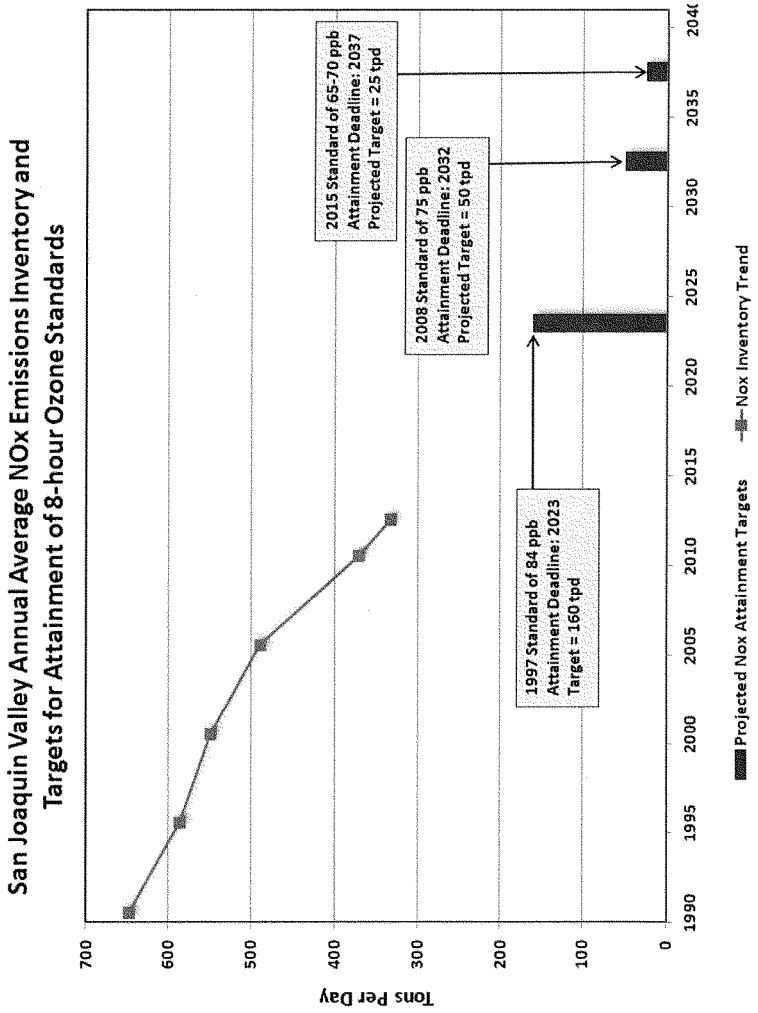


HEALTHY AIR LIVING

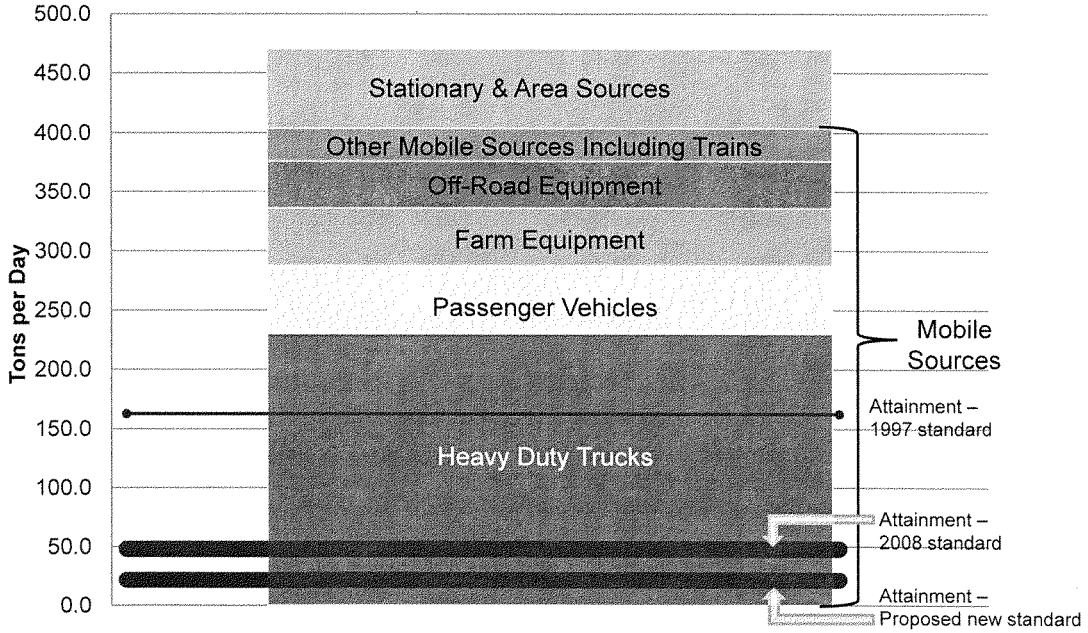

Total Hours over the 1-hour Ozone Standard
among all Sites per Year
97% reduction
Hours over standard
350
300
250
200
150
100
50
0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Year

New Ozone NAAQS

- New federal standards approach ~~background~~ baseline pollution concentrations
- Technology does not exist to get all the emission reductions needed
- Meeting the standards require ban on fossil fuel combustion or emissions
- Meeting the standards require transformative changes
  - Cost prohibitive?
  - Require more time than allowed under the Clean Air Act


San Joaquin Valley Annual Average NOx Emissions Inventory and Targets for Attainment of 8-hour Ozone Standards
Tons Per Day
700
600
500
400
300
200
100
0
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
1997 Standard of 84 ppb Attainment Deadline: 2023 Target = 160 tpd
2008 Standard of 75 ppb Attainment Deadline: 2032 Projected Target = 50 tpd
2015 Standard of 65-70 ppb Attainment Deadline: 2037 Projected Target = 25 tpd
Projected Nox Attainment Targets
Nox Inventory Trend

Meeting New Federal Ozone Standards
San Joaquin Valley



Why SJV is Involved

- We **MUST and WILL** do everything feasible to control local sources regardless of background (including Asia transport)
- Majority of our ozone is from local sources but background concentrations are policy relevant
  - EPA estimate (35 ppb) - Models and field observations (50+ ppb)
- Policy relevance
  - Is attainment possible given the background?
  - How much does it cost to reduce 1ppb of ozone transported from Asia?
  - Is it fair for Valley residents & businesses to pay for Asian pollution?
- Need to invest in scientific research to develop tools to better estimate all contributors to background concentrations including transboundary ozone
- More work needed on exceptional event policy and 179B application to TAO impact (stratospheric intrusion?)

My Initial Conference Takeaways

$ Need to do more work to reconcile difference between global models and monitored data

- Dr. Parrish presents some inconvenient truths
  - Identifies gaps in the state of science and public policy that need to be further explored
  - His Eulerian qualitative analysis can easily be cherry picked and misrepresented by transport deniers to attack his credibility
- Best defense offered for use of global models
  - Models may have canceling errors but have no bias
  - No sound evidence of lack of bias
  - In 34 years, I have not seen a model that comes close
- Use the right model - the right way - to get the right answer
  - Once you get the answer you like – STOP!

  $ Need to use better inventory

More Conference Takeaways

- Global models fall short once they hit the boundary layer
  - – Cannot handle regional boundary layer entrainment dynamics
  - $ Need higher resolution to better quantify regional impacts
  - $ Ground based LIDAR, combined with air flights and satellite data will help this as well as efforts to reconcile observed monitoring and modeling results
  - $ Based on extensive field research, Dr. Faloona is on the cutting edge when it comes to understanding boundary layer dynamics especially in the complex terrain of the Valley
  - $ More in-situ measurements with more robust tracers
- Need to enhance global models to provide better boundary conditions for regional models
  - $ Need to capture daily peaks, not monthly or seasonal mean values

Attachment B – 2015 Federal Clean Air Act Modernization Proposal, from the San Joaquin Valley Air Pollution Control District

San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

HEALTHY AIR LIVING

2015 Federal Clean Air Act Modernization Proposal

Since its adoption, the Clean Air Act has led to significant improvements in air quality and public health benefits throughout the nation. In many areas of the nation, air pollution levels have been reduced to historical lows. We support the well-intentioned concepts in the Clean Air Act that call for routine review of health-based air quality standards, clean air objectives that are technology-forcing, and clean-air deadlines that ensure expeditious clean-up and timely action.

The Clean Air Act was last amended in 1990. Over the last 25 years, local, state, and federal agencies and affected stakeholders have learned important lessons from implementing the law and it is clear now that a number of well-intentioned provisions in the Act are leading to unintended consequences. This experience can inform efforts to enhance the Clean Air Act with much needed modernization. The following proposal is designed to provide specific language aimed at improving the Act's effectiveness and efficiency.

1. **PROBLEM:** Since the 1970's, EPA has established numerous ambient air quality standards for individual pollutants. We have now reached a point where various regions throughout the nation are subject to multiple iterations of standards for a single pollutant. For instance, there are currently 4 pending standards for ozone and 4 pending standards for PM2.5. Each of these standards requires a separate attainment plan which leads to multiple overlapping requirements and deadlines. This in turn results in a great deal of confusion, costly bureaucracy, and duplicative regulations, all without corresponding public health benefits.

SOLUTION: When a new standard is published, the old standard for that pollutant should be subsumed. States should be allowed to develop a single attainment plan that harmonizes increments of progress and other milestones without allowing for any rollback or backsliding.

PROPOSED AMENDMENTS: To avoid duplicative requirements and confusion, the RFP milestones must be synchronized when a new standard is published, for any region with a pending implementation plan for an older version of the standard for that pollutant. Towards that end, the first RFP milestone for the new standard should be aligned with the next required milestone for the old standard. The reductions required for aligned milestones shall be either 3 percent of the baseline for the new standard or the RFP emission reduction targets established under the existing plan, whichever is greater.

For ozone, add new subsection 182(k) as follows:

(k) RFP Milestone Alignment for Areas with Pending Attainment Plans

Notwithstanding any other provisions of this section, the RFP milestones and emission reduction targets in areas that have submitted a plan to the Administrator for the older version of a standard for the same pollutant being addressed by a new standard shall be set as follows:

The first RFP milestone for the new standard shall be set at the next RFP milestone date for the existing standard addressed in the current plan. Subsequent milestones will be every three years from the first milestone until attainment. The reductions required at the aligned milestones that address more than one standard shall be either 3 percent of the baseline for the new standard or the RFP emission reduction targets established under the current plan for the older standard, whichever is greater.

For particulates, add new subsection 189(c)(4) as follows:

(4) RFP Milestone Alignment for Areas with Pending Attainment Plans

Notwithstanding any other provisions of this section, the RFP milestones and emission reduction targets in areas that have submitted a plan to the Administrator for the older version of a standard for the same pollutant being addressed by a new standard shall be set as follows:

The first RFP milestone for the new standard shall be set at the next RFP milestone date for the existing standard addressed in the current plan. Subsequent milestones will be every three years from the first milestone until attainment. The reductions required at the aligned milestones that address more than one standard shall be either those required for the new standard or the RFP emission reduction targets established under the current plan for the older standard, whichever is greater.

2. PROBLEM: Mobile and stationary sources throughout the nation have now been subject to multiple generations of technology forcing regulations that have achieved significant air quality benefits. Meeting the new standards that approach background concentrations call for transformative measures that require time to develop and implement. These transformative measures require new technologies that in many cases are not yet commercially available or even conceived. The formula-based deadlines and milestones that were prescribed in the Act 25 years ago now lead to mandates that are impossible to meet.

SOLUTION: In establishing deadlines and milestones, the Act should be amended to require control measures that lead to the most expeditious attainment of health based standards while taking into account technological and economic feasibility. These deadlines and milestones should also consider background pollution concentrations and

the region's geography, topography, and meteorology that affect pollutant formation and dispersion.

PROPOSED AMENDMENTS:

In relation to RFP targets for ozone, amend subsection 182(b)(1)(A)(ii)(III) as follows:

the plan reflecting a lesser percentage than 15 percent includes all measures that can feasibly be implemented in the area, in light of technological achievability and economic feasibility.

In relation to RFP targets for ozone, amend subsection 182(c)(2)(B)(ii) as follows:

an amount less than 3 percent of such baseline emissions each year, if the State demonstrates to the satisfaction of the Administrator that the plan reflecting such lesser amount includes all measures that can feasibly be implemented in the area, in light of technological achievability and economic feasibility.

In relation to RFP targets for ozone, amend subsection 182(e) as follows:

Each State in which all or part of an Extreme Area is located shall, with respect to the Extreme Area, make the submissions described under subsection (d) of this section (relating to Severe Areas), and shall also submit the revisions to the applicable implementation plan (including the plan items) described under this subsection. ~~The provisions of clause (ii) of subsection (c)(2)(B) of this section (relating to reductions of less than 3 percent), t~~The provisions of paragaphs [6] (6), (7) and (8) of subsection (c) of this section (relating to de minimus [7] rule and modification of sources), ~~and the provisions of clause (ii) of subsection (b)(1)(A) of this section (relating to reductions of less than 15 percent)~~ shall not apply in the case of an Extreme Area. For any Extreme Area, the terms "major source" and "major stationary source" includes [8] (in addition to the sources described in section 7602 of this title) any stationary source or group of sources located within a contiguous area and under common control that emits, or has the potential to emit, at least 10 tons per year of volatile organic compounds.

In relation to RFP targets for particulates, amend subsection 189(c)(1) as follows:

Plan revisions demonstrating attainment submitted to the Administrator for approval under this subpart shall contain quantitative milestones which are to be achieved every 3 years until the area is redesignated attainment and which demonstrate reasonable further progress, as defined in section 7501(1) of this title, and which take into account technological achievability and economic feasibility, toward attainment by the applicable date.

In relation to the attainment deadlines for ozone:

Amend section 181(a) by adding the following new subsection 181(a)(6):

Notwithstanding table 1, if an area is already classified as extreme for an existing standard, then the area shall be classified as extreme at the time of designation for the new standard.

Amend section 181(a) by amending table 1 as follows:

TABLE 1

Area class	***Design value****	***Primary standard attainment date***
Marginal	*0.121 up to 0.138*	*3 years after November 15, 1990*
Moderate	*0.138 up to 0.160*	*6 years after November 15, 1990*
Serious	*0.160 up to 0.180*	*9 years after November 15, 1990*
Severe	*0.180 up to 0.280*	*15 years after November 15, 1990*
Extreme	*0.280 and above*	~~*20 years after November 15, 1990*~~ *As prescribed in section 181(a)(7)*

Amend section 181(a) by adding the following new subsection 181(a)(7):

Areas shall attain the standard as expeditiously as possible with the most effective measures that take into account technological achievability and economic feasibility. The area shall quantify reductions needed to achieve attainment consistent with section 182(e)(5). Every 5 years after the plan is approved by the Administrator, the area shall demonstrate that all measures that are technologically achievable and economically feasible are implemented or will be included in the plan to ensure expeditious implementation. The plan shall also include measures for advancing the development and deployment of new technologies.

Amend section 182(e)(5) as follows:

(5) New technologies
The Administrator may, in accordance with section 7410 of this title, approve provisions of an implementation plan for an Extreme Area which anticipate development of new control techniques or improvement of existing control technologies, and an attainment demonstration based on such provisions~~, if the State demonstrates to the satisfaction of the Administrator that—~~

~~*(A)such provisions are not necessary to achieve the incremental emission reductions required during the first 10 years after November 15, 1990; and*~~

~~*(B)the State has submitted enforceable commitments to develop and adopt contingency measures to be implemented as set forth herein if the anticipated technologies do not achieve planned reductions.*~~

~~*Such contingency measures shall be submitted to the Administrator no later than 3 years before proposed implementation of the plan provisions and approved or disapproved by the Administrator in accordance with section 7410 of this title. The contingency measures shall be adequate to produce emission reductions sufficient, in conjunction with other approved plan provisions, to achieve the periodic emission reductions required by subsection (b)(1) or (c)(2) of this section and attainment by the applicable dates. If the Administrator determines that an Extreme Area has failed to achieve an emission reduction requirement set forth in subsection (b)(1) or (c)(2) of this section, and that such failure is due in whole or part to an inability to fully implement provisions approved pursuant to this subsection, the Administrator shall require the State to implement the contingency measures to the extent necessary to assure compliance with subsections (b)(1) and (c)(2) of this section.*~~

~~*Any reference to the term "attainment date" in subsection (b), (c), or (d) of this section which is incorporated by reference into this subsection, shall refer to the attainment date for Extreme Areas.*~~

3. PROBLEM: The Act as it relates to the demonstration of Reasonable Further Progress or Rate of Progress treats all precursors the same, regardless of their potency in harming public health or achieving attainment. Driven by a rapidly expanding body of scientific research, there is now a growing recognition within the scientific community that from an exposure perspective, the National Ambient Air Quality Standards metrics for progress are a necessary but increasingly insufficient measure of total public health risk associated with air pollutants. In particular, control strategies for sources of PM2.5 and ozone do not necessarily account for qualitative differences in the nature of their emissions. For PM2.5, toxicity has been shown to vary depending on particle size, chemical species, and surface area. In the case of ozone, differences in the relative potency of ozone precursors, VOCs in particular, is not captured by a strict, mass-based approach to precursor controls.

SOLUTION: The Act should be amended to allow states to focus efforts on meeting new standards in the most expeditious fashion through deployment of scarce resources in a manner that provides the utmost benefit to public health. Towards that end, we recommend a more strategic approach in which public health serves as the key factor in prioritizing control measures, regulated pollutants, and sources of emissions. In establishing Reasonable Further Progress or Rate of Progress, the Act should give a greater weight to pollutants that have greater impact on achieving attainment and improving public health. Additionally, in evaluating Reasonably Available Control Technology (RACT), measures that reduce precursors with more impact on ozone formation should be given higher scores than measures that may reduce greater amounts of less potent ozone precursors.

For example, VOC compounds vary significantly in their contribution to the formation of ozone in the San Joaquin Valley. Similarly, NOx emissions reductions have been demonstrated to be approximately 20 times more effective than VOC emissions reductions in reducing the formation of ozone in the San Joaquin Valley. We therefore recommend that in demonstrating Reasonable Further Progress, EPA allow for an alternative approach that can demonstrate equivalent reductions in ozone concentrations as compared to the straight requirement of 3% per year reduction of VOCs and/or NOx.

PROPOSED AMENDMENTS:

Amend Section 182:

(C) NOx control
The revision may contain, in lieu of the demonstration required under subparagraph (B), a demonstration to the satisfaction of the Administrator that the applicable implementation plan, as revised, provides for reductions of emissions of VOC's and oxides of nitrogen (calculated according to the creditability provisions of subsection (b)(1)(C) and (D) of this section), that would result in a reduction in ozone concentrations at least equivalent to that which would result from the amount of VOC emission reductions required under subparagraph (B). Within 1 year after November 15, 1990, the Administrator shall issue guidance concerning the conditions under which NOx control may be substituted for VOC control or may be combined with VOC control in order to maximize the reduction in ozone air pollution. In accord with such guidance, a lesser percentage of VOCs may be accepted as an adequate demonstration for purposes of this subsection. <u>The Administrator shall allow the use of NOx reductions in lieu of VOC reductions. The credit for NOx reductions shall be weighted in proportion to their effectiveness in reducing ozone concentrations in relation to the effectiveness of VOC reductions as demonstrated by the attainment modeling submitted with the plan.</u>

4. PROBLEM: Requiring contingency measures in extreme nonattainment areas is irrational and unnecessary. The Act requires all attainment plans to include contingency measures, defined as extra control measures that go into effect without further regulatory action, if planned emissions controls fail to reach the goals or targets specified in the attainment plan. While requiring backup measures was a well-intentioned provision, it does not make sense in areas that have been classified as "extreme" non-attainment for ozone. These areas, by definition, have already implemented all available and foreseeable measures and still need a "black box" of future measures to define and employ. The term "black box" refers to reductions that are needed to attain the standard, but technology to achieve such reductions does not yet exist. No measures are held in reserve in areas that are classified as "extreme" non-attainment for ozone. With no stones left unturned in such plans, requiring contingency measures in such areas makes no sense.

SOLUTION: We recommend that the Act be amended to eliminate the requirement for contingency measures in areas classified as "extreme" non-attainment by EPA.

PROPOSED AMENDMENTS:

Add to 172(c)(9) as follows:

(9) Contingency measures
Such plan shall provide for the implementation of specific measures to be undertaken if the area fails to make reasonable further progress, or to attain the national primary ambient air quality standard by the attainment date applicable under this part. Such measures shall be included in the plan revision as contingency measures to take effect in any such case without further action by the State or the Administrator.
Notwithstanding this or other sections, contingency measures shall not be required for extreme ozone nonattainment areas.

5. PROBLEM: The Act requirements for severe and extreme ozone nonattainment areas to address vehicle-related emissions growth must be clarified. Section 182(d)(1)(A) requires such areas to develop enforceable transportation control measures (TCMs) and transportation strategies *"to offset any growth in emissions from growth in vehicle miles traveled ... and to attain reduction in motor vehicle emissions as necessary."* An area's vehicle miles traveled (VMT) may increase due to increases in population (i.e., more drivers), people driving further (i.e., sprawl), or increases in pass-through traffic (i.e., goods movement).

Historically, EPA's section 182(d)(1)(A) approach has allowed the use of vehicle turnover, tailpipe control standards, and the use of alternative fuels to offset the expected increase in VMT. This has allowed for the actual emissions reductions occurring from motor vehicles to be considered in meeting the applicable requirements. A recent Ninth Circuit Court decision, however, has called EPA's current approach for demonstrating the offsetting of vehicle mile-related emissions growth into question, and has forced EPA to reevaluate its approach. Any change in approach that would require regions to offset vehicle growth regardless of population growth, and without recognition of emission reduction measures such as vehicle turnover and tailpipe control standards, would have a significant impact on many regions' ability to develop an approvable attainment strategy and, under a strict interpretation, would actually render attainment impossible. Many TCMs and transportation strategies have already been implemented in nonattainment areas, and remaining opportunities are scarce and extremely expensive to implement, with relatively small amounts of emissions reductions available. A less inclusive section 182(d)(1)(A) approach would effectively penalize nonattainment areas for having population growth, and would not give credit to the significant emissions reductions being achieved from motor vehicles.

To illustrate this issue, such an interpretation applied to the District's 1997 8-hour ozone standard attainment plan would require the elimination of 5.1 million vehicles, while the vehicle population of the Valley is projected to be only 2.6 million vehicles in 2023.

EPA recently established new guidance to address this issue that provides a potential path for reasonably addressing this CAA requirement. However, the path provided under this guidance will undoubtedly be challenged in court as it is utilized by regions like the San Joaquin Valley in the coming years. To provide certainty moving forward, the CAA should be amended to clearly include the methodology for reasonably satisfying this requirement.

SOLUTION: The Act should be amended to allow states to take credit for all transportation control measures and strategies and not punish areas that have implemented transportation control measures and strategies that have achieved early reductions in emissions.

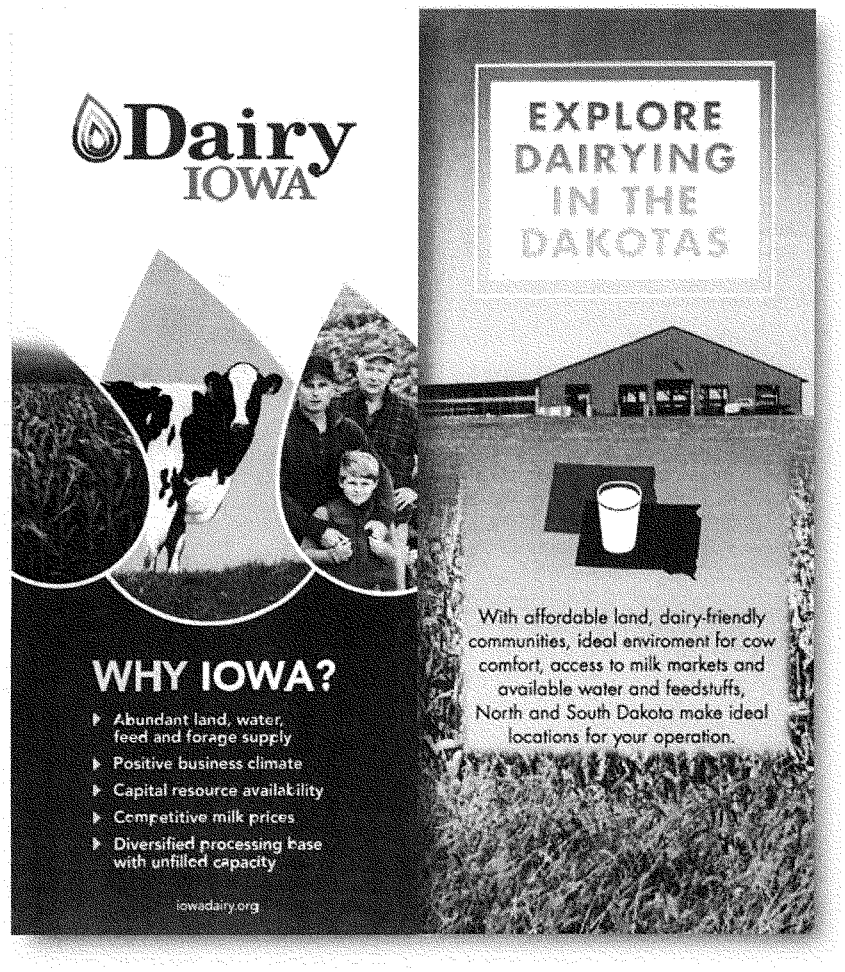
PROPOSED AMENDMENTS:

(1) Vehicle miles traveled
(A) Within 2 years after November 15, 1990, the State shall submit a revision that identifies and adopts specific enforceable transportation control strategies and transportation control measures to offset any growth in emissions from growth in vehicle miles traveled or numbers of vehicle trips in such area and to attain reduction in motor vehicle emissions as necessary, in combination with other emission reduction requirements of this subpart, to comply with the requirements of subsection [5] (b)(2)(B) and (c)(2)(B) of this section (pertaining to periodic emissions reduction requirements). The State shall consider measures specified in section 7408(f) of this title, and choose from among and implement such measures as necessary to demonstrate attainment with the national ambient air quality standards; in considering such measures, the State should ensure adequate access to downtown, other commercial, and residential areas and should avoid measures that increase or relocate emissions and congestion rather than reduce them. <u>As new ozone standards are established, for areas that have implemented early transportation control strategies and transportation control measures, the baseline for demonstrating compliance under this subsection shall remain fixed at 1990 independent of the baseline date for the new plan.</u>

Attachment C – Documentation of efforts by states to recruit California dairies

Recruitment efforts by other states

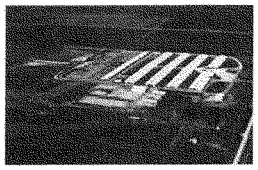
California's historic drought, regulatory environment and local land use policies is fostering a campaign by more than 5 states citing water and land availability with the hopes of courting California dairy families east.



Iowa supports the three essentials required for successful livestock production – **Water, Feed and Manure Management.**

Water

Traditionally high yields are accredited to Iowa's statewide availability of water, established wetlands, buffer strips and other efforts intended to manage water quality.



Manure Management

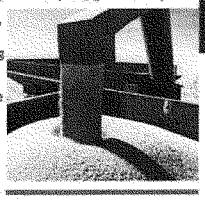
Deep soils and high yields are a perfect solution for recovering value from manure. Technologies for better spreading and more efficient handling are applied everywhere in Iowa.

Streamlined Permit Process with Ready-to-Go Dairy Sites

The Ag Team at Iowa Area Development Group is already working for you. We have dairy sites ready for your review. Local issues, water, hard surfaced roads, manure handling and other location factors have all been evaluated. The streamlined permitting process is handled through the State of Iowa and is typically completed within 90 days.

Feed

Iowa's fertile land allows the production of high quality feed grains and quality grass and hay, which adds to profitability and reduces the fluctuating feed prices. Iowa's central location in the Midwest also provides access to high-quality, low-cost rations.



The combination of stable pricing, quality products, access to quality feed, and support services creates a highly competitive scenario for existing and potential dairy operations in the state.

Abundant Milk Processing Capacity

Iowa has a robust and growing dairy industry and currently ranks 8th in total dairy products processed. Meaning there is high demand for locally produced milk.

Great Dairy Infrastructure

Iowa provides the full continuum of services, suppliers, transportation and processors to support successful operations. Veterinarians, dairy equipment service companies, manure handling companies and many more are readily available.

Great Family Infrastructure

What people find when they make Iowa home is a genuinely great place to live, work, and raise a family. They discover a place where neighbors are friendly, communities are welcoming, and quality public and private education is a reality.

- Iowa is ranked the nation's 2nd-most livable state.
- Iowa is named the 5th-best state to raise a child.

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the right resources

Knox County, NE can provide abundant feed and water, some of the lowest electric rates in the country, and ample rural areas to locate large dairies.

the right market

Six (6) dairy processors within a 125-mile radius and five (5) more within 200 miles that need you.

the right quality of life

Knox County is home to communities with great schools, safe neighborhoods, and affordable housing. It is within 30 to 60 minutes of larger city amenities of Norfolk, NE, Sioux City, IA or Yankton, SD. Knox County borders the magnificent 30-mile Lewis and Clark Lake, part of the Missouri National Recreational River, offering great fishing and boating opportunities and the largest camping destination in the Midwest.

Nebraska Livestock Friendly

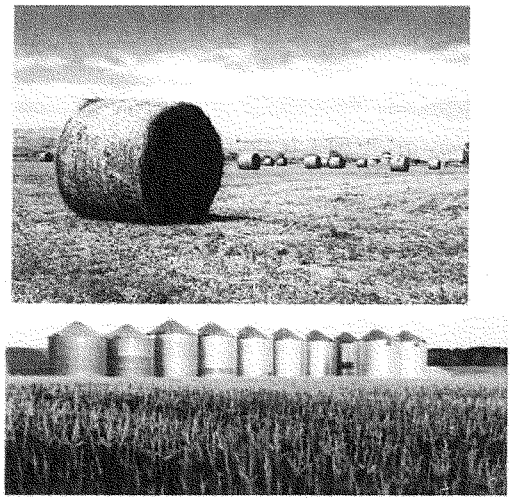
We are designated by the state as a Livestock Friendly County. The Livestock Industry is crucial to our future. Knox County is excited about the opportunity to show our county, communities and available land.

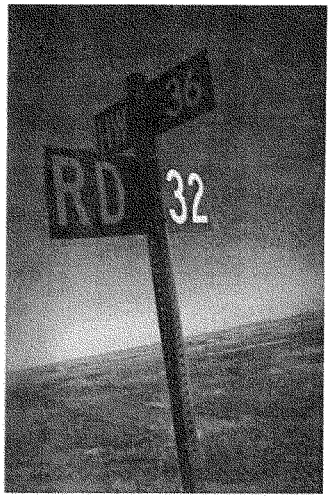
We believe Knox County is a great destination for your operation.

Let us show you. Contact us today.

KNOX COUNTY DEVELOPMENT AGENCY | NEBRASKA missouri river AREA

KNOX COUNTY DEVELOPMENT AGENCY
PO Box 165 | Center, NE 68724
(402) 288-5619 | knoxcodevelopment@gpcom.net
www.knoxcountyeconomicdevelopment.com





WIDE OPEN SPACES AND BLUE SKIES

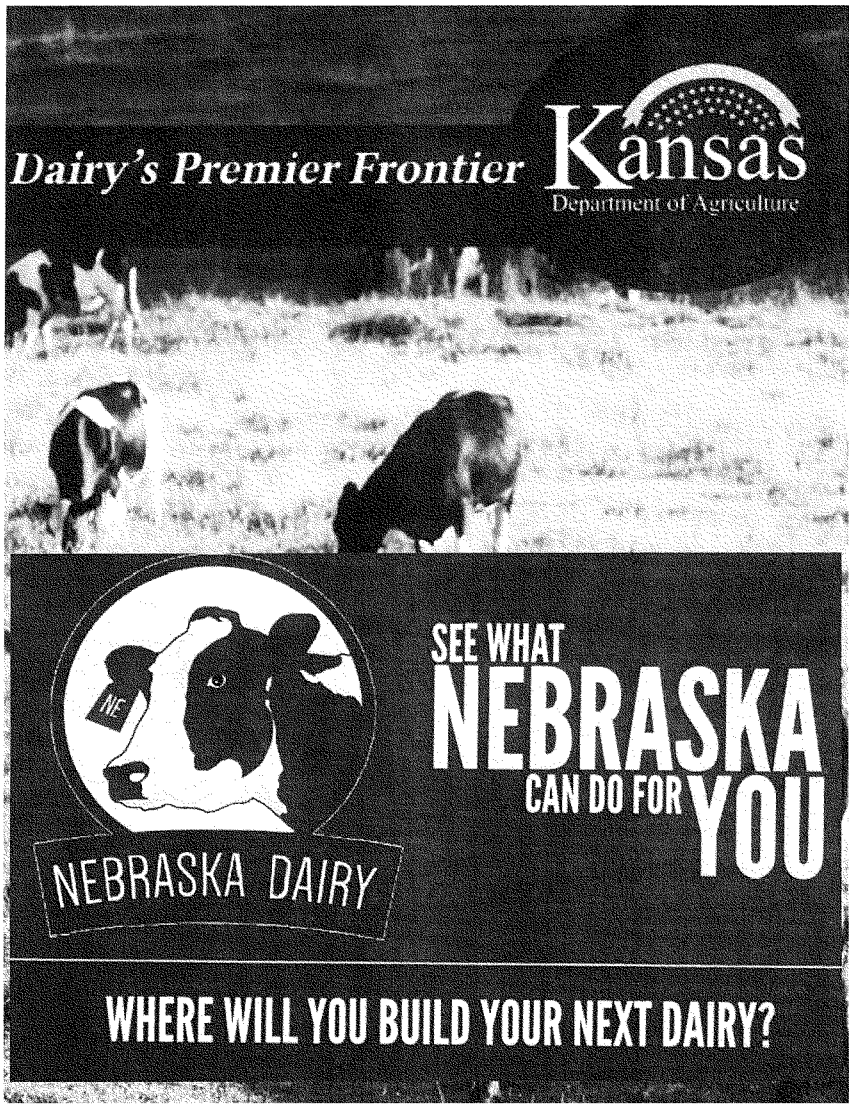
With abundant feed supplies, competitive land prices, ideal climate and supportive rural communities, Kansas is quickly establishing itself as a premier dairy location.

Kansas ranks third in the U.S. for the amount of land in farms with more than 46 million acres dedicated to agriculture. Ranking second in the nation for total cropland, Kansas is one of the largest Midwest feed sheds with abundant corn, alfalfa and soybeans. Commodities are easy to access with local feed cooperatives available in nearly every county.

Western Kansas' dry, arid climate and moderate temperature make it the ideal place to relocate or expand a dairy operation. Average precipitation for ideal dairy locations ranges from approximately 15 to 30 inches per year, with irrigation water available to assist in raising crops. The dry climate lends itself well to dry-lot or free stall operations.

Located directly above the Ogallala Aquifer, the world's largest underground water supply, Kansas has existing water rights available and is implementing proactive water conservation practices allowing farmers and ranchers to manage their own water while still preserving the aquifer for generations to come.

Rural communities are the driving force behind the success of agricultural in Kansas and Kansan's high quality of life. Low population density and close-knit agriculture-based communities in Kansas make it the perfect location for dairy operations and families alike.


Dairy's Premier Frontier
Kansas
Department of Agriculture
NE
NEBRASKA DAIRY
SEE WHAT
NEBRASKA
CAN DO FOR YOU
WHERE WILL YOU BUILD YOUR NEXT DAIRY?

KEVIN ABERNATHY, 2881 Geer Road, Suite D., Turlock, CA.

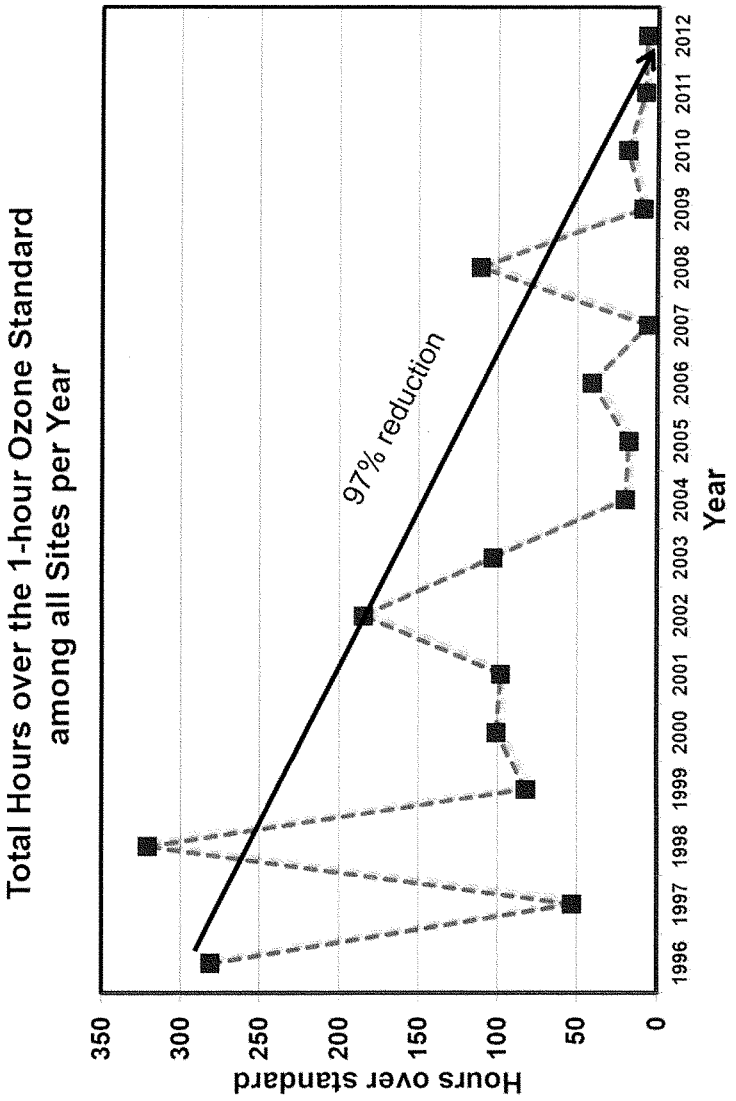
With over 30 years of experience in the dairy industry, Kevin spent the last four years as the director of regulatory affairs for the Milk Producers' Council and prior to that was the executive director for the California Dairy Campaign. Recent activities include his work in evaluating practical and effective innovative approaches to reducing dairy air emissions and developing air quality regulations for dairies in the San Joaquin Valley. In partnership with environmental organizations, researchers, and United States Department of Agriculture (USDA), the team is evaluating, demonstrating and fostering the adoption of several innovative and promising strategies for reducing agricultural air emissions. This is done in conjunction with supporting farm economics such as conservation tillage for improving dairy feed crop production yields, bio-energy production, and innovative physical, chemical and biological lagoon treatment technologies. He is also coordinating participation of dairy producers in on-farm research to quantify VOC and greenhouse gas emissions from feed sources for the purpose of improving the accuracy of dairy air emissions factors. By fostering partnerships between dairy producers and researchers, Kevin has helped to identify dairy air emissions sources and demonstrate cost-effective control strategies in the San Joaquin Valley.

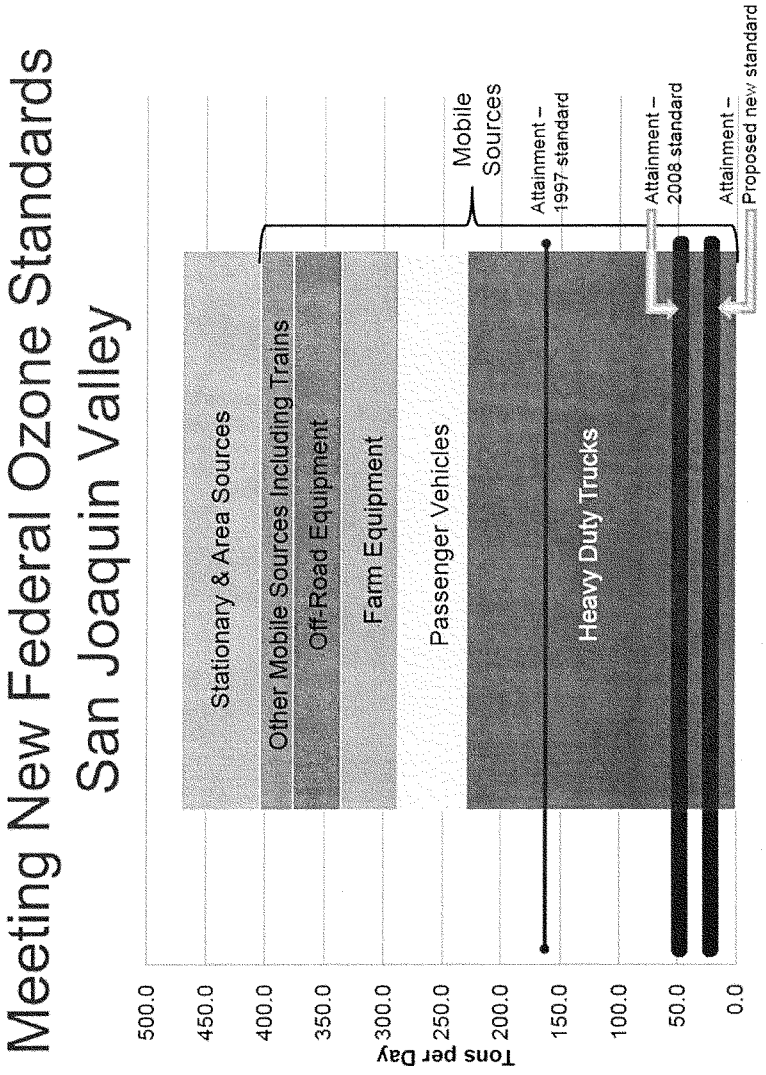
Kevin Abernathy is also engaged in numerous education and outreach programs for both dairy producers and the general public. With support from a USDA Conservation Innovation Grant, Kevin established a team of professional agronomists, environmental chemists, hydro-geologists and engineers to assist members in developing and complying with new California CAFO air and water quality regulations. In additional to this team of professionals, Kevin also directs a team of field advisors that guides dairy farmers through the environmental permitting process, facilitates development of applications for EQIP funding, and actively recruits farmers to participate in the California Dairy Quality Assurance Program (CDQAP). Through his leadership, the California Dairy Campaign field staff are certified as 'evaluators' for the CDQAP, an education-based, farm certification program developed by the dairy industry in partnership with University of California, USDA-NRCS, EPA and state regulatory agencies. Through CDQAP, over 1,600 producers have attended numerous environmental education courses that have been instrumental in helping producers comply with increasingly stringent air and water quality and animal welfare regulations. In addition, hundreds of producers have chosen to complete a thorough on-farm environmental evaluation inspection process and achieved certification. Kevin also serves as a board member for Dairy Community Alliance for Responsible Environmental Stewardship (CARES), where his primary responsibility is to represent the dairy industry in regulatory development, as well as to educate regulators, producers, and consumers regarding environmental issues related to California dairy farming. He is also working with the San Joaquin Valley Air Pollution Control District's (SJVAPCD) Healthy Air Living Program designed to educate the public about how they can reduce air emissions.

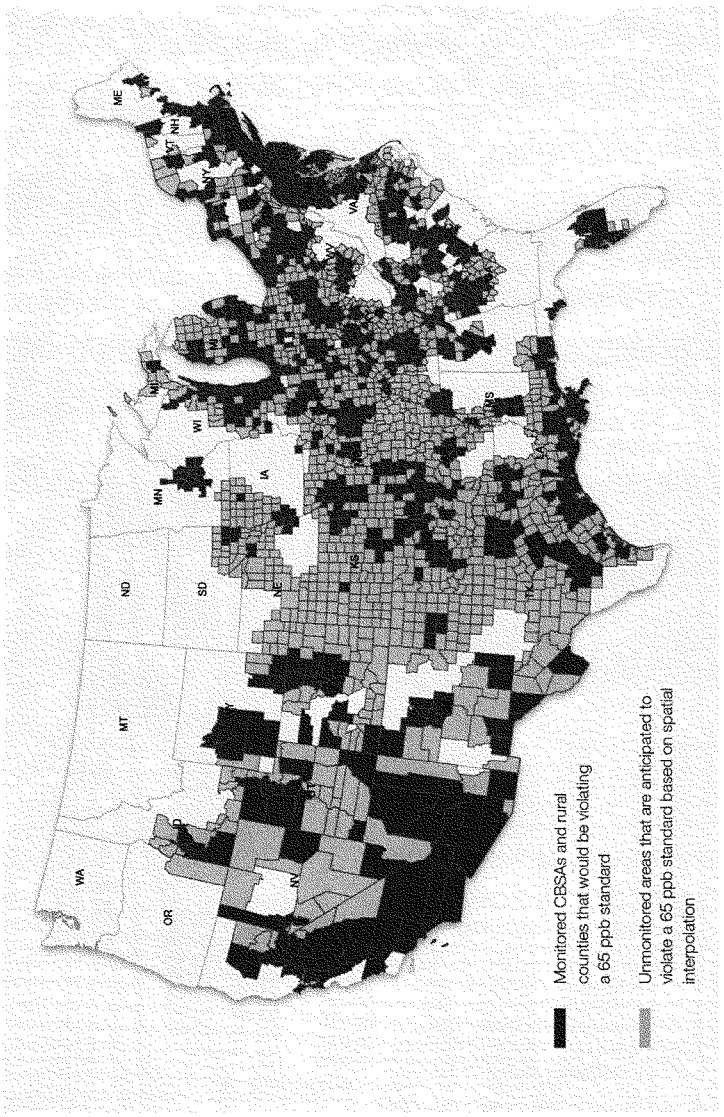
Kevin Abernathy fosters an atmosphere of collaboration, mutual education and cooperation between the dairy industry, environmental organizations, researchers, the USDA, and local and state regulatory agencies in California. He provided critical leadership, communication and education through participation on the San Joaquin Valley Air Pollution Control District (SJVAPCD) Dairy Producer Advisory Group. Through this group's efforts, the SJVAPCD developed regulations to reduce dairy particulate

matter, VOC, and ozone precursor emissions that are reasonable for farmers and are improving air quality. Kevin also serves on the Central California Ozone Policy Committee and the California Air Pollution Control Officers Association. In addition, Kevin serves as a committee member on various state and local committees and associations. These include the California Department of Food and Agriculture's Dairy Advisory Committee and their Environmental Steering Committee, and the San Joaquin Valley Dairy Manure Technology Assessment Panel.

Kevin represents the dairy industry at the federal and state levels on numerous issues concerning the industry's financial health and environmental performance. Since 2006, he served on the USDA Agricultural Air Quality Task Force. He has testified before the California Department of Food and Agriculture, the International Trade Commission, and other state and federal decision-making and legislative bodies on dairy industry perspectives. Issues such as international trade policies that keep the U.S. dairy industry competitive globally, as well as strategies that can help dairies reduce air and water emissions were two major subjects on which Kevin has provided technical leadership. Kevin is also a member of the Western States Trade Producers Association. With a Bachelor of Science in Animal Husbandry from Fresno State, Kevin has completed ongoing educational courses on air pollution in the Central Valley offered by the air district and Fresno State, as well as completing the Certification of Air Permitting Professional program for the purpose of providing assistance to producers on site-specific regulatory requirements.


Total Hours over the 1-hour Ozone Standard
among all Sites per Year
97% reduction
Hours over standard
350
300
250
200
150
100
50
0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Year


Meeting New Federal Ozone Standards
San Joaquin Valley
Tons per Day
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Stationary & Area Sources
Other Mobile Sources Including Trains
Off-Road Equipment
Farm Equipment
Passenger Vehicles
Heavy Duty Trucks
Mobile Sources
Attainment – 1997 standard
Attainment – 2008 standard
Attainment – Proposed new standard



Source: http://www.ozonefacts.com/wp-content/uploads/2015/03/projected-attainment-in-usa.jpg

Chairman BRIDENSTINE. Thank you, Mr. Abernathy.

I now recognize Commissioner Hiett for five minutes to present his testimony.

TESTIMONY OF THE HON. TODD HIETT,
COMMISSIONER,
OKLAHOMA CORPORATION COMMISSION

Mr. HIETT. Thank you, Mr. Chairman and Members of the Committee. I certainly appreciate the opportunity to be here. It's quite an honor and certainly important to our State of Oklahoma to weigh in on this very important issue.

This is a complicated issue, as you well know, subject to requiring technical, legal, and environmental expertise. However, without minimizing the importance of this issue, I would like for us to keep in mind just a few basic concepts. Number one, the proposed changes to NAAQS for ozone are unwarranted at this time. On March the 6th, 2015, the EPA finalized state implementation plan requirements for the current standard. That was just a little over a month ago. And these standards, we should note, are the most stringent ozone standards to be imposed yet. It leads me to ask why, and why now before the EPA has even had the opportunity to measure the achievements under the current standards that are beginning to go into place.

The second thing that I would like for us to keep in mind, retaining the current NAAQS for ozone would result in substantial compliance with the more stringent proposed standards. In other words, the rules that are already in place will actually work toward substantial compliance for the proposed standards. The EPA's projections show that the vast majority of U.S. counties with monitors would meet the proposed standards by 2025 with the rules that are already in place.

Third, the proposed rule is arguably the most expensive air regulation in U.S. history with a disproportionate negative impact on rural America. The EPA's own numbers say that the cost will be in excess of $15 billion. NERA, as was noted earlier, performed a study that indicated that that estimate may be way understated. Furthermore, they said that this would cost the United States gross domestic product $140 billion and cost us 1.4 million jobs. This is a lot of expense for a questionable return as to the ozone levels.

I'd like to narrow the focus now to the rural part of my testimony. As I stated earlier, the rural areas will be disproportionately affected by the proposed rules. The Department of Environmental Quality, the Oklahoma Department of Environmental Quality, explained that the areas primarily at risk for a violation would most likely be the rural areas that possess no ability to establish attainment through control of ozone precursors.

Next, I'd like to address—and it's been addressed a couple of times already—but I'd like to also address controlled agriculture burns. These prescribed burns are so important in so many different ways from environmental reasons to agricultural reasons to protecting—to public safety reasons. If we are limited, which is very possible under these proposed rules, if we are limited and pos-

sibly prohibited from prescribed burns in Oklahoma, I have no doubt we would experience more wildfires.

In 2012—in the fall of 2012, my home area experienced a wildfire that burned 60,000 acres and completely destroyed 209 homes. This was an area that unfortunately prescribed burning had not been practiced by the owners in that general area, and as a result, you see what happened. There are consequences to these actions.

Next, I'd like to address the emissions controls on trucks and heavy machinery. It's the farmer that will pick up the cost on that, and as you well know, the farmer doesn't get to pick his prices. He is a price-taker.

Another challenge facing rural Oklahoma is healthcare, a huge challenge that we address every day. Nearly 1/2 of the rural hospitals in the State of Oklahoma are experiencing negative trend lines according to a study recently done by the Oklahoma Hospital Association. Seven are currently in bankruptcy.

You wonder why does that have anything to do with energy costs? Energy costs are important to rural hospitals, to all hospitals. As a matter of fact, we have over a billion-dollar rate case before us at the Commission currently. The hospitals in Oklahoma have joined together and have become an intervenor in that case. So they obviously feel that it is important to them.

In conclusion, I'd just say the far-reaching effects of the proposed rule—proposed rules are immeasurable. The economy cannot face the unjustified expense associated with proposed rule and we owe to Americans to offer a balanced plan with achievable goals, as has been proposed previously in current standards.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Hiett follows:]

REALITY CHECK PART II: THE IMPACT OF EPA'S PROPOSED OZONE STANDARDS ON RURAL AMERICA

Testimony by
Todd Hiett
Oklahoma Corporation Commissioner

Before the
Committee on Science, Space, and Technology
Subcommittee on Environment
U.S. House of Representatives

April 29, 2015

INTRODUCTION

Good afternoon, my name is Todd Hiett and I am an Oklahoma Corporation Commissioner. The Oklahoma Corporation Commission (Commission) is comprised of three commissioners who are elected by statewide vote to serve six-year terms. The Commission has judicial, legislative and administrative authority and is charged with balancing the rights and needs of Oklahoma citizens and industries. Currently, the Commission regulates a wide range of activities in four core program areas: 1) oil and gas drilling and production; 2) public utility; 3) motor carrier, rail and pipeline transportation; and 4) petroleum storage tanks. Taken together, these responsibilities affect industries that are critical components of the State economy and touch the lives of all Oklahomans.[1] I am testifying today as an individual Commissioner, and the views expressed today are my own.

Prior to being elected Commissioner, I served twelve years in the Oklahoma Legislature serving my final term as Speaker of the House. I was born and raised in Kellyville, Oklahoma. I currently own and operate a ranch in Creek County, and previously owned and operated a 150 cow dairy. I was motivated to enter politics when the Department of Agriculture placed an unwarranted quarantine on my cattle herd based on an outdated federal program. I was successful in getting the quarantine lifted following a lengthy battle with the agency. I have experienced firsthand the overreach of government and the effects it has on its citizens and the financial impact it has on industry.

I thank you for the opportunity to appear today. I hope to provide the members information on the impact of proposed ozone standards on Rural America, from both a regulatory and personal perspective.

BACKGROUND

On March 17, 2015, this Committee conducted its hearing entitled: "Reality Check: The Impact and Achievability of EPA's Proposed Ozone Standards". The Committee received information concerning the EPA's proposed rule on National Ambient Air Quality Standards (NAAQS) for Ozone published December 17, 2014 (Proposed Rule). Written comments to the Proposed Rule were also due on March 17, 2015. Review of the docket in this proceeding reflects over 434,000 comments/submissions have been received.[2] Undeniably, this is a complicated subject requiring technical, legal and environmental expertise. However, without minimizing the importance and complexity of the issues, one must not lose sight of the following three fundamental concepts when assessing the Proposed Rule: 1) Proposed changes to NAAQS for ozone are unwarranted at

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[1] For additional information on the Oklahoma Corporation Commission, *see* http://www.occeweb.com/; Oklahoma Corporation Commission Annual Report Fiscal Year 2013, available at http://www.occeweb.com/FY13%20Annual%20Report%20FOR%20PRINTING.pdf; and Oklahoma Corporation Commission Strategic Plan FY 2014-2018 (June 2013).

[2] Review of the National Ambient Air Quality Standards for Ozone, Docket ID: EPA-HQ-OAR-2008-0699. Available at http://www.regulations.gov/#!docketDetail;D=EPA-HQ-OAR-2008-0699 (last accessed April 25, 2015).

this time, 2) Retaining the current NAAQS for ozone would result in substantial compliance with the more stringent proposed standards, and 3) The Proposed Rule is arguably the most expensive air regulation in U.S. history with a disproportionately negative impact on Rural America.

FUNDAMENTAL CONCEPTS

1) Proposed changes to NAAQS for ozone are unwarranted at this time

The current ozone standard of 75 parts per billion (ppb) was set in 2008. However, due to legal challenges and delay, the implementation of this standard was only finalized *less than two months* ago. On March 6, 2015, the EPA published its final State Implementation Plan requirements for the current standard.[3] Despite the current status and ongoing efforts to now implement years of efforts that resulted in the 2008 standards (which notably are the most stringent ozone standards to be imposed), one must ask, "Why?" and "Why, now?" It defies logic to reset the clock to 2008 and repeat the same process before EPA has even assessed the (to be determined) achievements of the current standards. Moving the goal posts in this manner exacerbates the business uncertainty for investments and plans; imprudently duplicates efforts, costs and resources; severely stifles economic growth; and recklessly harms millions of Americans.

Moreover, at this time EPA has not proven the need to change the ozone standards. In discussing the rationale for the proposed change to the primary standard (within the range of 65 to 70 ppb), EPA "recognizes that there is no sharp breakpoint within the exposure-response relationship for exposure concentrations at and above 80 ppb down to 60 ppb."[4]

2) Retaining the current NAAQS for ozone would result in substantial compliance with the more stringent proposed standards

EPA itself has provided the best argument in support of retaining the current NAAQS standards:

> Existing and proposed federal rules ... will help states meet the proposed standards by making significant strides toward reducing ozone-forming pollution. EPA projections show the vast majority of U.S. counties with monitors would meet the proposed standards by 2025 **just with the rules and programs now in place or under way**.

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[3] Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule. 80 Fed. Reg. 12264 (March 6, 2015). Available at http://www.gpo.gov/fdsys/pkg/FR-2015-03-06/pdf/2015-04012.pdf.

[4] National Ambient Air Quality Standards for Ozone; Proposed Rule. 79 Fed. Reg. 75234 at 75245 (Dec. 17, 2014). Available at http://www.gpo.gov/fdsys/pkg/FR-2014-12-17/pdf/2014-28674.pdf.

> Existing and proposed federal rules will help states meet the proposed standards by reducing ozone-forming pollution. These rules include: the final Mercury and Air Toxics Standards, requirements to reduce the interstate transport of air pollution, Regional Haze regulations, the proposed Clean Power Plan, and the final Tier 3 Vehicle Emissions and Fuels Standards. Other rules include: Light-Duty Vehicle Tier 2 Rule, the Mobile Source Air Toxics Rule, the Light-Duty Greenhouse Gas/Corporate Average Fuel Efficiency Standards, the Heavy-Duty Vehicle Greenhouse Gas Rule, the Reciprocating Internal Combustion Engines (RICE) NESHAP, and the Industrial/Commercial/Institutional Boilers and Process Heaters MACT and amendments. [5]

Oklahoma enjoys the benefits of low energy costs. Today, many industries realizing this competitive advantage are faced with real, challenging decisions in business planning. As a result of current and recently finalized environmental regulations (such as MATS and Regional Haze), these entities are evaluating the ability to continue doing business in Oklahoma. It is noteworthy that even *before* factoring in the increased costs of energy due to the proposed Clean Power Plan and the Proposed Rule, Oklahoma's economy is already at risk.

3) The Proposed Rule is arguably the most expensive air regulation in U.S. history with a disproportionately negative impact on Rural America

Although the Clean Air Act does not allow costs to be considered in setting NAAQS, the magnitude of this Proposed Rule cannot be left unsaid. This is particularly important when the standards fail on all levels to be ripe for consideration *at this time*. By EPA's own analysis, this regulation would exceed $15 billion. According to a recent analysis by NERA Economic Consulting (NERA), NERA found that "EPA has understated the potential compliance costs—including their likely range—of meeting more stringent ozone standard. Achieving a more stringent ozone standard could be substantially more costly than even the very substantial costs EPA has estimated."[6] In a prior study, NERA estimated that the "potential emissions control costs could reduce U.S. [GDP] by about $140 billion per year on average over the period from 2017 through 2040 and by about $1.7 trillion over that period in present value terms."[7] Additionally finding that "[t]he potential labor market impacts represent an average annual loss employment income equivalent to 1.4 million jobs (*i.e.*, job-equivalents)."[8]

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[5] EPA Fact Sheet: Overview of EPA's Proposal to Update the Air Quality Standards for Ground-Level Ozone at 2 and 5 (emphasis added). Available at http://epa.gov/groundlevelozone/pdfs/20141125fs-overview.pdf. *See also* 79 Fed. Reg. at 75371.

[6] NERA Economic Consulting, "EPA Regulatory Impact Analysis of Proposed Federal Ozone Standard: Potential Concerns Related to EPA Compliance Cost Estimates" (March 2015) at E-4. Available at http://www.nera.com/content/dam/nera/publications/2015/EPA_Regulatory_Impact_0315.pdf.

[7] NERA Economic Consulting, "Economic Impacts of a 65 ppb National Ambient Air Quality Standard for Ozone" (February 2015) at 1. Available at http://www.nam.org/Issues/Energy-and-Environment/Ozone/Economic-Impacts-of-a-65-ppb-NAAQS-for-Ozone-(NERA).pdf.

[8] *Id.* (references omitted)

As a regulator, costs (even in this initial stage) can never be ignored—because at the end of the day, the simple fact is that costs will be passed on to the citizens of Oklahoma. This Proposed Rule touches every facet of our economy, regulated and unregulated by the Commission. The cost, expense and burden the economy and, ultimately, the American citizens must endure to obtain a result that could have little to no impact on ozone levels cannot be taken lightly. It is clear a consensus exists—even amongst those opposing the Proposed Rule—that cleaner air is desirable and should be a priority. Yet, with this acknowledgement is the recognition to strive toward this goal in a reasonable, meaningful approach that will truly obtain achievable results at the proper time.

IMPACT ON RURAL AMERICA

Rural areas will be disproportionately affected by the Proposed Rule. Based upon even EPA's analysis, the majority of cities and counties would no longer be in compliance with ozone standards. As noted by the Oklahoma Department of Environmental Quality (ODEQ), most Oklahoma counties may be facing nonattainment status for the first time.[9] Oklahoma has been in attainment with ozone NAAQS since 1990. In commenting on the need to retain the same ozone levels for primary and secondary sources, ODEQ further explained the areas primarily at risk for a violation of the secondary standard but not the primary standard would "most likely be rural areas that possess no ability to establish attainment through control of ozone precursors within the designated nonattainment boundary due to the heavy impacts from the interstate transport of pollution."[10]

More stringent ozone standards will additionally place undue burdens on farmers. Every aspect of productivity will see an increase in costs: fuel, fertilizer, utilities and equipment. In turn, agricultural support and processing industries will be subjected to these impacts. The Proposed Rule fails to provide flexibility to rural areas that will undoubtedly be impacted by geographic expansion of nonattainment into rural areas. These areas, already struggling for social and economic development, will experience new burdens with no additional resources to prosper.

Controlled agricultural burns could also be restricted due to increased ozone standards. This is contrary to the necessity and benefits of this method to preserve the native prairie. Without controlled burns, Oklahoma will experience increased wildfires. EPA must account for exceptional events without penalizing areas due to natural occurrences. Furthermore, without the tool of controlled burning, farmers and ranchers will be forced to use more chemicals for control, which not only increases the cost of doing business, but will also have a negative impact on ozone levels.

Agriculture producers are heavily dependent on heavy equipment for operations and trucking for transportation. The increasing cost of emissions controls on trucks and heavy machinery will fall

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[9] ODEQ Comments (March 16, 2015). Available at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2008-0699-2121.
[10] *Id.* at 5.

directly on the farmer who does not have the ability to adjust the price of his/her product. Agriculture producers are at the mercy of global markets and weather conditions.

Negative impacts would extend beyond the transportation cost to the transportation infrastructure. An area deemed to be a nonattainment area would be subjected to additional burdens to proceed with a federal transportation project. Federal projects would be halted until the State could produce evidence the project would have no impact on ozone levels. In agriculture, unless a product makes it to the market it has no value. Agriculture currently struggles to move bulky commodities on a dilapidated surface and rail system. We are fortunate in Oklahoma to have the McClellan Kerr Arkansas River Navigation System (MKARNS) to transport fertilizer into, and the final agriculture product out of, the State and to the world market.

Most agriculture producers have some source of off-farm income to supplement the farming operation, such as a spouse working an off-farm job or the producer working an off-farm job on a part-time basis. The greatest economic challenge we face in Oklahoma is employment availability in rural areas. This has resulted in a massive exodus of population from rural to urban counties in recent decades. The best opportunities for job creation in rural Oklahoma are manufacturing, oil and gas and trucking—the very industries most negatively affected by the Proposed Rule.

Increased nonattainment areas will result in expansion into rural areas, which could hinder growth in energy production. As analyzed by NERA, rural areas active in oil and gas extraction could become subject to higher emissions and face barriers to obtaining new wells and pipelines.[11] Oklahoma's economy is largely dependent on the effects, positive or negative, of the oil and gas industry. Over twenty percent (20%) of the State's revenue comes directly from oil and gas production taxes. Additionally, much of the income tax collection results in royalties paid to landowners, employment derived from energy-related jobs and business income from many oil and gas producers in the State.

Another challenge facing rural Oklahoma is availability of healthcare. Due to populations shifting out of rural areas, most rural hospitals struggle financially. According to the Oklahoma Hospital Association, a recent financial stress test determined nearly one half of rural hospitals are experiencing negative trend lines financially, with seven currently in bankruptcy. Many rural hospitals have been closed and many others struggle financially. The increased energy costs resulting from the Proposed Rule would exacerbate this problem greatly. Hospitals in Oklahoma have recently joined together to intervene in a pending proceeding before the Commission that would result in a rate increase, demonstrating the importance of energy costs to their operations.[12]

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[11] *Supra* n7 at 2.

[12] *See* Entry of Appearance of the Oklahoma Hospital Association, filed August 27, 2014, Cause No. PUD 201400229, *In the Matter of the Application of Oklahoma Gas and Electric Company for Commission Authorization of a Plan to Comply with the Federal Clean Air Act and Cost Recovery; and for Approval of the Mustang Modernization and Cost Recovery.* Available at http://imaging.occeweb.com/AP/CaseFiles/occ5136109.pdf.

CONCLUSION

The far-reaching effects of the Proposed Rule are immeasurable. Efforts to tighten the 2008 standards resulted in suspension of implementing the current standards while EPA pursued an out-of-cycle rulemaking to impose more stringent standards. In this strikingly similar approach, EPA is making another attempt to accomplish what it previously failed to accomplish. The White House rejected EPA's attempt noting regulatory burdens and regulatory uncertainty as reasons the economy could not support such an unjustified expense. The economy still cannot face the unjustified expense associated with the Proposed Rule and we owe it to Americans to do more.

BIOGRAPHY
Todd Hiett

Todd Hiett is married to Bridget Hiett and they have three children, Jimmy, John and Hillary. The Hiett family lives on a ranch two miles south of Kellyville. Hiett graduated from Oklahoma State University.

Hiett was elected to the Oklahoma House of Representatives in 1994 at the age of twenty-seven. Hiett quickly ascended into leadership and was selected by his colleagues to be House Minority Leader in November of 2002. Two years later, he led the state House Republicans to their first majority in eight decades and their largest victory in nearly a half-century. Marking a historic shift in power at the Capitol, Hiett was chosen the first Republican Speaker of the House in more than eight decades.

During his first year as Speaker, Hiett oversaw a smooth transition as House Republicans ascended to power with a bold agenda. The new Speaker pushed through the largest tax cut in state history, the most significant right-to-life legislation in thirty years, an innovative highway-funding bill and significant education reforms, collectively known as the ACE Initiative, which raised the bar for curriculum standards and graduation requirements in Oklahoma.

After a successful twelve years in the Oklahoma Legislature, Speaker Hiett has worked for the past eight years with various entities in the manufacturing, navigation and energy industries. In this role, Hiett has enjoyed the opportunity to work with many pro-growth companies such as Webco Industries and Callidus Technologies to strengthen and expand their ability to provide jobs.

Todd and Bridget continue to operate a ranch south of Kellyville, and Todd serves on various boards of directors including SpiritBank and Farm Bureau.

Most recently, Hiett was elected to serve as Oklahoma's newest Corporation Commissioner.

Bridget teaches fourth grade at Kellyville Elementary, son Jimmy graduated Oklahoma State University, son John is attending Oklahoma State University and daughter Hillary is a junior at Kellyville High School. The Hietts attend First Baptist Church of Kellyville.

Chairman BRIDENSTINE. Thank you, Mr. Hiett, and thank you for your testimony, especially on the health effects. I think there's been a lot of evidence that when you control for poverty, asthma in rural areas and asthma in urban areas where there's higher, you know, outdoor ozone, when you control for poverty, there's a significant difference between asthma is really—it's not there when you control for those things. So the health effects work on two different sides. Poverty is—it does create, you know, bad health effects as well.

I wanted to ask—first of all, thank the witnesses for their testimony. Members are reminded that committee rules limit questioning to five minutes, and the Chair recognizes himself for five minutes of questions.

Starting with Secretary Reese, you are the Secretary of Agriculture for the great State of Oklahoma, and I wanted to—and you're a lifelong farmer. I wanted to ask you how this regulation would affect farmers not only in Oklahoma but all across the country?

Mr. REESE. As you know, Oklahoma is a full attainment State, and so currently we don't—aren't facing these regulations, but you would just have to look at other states as they've implemented these regulations and retrofitting tractors and machinery and going from the Tier 1, Tier 2, Tier 3, Tier 4 engines would be extremely, extremely expensive for the farm industry. Less than three percent of Oklahoma's tractors—this is just my estimate and I would assume it would be nationwide—would comply with the Tier 4 engines, combines, tractors, hay machines, all those things put together.

Chairman BRIDENSTINE. Real quick, is it your assessment that most farmers can afford those costs?

Mr. REESE. It would be my assessment that they cannot, and my assessment would be that the average farmer is 429 acres in Oklahoma and it's smaller across the country. And 429 acres does not necessarily support a $130,000 tractor or a $150,000 tractor. I mean it just takes times to make those investments for those—that machinery.

Energy costs—we're a high-energy consumer, dairy barns, poultry, swine, food costs. If we are required to upgrade all of our engines, all of our machinery, it will affect food costs, and thereby affecting poorer people who can't afford it. We have the safest and most affordable food supply the world, and as we increase that, it would be more difficult for people to get nutritious food.

And then finally just growing crops, as I said, is a timely issue. It has to be—if EPA is trying to govern when we apply, when we plant, when we harvest, it would be—it would increase food costs.

Chairman BRIDENSTINE. Can you share with this panel because a lot of us are not farmers, when you say it's a timely issue, can you share with us what that means?

Mr. REESE. Well, exactly right now it's spring. It's pretty—it's time to plant. We just had rains across the State, and in the next two weeks, farmers will be going out planting more acres as fast as they can get them planted. And if it was a nonattainment time, the EPA said, you know, you have to moderate your planting time, that's what your crop is based on is when you plant it, when you're

able to apply things to it. And so it's just time-sensitive. Every—plants are just time-sensitive.

Chairman BRIDENSTINE. So it could in fact delay planting and ultimately reduce your yield, which would of course also affect the bottom line for the farmer, in addition to all the costs that you've already talked about?

Mr. REESE. Exactly.

Chairman BRIDENSTINE. Really quickly, could you share with us, you mentioned redcedar in your testimony. Share with us what you go through with red cedar.

Mr. REESE. Well, red cedar is a nuisance. It's a public—it's a plant that we are trying to reduce. It's an invasive species. And the best way to maintain it and the most cost-effective and efficient way by virtually any environmental group will agree is to burn. And so we cut them and we burn them. And we need to prescribe burn to maintain that. And it is a heavy pollen sensitive plant—tree and it causes health concerns. And so you have to measure that, are you going to allow prescribed burns to take care of the health concern or are you not?

Chairman BRIDENSTINE. So from a—I guess from an allergy perspective or and asthma perspective, and of course as Commissioner Hiett talked about, that prescribed burns are necessary for safety, and it also reduces wildfires, that ultimately would create even more ozone concerns. So thank you for that testimony.

Commissioner Hiett, I've got about a minute left. Could you share with impacts these proposed rules would have on economic development, including transportation and other infrastructure projects in Oklahoma?

Mr. HIETT. One of the greatest challenges we have in economic development in the State of Oklahoma is the rural area. Our urban areas tend to have more jobs. Our rural areas struggle to have jobs. If you look at the areas that are the best opportunities for jobs in rural areas, it's going to be manufacturing, oil and gas, transportation, three industries that will be targeted, will be damaged by the proposed rules. So you can see the issue that's there.

Also, on the transportation side, and it was mentioned earlier, a nonattainment stops the Federal projects. Well, those of us in agriculture know if we can't get our product to market, it has a diminished value, if any value at all.

Chairman BRIDENSTINE. Thank you for that testimony.

I will now recognize the gentleman from Arkansas, Mr. Westerman, for five minutes of questions.

Mr. WESTERMAN. Thank you, Mr. Chairman.

In his testimony during last month's hearing, Dr. Allen Lefohn presented modeling results that indicated that if emissions were reduced across the United States to achieve alternative lower ozone standards, that there would be a tendency for the fourth-highest 8-hour concentration to occur not just during the summer but also in some locations during the spring when the main contributors to ozone are background or natural-occurring sources.

The locations affected by the springtime shift can appear anywhere across the United States. He also noted that with more stringent proposed standards, background would become an even more important contributor to exceedances of the standard. We all

know that models have limitations but we also know that some models are better than others. The modeling results that Dr. Lefohn described appear to be supported by EPA's own recent analysis.

I would like to enter into the record a memo dated November 19, 2014, from Ms. Joann Rice of the EPA. In her memo, Ms. Rice indicates that EPA is proposing that the ozone season be extended from its current period to longer periods of time. The result of EPA's analysis was a total—was that a total of 39 States across the United States experienced exceedances of the 60 parts per million level during the spring. Background ground ozone is highest during the spring.

As indicated earlier, ozone formation during the spring from manmade sources is much less than during the summer. It appears that naturally occurring ozone is a national issue, not just limited to Yellowstone and to the Intermountain West. The difficulties dealing with background ozone as experienced in these States is only a precursor for the entire Nation.

As a forester and an engineer and after hearing much testimony in this and other committees, it appears to me that we've become so regulatory aggressive that we not only are regulating humans but we're now attempting to regulate nature itself.

Mr. Abernathy and Ms. Keslar and Mr. Reese, my question for you is it time that Congress should revisit and modernize the Clean Air Act?

Mr. REESE. I will say yes. We talk about—at least my perception is the—the Secretary is a—the Administrator is supposed to use criteria requisite to protect public health. And so what does that mean? You have public health issues on all sides of the issue, the redcedar issue versus asthma versus other lung disease, and so I think that—and food and the need to eat nutritious, economically produced food. So I think there are a number of factors that need to be considered in addition to define public health.

Mr. ABERNATHY. Mr. Westerman, the resounding answer is absolutely. When you come from a State like—especially in California and the Central Valley, we've implemented virtually as many rules as we possibly can even though we still have a no-stone-left-unturned mentality. When you're approaching those background levels, the ability to get significant reductions through the—through a rule process becomes extraordinarily difficult if not impossible, and I think the best way to answer your question—and this has actually been proposed in California—that we have no farm days.

Ms. KESLAR. I would also agree with the other two members of the panel that it's absolutely time to revisit the Clean Air Act. From my perspective and the implementation perspective is that the Clean Air Act is very vague and it's left up to EPA to interpret the Clean Air Act, and then States are left to deal with the consequences of EPA interpretations of the Clean Air Act. So—especially with respect to background, international transport, rural transport areas, and the exceptional event rule are very vague in the Clean Air Act and there's not a good precedent for implementing those with the current EPA rules.

Mr. WESTERMAN. And if you will hold those thoughts, I'll yield back to the Chairman because I believe we need to go vote.

Chairman BRIDENSTINE. We have a vote on the Floor that we've got to get to, but what we'll do is we'll just recess and immediately following—we've got one vote. Immediately following the vote, we'll come back here and convene, and if you'd like to have two and a half minutes of the rest of your time, we'll do that. Is that all right?

Okay. Well, we are now in recess until after the vote.

[Recess.]

Chairman BRIDENSTINE. All right. We are back from recess and we will reconvene.

We were in the middle of my good friend from Arkansas, Mr. Westerman, asking five minutes of questions, and on the clock we had two and a half minutes when we departed, so we will resume with Mr. Westerman for two and a half minutes.

Mr. WESTERMAN. Thank you, Mr. Chairman. I believe Mr. Abernathy was in the middle of a thought when we recessed, so if you would like to pick up with that answer.

Mr. ABERNATHY. Thank you, sir.

It would be remiss for me not to include that in my written testimony there was a series of potential modifications to the implementation of the Clean Air Act that I think would be a wonderful starting point for the committee to discuss moving forward. And also on your question of how it affects agriculture, Rule 4570 that I referenced in my oral in my written testimony has had an economic burden to individual producers in California to the tune of about $50,000 in cost just to implement on an annual basis for Rule 4570. So that certainly takes away from spending money on potentially more important things from a dairymen's perspective when you're looking at those kind of costs ongoing on an annual basis, especially for small farmers.

Mr. WESTERMAN. All right. So are there ambiguities and issues with the ozone NAAQS that the judicial and executive branch cannot properly deal with because the Clean Air Act hasn't been modernized?

Are there any ambiguities or issues that—with ozone NAAQS that the judicial and executive branch can't properly deal with because the Clean Air Act hasn't been modernized?

Mr. ABERNATHY. I'll take a stab at it. We—I think this really lends to a unique opportunity for Congress to dive into this from the standpoint that in California, as I mentioned with a mature regulatory program, way all too often we're having our futures decided in a courtroom with a judge. And I'll let you think about that for a little bit because that's really—that has nothing to do to benefit public health or air quality when you're in a courtroom and a judge is making those decisions based on a very stringent look at simply the law.

Mr. WESTERMAN. And, Mr. Chairman, with that I'll yield back.

Chairman BRIDENSTINE. I'd like to thank my friend from Arkansas.

I'd like to recognize my good friend, Ms. Bonamici from Oregon, for five minutes of questions.

Ms. BONAMICI. Thank you very much, Mr. Chairman, and thank you again to your—to the witnesses for their testimony.

I want to follow up on the line of questioning and also Ms. Keslar's testimony. Mr. Chairman, I think it would be very useful for us to have the EPA come in and inform us about things like the exceptional event rule. I appreciate your testimony, Ms. Keslar, about what it takes to comply with that. It would be helpful for us to hear from the EPA about their efforts and what can be done to make it easier for jurisdictions to comply with that rule. That would be very useful for us.

But Dr. Miller, the EPA and others have estimated the benefits achieved by lowering the ozone standard, and you talked about that in your testimony. Specifically, under the proposed standard of 65 to 70 parts per billion, the EPA estimates that it would generate an estimated $19-$38 billion worth of benefits, and that includes a range of components from the number of premature deaths avoided to the number of children's asthma attacks that can be prevented. Can you please describe some of the other benefits that could come from and ozone standard in the range of 70 to 65 parts per billion?

Dr. MILLER. Yes, thank you. What I would like to start with is in the context of the need to modernize the Clean Air Act, I would flip it and I would say maybe it's time to recognize that the Clean Air Act has modernized America. And this is seen through its technology-forcing nature and the innovation that has resulted from in the past setting what was at that time viewed as stringent and unachievable ozone standards, yet we achieved them. Right now, in the Northeast we're largely achieving the current standard outside of New York City. We have achieved that. I'm hoping we can maintain that, but we have achieved that already. And that was viewed at one time as impossible.

Ms. BONAMICI. And, Dr. Miller, can you talk just a little bit about—I know you talked about where your organization—your area. Can you talk about how much of that is urban and how much of it is rural?

Dr. MILLER. We also suffer from transport. Now, the largest portion of our pollution load is urban. It is from transportation and urban sources. But on top of that, we get a pollution load from the West. There are large sources to the West. We've actually successfully addressed to some extent power plant pollution that comes across on the westerly winds. So we have a mix, and so we're sympathetic to Western issues, to transport from Asia. We don't get that kind of transport from Asia.

We have our own kind of transport, and it is controllable not by our States but through Federal measures that create regional programs that have been done in the past such as a NOX SIP Call that have been very effective and resulted in deep reductions of ozone not just in the urban areas but across these broad regional and rural areas that are under discussion today.

Ms. BONAMICI. Terrific. And I know that some of the benefits associated with improving the ecosystem are hard to quantify, and it's likely that there's some benefits that don't reflect in the full range of outcomes. Can you describe some of the ecosystem services and their value to the economy, for example, water regulation?

Dr. MILLER. Right. So the same kind of emissions, specifically nitrogen oxides that contribute to ozone formation also contribute to

acid rain, nitric acid. Nitric acid has ecological impacts in terms of forest health. It frees up aluminum ions in forest soils. Aluminum ions are toxic to aquatic life so it ends up in streams and rivers, kills fish. That has a detrimental impact on, say, sportsmen who like to catch fish.

It has—nitrogen deposition in water has a fertilizing effect. It creates algal blooms. Those blooms suffocate aquatic life. Fisheries have large economic benefits, large economic value, and that kind of impact diminishes those as well.

Ms. BONAMICI. And thank you. We've heard a lot about some of the costs and technical challenges, and you talked about this a bit. The EPA does not allow consideration of those factors when setting a standard, but can you comment on the importance of separating the costs associated with attaining or implementing the ozone standard from the assessment of what level is appropriate to protect public health? And I know you mentioned the incentives to develop new technology that come from such regulation.

Dr. MILLER. First, I'd like to just clarify. It's not EPA that doesn't allow consideration of cost in the setting the standard. Those are science-based standards based on health and protecting public welfare. It's—the Clean Air Act is created by Congress and is interpreted unanimously by the Supreme Court—

Ms. BONAMICI. Right.

Dr. MILLER. —that requires standards to reflect science.

Ms. BONAMICI. Understood. Thank you.

Dr. MILLER. The implementation part is where costs come in. We've been very successful in that and that's where the innovation comes.

Ms. BONAMICI. Terrific, thank you. And I just wanted to mention that this committee did pass in the last Congress a bill to do more research about the harmful algal blooms that you mentioned, and I was proud to work on that with my colleague from Florida, Mr. Posey.

And I'm out of time and I yield back. Thank you, Mr. Chairman.

Chairman BRIDENSTINE. I'd like to thank the gentlelady from Oregon, Ms. Bonamici.

Without objection, I'd like to enter into a second round of questions. I'll recognize myself for five minutes. And if it's all right, you're willing to stick around for another five minutes?

So there's a couple of things I'd like to bring out. I think all of us recognize that in urban areas there's a higher incidence of surface ozone than in rural areas, not always the case but in many cases that's the case.

I would like to submit for the record a study from Johns Hopkins University, and what they attempted to do is they sought—according to them, the objective, "we sought to estimate the prevalence of current asthma in U.S. children living in inner-city and non-inner-city areas and to examine whether urban resident, poverty, or race/ethnicity are the main drivers of asthma disparities."

What they found is that there was no statistically significant difference once you control for poverty, once you control for race and ethnicity, the incidence of asthma in areas that have higher surface ozone are not greater than the incidents that don't have as high ground level ozone.

So I'd like to introduce for the record the scientific study from Johns Hopkins University.

[The appears in Appendix II]

Chairman BRIDENSTINE. I'd also like to—actually, we now have back one of our Members here. I will retain my remaining three minutes and fifty seconds. And is it possible to yield at this time to the gentleman from Texas, Mr. Weber?

Mr. WEBER. Yes, sir, it is. Thank you, Mr. Chairman.

Chairman BRIDENSTINE. You're recognized for five minutes.

Mr. WEBER. I'm not sure five minutes is enough. Can I have your other three minutes?

Chairman BRIDENSTINE. Negative.

Mr. WEBER. Mr. Hiett—is it Hiett? Is that how you that? Commissioner Hiett?

Mr. HIETT. Yes, sir, Hiett.

Mr. WEBER. Okay. You said on March 6, 2015, the SIP, state implementation plan, was approved for Oklahoma or finalized I think you said. How long did that process take?

Mr. HIETT. I'm sorry, that was the requirement.

Mr. WEBER. Was that the requirements?

Mr. HIETT. That was the requirements that were issued on March 6——

Mr. WEBER. Okay.

Mr. HIETT. —of 2015.

Mr. WEBER. Can you describe the length of that process?

Mr. HIETT. It began in 2008 is my understanding.

Mr. WEBER. So that's seven years——

Mr. HIETT. Yes.

Mr. WEBER. —give or take? When were—and I'll ask this question of Dr. Miller. When were the last EPA—ozone regs changed or recommended to be changed? Was it six years ago, ten years ago?

Dr. MILLER. Regs, you mean standards?

Mr. WEBER. Standards, yeah, National Air Indoor Quality——

Dr. MILLER. The last time the ozone standards were revised was 2008.

Mr. WEBER. 2008, so that's seven years ago. Okay. And if I understand your testimony, Commissioner, earlier, prescribed burning actually would help in your area in Oklahoma?

Mr. HIETT. Absolutely. There's a public safety factor——

Mr. WEBER. Okay.

Mr. HIETT. —there's a health factor, there's—and of course the agricultural and economic factors.

Mr. WEBER. Sure, but your testimony here today is that proposed—I call them regs—would actually prevent that it would actually endanger lives, property, and commerce?

Mr. HIETT. And in addition to that would—yes, that is correct, and in addition to that would require that agriculture producers use more chemical to fight—to battle these invasive species——

Mr. WEBER. Sure.

Mr. HIETT. —where now they can do it with fire.

Mr. WEBER. Sure, absolutely.

Mr. HIETT. With prescribed burning.

Mr. WEBER. So thank you. Dr. Miller, you testified earlier right before we went to votes, when Congress set up the Clean Air Act, they were very specific that they don't take the cost into account. Do I recall correctly you said something to that effect?

Dr. MILLER. Yes, it's setting standards. They are health-based, based on science. Costs come into implementing the standards.

Mr. WEBER. Okay. Do you think that that might have been shortsighted on their part? Is there any possibility, on Congress' part? Not that we would ever be shortsighted.

Dr. MILLER. Actually, I think was very farsighted. And as I've mentioned several times, I think that's forced areas to innovate, industry to innovate in areas that they weren't going to do, and that's——

Mr. WEBER. So it's not like Congress couldn't have been wrong or the Supreme Court could never be wrong? The Supreme Court has never reversed itself. Or is that——

Dr. MILLER. It does all the time.

Mr. WEBER. They do all the time. Congress I would submit probably does need to as well.

Mr. Abernathy, the EPA's cost-benefit analysis for the ozone proposal caps, the cost of unknown controls, I'm from Texas, Gulf Coast, a lot of chemical plants, refineries there on the Gulf Coast. Texas produces 60 percent of the Nation's jet fuel in my district, and I think maybe again it was Dr. Miller said that this was the most expensive regulation—going to be—one of you said that and we've heard that over and over again. But my question is more specific.

So industry—I own an air-conditioning company. Industry will do what's very pretty to and very competitive to be able to get that competitive edge for the most part. Mr. Abernathy, I think the controls—they're saying in the proposal that the caps have cost of unknown controls that don't even exist are assumed to be around $15,000. Have you seen that figure?

Mr. ABERNATHY. Yes, sir.

Mr. WEBER. Does that sound reasonable to you?

Mr. ABERNATHY. No.

Mr. WEBER. I've been in these chemical plants and refineries and I can tell you—and in the Texas Legislature I was on the Environmental Reg Committee. I can tell you without a shadow of a doubt that's nowhere near close to the cost. So, you know, when they say it's assumed to be that kind of a low, I think that's pie-in-the-sky or dare I say ozone-in-the-sky.

Mr. Abernathy, one other question. What happens to permitting for the dairy industry throughout the country, throughout the country when ozone standards are set basically to background levels?

Mr. ABERNATHY. Sir, would you like me to answer the first—end of your first question?

Mr. WEBER. Absolutely. You've got more input on it, you bet.

Mr. ABERNATHY. Thank you. I actually have the privilege of knowing Chairman Shaw and——

Mr. WEBER. TCEQ.

Mr. ABERNATHY. Yes, sir, and working with the Dr. Shaw, Chairman Shaw with the USDA Air Quality Task Force, and we've had

the pleasure of going over quite a few of the struggles that Texas has had as an extreme nonattainment area. And keeping that into consideration, he's bumping up to the same virtually impossible task of trying to continue to regulate industries that he has really regulated to the point where there's nothing left to pick off the tree. So I have firsthand knowledge of the commonality that the Central Valley in California, along with South Coast and Texas share when it comes to setting standards that are right at background levels of ozone.

And with that, on the cost, this is—in California we call it a black box. We've had standards that we've had to meet, we've had technologies that didn't exist, and we've had a timeline that we have to meet.

Mr. WEBER. All within seven years and it's fixing to be changed again.

Mr. ABERNATHY. Yes, sir. And the interesting part about that is when we—when the board—San Joaquin Valley Board passes a rule on a business, we have no idea or hopes that there will be technology that will get us there. The district has had the farsightedness to actually develop one program that I've been associated with that's called the Technology Advancement Program that actually looks at new and innovative processes, whether it's emission controls or so forth to help advance.

But even those certain things—and I'll give you this as an example—we had John Deere at one of my members' dairies in Fresno County. It was a million-dollar piece of equipment. It was the latest, greatest technology that had ever been put into a John Deere tractor. During the silage harvest, it burned to the ground. So with that, technology does come along and innovations do come along, but as every farmer at this table knows, it takes a long time to go from conceptual to reality where you can depend on that 24 hours a day, 365 days year.

But answering your question, $15,000 a ton, just as another number, when the $61.5 million that Rule 4570 cost Central Valley dairy farmers came out to about $6,700 a ton. At the same time, NOx was being traded as environmental reduction credits/ERCs from businesses that had closed down in the Central Valley at a tune of $32,500.

Mr. WEBER. And they still had a way to make money.

Mr. ABERNATHY. That's right.

Mr. WEBER. And you—and forgive me, Mr. Chairman, if you'll indulge me for one more half-a-minute—and you know that 70 percent of NOx comes from nonstationary point sources, i.e., vehicles.

Mr. Chairman, I yield back.

Chairman BRIDENSTINE. Roger that. And thank you for your questions.

And just as a reminder, the record will remain open for two weeks for additional comments and written questions if the gentleman from Texas would like to submit more written questions. I know you definitely needed more than five minutes. Yeah, you bet.

I'm going to yield. I've got three minutes and fifty seconds remaining. I'm going to yield two minutes to my friend from Oregon, Ms. Bonamici, and then we'll close the hearing at that point.

Ms. BONAMICI. Thank you, Mr. Chairman. I don't think I'll need two minutes.

I wanted to add to the record, first, a letter from the National Farmers Union, the second-largest general farm organization in the United States, in support of the EPA's proposed revisions. Particularly, they found compelling the effect on crop yields a causal relationship between exposure to ozone and ambient air and visual—visible foliar injury affects on vegetation, reduced vegetation growth, reduced productivity and terrestrial ecosystems, reduced yield, and quality of agricultural crops.

So with that, I'd like to enter that into the record.

And one more thing, just released today is the American Lung Association's 2015 State of the Air Report showing that more than four in ten people live in areas with an unhealthful—unhealthy level of ozone. According to this report, there's more than 17.7 million people in the United States who live in counties where the outdoor air failed all three of the tests.

So, Mr. Chairman, I would like to introduce this letter and this report into the record.

Chairman BRIDENSTINE. Without objection, they will be introduced into the record.

[The appears in Appendix II]

Chairman BRIDENSTINE. I would like to—are you yielding back?

Ms. BONAMICI. I yield back.

Chairman BRIDENSTINE. Okay.

Ms. BONAMICI. Thank you.

Chairman BRIDENSTINE. I would like to thank the witnesses for their valuable testimony. Thank you for sticking around and answering questions. I apologize that we had a vote in the middle of it. I'd like to thank the Members for their questions.

As a reminder, the record will remain open for two weeks for additional comments and written questions from the Members.

And with that, this hearing is adjourned. Thank you.

[Whereupon, at 4:15 p.m., the Subcommittee was adjourned.]

Appendix I

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by The Hon. Jim Reese

QUESTIONS FOR THE RECORD
The Honorable Jim Bridenstine (R-OK)
U.S. House Committee on Science, Space, and Technology

Reality Check Part II: The Impact of EPA's Proposed Ozone Standards on Rural America

Friday, May 15, 2015

Questions for Secretary Reese

1. What will this proposed standard do to the stability of our food supply if the input costs drive up food prices and forces farmers to quit the industry? America has consistently produced the safest, most affordable food supply in the world. Machinery and engine upgrades throughout the ag industry will undoubtedly raise food prices. Any EPA effort to limit prescribed burns, fertilizer and pesticide applications, or planting decisions will limit Americans amazingly efficient production system. For example, American farmers planted 33 million acres or corn in the last three weeks of May. It is critical to take advantage of cool spring and early summer temperatures and spring rains. Any government agency interfering with that amazing efficiency will hurt production capabilities.

2. Can you speak to the burden that will be put on states to implement both the 2008 standards along with developing plans to comply with these potential new standards? The new standards will just affect so many new areas of the country. The 2008 standards are working. Our ozone is improving and will continue to improve without the new standards.

3. If background levels consistently exceed the NAAQS standard, is EPA planning to hold states accountable for factors outside their control? With the 2008 standards they are.

4. EPA updated ozone standards in 2008, shouldn't we focus on implementing that standard before making a new one? YES

5. Do we need more stringent ozone standards to have cleaner air? As stated above, our air is cleaner and I see no reason to believe that the EPA's own records of improved clean air results will change directions of the last 10 years.

6. Even rural areas far from industrial activity would fail EPA's stringent ozone proposal. Other than hoping that other city or even other countries reduce emissions, what option do these areas have to meet the standard? Many times weather events, particularly prolonged drought can be a reason for exceeding standards. Oklahoma recently had the wettest May in the history of the state, but 2011 was the beginning or a drought period that we could not control.

7. Could EPA's ozone proposal result in mandatory emissions reduction measure being imposed on farmers? Absolutely. That is exactly what is happening in California. Retrofitting machinery and engines would be a tremendous cost for the industry. A simple example is a John Deere Ztrac lawn mower which was upgraded to tier 4 this year cost 33% more or $5,000 more than the year before. That is a small commercial lawn mower, tractors, combines, irrigation motors and the like would be an

exorbitant amount.

7.

8. How do farmers rely on transportation infrastructure projects, and could those projects be threatened by EPA's stringent ozone proposal? Every food product starts in the field. It must be transported from the field, to a collection site, to a production site, to a wholesale delivery site, to a grocery store, home from the store, to the plate of every American. Add to that, exports to feed the rest of the world. Again, I cannot even monetize what it takes transportation wise to get the world fed. **And to re-emphasize, Food, Water, and Air are essential to sustain human life.** This is not a convenience we are talking about.

9. What other income sources that farmers rely on could be threatened by EPA's stringent ozone proposal? Fertilizer, Chemical, and fuel production costs will escalate increasing costs to farmers.

10. What are some of the public health impacts of unemployment or underemployment? Unemployed and underemployed eat less healthy and increased food costs will exacerbate the problems associated with underemployment.

11. Could EPA's stringent ozone proposal have a ripple effect throughout rural economies? YES

12. Rural communities are far away from urban and industrial areas and often have few emissions that could result in ozone. Do rural communities still need to be concerned about EPA's stringent ozone proposal? YES, See 7. In addition, increased food costs affect everyone and every economy.

13. Can even a small increase in energy prices be amplified to significant impact on rural economies? YES. Agriculture is a large energy user, particularly Swine and Poultry.

14.

15. Would EPA's ozone proposal just affect big factories and power plants, or could farmers and other rural families also be impacted? YES, See 7. In addition, increased food costs affect everyone and every economy.

Responses by Ms. Cara Keslar

QUESTIONS FOR THE RECORD The Honorable Bruce Westerman (R-AR) U.S. House Committee on Science, Space, and Technology

Reality Check Part II: The Impact of EPA's Proposed Ozone Standards on Rural America

Friday, May 15,2015

Questions for Ms. Keslar

1. Ms Keslar, you state in your testimony (on page 4) that without a better understanding of background ozone, it will be "difficult and ineffectual for rural western states to develop plans that focus on controlling" emissions. Can you explain this statement further?
   a. Without having this information upfront, how can you be sure that a lower standard in the 65 to 70 ppb range is achievable for your state?
   b. Wouldn't it be better for EPA to have conducted this research prior to proposing a change in the standard?

   Answer: *If states do not have a clear understanding of the components/sources that are contributing to ozone levels, states cannot evaluate which sources are in their jurisdiction or control. Without this knowledge, states cannot evaluate control strategies and develop effective plans for reducing ozone. Even with an understanding of components of background that contribute to Wyoming's ozone level; an ozone NAAQS of 65 ppb will be difficult to achieve for states with higher background concentrations. It is my understanding that EPA is under statutory and court ordered deadlines to evaluate the ozone NAAQS. That being said, EPA should consider the uncertainty and the challenges of dealing with background when setting the ozone NAAQS..*

2. Last July, this Committee wrote EPA requesting that CASAC fulfill its statutory duties under the Clean Air Act to advise the Administrator of any adverse public health, welfare, social, economic, or energy effects which may result from various strategies for attainment and maintenance of the ozone NAAQs. Given the many implementation issues you are raising here today, do you agree with us that this analysis is important and should be done immediately, if not before, EPA issues the final rule?

   Answer: *Yes it is very important that the implementation issues are analyzed and considered when setting the ozone NAAQS. It is my understanding that EPA is under statutory and court ordered deadlines to evaluate the ozone NAAQS. That being said, EPA should consider the uncertainty and the challenges of dealing with background when setting the ozone NAAQS.*

3. You also note in your testimony that CASAC recommended to EPA "that EPA facilitate research to better characterize background levels". In fact, the Clean Air Act actually *requires* CASAC to provide the Administrator with advice "on the relative contribution to air pollution" from "natural as well as anthropogenic activity". Ideally, shouldn't CASAC have provided this input along with it recommendation?
   a. Given that EPA can consider proximity to background, how do you think this lack of information affected CASAC's recommendations on setting a lower standard?

   Answer: *Ideally, if further information was available it should have been presented*

to EPA. I cannot speak to how this would have affected CASAC's recommendation.

4. In your testimony (page 4) you state that EPA should commit to developing timely implementation guidance specific to high-elevation rural areas to address the treatment of background ozone. However, earlier this month, EPA announced that it was unlikely to issue implementation rules when it finalizes the ozone standard. This is not a total surprise since EPA just issued the final implementation rules for the 2008 standard. What do you think is the likelihood that EPA will develop the implementation tools you request in time to assist you in making designations and developing attainment strategies?
   Answer: *Given the AQD's past experience on the timeliness of EPA guidance and tools, it is unlikely that all guidance and tools will be ready to use for designations and implementation. However, this should not discourage the EPA and States from working together and move forward to develop necessary tools and guidance as soon as possible.*

5. According to EPA's latest schedule, EPA will *not* be *proposing* revisions to its 2007 Exceptional Events Rule or issuing draft wildfire guidance until sometime in the Fall of 2015. How can states use any of this information in a timely way in making designations recommendations, especially given the likelihood of further delays?

   a. Unless there is a dramatic change in the level of evidence required, do you believe Wyoming will be able to obtain approval for any exceptional events by the time it submits and EPA approves designations?

   b. What kind of a jam does EPA's implementation schedules place you and other states?
   Answer: *Since the proposal and/or final rule changes are not under court-ordered deadline, it is unlikely final changes to the Exceptional Event Rule will be implementable prior to developing designation recommendations. Based on the schedule proposed for flagging and submitting demonstrations of ozone related Exceptional Events in the proposed ozone NAAQS, it will be difficult for states to produce demonstrations and for EPA to get demonstrations with regulatory consequence through the approval process without a major streamlining effort on EPA's part. The level of effort for demonstrations required for ozone related Exceptional Events and resource needs (both monetary and staff-related) coupled with the lack of guidance on ozone related events will make it very difficult for states to get any demonstrations approved by the EPA. This presents an issue if these Exceptional Events are included in a data record that leads to a non-attainment designation. States will then be responsible for non-attainment requirements due to these uncontrollable Exceptional Events.*

6. You state in your testimony (on page 7) that Wyoming has submitted 5 demonstrations or petitions to EPA Region 8 for exceptional events decisions for stratospheric intrusions, but has only received concurrence for one. Is that correct?

   a. How long has EPA had these demonstrations or petitions?
   b. Have they given you any reasons for the delay?
   c. What kind of confidence does this track record give you with regard to future petitions under a lower standard?

   Answer: *This is correct, Wyoming has only received one concurrence. The EPA has not acted on the other four demonstrations. The demonstrations were*

submitted between 2010 and 2013. The EPA's Exceptional Event Guidance discusses EPA's process of choosing which packages to evaluate based on the Region's determination of "regulatory consequence". Since the Exceptional Events discussed in the four packages took place in areas that were not in non-attainment and the Events did not result in a 3-year design value that was violating the ozone NAAQS, the Region determined those Exceptional Events did not warrant being placed at the top of the priority list. This "track record" leaves Wyoming uncertain as to EPA's ability to process all or even a portion of the demonstrations that will be submitted under a lower ozone NAAQS.

7. You also note that you are the only agency in the nation that has received approval for a stratospheric intrusion event. Do you have any sense of how many other petitions have been submitted on intrusions with no response from EPA?
   a. Do you believe it would be helpful to have a publicly accessible website that shows when demonstrations were submitted and EPA's response?

   Answer: *I do not know how many other stratospheric intrusion demonstrations have been submitted to EPA. Yes, it would be helpful to see how many demonstrations have been submitted and EPA's response.*

8. EPA in its draft RIA agrees with your testimony when it states (on page 3A-55) that "current ozone modeling tools are not sufficient to properly characterize ozone formation for these winter ozone episodes". And yet, am I right in noting that when EPA issues a lower standard, Wyoming, not EPA, will be responsible for demonstrating attainment when neither EPA nor your state understands how?
   a. Do you believe this is fair?

   Answer: *In Wyoming, the Upper Green River Basin is currently designated non-attainment based on a winter time ozone issue. Wyoming has always taken responsibility for this issue and will continue to in the future if the area is designated as non-attainment under a lower ozone NAAQS. Wyoming has worked very hard, even prior to the official designation in 2012, to study the issue and work with area stakeholders to solve the issue in the absence of a model. That being said, it has always been, and will continue to be, a challenge to develop and test targeted control strategies in the absence of a model. Wyoming believes that EPA is working toward developing a model to better characterize these areas, although it is not expected in time for the next ozone NAAQS designations.*

9. EPA's draft RIA also notes (3A-54) that there are 26 monitors in rural and remote western areas (2 in Wyoming) that were excluded from the modeling analysis because these monitors did not respond to large modeled regional emission reductions and remained above the standard after applying these reductions. Will you be able to throw out these monitors as well in implementing the standard, or will Wyoming be held accountable in a way that EPA is not?

   Answer: *If Wyoming and other states have rural ozone monitors that violate the ozone NAAQS and are designated non-attainment, states will be responsible for implementation actions under the NAAQS.*

QUESTIONS FOR THE RECORD
The Honorable Jim Bridenstine (R-OK)
U.S. House Committee on Science, Space, and Technology

Reality Check Part II· The Impact of EPA's Proposed Ozone Standards on Rural America

Friday, May 15, 2015

Questions for Ms. Keslar

1. In your testimony you say that "overburdening State resources with administrative exercises will not be conducive to attaining this objective" of compliance with the ozone standard, and that background ozone can account for as much as 80 percent of measured values. Can you speak to how much time and resources you would have to put in to compliance with a lower standard?
   Answer: *It is difficult to assess the exact time and resource burden it will take to comply with an ozone NAAQS at sites where the majority of the ozone comes from uncontrollable sources. Each demonstration to show that ozone in an area with high background is either an Exceptional Event, or transported from other areas will take at a minimum between 4-8 months to produce and could cost an agency more than $150,000 in contractor costs to assist in developing demonstrations. Under a lower ozone NAAQS it is possible that states will need to develop multiple demonstrations to account for the background, without a guarantee that the area will not be designated non-attainment.*

2. Can you speak to the burden that will be put on states to implement both the 2008 standards along with developing plans to comply with these potential new standards?
   Answer: *Currently, Wyoming has one ozone non-attainment area under the 2008 NAAQS. Wyoming has spent $9.5 million in contracted assistance over 10 years and allocated close to 25% of its staff to working full- or part-time on solutions for Wyoming's one ozone non-attainment area. With a lower ozone NAAQS, and the possibility of multiple areas being designated as non-attainment, it will be difficult to absorb those duties in addition to implementing other EPA rules, NAAQS, and other regular duties associated with protecting Wyoming's air resource.*

3. If background levels consistently exceed the NAAQS standard, is EPA planning to hold states accountable for factors outside their control?
   Answer: *EPA has discussed in the proposed ozone NAAQS that it has made regulatory relief mechanisms available for areas that are influenced by uncontrollable factors (background). However, without further guidance and streamlined rules, it is difficult to understand whether these will truly help areas from being designated non-attainment for factors outside of their control.*

Responses by Mr. Kevin Abernathy

QUESTIONS FOR THE RECORD
The Honorable John Moolenaar (R-WI)
U.S. House Committee on Science, Space, and Technology

Reality Check Part II: The Impact of EPA's Proposed Ozone Standards on Rural America

Friday, May 15, 2015

Questions for Mr. Abernathy

1. **Will the ozone proposal just mean that large facilities have to put on expensive controls, or could emission reduction measures impact small businesses?**

Both. As ambient air quality standards are ratcheted downward, air agencies are forced to find additional emissions reductions. There are two places they look: Previously unregulated sources, or tightening restrictions on already regulated sources. In some cases, smaller sources within a category have not been regulated because the cost of regulation (to the regulated and the government) was not considered to be worth the return on investment. Today, virtually all sources in the San Joaquin Valley are regulated, from factories and refineries, to small businesses such as dry cleaners, paint booths, fireplaces, gas stations and even restaurants that charbroil hamburgers.

To meet previous ozone standards, dairies were regulated in 2006 to reduce emissions of Volatile Organic Compounds, that is, VOCs emitted mostly from manure. Initial regulations applied only to average and large-sized California dairies. By 2010, to meet even tougher standards, the district cut the size threshold for regulation in half, then added additional controls to reduce emissions from cattle feed. The cost of this regulation is estimated by the air district at $61.5 million, or close to $6,700 per ton. Ratcheting the ozone standard down would force the district to consider tightening rules even further on existing businesses.

2. **EPA Administrator Gina McCarthy wrote an op-ed saying that the Agency's air standards "attract new business, new investment, and new jobs." That might sound good politically, but is that what dairy farmers have found?**

As ozone levels reach near background levels, we seem to be reaching a point of diminishing return. Dollars invested in control strategies to achieve incremental improvement begin to increase exponentially while the positive effects become more uncertain and hard to measure. One thing we know is that dairies have not benefitted; as we note in our testimony we have lost 500 dairies in California in the past five years.

3. **Could unnecessarily stringent regulations like EPA's ozone proposal push businesses off shore to countries with lower environmental protections? How does that help the environment?**

Clearly, that doesn't benefit anyone. Food production inside our borders is a particularly important issue to consider as it may not be wise to outsource our food security. We've already

seen businesses move out of California, and lured to other states with promises that include fewer regulations. But as you can see in our written testimony, the escape routes are being blocked, with 44 states that are in danger of exceeding current and proposed ozone standards. As this situation worsens, it will be tempting to move more and more of our agricultural production to Mexico, Canada, South America and overseas.

4. What are the hidden costs of regulations like EPA's stringent ozone proposal?

Without reform of the federal Clean Air Act, one hidden cost is multiple, redundant planning and reporting timelines for agencies to juggle. This raises costs for regulated business and taxpayers. Other hidden costs include lost economic opportunities as businesses choose to expand or relocate in other air basins not affected by the standard, including outside the U.S.

5. What are some of the emissions reduction measures that could be imposed on farmers under EPA's stringent ozone proposal?

Farmers can expect further controls on engines that power mobile farm equipment such as tractors, trucks, harvesters, and balers. In many cases this really means retiring these vehicles and replacing them with new and often more expensive equipment. The same is true stationary engines, such as pumps and generators. This can have a number of negative impacts, including the possibility of being forced to purchase equipment before needed, and devaluing older equipment that might have a long service life still ahead. In some cases, farm vehicles are only used seasonally and infrequently.

6. EPA's cost-benefit analysis for the ozone proposal caps the cost of unknown controls – that is, controls that don't yet exist but are assumed to be invented someday – at just $15,000. In your experience with implementing "unknown controls" does that sound reasonable?

To me, probably not. It's important to start by understanding what EPA means by that figure. That is a blanket estimate, on a per-ton basis, for reductions of ozone. So the first thing we need to say is that $15,000 is not the total cost per business or per control, but the cost per ton. In a real world example, such as the 2010 San Joaquin Valley Rule 4570 for dairies – which resulted from tightening ozone standards – the estimated cost averaged more than $50,000 per regulated dairy to actually implement the ozone reduction measures.

Also, EPA's estimate is a general estimate across all sources in all areas. This means even if the estimate is accurate, it could still be much higher in some areas.

Finally, while it is difficult to argue what future costs will be for "black box" controls not yet invented, long-term trends suggest that overall emissions control costs tend to go up, not down. And in many cases controls for ozone precursors are already much higher than $15,000 per ton, at least in California and in the San Joaquin Valley. For example, according to a 2012 California

Air Resources Board report,[1] emissions reductions offsets for oxides of nitrogen (NO_X – the most important ozone precursor in the San Joaquin Valley) traded at between $32,500 and $63,250 per ton. Of course, with a tighter standard and population growth we would expect the costs to climb higher. This strongly suggests that EPA's estimate is far too low for some areas of the country.

To the degree that farm equipment must be replaced to meet standards, costs could soar much higher. New farm equipment can costs hundreds of thousands of dollars. For other businesses, costs could easily be higher. This does not include costs to comply with other rules related to ozone, such as those for stationary engines (pumps and generators) and costs related to mobile equipment.

7. EPA's cost analysis claims that the costs of implementing its proposed ozone standard have gone down by $29 billion in the last four years. Is this consistent with your experience – has there been some sort of breakthrough in the last four years?

As you've heard from me today, it gets increasingly expensive as we strive to achieve ever more difficult targets. In many cases, transformative technology will be needed – e.g. replacing diesel powered farm equipment with electric equipment, and replacing nearly every vehicle in our state with electric or hydrogen-fuel-cell vehicles, or other zero emission technologies. It's always difficult to predict future costs – but keep in mind business in the San Joaquin Valley has already spent $40 billion meeting past standards. It's hard to imagine that $29 billion could possible cover the costs of the transformational measures that will be needed in much of the nation to meet proposed ozone standards.

8. EPA can't even point to controls capable of almost half the emissions reductions needed in the east – and all of the reductions required in California – to meet its stringent proposed ozone standard. This sounds like shoot first, ask questions later rulemaking. Should we be imposing this much burden on the American people when EPA doesn't even know how this rule can be accomplished?

No, we should not. As we've suggested in our written testimony, economic and technical achievability of standards needs to become a component of setting ambient air quality standards. We know longer have the luxury of adopting a standard and assuming that we will be able to achieve it within the timelines prescribed under the federal Clean Air Act, especially when we may need to rely on "black box" technologies or replace and retire whole fleets of tractors and other agricultural equipment. We are already seeing our air districts and businesses cracking under the strain of what appears to be an "autopilot" strategy of implementing the Clean Air Act. It is time for us to take back the controls and be more strategic so we can navigate the challenges and obstacles ahead more efficiently and effectively.

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[1] "Emission Reduction Offset Transaction Costs, Summary Report for 2012," California Air Resources Board, http://www.arb.ca.gov/nsr/erco/erc12.pdf Accessed April 28, 2015.

9. EPA can't identify the controls to accomplish much of the reductions required under its stringent ozone proposal, but just assumes low-cost technologies will be developed. How realistic is this in your experience?

It might be realistic if we add the word "someday" to your question. Will we have low-cost clean technologies available everywhere that allow us to meet the proposed standards? Will upwind areas stop contributing to the pollution burdens of others? This should be possible – someday. But blindly assuming it will happen within the timeframe of the federal Clean Air Act, and that it can happen everywhere, regardless of the site-specific challenges, ignores reality. Setting up air basins to meet unachievable goals with impossible deadlines might make us feel good that we're protecting air quality, but in fact, this strategy doesn't work, risks jobs and the economy, and poses enormous administrative and business costs.

10. EPA talks about "unknown controls" as if technology will just magically be developed to implement their stringent regulations. What are unknown controls in practice? Are they things like shutting down power plants, less economic activity, mandatory electric cars?

As we have testified today, there are clearly areas of the country that need to essentially eliminate all fossil fuel combustion to achieve even current ozone standards. This would require replacing all diesel and gasoline engines, and replacing coal and natural gas-fired power plants with wind, solar or other alternative energy sources. This kind of major transformation has to be managed carefully if we are to maintain reasonable energy costs necessary for a stable economy.

11. EPA assumes a lot of so-called "unknown controls" to accomplish its stringent proposed ozone standard. Is that just another word for unpopular measures that EPA doesn't want to admit would be necessary under this proposal?

In many areas, our choices are limited. Either remove virtually all pollution from combustion sources – engines, boilers, power plants, refineries, and factories – with cleaning and capturing technology that is not yet available or even invented, or stop using these fossil fuel-powered sources entirely and replace them with zero emissions technology. Popularity of the measures will depend entirely on how strategic and flexible we are as we consider phasing them in.

12. EPA's stringent proposed ozone standard could create more barriers to economic development for farmers. Do you think there is a public health effect to not being able to get a job?

I do. More importantly, scientists do. In 2005, scientists published a meta-analysis of 104 different studies, showing that unemployed individuals had lower psychological and physical well-being than their employed counterparts.[2]

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[2] "Psychological and Physical Well-Being During Unemployment: A Meta-Analytic Study," McKee-Ryan; Song; Wanberg and Kinicki; January, 2005, *Journal of Applied Psychology*. http://psycnet.apa.org/journals/apl/90/1/53/

13. Do you think that ozone standards should be achievable? What is the public health benefit of setting a standard on paper that cannot be met in the real world?

Setting an unreachable goal, and coupling it with an impossible timeline, does no one any good. Clearly there is no health benefit and there also is the potential to do more harm than good by triggering unnecessary costs and economic impacts. This does not mean that we cannot set goals for improvement. It means that – thanks largely to incredible success of air agencies like ours in the San Joaquin Valley – if we want to continue to improve, we need go after those goals more strategically. We need to consider site specific factors, such as climate, topography and meteorology. We need to support technological progress, but recognize practical limits and real-world logistics. The one-size-fits-all strategy is already failing. We should fix it now instead of waiting for the system to collapse.

QUESTIONS FOR THE RECORD
The Honorable Jim Bridenstine (R-OK)
U.S. House Committee on Science, Space, and Technology

Reality Check Part II: The Impact of EPA's Proposed Ozone Standards on Rural America

Friday, May 15, 2015

Questions for Mr. Abernathy

1. **In your testimony you state if we lower the standards and huge portions of the country fall into nonattainment, it could force the dairy industry completely out of the United States. Is it your opinion that, through this rule, the EPA is outsourcing jobs?**

While it's unlikely the dairy industry would ever be completely forced out of the United States, the risk of outsourcing significant portions of U.S. dairy production to other areas is very real. Many of our markets for dairy products are outside of the U.S. already, and as costs related to producing milk increase to levels that make us uncompetitive in the global market, the choices will be very stark indeed for U.S.-based companies. They will either need to rely on milk production and processing outside of our borders – moving farms and processing capacity outside our borders – to meet the demands of the global marketplace, or they will lose their market share to non-U.S. companies producing outside the U.S. at a more competitive cost. Either way, U.S. jobs are at risk of being outsourced.

2. **Can you speak to the burden that will be put on states to implement both the 2008 standards along with the developing plans to comply with these potential new standards?**

Even with today's (2008) NAAQS for ozone, significant and unnecessary problems are occurring for states during implementation of the federal Clean Air Act. In our written testimony, we described these problems and offered practical solutions, which do not force an unnecessary choice between protecting the economy and protecting air quality. We reiterate here:

Problem 1 is implementing multiple NAAQS standards. Today, when a newer, more stringent standard is adopted, the older standard remains in place. This creates multiple, redundant planning timelines and public processes. For example, the SJVAPCD is currently addressing four pending standards for ozone and four additional standards for $PM_{2.5}$. In 2016 alone (after addressing the 1997 $PM_{2.5}$ standard during 2015) the district will be forced to report progress again on the 2006 *and* 2012 standards for, incredibly, $PM_{2.5}$. On top of that, SJVAPCD will also have to address the 2008 standard for ozone in 2016. These multi-layered planning timelines exponentially increase the cost of implementing attainment plans and reporting on progress. They do nothing to improve air quality, because air quality could be protected by simply aligning the existing plans to newly adopted standards. This additional administrative burden not only raises costs for taxpayers, but increases the costs of compliance for the regulated community, again without an air quality benefit. Businesses are also burdened with the substantial uncertainty associated with tracking multiple State Implementation Plans, associated rulemaking and permitting processes, and maintaining understanding about likely future requirements. This makes it that much more difficult to plan equipment retirement and replacement and potential future expansions or facility upgrades. Specific recommendations on how to address this issue, without sacrificing air quality, have been put forward by SJVAPCD in its "2015 Federal Clean Air Act Modernization Proposal" (see Attachment B of our written comments). We support these recommendations.

A second problem is the heavier reliance air regulators will need to make on new or transformative technologies to reach newly adopted standards. This is an increasing problem as the standards reach near-baseline levels. There is substantial uncertainty about whether these technologies – sometimes called "black box" technologies because it is not yet understood even what the technologies will be – will be technically or economically feasible. The Clean Air Act today does not currently allow economic feasibility to be considered when considering a more stringent NAAQS; we believe it is time to revisit this issue because adoption of unattainable standards automatically leads to requirements that air regulators work to achieve those unattainable standards. As standards move closer and closer to baseline, the luxury of waiting until the future to find out if they can be met no longer exists. SJVAPCD has proposed very reasonable, narrow and specific amendments to the Clean Air Act that address this problem (again we refer to Attachment B of our written comments).

A third problem is rigidity in the requirements for reporting progress on reductions from sources of criteria pollutant precursors. Regulators have long recognized that not all precursors are created equal. For example, in the San Joaquin Valley, oxides of nitrogen have proven to be 20 times more powerful than VOCs in creating ozone. Yet regulators can be handcuffed into achieving equal reductions of both VOCs and nitrogen oxides as they report Reasonable Further Progress in attaining a standard. Alternative strategies that achieve an equal or even greater

amount of pollution reduction are not allowed. Again, SJVAPCD has suggested specific changes that would solve this issue without sacrificing achievable air quality goals (Ibid., Attachment B). There are additional technical changes that SJVAPCD has proposed related to when contingency measures should be required, and to clarify the role of vehicle pollution control measures in attaining standards after recent court rulings left this important program in question. In summary, SJVAPCD has suggested several specific, workable changes to the sections 172, 181, 182 and 189 of the Clean Air Act. We hope your subcommittee will take these under advisement.

3. If background levels consistently exceed the NAAQS standard, is EPA planning to hold states accountable for factors outside their control?

In our view, EPA has no plan to avoid holding states accountable for factors beyond their control. The current Clean Air Act implementation scheme only allows for revised compliance timelines, which come with significant strings attached in the form of increased administrative burdens and potential penalties. While defining "background" levels of precursors remains a controversial issue, it is clear that in some air basins, pollutants transported into the basin contribute significantly to nonattainment. We do not believe it was the intent of Congress in adopting the Clean Air Act to hold states responsible for pollution transported from other areas. Again, we refer to Attachment B of our written comments as containing common-sense considerations for dealing with this difficult issue. In our view, it makes no sense to adopt more stringent NAAQS for ozone before addressing these practical, real-world implementation issues.

1. **Can you speak to the burden that will be put on states to implement both the 2008 standards along with developing plans to comply with these potential new standards?**

Simply stated, states will have wasted previous efforts which resulted in the current (2008) standards. The years of work that have only just begun to be implemented will have been futile. Repeating the same process before EPA has ascertained the effects of the 2008 standards will subject states to even greater business uncertainty for investments and plans; imprudently duplicate efforts, costs and resources; severely stifle economic growth; and recklessly harm millions of Americans.

2. **If background levels consistently exceed the NAAQS standard, is EPA planning to hold states accountable for factors outside their control?**

Without providing for exceptions or abilities to address background levels, it appears EPA would in effect be holding states accountable for factors outside their control.

3. **EPA updated ozone standards in 2008. If EPA sets a new more stringent standard, will the states have to implement two ozone standards at the same time?**

Arguably, if EPA sets a more stringent standard, the new rules would supersede the 2008 standards. However, due to the fact under the current process states are in the early stages of implementation, there would be duplicative and wasted efforts to obtain compliance for an abandoned standard. In essence, a new more stringent standard being developed at the same time the current standard is being implemented—results in the practical effect of states undergoing implementation of two ozone standards at the same time.

4. **EPA updated ozone standards in 2008, but you testify that EPA is just now publishing rules to implement that standard. What took so long?**

Due to legal challenges and delay, the current ozone standard was only finalized in March of 2015, when the EPA published its final State Implementation Plan requirements for the 2008 standard. Notably, The White House rejected EPA's attempt to impose more stringent standards in an out-of-cycle rulemaking, noting regulatory burdens and regulatory uncertainty as reasons the economy could not support such an unjustified expense.

5. **EPA updated ozone standards in 2008, shouldn't we focus on implementing that standard before making a new one?**

Yes. It defies logic to change the goal posts before even knowing the effects of the current standards. Moreover, EPA has failed to demonstrate the need to change the ozone standards at this time.

6. Do we need more stringent ozone standards to have cleaner air?

No. EPA itself has stated the proposed standards are projected to be met by 2025 with the current rules and programs now in place or under way.

7. Could more stringent ozone standards undermine the benefits that Oklahoma enjoys by being at the forefront of this country's energy revolution?

Absolutely. As the effects of increasing federal requirements (such as NAAQS, Clean Power Plan, MATS and Regional Haze, to name just a few) are realized by industry and consumers, Oklahoma's competitive advantage of being a low energy cost state is being tested. The current threats are real, and every industry is faced with the difficult task of assessing whether it remains economically feasible to conduct business in Oklahoma.

8. What are some of the public health impacts of unemployment or underemployment?

As individuals are impacted by less income and rising energy costs, access to daily necessities become more restricted and individuals are faced with the difficulty of choosing among medicine, food, heat, and/or air. The inability to frequently access medical care has a direct impact to the health, safety and wellbeing of Americans.

9. Could EPA's stringent ozone proposal have a ripple effect throughout rural economies?

Yes. Unfortunately, under the proposed more stringent ozone standards—no economy is immune from its detrimental effects. Rural economies, already struggling for social and economic development, will simply feel the effects quicker and/or be unable to rebound from the increase in costs experienced in all economies, including the loss of jobs and reduction in opportunities and growth.

10. Rural communities are far away from urban and industrial areas and often have few emissions that could result in ozone. Do rural communities still need to be concerned about EPA's stringent ozone proposal?

Yes. Rural areas will be disproportionately affected by the proposed standards. As the majority of areas will be facing nonattainment for the first time, rural areas are at the greatest risk for a violation of the secondary standard. Rural communities are without the ability to reduce or otherwise control ozone precursors within a designated nonattainment boundary due to the heavy impacts from the interstate transport of pollution.

11. Does EPA's stringent ozone proposal pose risks to natural gas supply? Could this pose problems to electric utilities looking to natural gas to comply with EPA's power plan regulations?

Yes. As electric utilities are striving to minimize the detrimental effects under the Clean Power Plan, these entities are making decisions which will likely conflict with more stringent ozone

standards. The building blocks set forth under proposed 111(d) may ultimately lead to higher ozone emissions. Additionally, energy production will face increased barriers and hinder growth. Increased natural gas costs have a direct impact on efforts being taken to comply with the Clean Power Plan.

12. Can even a small increase in energy prices be amplified to significant impact on rural economies?

Yes. Energy prices affect every aspect of rural economies. For example, farmers feel the real increase in costs in all aspects of productivity, such as: fuel, fertilizer, utilities and equipment.

13. Can you explain the impact of EPA's stringent ozone proposal on rural healthcare?

Rural healthcare is no less affected by EPA's proposed ozone standards. Rural communities currently face the challenge of healthcare availability. Rural hospitals in Oklahoma are experiencing financial stress, including bankruptcies and closures. As energy costs increase as a direct result of the impacts of stricter ozone standards, the financial situation and ability to obtain healthcare in rural areas are exacerbated.

Appendix II

Additional Material for the Record

STATEMENT SUBMITTED BY FULL COMMITTEE RANKING MEMBER
EDDIE BERNICE JOHNSON

Opening Statement

Ranking Member Eddie Bernice Johnson
House Committee on Science, Space, and Technology

"Reality Check Part II: The Impact of EPA's Proposed Ozone Standards on Rural America"

April 29, 2015

Thank you, Mr. Chairman, and thank you to our witnesses for being here this afternoon. We are here once again to discuss EPA's proposal to lower the standard for ozone, the pollutant that causes smog.

We have heard before and we are likely to hear it again today that EPA's efforts will be destructive to the nation's economy. Fortunately, such doomsday predictions have been proven to be false time and time again. Americans have a strong track record of resourcefulness and innovation in the face of obstacles and I am confident that we will once again be successful in our efforts to improve the quality of the air we breathe.

I'd like to remind everyone here today why EPA is putting forward regulations to combat ozone and our biggest environmental challenge climate change. EPA is doing it not to advance a political agenda as some would have you believe, but as part of its statutorily defined mission to protect the health and well-being of Americans. In short, EPA is fulfilling the critical mission that Congress entrusted it with. And it is taking such actions because the scientific evidence supports them.

During the hearing we had last month on EPA's ozone standard, some of my colleagues seemed to suggest that there was disagreement within the scientific community on the health effects of ozone so I asked one of our witnesses, Dr. Mary Rice, an adult pulmonologist and critical care physician, to comment on that opinion.

In her response to the Committee, she stated "that ozone exposure harms human health is a well-established scientific conclusion." Organizations such as the World Health Organization, the National Academies of Science, the American Lung Association, the Academy of Pediatrics, the American Public Health Association, the American Thoracic Society and many others have independently examined the scientific evidence and reached the same conclusion-- ozone is harmful to human health.

It is time for us to be supportive of EPA's efforts to protect the American people. We need to allow EPA and the States to take the needed steps to improve our air. Thank you, Mr. Chairman, and I yield back the balance of my time.

DOCUMENTS SUBMITTED BY REPRESENTATIVE FRANK LUCUS

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March 17, 2015

The Honorable Gina McCarthy
Administrator
U.S. Environment Protection Agency

Attn: **Docket ID No. EPA-HQ- OAR-2008-0699**

Dear Administrator McCarthy:

On behalf of all of the cotton growers and operating cotton gins employing thousands of people in California, the California Cotton Ginners and Growers Association is deeply concerned about the harmful impact that the Environmental Protection Agency's (EPA) recently proposed rule to make ozone standards more stringent could have on the still struggling economy. Ozone standards at the levels considered in EPA's proposal could push virtually the entire country into "nonattainment" – where local communities face burdens to commercial and industrial activity not only vital to creating jobs, but also to providing tax revenue that support important local services like public safety and education. This proposal's hardship to the American worker is real and immediate, while the benefits are unverified and uncertain. Therefore, CCGGA strongly urges you to retain the current ozone standard when finalizing this proposal.

We all value clean air, as our families all breathe the same air. We are proud that emissions of ozone-forming emissions have been cut in half since 1980, leading to a 33% drop in ozone concentrations across the country. Moreover, EPA just updated ozone standards six years ago. These current standards are behind schedule due to EPA effectively suspending their implementation from 2010-2012 while the Agency unsuccessfully pursued reconsideration. Here in the San Joaquin Valley, exceedances of the original one hour ozone standard have been reduced from 281 exceedances in 1996 to zero (0) in 2014! This was due in part to an 80% reduction in emissions from stationary sources in that same time period. In comparison to the 84 ppb 8-hour ozone standard, the San Joaquin Valley reduced the number of exceedances by 70%. In comparison to the 75 ppb 8-hour ozone standard, there has been a 41% reduction in the number of exceedances. Over $40 billion has been spent by industry to reduce those emissions, by installing the most effective control technology in the country.

Indeed, states are currently committing substantial resources – both in time and money – towards achieving emissions reductions under those current ozone standards. Yet despite over three decades of cleaner air and before states can catch up with EPA's delays in implementing existing ozone standards, EPA is now proposing a new stringent range of standards from 70 to 65 parts

per billion that would bring vast swaths of the country into nonattainment. In some areas, this proposed range is at or near the level of background ozone that is naturally occurring or internationally transported, pushing even remote counties far from industrial activity into nonattainment. According to EPA's own data, even the pristine Grand Canyon and Yellowstone National Parks would fail the proposed ozone standards.

It has been stated by the San Joaquin Valley Air Pollution Control District and by EPA that the technology does not exist to bring the San Joaquin Valley into attainment for this proposed ozone standard. It has even been stated that even if all fossil fuel combustion were eliminated in the San Joaquin Valley, attainment of the proposed ozone standard could not be achieved. Considering the District has the most stringent rules and regulations governing sources of ozone in the country, we are deeply concerned on the impact of the potential elimination of any fossil fuel combustion in the San Joaquin Valley. Our members are already replacing their forklifts, trucks and now tractors, at a time no one else in the world is required to do so; yet, this will not go far enough should EPA adopt the proposed standard. Over $1 billion has been spent in a public/private partnership to voluntarily reduce emissions through incentive programs for early implementation of advanced technologies resulting in over 100,000 tons of emissions reductions. Yet, this is not enough.

Against these economic consequences, scientific uncertainties regarding the benefits of more stringent ozone standards have increased. Indeed, stringent ozone standards may have severe unintended consequences for public health. Studies show that by increasing the costs of goods and services such as energy, and decreasing disposable incomes, regulation can inadvertently harm the socio-economic status of individuals and, thereby, contribute to poor heath and premature death. As businesses employing needed jobs in our communities, CCGGA believes these scientific uncertainties should be better explored in order to best allocate resources in a manner that strengthens both the economy and the environment.

Lastly, it is important for EPA to recognize the impact of transboundary anthropogenic ozone (TAO) on the Western United States, particularly California. As EPA considers lowering the ozone standards to background levels, the impact of TAO cannot be ignored and must be acknowledged. Considering the rapid growth in fossil fuel combustion in Asia, including China and India, TAO is a source of ozone that must be considered. Most recently, the San Joaquin Valley Air Pollution Control District surmised that "Based on the weight of evidence, 10 to 15 ppbv represents a conservative estimate of the TAO fraction contained within total transboundary ozone entering the West Coast airspace in the lower free troposphere."[1] Failure to address and include these impacts will unfairly and inappropriately penalize businesses in the United States, particularly businesses located in those areas with background ozone levels at or near the proposed National Ambient Air Quality Standard for ozone.

[1] Attainment Determination Request for the Revoked 1-hour Ozone Standard, Attachment B pg. 15, SJVAPCD, May 5, 2014.

The air is getting cleaner, and current ozone standards need an opportunity to work. Therefore, in light of the economic hardship, and uncertain benefits all related to the stringent ozone standards that EPA is now considering, CCGGA calls on EPA to retain the existing ozone standards in the final rule.

Sincerely,

Roger A. Isom
President/CEO

CALIFORNIA FARM BUREAU FEDERATION
GOVERNMENTAL AFFAIRS DIVISION
1127-11TH STREET, SUITE 626, SACRAMENTO, CA 95814 · PHONE (916) 446-4647

The Honorable Gina McCarthy
Administrator
U.S. Environment Protection Agency
Attn: Docket ID No. EPA-HQ-OAR-2008-0699

Dear Administrator McCarthy:

The California Farm Bureau Federation (CFBF) is California's largest farm organization, comprised of 53 county Farm Bureaus currently representing over 57,000 agricultural and associate members in 56 counties. Farm Bureau strives to protect and improve the ability of farmers and ranchers engaged in production agriculture to provide a reliable supply of food and fiber through responsible stewardship of California's resources. We appreciated the opportunity to testify at the February 2nd public hearing in Sacramento and would like to submit the following comments.

CFBF has worked closely with the California Air Resources Board (CARB) and local air districts for the past decade. As you are aware, California regulates air quality on farms and ranches in a manner that has no comparison in other states and nations. As a result of the state's strict air quality program, Californians today breathe the cleanest air since measurements have been recorded. First stage alerts in the L.A. area have been cut from over 200/year in the 1970's to less than 10/ year today. Other parts of the state have also improved air quality despite massive increases in a population who drive more cars further than ever before.

CARB has funded cutting edge research with financial support from USEPA to understand and reduce the risks of air pollution exposure to children's health. Additionally CARB has completed and implemented indoor Air quality assessments; stationary & mobiles source regulations; consumer products regulations and a Toxic Air Contaminants program among many other air quality efforts. It is important to note that:

- California has the cleanest and most expensive fuel in the nation
- We are the only state in the nation that mandates every diesel truck owner (over 14,000 GVWR) to be driving a 2010 engine within the next 8 years
- We are the only state in the nation that is creating a rule that will require farmers to replace their farm equipment
- We are the only state in the nation with a real mandatory GHG program
- Wide scale electrification mandates are being proposed for our goods movement

All of these programs are why we have cleaner air now than ever before but they all come at cost. We are getting to the point under current standards that in the eight counties of the San Joaquin Valley (the most agriculturally productive area in the nation) the Air Pollution Control Officer says that fuel combustion emissions from commerce and transportation could be completely stopped and attainment of an ozone standard lower than 75 ppb can still not be reached.

Since stopping commerce and transportation is not an option, we ask that USEPA incorporate more flexibility into their air quality oversight and take advantage of new air quality monitoring technology to update their computer modeling to better reflect unique areas like California that have done more to clean their air than any place in the nation, if not the world. With 39 million+ people spread across numerous geographic ecosystems, an outdated one size fits all approach will not be effective to improve air quality.

We ask that you re-evaluate and include more accurate modeling design values that reflect the scientifically justifiable fraction of ozone in the region that is contributed by biogenic and international transboundary emissions. Regulating commerce in our country, while dramatic increases in fossil fuel emissions from China are being transported in the troposphere and becoming our responsibility to clean up, is not a sustainable strategy.

Significant monitoring is being done on California's west coast that show a large percentage of the ozone in our airsheds was not generated by our stationary or mobiles sources that we operate here and are being controlled under the Clean Air Act. The National Oceanic Atmospheric Administration 2010 CalNEX studay (published in the *JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 116, D00V03, doi:10.1029/2011JD016095, 2011*) study found that 80% of the ozone in the bottom 3km of our atmosphere in the Central Valley of California is not from North American anthropogenic sources, but instead is a composite of biogenic and transboundary ozone being transported in via the free troposphere. For the Los Angeles basin and nearby desert area the baseline is 63–76% that is coming from outside sources.

Thus Section 179B of the CCA which deals with these issues is extremely important and must be carefully evaluated in relation to California. We strongly disagree, as stated in the proposed rule, that if the standards are lowered to 70 ppb that "background ozone would NOT create a significant implementation challenge in meeting attainment of the NAAQS." We find this clearly not to be the case in California.

Once baseline and international emissions are more equitably recognized then making "Reasonable Further Progress" can be supported instead of being penalized under Section 185. We cannot continue to demand unrealistic expectations of what we can control in our air districts when such significant fractions of our ozone are coming from outside our control. This has to be recognized with more transparency and accessibility in USEPA oversight.

This flexibility and attention to local sources of emissions will be especially important when US EPA undertakes their proposed Exceptional Events review. It is important to streamline the process and insure that a realistic amount of staff time is adequate to provide the necessary demonstration that a wildfire or long distance transport has in fact occurred.

For these stated reasons we do not support reducing the standards and thank you for the opportunity to provide our comments.

Sincerely,

Cynthia L. Cory

Cynthia L. Cory
Director, Environmental Affairs

FARM BUREAU GEORGIA
www.gfb.org

Georgia Farm Bureau Federation
P.O. BOX 7068 • MACON, GEORGIA 31209-7068
478-474-8411

March 17, 2015

Administrator Gina McCarthy
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue NW
Washington, DC 20460

RE: Docket ID No. EPA-HQ-OAR-2008-0699-National Ambient Air Quality Standards for Ozone

Dear Administrator McCarthy,

Georgia Farm Bureau is the state's largest general farm organization with over 300,000 members. We appreciate the opportunity to provide comments regarding the proposed revisions to the existing National Ambient Air Quality Standards (NAAQS) for ozone published in the *Federal Register* on December 17, 2014.

EPA's proposal to reduce the current ozone standard from 70 parts per billion to 65 parts per billion will increase regulations on volatile organic compounds and nitrogen oxides. Although a relatively small contributor, agriculture produces levels of volatile organic compounds (via livestock production and pesticide use) and nitrogen oxides (via the use of engines and other sources) in sufficient quantities that might be regulated.

Restrictions limiting these compounds could create a significant problem for farmers. Control measures could be implemented that would further restrict pesticide applications and pesticide availability. We are concerned there would be greater restrictions on animal agriculture operations because of more regulations on animal waste handling and storage.

Farming is an energy intensive business, and we are concerned that farmers will be indirectly impacted by additional costs associated with special requirements for vehicles and fuels (diesel trucks and farm equipment). For farmers competing in a global economy, higher energy costs hurt competitiveness.

Rural areas of our nation need additional development to create jobs for more citizens. We believe EPA's proposed ozone standards will limit the ability of U.S. companies to create new jobs in rural communities.

Nonattainment designation has profound impact on infrastructure development vital to the agriculture community. Beginning one year from the date of the nonattainment designation, federally supported highway and transit projects cannot proceed in a nonattainment area unless the state can demonstrate the project will cause no increase in ozone emissions.

The restrictions do not disappear when an area finally comes into attainment. Before a nonattainment area can be redesignated to attainment, EPA must receive and approve an enforceable maintenance plan for that area that specifies measures providing continued maintenance of ozone standards and contingency measures to be implemented promptly if an ozone standard is violated.

The stringent new ozone standards have the potential for damaging economic consequences across the economy while increasing input costs and land use restrictions on farmers. Farm Bureau encourages EPA to retain the existing ozone standard in the final rule.

Thank you for your consideration of our views on this important issue.

Sincerely,

Zippy Duvall

Zippy Duvall, President

March 17, 2015

The Honorable Gina McCarthy
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW
Washington, D.C. 20460

RE: Docket ID No. EPA-HQ- OAR-2008-0699 – National Ambient Air Quality Standards for Ozone

Dear Administrator McCarthy:

The Iowa Farm Bureau Federation (IFBF) is the state's largest general farm organization, representing more than 156,000 member families. We appreciate the opportunity to share these additional brief comments of concern on the proposed revisions to the existing National Ambient Air Quality Standards for ozone. The IFBF was one of more than 150 organizations, businesses and companies that signed a letter outlining how EPA's proposal has the potential to be the most costly regulation in our nation's history and could push almost all of the country into "nonattainment" – where local communities would face new limitations in creating jobs and providing tax revenue that support local public safety and education.

The IFBF is also very concerned about how the proposed revisions in primary (health based) and secondary (welfare-based) standards will impose real and significant costs to agriculture while providing uncertain and unverified benefits, and in the difficulty regulating volatile organic compounds, nitrogen oxides and other potential ozone precursors from agriculture.

While great efficiencies have been achieved in agriculture, farming can be an energy-intensive business. Farmers depend on reliable, affordable sources of energy in their daily operations. Iowa farmers compete in a global economy, and higher energy costs and fewer transportation options that are likely to result from these new regulations not only hurt competitiveness, but can negatively impact net farm income, prosperity and quality of life.

These stringent new ozone standards also have the potential for damaging economic consequences across the entire Iowa economy and would place serious restrictions on farmers, increasing input costs for electricity, fuel, fertilizer and equipment. And as ozone standards are ratcheted down closer to levels that exist naturally, more farmers will be forced to abide by restrictions on equipment use and land management, making it harder to stay in business. EPA's own estimates show that a new ozone rule could cost tens of billions of dollars per year. Independent estimates indicate that the costs will likely be much higher, putting millions of jobs at risk across the country.

Although agriculture is a relatively small contributor, ozone precursors that may be regulated through monitoring and control measures may create a significant problem for agriculture. For example, the

investment by Iowa and U.S. ethanol producers on raw materials, goods and services contribute more than $44 billion to the nation's gross domestic product and support a significant number of jobs in all sectors of the economy. Iowa has 43 ethanol refineries capable of producing more than 3.8 billion gallons annually, including 22 million gallons of annual cellulosic ethanol production capacity and one cellulosic ethanol facility currently under construction. In addition, Iowa has 12 biodiesel facilities with the capacity to produce nearly 315 million gallons annually. The state's renewable fuels industry could be greatly affected by more stringent control measures.

We are also concerned about other control measures that might include restricted pesticide applications, restricted livestock manure handling options, and ineffective control measures for certain food and agricultural processing industries.

In addition, agriculture is likely to be indirectly impacted by costs passed on from special requirements for diesel trucks and farm equipment, restrictive permitting requirements that affect ag processing plant expansions, and the loss of federal highway and transit funding.

If finalized, EPA's proposed stringent ozone standards will likely limit farm and business expansion in Iowa, and impair the ability of farmers and businesses to create new jobs and remain competitive. This proposal's hardship to all segments of the economy is real and immediate, while the benefits are unverified and uncertain.

In light of the economic hardship a new ozone standard would cause to farmers in Iowa and throughout the country, while only providing uncertain benefits, the IFBF encourages the EPA to retain the existing ozone standard in the final rule. Iowa farmers cannot afford a stricter ozone standard.

Sincerely,

Rick Robinson

Rick Robinson
Environmental Policy Advisor
Iowa Farm Bureau Federation

KANSAS FARM BUREAU
The Voice of Agriculture

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Office of the President

March 12, 2015

The Honorable Gina McCarthy
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW
Washington, DC 20460

Re: Docket ID No. EPA-HQ-OAR-2008-0699 – National Ambient Air Quality Standards for Ozone

Dear Administrator McCarthy,

Kansas Farm Bureau is the state's largest general farm organization, representing 40,000 farm and ranch families across the state. We appreciate this opportunity to offer comments on the proposed revisions to the existing National Ambient Air Quality Standards (NAAQS) for ozone published in the *Federal Register* on Dec. 17, 2014.

The proposed revisions tighten primary (health based) and secondary (welfare-based) standards, a move that will impose real and significant costs while providing uncertain and unverified benefits. Farm Bureau is concerned about the difficulty regulating volatile organic compounds (VOCs), nitrogen oxides (NOx), and other potential ozone precursors from agriculture and the chilling effect of these standards on the economy as a whole.

The Clean Air Act directs the EPA to set NAAQS for ozone at a level that is protective of human health and the environment, and to regulate both VOC and NOx emissions as ozone precursors. EPA's past efforts to reduce NOx and VOCs have helped decrease ozone levels. Since 1980, ozone-forming emissions have been cut in half and average ozone concentrations have dropped by 33 percent over the same period. EPA just updated ozone standards six years ago. These current standards are behind schedule due to EPA effectively suspending their implementation from 2010-2012 while it unsuccessfully pursued reconsideration. We can expect to see even greater reductions in ground-level ozone as states make up lost ground in putting the current standards into effect.

States are currently committing substantial time and money towards achieving emissions reductions under current ozone standards. Yet, despite more than three decades of cleaner air, EPA is now proposing a new stringent range of standards from 70 to 65 parts per billion that would bring vast swaths of the country into nonattainment. In some areas, the proposed range is at or near the level of background ozone that is naturally occurring or internationally transported, pushing even rural counties far from industrial activity into nonattainment. In the past, lower ozone standards were reached by requiring industrial facilities to install control equipment for NOx and VOCs. Large power plants historically have been a relatively cost-efficient way to achieve NOx reduction, but those opportunities are quickly diminishing because the majority of existing coal-fired power plant capacity is equipped with some form of NOx controls and further controls are expected to be installed because of other EPA regulations.

Although a relatively small contributor, agriculture produces VOCs (from pesticides and livestock) and NOx (from engines and other sources) that may be regulated through monitoring and control measures. Restrictions limiting NOx and VOCs may create a significant problem for agriculture. Control measures could be implemented that would curtail production activities; restrict pesticide applications; designate/limit pesticide application times; eliminate pesticide availability; restrict animal agricultural feeding operations due to emissions from animal waste handling and storage; prescribe costly control measures for animal agriculture; and prescribe costly and wasteful control measures for certain food and agricultural processing industries. The domestic renewable fuels industry (ethanol and biodiesel) could be greatly affected by control measures required for a more stringent standard since they too can contribute to VOCs and NOx during manufacture and use. Agriculture also will be indirectly impacted by costs passed on to the consumer from special requirements for diesel trucks and farm equipment, restrictive permitting requirements that affect plant expansions, and the loss of federal highway and transit funding. Farming and ranching are energy-intensive businesses. Farmers and ranchers depend on reliable, affordable sources of energy in their daily operations- including using tractors and operating dairy barns, poultry houses and irrigation pumps. For farmers and ranchers who compete in a global economy, higher energy costs and fewer transportation options not only hurt competitiveness, but can determine farm viability and prosperity.

The proposed stringent new ozone standards have the potential for damaging economic consequences across the entire economy and would increase input costs for electricity, fuel, fertilizer and equipment. Further, as ozone standards are ratcheted down closer to levels that exist naturally, more farmers will be forced to abide by restrictions on equipment use and land management, making it harder to stay in business. EPA's own estimates show that a new ozone rule could cost tens of billions of dollars per year and independent estimates indicate that the costs will likely be much higher, putting millions of jobs at risk. A new ozone rule has the potential to be the most costly regulation in our nation's history.

In light of the economic hardship a new ozone standard would cause to farmers throughout the country, including the reduction in funding for crucial civic services, and providing uncertain benefits, Kansas Farm Bureau encourages the agency to retain the existing ozone standard in the final rule. Kansas farmers cannot afford a stricter ozone standard.

Sincerely,

Richard Felts
President

MICHIGAN FARM BUREAU®
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March 17, 2015

The Honorable Gina McCarthy
Administrator
U.S. Environmental Protection Agency

Submitted via the federal rulemaking portal, at www.regulations.gov

RE: Docket ID No. EPA-HQ- OAR-2008-0699 – National Ambient Air Quality Standards for Ozone

Dear Administrator McCarthy,

Thank you for the opportunity to comment on the proposed revisions to the existing National Ambient Air Quality Standards (NAAQS) for ozone, Docket No. EPA–HQ–OAR–2008–0699. Michigan Farm Bureau is our state's largest general farm organization, representing more than 46,500 farming families across Michigan. Agriculture is one of Michigan's most important industries, with food, fiber and fuel related to agricultural production providing over $100 billion in economic development to our state. The proposed revisions tighten primary (health based) and secondary (welfare-based) standards, which will impose harmful and damaging costs across our entire state as well as the rest of the nation, for uncertain benefits. We are concerned that the difficulty of regulating the causes of ozone will hurt farmers as well as many other industries, to satisfy the agency's pursuit of standards that cannot be attained, even while the existing standards developed in 2008 await full implementation. Therefore, we must oppose the proposed standards as written.

The Clean Air Act directs the EPA to set National Ambient Air Quality Standards (NAAQS) for ozone at a level that is protective of human health and the environment, and to regulate both volatile organic compounds (VOC) and nitrogen oxide (NOx) emissions as ozone precursors. For each state with areas not attaining the ozone NAAQS, EPA provides guidance to the state to develop its State Implementation Plan (SIP) to attain the standard by a required attainment date. Since 1970, EPA's strategy to reduce ozone levels in nonattainment areas has focused mainly on reducing total VOC emissions. In the 1990s, the EPA developed a strategy to reduce NOx. The NOx reduction strategy and the VOC reduction strategy have helped decrease ozone levels. Since 1980, ozone forming emissions have already been cut in half and average ozone concentrations have dropped by 33 percent over the same period. Beyond that, air quality rules implemented in 2008 have not yet been fully implemented but are expected to have further positive impact on air quality.

Michigan has committed tremendous resources toward improving air quality over many years, including monitoring for ozone levels in nearly half our state's counties where ozone levels have

been historically recorded at high levels. Much improvement has been seen, with many counties recording ozone levels having dropped to ozone levels in the 70-79 parts per billion (ppb) range. However, now EPA is proposing a new range of standards lowering allowable limits to between 70 and 65 ppb. This would bring 80 of our state's 83 counties into nonattainment, including many counties with limited ozone-producing activities. In the past, ozone standards were met by installing NOx and VOC control equipment on large power plants and industrial facilities, which were able to implement such measures and provide measurable improvement in a cost-efficient way for citizens. Now that those sources have been controlled, the only way to produce further reductions in ozone production will require turning to smaller sources of ozone production, many of which will not be able to produce the necessary results without considerable cost and/or loss of business or production capability.

Restrictions limiting NOx and VOCs may create a significant problem for agriculture. As a direct impact, control measures on agriculture could restrict pesticide applications and availability, restrict animal agriculture through expensive control measures, and require difficult and expensive control measures for food processors. It could impact our state's ethanol production and our forest management and timber harvest production for renewable biomass fuels, both of which provide billions of dollars in economic activity to the state and which provide cleaner alternatives to fossil fuels.

Indirect impacts could also be a heavy burden on agriculture along with all other consumers as vehicle requirements, manufacturing and natural resource development, and energy production, will all be impacted. The National Association of Manufacturers has estimated that economic impacts of this rule in Michigan will result in:

- $75 Billion Gross State Product Loss from 2017 to 2040
- 83,092 Lost Jobs or Job Equivalents per Year
- $58 Billion in Total Compliance Costs
- $1,330 Drop in Average Household Consumption per Year
- $9.3 Billion More for Residents to Own/Operate Their Vehicles Statewide (2017 to 2040)
- Up to a 15 Percent Increase in Residential Electricity Prices (National Average)
- Up to a 32 Percent Increase in Residential Natural Gas Prices (National Average)
- Shutdown of 18 Percent of Michigan's Coal-Fired Generating Capacity

Farmers competing in a global economy depend on a competitive ability to seek the products and tools they need to run their operations, and on reliable, affordable sources of energy. Higher energy costs and fewer transportation options not only hurt competitiveness, but can damage farm viability and prosperity.

EPA's proposed rule could severely limit business operation and expansion in Michigan, and could hurt job growth and agriculture in an economy only recently emerging from extreme economic trouble. Local companies and family farms that provide jobs and food for not only our state's citizens but many other people around the nation and the world would struggle to

remain competitive. A nationwide cost estimated by the National Association of Manufacturers to be $90 billion per year significant hardship to not only our members but all citizens across our state and the nation. We urge EPA to consider that it must keep its ozone standard at the current level and finish implementing its 2008 standards for attainment rather than giving our businesses, farms, and citizens a moving target to shoot for that we may never achieve but will certainly harm our livelihoods.

Thank you again for your attention to our concerns. We look forward to working with our state and federal partners in developing ways to continue to improve air quality for everyone, without causing undue harm to the farms and businesses they are a part of, and which support their ways of life.

Sincerely,

Laura A. Campbell, Manager
Agricultural Ecology Department

Pennsylvania Farm Bureau

510 S. 31st Street, P.O. Box 8736 | Camp Hill, PA 17001-8736 | 717.761.2740 | www.pfb.com

March 17, 2015

The Honorable Gina McCarthy
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW
Washington, D.C. 20460

RE: Docket ID No. EPA-HQ-OAR-2008-0699—
National Ambient Air Quality Standards (NAAQS) for Ozone

Dear Ms. McCarthy:

Pennsylvania Farm Bureau (PFB) is pleased to offer its comments on the rule proposed by the Environmental Protection Agency (EPA), "National Ambient Air Quality Standards" (Docket ID No. EPA-HQ-OAR-2008-0699), which was published in the *Federal Register* on Dec. 17, 2014. PFB is a general farm organization, made up of more than 59,780 members, providing legislative support, information, and services to Pennsylvania's farmers and rural families since 1950. Our organization includes 54 local organizations (county Farm Bureaus) that actively operate in 64 of Pennsylvania's 67 counties. PFB is the state affiliate of the American Farm Bureau Federation (AFBF), an organization representing more than six million, two hundred thousand member families throughout the United States. In addition to the comments we are offering today, we want to affirm our support of the comments to be filed on this proposed rule by AFBF, and would request that such comments be treated as part of the comments contained herein.

Generally speaking, the proposed NAAQS revisions tighten primary (health-based) and secondary (welfare-based) standards for ozone—changes that will impose real and significant costs while providing benefits whose existence is speculative at best. PFB is especially concerned about the difficulty in regulating volatile organic compounds (VOCs), nitrogen oxides (NOx), and other potential ozone precursors from agriculture, as well as the chilling effect of these standards on the national economy as a whole and on Pennsylvania specifically.

We understand that the Clean Air Act directs the EPA to set NAAQS for ozone at a level that is protective of human health and the environment, and to regulate both VOC and NOx emissions as ozone precursors. However, it is important to recognize that since 1980, ozone forming emissions have already been cut in half, and average ozone concentrations have dropped by 33 percent over the same period. EPA's proposal also flies in the face of the fact that the agency updated ozone standards only six years ago—standards which are behind schedule due to EPA effectively suspending their implementation from 2010-2012 while it unsuccessfully pursued reconsideration. As states make up lost ground in putting the current standards into effect, we are likely to see additional air quality improvements.

States are currently committing substantial resources–both in time and money–toward achieving emissions reductions under current ozone standards. Yet EPA seemingly is disregarding the above referenced air quality progress of the past three decades and its own recently updated ozone standards in favor of a proposed new stringent range of standards from 70 to 65 parts per billion (ppb) that would bring vast swaths of the country into nonattainment. In some areas, the proposed range is at or near the level of background ozone that is naturally occurring or internationally transported, pushing even rural counties far from industrial activity into nonattainment.

Pennsylvania Farm Bureau

510 S. 31st Street, P.O. Box 8736 | Camp Hill, PA 17001-8736 | 717.761.2740 | www.pfb.com

For example, according to data from URS, as of July 2014, 44 of Pennsylvania's 67 counties would be violating a 60 ppb ozone standard, while the remaining 23 (predominately rural) counties would be anticipated to violate that standard (based on special interpolation)—a result that most observers would find to be nonsensical.

As you are likely aware, agriculture is a critically important industry in Pennsylvania. Although a relatively small contributor, agriculture produces VOCs (from pesticides and livestock) and NOx (from engines and other sources) that may be regulated through monitoring and control measures. Restrictions limiting NOx and VOCs may create a significant problem for agriculture in Pennsylvania and nationally, as the proposed standard may require the implementation of control measures that would:

- Curtail production activities.
- Restrict pesticide applications, designate/limit pesticide application times, and eliminate pesticide availability.
- Restrict animal agricultural feeding operations due to emissions from animal waste handling and storage.
- Prescribe costly control measures for animal agriculture.
- Prescribe costly and wasteful control measures for certain food and agricultural processing industries.

In addition, the domestic renewable fuels industry (ethanol and biodiesel) could be greatly affected by control measures required for a more stringent standard since they too can contribute to VOCs and NOx during manufacture and use.

The proposed rule will also indirectly affect agriculture via the costs passed on to the consumer from special requirements for vehicles and fuels (diesel trucks and farm equipment), restrictive permitting requirements that affect plant expansions, and the loss of federal highway and transit funding. Farming is an energy-intensive business that depends on reliable, affordable sources of energy for daily operations, such as using tractors and operating dairy barns, poultry houses and irrigation pumps. For farmers that compete in a global economy, higher energy costs and fewer transportation options not only hurt competitiveness, but can determine farm viability and prosperity.

If finalized, EPA's proposed stringent ozone standards could limit business expansion in nearly every populated region of the U.S. and impair the ability of U.S. companies to create new jobs and of agriculture, in particular, to remain competitive. Local communities will face burdens to commercial, industrial and agricultural activity not only vital to creating jobs, but also to providing tax revenue that support local services like public safety and education. This is of great concern to PFB, whose mission is not only to increase the viability of farmers and ranchers but to improve the quality of life in Pennsylvania's rural communities. This proposal's hardship to rural Pennsylvania is real and immediate, while the benefits are unverified and uncertain.

Building a new facility or performing major modifications to certain existing facilities that result in increased ozone concentrations in, or near, a nonattainment area will require permits that meet the most stringent Clean Air Act standard by installing the most effective emission reduction technology regardless of cost. In addition, states are mandated to offset any ozone-forming emissions from new projects or projects undergoing major modifications by reducing emissions from other existing sources in a nonattainment area. If no party is willing to provide offsets, then the project cannot go forward. Nonattainment designation also has a profound impact on infrastructure development vital to the agriculture community. Beginning one year from the date of the nonattainment designation, federally-supported highway and transit projects cannot proceed in a nonattainment area unless the state can demonstrate that the project will cause no increase in ozone emissions.

Pennsylvania Farm Bureau

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The restrictions do not disappear when an area finally comes into attainment. Instead, former nonattainment areas face a legacy of EPA regulatory oversight. Before a nonattainment area can be redesignated to attainment, EPA must receive and approve an enforceable maintenance plan for the area that specifies measures providing continued maintenance of ozone standards and contingency measures to be implemented promptly if an ozone standard is violated.

In closing, the stringent new ozone standards have the potential for damaging economic consequences across the entire economy and would place serious restrictions on farmers, increasing input costs for things like electricity, fuel, fertilizer and equipment. Further, as ozone standards are ratcheted down closer to levels that exist naturally, more farmers will be forced to abide by restrictions on equipment use and land management, making it harder to stay in business. EPA's own estimates show that a new ozone rule could cost tens of billions of dollars per year and independent estimates indicate that the costs will likely be much higher, putting millions of jobs at risk. A new ozone rule has the potential to be the most costly regulation in our nation's history.

In light of the economic hardship a new ozone standard would cause to farmers in Pennsylvania and throughout the country, including the reduction in funding for crucial civic services, and the lack of evidence supporting the proposition that the benefits of the new standard would outweigh its costs, PFB encourages the EPA to retain the existing ozone standard in the final rule.

Thank you for the opportunity to comment on this proposal.

Sincerely,

Grant R. Gulibon

Grant Gulibon
Director, Regulatory Affairs

SOUTH DAKOTA FARM BUREAU®

March 12, 2015

The Honorable Gina McCarthy
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW
Washington, D.C. 20460

RE: Docket ID No. EPA-HQ- OAR-2008-0699 – National Ambient Air Quality Standards for Ozone

Dear Administrator McCarthy,

The South Dakota Farm Bureau Federation (Farm Bureau) is South Dakota's largest general farm organization, representing agricultural producers of nearly every type of crop and livestock in South Dakota. We have a vital interest in enhancing and strengthening the lives of farm and ranch families. Farm Bureau appreciates this opportunity to provide comments regarding the proposed revisions to the existing National Ambient Air Quality Standards (NAAQS) for ozone published in the *Federal Register* on Dec. 17, 2014. The proposed revisions tighten primary (health-based) and secondary (welfare-based) standards, a move that will impose real and significant costs while providing uncertain and unverified benefits. Farm Bureau is concerned about the difficulty regulating volatile organic compounds (VOCs), nitrogen oxides (NOx), and other potential ozone precursors from agriculture and the effect of these standards on the state's economy.

In the presence of heat and sunlight, atmospheric reactions of NOx and VOCs emitted from various biogenic and anthropogenic sources produce ozone. VOCs are defined in 40 CFR 51.100 as "any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions." NOx are created from lightning, soil microbial activity, burning biomass, and fuel combustion. The Clean Air Act directs the EPA to set NAAQS for ozone at a level that is protective of human health and the environment, and to regulate both VOC and NOx emissions as ozone precursors.

The South Dakota monitoring sites using a three year average are currently meeting the 0.075 ppm standard implemented in 2011. If the standard is lowered to 0.065, which is almost a 13% reduction, all but one of the monitoring sites would meet the standard. This percent reduction is over aggressive.

South Dakota is currently committing substantial resources – both in time and money – towards achieving emissions reductions under current ozone standards. Continuing this over aggressive reduction will limit industrial and agriculture development even in a rural state like South Dakota.
Although a relatively small contributor, agriculture produces VOCs (from pesticides and livestock) and NOx (from engines and other sources) that may be regulated through monitoring and control measures. Restrictions limiting NOx and VOCs may create a significant problem for agriculture. Control measures could be implemented that would: curtail production activities; restrict pesticide applications; designate/limit pesticide application times; eliminate pesticide availability; restrict animal agricultural feeding operations due to emissions from animal waste handling and storage; prescribe costly control measures for animal agriculture; and prescribe costly and wasteful control measures for certain food and agricultural processing industries. The domestic renewable fuels industry (ethanol and biodiesel) could be greatly affected by control measures required for a more stringent standard since they too can contribute to VOCs and NOx during manufacture and use.
Agriculture also will be indirectly impacted by costs passed on to the consumer from special requirements for vehicles and fuels (diesel trucks and farm equipment), restrictive permitting requirements that affect plant expansions, and the loss of federal highway and transit funding. Farming and ranching are energy-intensive

businesses. Farmers and ranchers depend on reliable, affordable sources of energy in their daily operations - including using tractors and operating dairy barns, poultry houses and irrigation pumps. For farmers and ranchers that compete in a global economy, higher energy costs and fewer transportation options not only hurt competitiveness, but can determine farm viability and prosperity. This proposal's hardship to rural America is real and immediate, while the benefits are unverified and uncertain.

In closing, the stringent new ozone standards have the potential for damaging economic consequences across South Dakota. EPA's own estimates show that a new ozone rule could cost millions of dollars per year and independent estimates indicate that the costs will likely be much higher, putting jobs at risk. A new ozone rule has the potential to be the most costly regulation in our state's history. South Dakota cannot afford a stricter ozone standard.

Sincerely,

Scott VanderWal, SDFB President

March 11, 2015
The Honorable Gina McCarthy
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW
Washington, D.C. 20460

RE: Docket ID No. EPA-HQ- OAR-2008-0699 – National Ambient Air Quality Standards for Ozone

Dear Administrator McCarthy,

Texas Farm Bureau (TFB) appreciates the opportunity to provide comments regarding the proposed revisions to the existing National Ambient Air Quality Standards (NAAQS) for ozone published in the *Federal Register* on Dec. 17, 2014.

TFB is a membership organization representing more than 513,000 member families in Texas. Our organization's goal is to enhance the quality of living for our members and all Texans through the promotion of a healthy agricultural sector. A balanced and science-based implementation of the Clean Air Act is of the utmost concern to our members.

The proposed revisions to NAAQS would tighten primary [health based] and secondary [welfare-based] air quality standards. However, available science does not support the need for a more stringent standard. An integrated analysis of the weight of the evidence does not demonstrate measurable health benefits from lowering the current standard.

Despite the lack of scientific clarity, the proposed the standard would result in much of the state of Texas failing to meet the ambient air quality standards for ozone.

Since 1980, Texas has made great strides to achieve the existing NAAWS. Dallas has reduced ozone concentrations by 29% and Houston by 21%. This has been accomplished primarily through more stringent regulations for large industrial facilities and power plants.

The proposed changes to NAAQS would reduce allowable ozone concentrations to levels that are near naturally occurring or internationally transported. This pushes many rural counties, far from industrial activity, into nonattainment.

Livestock production and pesticide use emits small amounts of volatile organic compounds (VOCs) and farm engines and other related activities can contribute to atmospheric nitrous oxides (NOx) concentrations – precursors of ozone.

In rural areas, there is great fear that following actions would be considered to achieve the proposed NAAQS:

- Curtailing agricultural production activities;

- Restricting pesticide applications;
- Limiting pesticide application times;
- Eliminating pesticide availability;
- Restricting animal agricultural feeding operations due to emissions from animal waste handling and storage;
- Adding costly control measures for animal agriculture; and
- Prescribing costly and wasteful control measures for certain food and agricultural processing industries.

Such measures would also disrupt the domestic renewable fuels industry (ethanol and biodiesel) since they too can contribute to VOCs and NOx during manufacture and use.

In addition, agriculture would also be indirectly impacted by costs passed on to the consumer from special requirements for vehicles and fuels (diesel trucks and farm equipment), restrictive permitting requirements that affect plant expansions, and the loss of federal highway and transit funding.

Farmers and ranchers compete in a global economy. Higher energy costs and fewer transportation options not only hurt competitiveness, but can determine farm viability and prosperity.

The proposed NAAQS would touch practically every person in the country either directly or indirectly and the costs of implementation would be tremendous. As such, it is vital that the science justifies the expense of the rule. In this case, it does not.

Texas Farm Bureau respectfully requests that EPA retain the existing NAAQs standard in its final rule.

Sincerely,

Jay Bragg
Associate Director,
Commodity and Regulatory Activities

Regulations.gov will undergo system upgrades and as a result the site will be unavailable Saturday, March 28, from 6:30am through 8am (ET).

regulations.gov
Your Voice in Federal Decision-Making

Comment submitted by Howard Pearl, Pearl & Sons Farm LLC

This is a Comment on the **Environmental Protection Agency** (EPA) Proposed Rule: **National Ambient Air Quality Standards for Ozone**

For related information, **Open Docket Folder**

Comment Period Closed
Mar 17 2015, at 11:59 PM ET

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Feb 20, 2015

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Comment

Ms. Susan Lyon Stone:

The Environmental Protection Agency does not need to lower the ozone standard and should continue to work with states and localities to reach the standards set in 2008.

As of July 2014, 123 million people (40% of the United States population) live in areas classified as non attainment for the primary ozone National Ambient Air Quality Standards (NAAQS). Of these people, 105 million still live in areas deemed non attainment from 1997s ozone regulations set at 85 ppb.

Reducing the ozone standard could reduce GDP by $270 billion per year, and result in 2.9 million fewer jobs per year through 2040. Businesses might not be able to expand and it could stall an economy that is just starting to grow all for a standard that does not need to be changed.

As a small business owner and farm operator in New Hampshire, I have seen first hand the struggle businesses were faced with in climbing out of recession and we simply cannot risk slowing our fragile economy.

I am urging the Environmental Protection Agency not to pursue lower levels of acceptable ozone in the atmosphere. There must be a careful balance of clean air and economic growth.

I hope the EPA will consider the state's economies before lowering standards further.

Sincerely,

Howard Pearl
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Loudon, NH

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March 9, 2015

The Honorable Gina McCarthy
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW
Washington, D.C. 20460

RE: Docket ID No. EPA-HQ- OAR-2008-0699 – National Ambient Air Quality Standards for Ozone

Dear Administrator McCarthy,

The American Farm Bureau Federation (Farm Bureau) is the nation's largest general farm organization, representing agricultural producers of nearly every type of crop and livestock across all 50 states and Puerto Rico. We have a vital interest in enhancing and strengthening the lives of farmers and ranchers. Farm Bureau appreciates this opportunity to provide comments regarding the proposed revisions to the existing National Ambient Air Quality Standards (NAAQS) for ozone published in the *Federal Register* on Dec. 17, 2014. The proposed revisions tighten primary (health based) and secondary (welfare-based) standards, a move that will impose real and significant costs while providing uncertain and unverified benefits. Farm Bureau is concerned about the difficulty regulating volatile organic compounds (VOCs), nitrogen oxides (NOx), and other potential ozone precursors from agriculture and the chilling effect of these standards on the economy as a whole.

In the presence of heat and sunlight, atmospheric reactions of NOx and VOCs emitted from various biogenic and anthropogenic sources produce ozone. VOCs are defined in 40 CFR 51.100 as "any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions." NOx are created from lightning, soil microbial activity, burning biomass, and fuel combustion. The Clean Air Act directs the EPA to set NAAQS for ozone at a level that is protective of human health and the environment, and to regulate both VOC and NOx emissions as ozone precursors.

For each state with areas not attaining the ozone NAAQS, EPA provides guidance to the state to develop its State Implementation Plan (SIP) to attain the standard by a required attainment date. Since 1970, EPA's strategy to reduce tropospheric ozone levels in nonattainment areas has focused mainly on reducing the total mass of VOC emissions. In the 1990s, the EPA developed a strategy to reduce NOx. The NOx reduction strategy and the VOC reduction strategy have helped decrease ozone levels. Since 1980, ozone forming emissions have already been cut in half and average ozone concentrations have dropped by 33 percent over the same period. EPA just updated ozone standards six years ago. These current standards are behind schedule due to EPA effectively suspending their implementation from 2010-2012 while the Agency

unsuccessfully pursued reconsideration. We can expect to see even greater reductions in ground-level ozone as states make up lost ground in putting the current standards into effect.

States are currently committing substantial resources – both in time and money – towards achieving emissions reductions under current ozone standards. Yet, despite over three decades of cleaner air, EPA is now proposing a new stringent range of standards from 70 to 65 parts per billion that would bring vast swaths of the country into nonattainment. In some areas, the proposed range is at or near the level of background ozone that is naturally occurring or internationally transported, pushing even rural counties far from industrial activity into nonattainment. In the past, lower ozone standards were reached by requiring industrial facilities to install control equipment for NOx and VOCs. Large power plants historically have been a relatively cost-efficient way to achieve NOx reduction, but those opportunities are quickly diminishing because the majority of existing coal-fired power plant capacity is equipped with some form of NOx controls and further controls are expected to be installed because of other EPA regulations.

Although a relatively small contributor, agriculture produces VOCs (from pesticides and livestock) and NOx (from engines and other sources) that may be regulated through monitoring and control measures. Restrictions limiting NOx and VOCs may create a significant problem for agriculture. Control measures could be implemented that would: curtail production activities; restrict pesticide applications; designate/limit pesticide application times; eliminate pesticide availability; restrict animal agricultural feeding operations due to emissions from animal waste handling and storage; prescribe costly control measures for animal agriculture; and prescribe costly and wasteful control measures for certain food and agricultural processing industries. The domestic renewable fuels industry (ethanol and biodiesel) could be greatly affected by control measures required for a more stringent standard since they too can contribute to VOCs and NOx during manufacture and use.

Agriculture also will be indirectly impacted by costs passed on to the consumer from special requirements for vehicles and fuels (diesel trucks and farm equipment), restrictive permitting requirements that affect plant expansions, and the loss of federal highway and transit funding. Farming and ranching are energy-intensive businesses. Farmers and ranchers depend on reliable, affordable sources of energy in their daily operations- including using tractors and operating dairy barns, poultry houses and irrigation pumps. For farmers and ranchers that compete in a global economy, higher energy costs and fewer transportation options not only hurt competitiveness, but can determine farm viability and prosperity.

If finalized, EPA's proposed stringent ozone standards could limit business expansion in nearly every populated region of the U.S. and impairs the ability of U.S. companies to create new jobs and agriculture to remain competitive. Local communities will face burdens to commercial, industrial and agricultural activity not only vital to creating jobs, but also to providing tax revenue that support local services like public safety and education. This is of great concern to Farm Bureau, whose mission is not only to increase the viability of farmers and ranchers but to improve the quality of life in rural communities. This proposal's hardship to rural America is real and immediate, while the benefits are unverified and uncertain.

Building a new facility or performing major modifications to certain existing facilities that result in increased ozone concentrations in, or near, a nonattainment area will require permits that meet the most stringent Clean Air Act standard by installing the most effective emission reduction technology regardless of cost. In addition, states are mandated to offset any ozone-forming emissions from new projects or projects undergoing major modifications by reducing emissions from other existing sources in a nonattainment area. If no party is willing to provide offsets, then the project cannot go forward. Nonattainment designation also has profound impact on infrastructure development vital to the agriculture community. Beginning one year from the date of the nonattainment designation, federally-supported highway and transit projects cannot proceed in a nonattainment area unless the state can demonstrate that the project will cause no increase in ozone emissions.

The restrictions do not disappear when an area finally comes into attainment. Instead, former nonattainment areas face a legacy of EPA regulatory oversight. Before a nonattainment area can be redesignated to attainment, EPA must receive and approve an enforceable maintenance plan for the area that specifies measures providing continued maintenance of ozone standards and contingency measures to be implemented promptly if an ozone standard is violated.

In closing, the stringent new ozone standards have the potential for damaging economic consequences across the entire economy and would place serious restrictions on farmers, increasing input costs for things like electricity, fuel, fertilizer and equipment. Further, as ozone standards are ratcheted down closer to levels that exist naturally, more farmers will be forced to abide by restrictions on equipment use and land management, making it harder to stay in business. EPA's own estimates show that a new ozone rule could cost tens of billions of dollars per year and independent estimates indicate that the costs will likely be much higher, putting millions of jobs at risk. A new ozone rule has the potential to be the most costly regulation in our nation's history.

In light of the economic hardship a new ozone standard would cause to farmers throughout the country, including the reduction in funding for crucial civic services, and only providing uncertain benefits, Farm Bureau encourages the EPA to retain the existing ozone standard in the final rule. Our country's farmers cannot afford a stricter ozone standard.

Sincerely,

Dale W. Moore

Dale Moore
Executive Director
Public Policy

Asthma and lower airway disease

Neighborhood poverty, urban residence, race/ethnicity, and asthma: Rethinking the inner-city asthma epidemic

Corinne A. Keet, MD, PhD,[a] Meredith C. McCormack, MD,[b] Craig E. Pollack, MD, MHS,[c] Roger D. Peng, PhD,[d] Emily McGowan, MD,[e,f] and Elizabeth C. Matsui, MD, MHS[a] *Baltimore, Md*

Background: Although it is thought that inner-city areas have a high burden of asthma, the prevalence of asthma in inner cities across the United States is not known.
Objective: We sought to estimate the prevalence of current asthma in US children living in inner-city and non–inner-city areas and to examine whether urban residence, poverty, or race/ethnicity are the main drivers of asthma disparities.
Methods: The National Health Interview Survey 2009-2011 was linked by census tract to data from the US Census and the National Center for Health Statistics. Multivariate logistic regression models adjusted for sex; age; race/ethnicity; residence in an urban, suburban, medium metro, or small metro/rural area; poverty; and birth outside the United States, with current asthma and asthma morbidity as outcome variables. Inner-city areas were defined as urban areas with 20% or more of households at below the poverty line.
Results: We included 23,065 children living in 5,853 census tracts. The prevalence of current asthma was 12.9% in inner-city and 10.6% in non–inner-city areas, but this difference was not significant after adjusting for race/ethnicity, region, age, and sex. In fully adjusted models black race, Puerto Rican ethnicity, and lower household income but not residence in poor or urban areas were independent risk factors for current asthma. Household poverty increased the risk of asthma among non-Hispanics and Puerto Ricans but not among other Hispanics. Associations with asthma morbidity were very similar to those with prevalent asthma.
Conclusions: Although the prevalence of asthma is high in some inner-city areas, this is largely explained by demographic factors and not by living in an urban neighborhood. (J Allergy Clin Immunol 2015;135:655-62.)

Key words: *Inner-city asthma, childhood asthma, urban/rural, neighborhood, race/ethnicity*

The idea that certain features of life in poor urban areas promote asthma dates back to more than a half century ago, when researchers began to describe an "inner-city asthma epidemic" of high asthma prevalence and morbidity in poor areas of large cities.[1-8] Research focusing on the inner city, which was typically defined as census tracts in large metro center areas with at least 20% of households at below the poverty line,[9] has led to significant advances in our understanding of what causes asthma and how to treat it,[10] but the prevalence of asthma in inner-city areas across the United States is not known nor is it known how it compares with prevalence in other types of communities. Studies of asthma prevalence in the inner city have generally focused on individual urban communities and have not separated demographic features of inner-city areas from their metropolitan status.[5,11-19] Nationally representative studies have also had several limitations, including the fact that much of the work on the relative contribution of metropolitan status to asthma disparities overall was done decades ago, used measures of metropolitan status that are not consistent with National Institutes of Health definitions of the inner city, and rarely looked at the independent contributions of poverty, metropolitan status, and race/ethnicity.[3,6,20] Despite our significant and ongoing national commitment to combating inner-city asthma, we do not actually know the prevalence of asthma in inner cities across the United States, whether it is in fact greater than that found in other areas, and, if there are differences, whether race/ethnicity, poverty, or residence in an urban area explain them.

Thus our primary objectives were to (1) estimate childhood asthma prevalence for inner-city and non–inner-city areas in the United States and (2) disentangle the effects of urban residence, neighborhood-level poverty, race/ethnicity, and household poverty on asthma prevalence. Understanding whether asthma disparities seen in various geographic areas are primarily a result of environmental exposures concentrated in the inner city or are instead related to sociodemographic features of the inhabitants of these neighborhoods is key to advancing an efficient and effective national research and public health agenda.

From the Divisions of [a]Pediatric Allergy and Immunology, [b]Pulmonary and Critical Care Medicine, [c]General Internal Medicine, and [e]Allergy and Clinical Immunology, Johns Hopkins University School of Medicine, and [d]the Department of Biostatistics and [f]the Graduate Program in Clinical Investigation, Johns Hopkins Bloomberg School of Public Health, Baltimore.

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Abbreviations used
CDC: Centers for Disease Control and Prevention
NCHS: National Center for Health Statistics
NHIS: National Health Interview Survey
OR: Odds ratio

METHODS

Data were drawn from the National Health Interview Survey (NHIS) 2009-2011. The NHIS is a survey conducted annually by the National Center for Health Statistics (NCHS), which is part of the Centers for Disease Control and Prevention (CDC). It has a multistate probability design that covers all 50 states and the District of Columbia and is intended to be representative of the civilian noninstitutionalized population living in the United States. Black, Asian, and Hispanic populations are oversampled to increase precision of estimates in certain subgroups. Data collection is done in person using a computer-assisted personal interviewing mode. The overall response rate for the child section of these surveys ranged from 71% to 75%.[21-23] Because asthma is not reliably diagnosed in young children, the sample population was limited to children aged 6 to 17 years.

To evaluate the effect of geographic variables on asthma outcomes, we linked participants' census tracts, as classified by the 2000 Census, to 2 additional data sets: the 2006 NCHS Urban-Rural Classification Scheme for Counties and the 2000 US Census. The 2006 NCHS Urban-Rural Classification scheme divides counties into 6 categories based on population density and other measures of urbanization: (1) large metro, central; (2) large metro, fringe; (3) medium metro; (4) small metro; (5) micropolitan; and (6) noncore. Generally, "large metro, central" is considered the urban core, whereas "large metro, fringe" is thought to be equivalent to "suburban."[24] Because there were relatively few people residing in small metro, micropolitan, and noncore areas, these categories were combined and classified as small metro/rural areas. The 2000 Census provided the percentage of households living at below the federally defined poverty level in each census tract. This was generally treated as a continuous variable in our analyses, although in some analyses we defined inner-city neighborhoods as census tracts located in large metro central areas with 20% or more of households at below the poverty line.[7] *Household income* was defined as household income divided by the federally defined poverty level.

Ever asthma was defined by a yes answer to the following question: "Has a doctor or other health professional EVER told you that [name] had asthma?" Other questions that defined asthma were as follows: "Does [name] still have asthma?," which was used for current asthma. "During the past 12 months, has [name] had an episode of asthma or an asthma attack?," which was used for an asthma episode. "During the past 12 months, did [name] have to visit an emergency room or urgent care center because of [his/her] asthma?," which was for an asthma emergency department visit.

Race/ethnicity was by self-report and recoded in the NHIS data in the following categories: Hispanic, non-Hispanic white (called "white" here), non-Hispanic black (called "black" here), non-Hispanic Asian (called "Asian" here), and all other race/ethnicities, a group comprising less than 1% of the total population. Because it has been previously reported that Puerto Rican Hispanics have different asthma risk than other Hispanics,[25] we created a separate race/ethnicity category for those of Puerto Rican heritage. Hereafter, "Hispanic" refers to non-Puerto Rican Hispanics.

Although multilevel modeling is often used in analyses of the association between neighborhood factors and disease, multilevel modeling typically requires at least 25 subjects per group (in this case census tract),[26] and in this analysis there were an average of only 4 subjects per census tract. Thus, for this analysis, standard survey methods were used with sample weights and strata provided in the survey. This accounts for the complex survey design, correctly adjusts the variances for clustering within a sampling unit, and does not require a minimum number of subjects per group. For analyses of individual-level income, the CDC provides multiply imputed data for subjects missing income data. These data are generated by the CDC by using sequential regression multivariate imputation implemented with the module IMPUTE with IVEware (www.isr.umich.edu/src/smp/ive)[27] and were analyzed with the MI ESTIMATE commands in Stata, which accounts for the imputation uncertainty using the methods of Rubin.[28] Three logistic regression models for prediction of current asthma, asthma episodes, and emergency department visits in the past year were generated: crude bivariate analyses; multivariate models adjusted for age, sex, race/ethnicity, region of residence, neighborhood-level poverty, and urban/rural status; and multivariate models additionally adjusted for household income. To determine whether race/ethnicity or metropolitan residence modified the relationship between poverty and asthma, we also investigated interactions between these factors and constructed stratified models. Model diagnostics included the Pearson goodness-of-fit test, visual examination of the data, and sensitivity analyses excluding very large values. Individual- and neighborhood-level poverty were examined for collinearity, and because the collinearity was not strong (variance inflation factor of 1.2), both variables were included in some models. Because we identified differences in the relationship between current asthma and both neighborhood- and individual-level poverty between Hispanics and non-Hispanics, we stratified these analyses into (1) Hispanics and (2) all others, including Puerto Ricans. Our analyses confirmed that children of Puerto Rican heritage were more similar to non-Hispanic populations than Hispanics in the relationship between asthma and poverty (data not shown), supporting this method of stratification. Sensitivity analyses of the main model were done, including the following variables: (1) whether the child had a well-child visit in the past year and (2) whether the child had at any point been uninsured in the past year. A significance level of .05 was used. All analyses were done with Stata 13/SE software (StataCorp, College Station, Tex). Because census tract information is not available in the public NHIS data set, these analyses were conducted at the Research Data Center with approval from the NCHS Research Ethics Review Board. Data collection for the NHIS was approved by the NCHS Research Ethics Review Board.

RESULTS

Population characteristics

Twenty-three thousand sixty-five subjects aged 6 to 17 years living in 5,853 different census tracts were included in this analysis. Because the sample was derived from a population-based survey and was weighted to reflect the noninstitutionalized US population, the demographics of the analytic population matched those of children aged 6 to 17 years in the United States as a whole (Table I). On average, subjects resided in census tracts in which 12% of households lived at below the poverty line. Twenty-eight percent resided in urban census tracts, 16% resided in poor tracts (defined as ≥20% living at below the poverty line), and 7% resided in poor urban tracts (the inner city, Table I). The lifetime asthma prevalence was 16.3%, the current asthma prevalence was 10.7%, 5.9% reported an asthma episode, and 1.6% reported visiting the emergency department for asthma in the prior year.

Prevalence of asthma in urban poor (inner-city) and other poor areas

The overall prevalence of current asthma in inner-city neighborhoods in the United States was 12.9% (95% CI, 11.1% to 14.9%) compared with 10.6% (95% CI, 10.0% to 11.2%) in non–inner-city areas ($P = .01$), but this difference was no longer significant after adjusting for race/ethnicity, region, sex, and age (odds ratio [OR], 1.01; 95% CI, 0.84-1.21; $P = .90$). Approximately 8% of asthmatic children are estimated to live in inner-city areas compared with 7% of children overall (see Table E1 in this article's Online Repository at www.jacionline.org). The prevalence of asthma in inner-city neighborhoods was not constant throughout the United States and ranged from 7.9% (95% CI, 5.9% to 10.5%) in the West to 17.3% (95% CI, 13.2% to 22.4%) in the Northeast (Fig 1). In addition, poor

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TABLE I. Demographic characteristics

Characteristic	No.	Overall	Poor* urban (n = 2,411)	Nonpoor urban (n = 5,383)	Poor nonurban (n = 2,337)	Nonpoor nonurban (n = 12,934)
		% (95% CI)				
Race/ethnicity						
White	10,425	57.6 (56.5-58.7)	7.2 (5.0-10.3)	45.3 (42.3-47.8)	32.3 (28.3-36.6)	71.3 (70.0-72.6)
Black	4,067	15.2 (14.5-16.0)	36.7 (32.9-40.7)	16.7 (15.0-18.6)	28.5 (24.9-32.3)	10.4 (9.6-11.2)
Hispanic (non–Puerto Rican)	6,301	19.5 (18.7-20.4)	48 (44.2-52.0)	27 (25.0-29.2)	31 (27.3-35.1)	12.1 (11.1-13.2)
Puerto Rican	600	2.1 (1.8-2.3)	3.9 (2.9-5.2)	2.2 (1.7-2.8)	3.6 (2.6-4.9)	1.6 (1.3-1.9)
Asian	1,464	4.5 (4.1-4.9)	3.7 (2.6-5.3)	8.4 (7.4-9.6)	1.6 (1.1-2.4)	3.7 (3.3-4.2)
Region						
Northeast	3,475	16.5 (15.6-17.4)	24.2 (20.7-28.1)	11.2 (9.5-13.1)	9.5 (7.1-12.5)	18.5 (17.2-19.8)
Midwest	4,564	24.2 (23.0-25.3)	13.8 (11.2-16.7)	18.5 (15.8-21.5)	13.2 (9.7-17.6)	28.9 (27.2-30.5)
South	7,871	35.3 (34.0-36.6)	24.6 (20.7-29.0)	30.6 (27.6-33.7)	51.3 (46.1-56.5)	35.7 (34.0-37.5)
West	6,047	24.0 (22.8-25.2)	37.5 (32.7-42.5)	39.8 (36.8-42.8)	26.1 (22.0-30.7)	17.0 (15.4-18.7)
Born in United States						
Yes	21,320	94.3 (93.9-94.7)	89.1 (87.4-90.7)	92 (91.0-92.9)	92.9 (90.8-94.5)	95.9 (95.4-96.3)
No	1,735	5.7 (5.3-6.1)	10.9 (9.4-12.6)	8 (7.2-9.0)	7.1 (5.5-9.2)	4.1 (3.7-4.6)
Asthma prevalence						
Asthma, lifetime	3,933	16.3 (15.7-17.0)	18.7 (16.5-21.2)	15.3 (14.0-16.6)	19.2 (17.1-21.5)	16 (15.3-16.8)
Asthma, current	2,574	10.7 (10.2-11.3)	12.9 (11.1-14.9)	10 (9.0-11.2)	12.4 (10.8-14.2)	10.5 (9.9-11.2)
Asthma episode, past 12 mo	1,378	5.9 (5.5-6.3)	6.5 (5.5-7.7)	5.6 (4.8-6.5)	6.1 (4.9-7.6)	5.9 (5.4-6.4)
ED visit for asthma, past 12 mo	408	1.6 (1.4-1.8)	3.0 (2.2-4.0)	1.8 (1.3-2.5)	2.3 (1.6-3.1)	1.3 (1.4-1.8)

ED, Emergency department.
**Poor* was defined as 20% or more of households living below the poverty line.

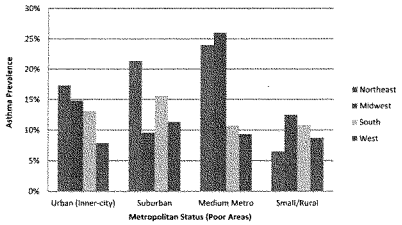

FIG 1. Asthma prevalence according to metropolitan status and region among children living in poor areas (defined as neighborhoods with ≥20% of households below the poverty line).

non–inner-city areas in some regions had prevalence rates exceeding those in inner-city areas (Fig 1 and see Table E2 in this article's Online Repository at www.jacionline.org). Although in crude stratified analyses inner-city areas in the Northeast had higher prevalence rates than non–inner-city areas, in stratified models adjusted for age, sex, place of birth, and race/ethnicity, the prevalence of asthma in inner-city neighborhoods was not significantly higher than in non–inner-city areas in any region of the United States (data not shown). As shown below, differences in asthma prevalence were driven by racial/ethnic and socioeconomic factors and not urban/rural status.

Associations with current asthma prevalence

Race/ethnicity. In unadjusted models current asthma prevalence was significantly higher among blacks (17.1%; 95% CI, 15.6% to 18.8%) and Puerto Ricans (19.8%; 95% CI, 16.6% to 23.5%) than among whites (9.6%; 95% CI, 8.9% to 10.3%), Hispanics (8.8%; 95% CI, 7.8% to 10.0%), and Asians (8.1%; 95% CI, 6.5% to 10.0%). Black race and Puerto Rican ethnicity remained strong and independent predictors of current asthma, even when neighborhood-level poverty, urban/rural status, region, sex, age, and birth in the United States were included in the model and, additionally, in analyses that further adjusted for household poverty (Table II and see Table E3 in this article's Online Repository at www.jacionline.org). Birth outside the United States was a strong and independent protective factor for asthma (Table II).

Neighborhood poverty. A 10 percentage point increase in the number of households living below the poverty line (neighborhood-level poverty) was associated with a 10% increase in the odds of prevalent asthma in crude analyses (OR, 1.10; 95% CI, 1.05-1.14; $P < .001$), although this was no longer significant in adjusted analyses (OR, 1.04; 95% CI, 0.99-1.10; $P = .09$). Race/ethnicity was found to significantly modify the relationship between neighborhood-level poverty and prevalent asthma ($P = .004$ for the interaction between Hispanic ethnicity and neighborhood-level poverty), with neighborhood-level poverty as a significant risk factor among non-Hispanics and Puerto Ricans in adjusted analyses but protective among Hispanics (Table II). Sensitivity analyses, including whether the child received well-child care in the past year or was uninsured at any point, did not materially change the results of these analyses or those of residence in an urban neighborhood (data not shown).

Individual-level household poverty. In unadjusted analyses a 1-unit decrease in the household income to poverty ratio was associated with a 7% increase in the odds of prevalent asthma (95% CI, 1.05-1.10; $P < .001$), with similar results in the model that adjusted for race/ethnicity, urban/rural status, region, age,

TABLE II. Predictors of current asthma

	Crude			Adjusted*		
	OR	95% CI	*P* value	OR	95% CI	*P* value
Overall						
Race/ethnicity						
White			Reference			
Black	1.95	1.70-2.23	<.001	1.87	1.59-2.19	<.001
Hispanic	0.91	0.78-1.07	.26	1.02	0.85-1.23	.81
Puerto Rican	2.33	1.83-2.95	<.001	2.38	1.82-3.11	<.001
Asian	0.83	0.65-1.06	.13	1.01	0.79-1.30	.93
Urbanization						
Urban			Reference			
Suburban	1.03	0.90-1.19	.66	1.14	0.97-1.33	.11
Medium metro	0.97	0.83-1.14	.72	1.05	0.88-1.24	.60
Small metro/rural	1.00	0.85-1.16	.95	1.10	0.92-1.31	.30
Region						
Northeast			Reference			
Midwest	0.93	0.79-1.11	.43	0.98	0.82-1.16	.81
South	0.87	0.75-1.01	.06	0.85	0.73-0.99	.40
West	0.77	0.66-0.91	.002	0.90	0.76-1.07	.25
Birth outside the United States	0.32	0.23-0.45	<.001	0.33	0.24-0.47	<.001
Household poverty†	1.07	1.05-1.10	<.001			
Neighborhood poverty‡	1.10	1.05-1.14	<.001	1.04	0.99-1.10	.09
Hispanics						
Urbanization						
Urban			Reference			
Suburban	1.21	0.88-1.66	.24	1.13	0.81-1.57	.48
Medium metro	1.21	0.85-1.72	.28	1.25	0.88-1.78	.22
Small metro/rural	1.08	0.71-1.64	.72	1.11	0.72-1.70	.64
Household poverty†	0.95	0.89-1.01	.09			
Neighborhood poverty‡	0.90	0.83-0.98	.02	0.90	0.83-0.98	.02
Non-Hispanics and Puerto Ricans						
Urbanization						
Urban			Reference			
Suburban	0.93	0.79-1.09	.37	1.13	0.95-1.36	.17
Medium metro	0.88	0.73-1.05	.15	1.01	0.83-1.22	.93
Small metro/rural	0.91	0.76-1.08	.28	1.07	0.88-1.30	.48
Household poverty†	1.10	1.07-1.14	<.001			
Neighborhood poverty‡	1.20	1.14-1.26	<.001	1.09	1.02-1.16	.008

*Adjusted for age, sex, race/ethnicity, region, neighborhood-level poverty, urban/rural status, and birth outside the United States.
†One-unit decrease in ratio of household income to the poverty line.
‡Ten percentage point increase in households living below the poverty line.

sex, and birth in the United States (OR, 1.06; 95% CI, 1.03-1.09; $P < .001$). As was the case for neighborhood-level poverty, Hispanic ethnicity significantly modified the relationship between household poverty and prevalent asthma ($P = .002$), and household poverty was a risk factor for asthma among non-Hispanics and Puerto Ricans (OR, 1.07; 95% CI, 1.03-1.10; $P < .001$) but not Hispanics (OR, 1.00; 95% CI, 0.94-1.07; $P = .94$) in adjusted analyses.

When both neighborhood- and individual-level poverty were included in the model, neighborhood-level poverty was no longer a significant predictor of prevalent asthma in the overall or stratified models, but individual-level poverty remained an independent predictor overall and among non-Hispanics and Puerto Ricans (see Table E3 in this article's Online Repository at www.jacionline.org).

Residence in an urban neighborhood. There were no differences in asthma prevalence in suburban, small-town, and rural neighborhoods compared with urban neighborhoods in either crude or adjusted analyses overall or in analyses stratified by Hispanic ethnicity (Table II), and residence in an urban area did not increase the association between race/ethnicity and asthma prevalence (data not shown). Moreover, living in an urban environment did not increase the association between neighborhood-level poverty and asthma prevalence ($P = .62$).

Asthma morbidity

Black race, Puerto Rican ethnicity, and lower household income were strong independent risk factors for asthma exacerbation and emergency department visits for asthma (Tables III and IV and see Table E3). Neighborhood poverty and urban/rural status were not risk factors in adjusted analyses, with the exception of a protective effect of residence in small metro/rural areas compared with urban areas for emergency department visits in fully adjusted models of the overall population and among non-Hispanics and Puerto Ricans (see Table E3).

DISCUSSION

Although it has long been thought that the prevalence of asthma is high among children living in poor urban neighborhoods in the

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TABLE III. Predictors of asthma episode

	Crude			Adjusted*		
	OR	95% CI	*P* value	OR	95% CI	*P* value
Overall						
Race/ethnicity						
White			Reference			
Black	1.71	1.45-2.01	<.001	1.64	1.36-1.97	<.001
Hispanic	0.78	0.65-0.95	.01	0.84	0.68-1.05	.13
Puerto Rican	2.32	1.67-3.22	<.001	2.40	1.66-3.47	<.001
Asian	0.74	0.51-1.08	.11	0.93	0.63-1.36	.70
Urbanization						
Urban			Reference			
Suburban	1.02	0.85-1.22	.83	1.09	0.88-1.34	.43
Medium metro	1.02	0.84-1.26	.78	1.09	0.87-1.35	.46
Small metro/rural	0.99	0.82-1.19	.89	1.03	0.83-1.29	.77
Region						
Northeast			Reference			
Midwest	1.01	0.80-1.28	.93	1.07	0.84-1.37	.58
South	0.99	0.80-1.21	.89	1.01	0.82-1.24	.94
West	0.82	0.66-1.02	.07	1.00	0.79-1.26	.98
Birth outside the United States	0.31	0.20-0.47	<.001	0.34	0.22-0.53	<.001
Household poverty†	1.06	1.02-1.10	.003			
Neighborhood poverty‡	1.06	1.00-1.11	.04	1.02	0.96-1.09	.50
Hispanics						
Urbanization						
Urban			Reference			
Suburban	0.95	0.63-1.45	.82	0.89	0.57-1.39	.61
Medium metro	1.26	0.87-1.84	.21	1.08	0.93-1.95	.12
Small metro/rural	0.88	0.51-1.54	.66	0.87	0.50-1.52	.63
Household poverty†	0.98	0.92-1.03	.4			
Neighborhood poverty‡	0.9	0.79-1.02	.09	0.91	0.80-1.03	.13
Non-Hispanics and Puerto Ricans						
Urbanization						
Urban			Reference			
Suburban	0.94	0.76-1.15	.53	1.12	0.88-1.42	.36
Medium metro	0.93	0.74-1.17	.53	1.05	0.81-1.36	.70
Small metro/rural	0.91	0.74-1.13	.39	1.05	0.82-1.35	.70
Household poverty†	1.09	1.05-1.14	<.001			
Neighborhood poverty‡	1.15	1.08-1.23	<.001	1.05	0.97-1.13	.20

*Adjusted for age, sex, race/ethnicity, region, neighborhood-level poverty, urban/rural status, and birth outside the United States.
†One-unit decrease in ratio of household income to the poverty line.
‡Ten percentage point increase in households living below the poverty line.

United States, the prevalence of asthma in these neighborhoods throughout the United States has, surprisingly, not been described. Moreover, the relative contribution of race/ethnicity and household poverty versus other contextual neighborhood-level factors to asthma disparities related to the inner city remains unclear. Here we show that although some inner-city areas have high rates of asthma, particularly in the Midwest and Northeast, other nonurban poor areas have equal or higher asthma prevalence. Overall, black race, Puerto Rican ethnicity, and poverty rather than residence in an urban area *per se* are the major risk factors for prevalent asthma. These findings suggest that the concept of inner-city asthma might need to be refined.

Original reports heralding the phenomenon of inner-city asthma were based on findings of very high asthma morbidity and mortality in several cities, including Baltimore, Chicago, and New York City, and further research documented that poor neighborhoods in these cities were particularly affected.[1,5,7,8,14] These urban areas were also disproportionately home to ethnic minorities, particularly non-Hispanic blacks and Puerto Ricans, who were known to be at risk for asthma.[4] However, early research found conflicting results about whether racial/ethnic disparities were independent of socioeconomic factors.[3,6,20] Since that time, black race and Puerto Rican ethnicity have become clear risk factors for asthma, although how much this is due to environmental exposures, including urban exposures, or to underlying susceptibility remains unknown. Race is a complex concept that is informed by genetic, cultural, and historical factors, and thus it can be hard to parse genetic from environmental risk factors. Degree of African ancestry has been associated with asthma,[29-31] suggesting a genetic explanation, although it can be difficult to fully account for confounding by socioeconomic status, even in genetic analyses,[32,33] particularly because disparities in wealth, educational opportunities, family structure, and employment by race/ethnicity are even higher than what is represented by income[34] and can correlate with ancestry. Here, in a very large and nationally representative data set, we found that black race and Puerto Rican ethnicity were strong risk factors for prevalent asthma and asthma morbidity independent of income, neighborhood-level poverty, and residence in an urban setting, but we cannot exclude residual confounding as an explanation for the association between race/ethnicity and asthma.

TABLE IV. Predictors of asthma ED visit

	Crude			Adjusted*		
	OR	95% CI	*P* value	OR	95% CI	*P* value
Overall						
Race/ethnicity						
White			Reference			
Black	4.07	3.03-5.46	<.001	3.45	2.45-4.87	<.001
Hispanic	1.41	0.98-2.01	.06	1.24	0.81-1.90	.31
Puerto Rican	5.41	3.23-9.04	<.001	4.48	2.64-7.58	<.001
Asian	0.89	0.46-1.73	.74	0.96	0.48-1.92	.90
Urbanization						
Urban			Reference			
Suburban	0.61	0.41-0.89	.01	0.75	0.47-1.18	.21
Medium metro	0.88	0.60-1.29	.52	1.06	0.70-1.58	.79
Small metro/rural	0.51	0.35-0.74	<.001	0.66	0.43-1.02	.06
Region						
Northeast			Reference			
Midwest	0.74	0.49-1.12	.16	0.89	0.60-1.32	.56
South	0.82	0.58-1.16	.25	0.82	0.58-1.16	.25
West	0.66	0.43-1.00	.049	0.80	0.51-1.24	.31
Birth outside the United States	0.36	0.19-0.66	.001	0.38	0.19-0.75	.005
Household poverty†	1.22	1.13-1.31	<.001			
Neighborhood poverty‡	1.24	1.14-1.36	<.001	1.04	0.93-1.16	.49
Hispanics						
Urbanization						
Urban			Reference			
Suburban	0.67	0.30-1.48	.32	0.70	0.29-1.68	.42
Medium metro	1.08	0.52-2.21	.84	1.22	0.61-2.46	.57
Small metro/rural	0.65	0.20-2.08	.46	0.79	0.24-2.56	.69
Household poverty†	1.06	0.90-1.26	.49			
Neighborhood poverty‡	1.04	0.83-1.32	.71	1.07	0.86-1.33	.50
Non-Hispanics and Puerto Ricans						
Urbanization						
Urban			Reference			
Suburban	0.55	0.35-0.86	.008	0.75	0.44-1.26	.28
Medium metro	0.80	0.52-1.23	.31	1.02	0.64-1.63	.93
Small metro/rural	0.45	0.31-0.67	<.001	0.65	0.41-1.03	.07
Household poverty†	1.27	1.16-1.38	<.001			
Neighborhood poverty‡	1.34	1.22-1.48	<.001	1.03	0.90-1.18	.65

ED, Emergency department.
*Adjusted for age, sex, race/ethnicity, region, neighborhood-level poverty, urban/rural status, and birth outside the United States.
†One-unit decrease in ratio of household income to the poverty line.
‡Ten percentage point increase in households living below the poverty line.

Residence in urban areas, a potential risk factor for asthma hypothesized to be mediated by exposure to indoor and outdoor pollution, pest allergens, and violence and other stressful life events,[20,35] was not found to be a significant risk factor for prevalent asthma or asthma morbidity in this US population–based analysis. The lack of a relationship between urban residence and asthma prevalence, even in crude analyses, might reflect shifting demographics since the inner-city asthma epidemic was first described. Although urban areas have historically tended to be poor, in recent years, the fastest growth in high-poverty areas has occurred in suburban and smaller metropolitan areas, with the slowest growth in the largest cities, as shown by the US Census' Decennial and American Communities Surveys.[36,37] The suburbanization of poverty means that despite continued high rates of concentrated poverty in cities, there are now more poor people living in suburban than urban communities.[36,37] The ethnic composition of poor and urban areas has also shifted, with a so-called "reverse migration" of black populations from Northern cities to the South[38] and an influx of Hispanic populations to urban areas,[39] where they are now the most common ethnic group. These demographic changes challenge the use of "inner city" as interchangeable with black race and mean that focusing on the inner city might not fully capture the population most at risk for asthma. In this survey we estimate that inner-city areas now house only 8% of all children with current asthma compared with the 46% living in suburban or wealthier urban areas, which follows a similar distribution to children as a whole. The environmental factors contributing to asthma in non–inner-city areas, especially poor suburban and medium metro areas, have been relatively less studied than those in the inner city.

In contrast to residence in an urban area, neighborhood- and individual-level poverty were both associated with prevalent asthma, although neighborhood-level poverty was not independent of individual-level household poverty. Poverty can lead to increased risk of asthma through many pathways because known risk factors for asthma are more common in poorer households;

including smoking; shorter duration of breast-feeding; prematurity; higher levels of indoor allergens, such as cockroach and mouse allergens; exposure to outdoor pollution, such as diesel particles; poorer diet; and psychological stress.[40] Poverty (both neighborhood and household) was not a risk factor for non-Puerto Rican Hispanics and was in fact protective, a finding that has been reported in a smaller study in California.[41] Many of the risk factors for asthma that are found in poorer households in general might actually be less common among poorer, less acculturated Hispanic households.[42] Increased acculturation has been linked to higher prevalence of asthma risk factors, including shorter duration of breast-feeding,[43] smoking,[44] prematurity,[45,46] and poor diet,[47] and has been shown to be a risk factor for asthma among Mexican Hispanics.[48,49] Although we adjusted for the subject child's birth outside the United States, our analyses did not adjust for the immigration status of the child's parent, and thus acculturation is a potential explanation for the inverse relationship between poverty and asthma we found among Hispanics, although differences in diagnosis and gene-environment interactions might also play a role.

There are several important caveats to our findings. First, because the research questions addressed in this study could only be answered with a very large study population, the data, by necessity, were obtained by means of self-report. Differences in the likelihood of diagnosis of asthma by race, socioeconomic status, or geography could potentially bias our results. However, assessment of asthma by the NHIS questions is a standard and well-accepted approach to identifying asthma,[50] and self-report of race/ethnicity is considered the gold standard.

Second, there is potential for misclassification of neighborhood characteristics because subjects were surveyed in 2009-2010 but were assigned to year 2000 census tracts in the NHIS survey. These tracts were linked to year 2000 census data for poverty and year 2005 urban/rural definitions. We expect that any changes in distribution of neighborhood-level poverty over the past decade, leading to misclassification of neighborhood-level poverty, are likely to lead to a bias toward the null in our analyses of the relationship between neighborhood-level poverty and asthma, whereas urban/rural status is unlikely to change substantially over 4 to 6 years.

Finally, with regard to asthma morbidity, the outcome measures were fairly crude, and there was less power than for analyses of asthma prevalence overall. Therefore we cannot exclude the possibility that residence in an urban area and poverty might have a stronger role in asthma morbidity than prevalent asthma. In addition, access to care, including emergency care, might explain some of our results, particularly the finding that those living in a rural area were less likely to have emergency department visits for asthma. More research is needed to understand how urban/rural status might affect other measures of asthma morbidity and asthma severity.

These limitations, however, are countered by the study's strengths, which are that it is representative of the US population and of sufficient size to disentangle the effects of race/ethnicity, neighborhood-level poverty, and urban residence on asthma.

In conclusion, our work suggests that the concept of inner-city asthma might need to be revised. Focusing only on urban areas could miss communities that are also at high risk of asthma, particularly those with high concentrations of black, Puerto Rican, and poor children. This work highlights the need for a broad view of asthma disparities to develop the research and public health measures that are most likely to be effective in preventing and managing asthma.

Key messages

- **Although the prevalence of asthma is high in some US inner cities, it is equally high in some poor nonurban areas.**
- **Taking the United States as a whole, living in an urban neighborhood is not associated with increased asthma prevalence.**

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

November 19, 2014

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: O_3 Monitoring Season Analysis

FROM: Joann Rice (EPA, OAQPS, AQAD, AAMG)

TO: O_3 NAAQS Review Docket, EPA-HQ-OAR-2008-0699

This memo presents the findings from an analysis of daily maximum 8-hour O_3 values to assess whether the current O_3 monitoring seasons are adequate in light of a proposed NAAQS. EPA is proposing to extend the length of the required O_3 monitoring season in some states to be appropriate for the O_3 NAAQS revision finalized in 2008, as well as a final revised O_3 standard, if a revision is finalized in 2015.

Analysis to Determine the Proposed Length of the O_3 Monitoring Season by State

Unlike the ambient monitoring requirements for other criteria pollutants that mandate year-round monitoring, O_3 monitoring is currently only required during the seasons of the year that are conducive to O_3 formation. These seasons vary in length from place to place as the conditions that determine the likely O_3 formation (i.e., seasonally-dependent factors such as ambient temperature, strength of solar insolation, and length of day) differ by location. In some locations, conditions conducive to O_3 formation are limited to the summer months of the year. For example, in states with colder climates such as Montana and South Dakota, the currently required O_3 monitoring season is 4 months long. However, in other states with warmer climates, such as California, Nevada, and Arizona, the currently required O_3 monitoring season is year-round.

An analysis was done to address the issue of whether extensions of the currently required monitoring seasons are appropriate. EPA reviewed the year-round O_3 data for 2010 through 2013. A year-round monitor was identified as "year-round" if it had at least 20 daily observations in all 12 months, for at least 1 year of the 4 year period. The year-round monitor locations are shown in Figure 1. Greater than 50 percent of the monitors (about 800 of the approximately 1500 monitors) with data during 2010-2013 were operating year-round. States currently required to operate year-round were not considered in the analysis. During the 2010-2013 period, all states operated at least one monitor year-round and reported the data to EPA's Air Quality System (AQS). In the analysis, we determined the number of days where one or more monitors had a daily maximum 8-hour O_3 average equal to or above 0.060 ppm in the months outside the currently-required state O_3 monitoring season.[1]

Although we refer to the number of days as "exceedance days" in the analysis, this threshold is simply a conservative benchmark that is below the levels proposed (0.065 to 0.070 ppm) for the revised NAAQS.

[1] See 40 CFR part 58 Appendix D, section 4.1, Table D-3 for a table of required O_3 seasons.

We find that this level, taking into consideration reasonable uncertainty, serves as an appropriate indicator of ambient conditions that may be conducive to the formation of O_3 concentrations that approach or may exceed the proposed 8-hour average range. Proposed revisions for each state's required monitoring season are based on the number of days equal to or above the 0.060 ppm level in and surrounding the state. EPA considered a number of factors including out of season exceedance days either before or after the current O_3 monitoring season, the pattern of exceedance days in the out of season months, and regional consistency. We note that year-to-year variability occurs in seasonal O_3 patterns based on highly variable meteorological conditions which can support the formation of early or late season elevated O_3 concentrations in some years and not others. The EPA believes it is important that O_3 monitors operate during all periods when there is a reasonable possibility of ambient levels approaching the level of the proposed NAAQS.

EPA's analysis found that a total of 43 states experienced at least 1 day greater than or equal to 0.060 ppm outside of the current O_3 season; 21 states had exceedance days only before the required monitoring season; 4 states had exceedance days only after the required monitoring season; and 18 states had exceedance days both before and after the required monitoring season. In some cases, the frequency of exceedance days before the current O_3 season was high, with 4 states (Colorado, South Dakota, Utah, and Wyoming) experiencing between 31 and 230 out-of-season exceedance days from 2010 to 2013 at monitors operating year-round. Although 43 states had at least one exceedance day outside the current monitoring season, changes are proposed for only 33 of those states.

The specific proposed changes to the required state O_3 monitoring seasons are provided in Table 1 and shown in Figure 2. Table 2 provides the supporting details on the number of sites operating year-round by state, the time period of the exceedance days, and number of days with exceedances greater than or equal to 0.060 ppm before and after the current season for each state. The number of days greater than or equal to 0.060 ppm were used to determine the length of the proposed ozone seasons. EPA also considered regional consistency (seasons of surrounding states) in proposing a change to the season. To see the regional consistency of the seasons, see Figure 3 for a map of the proposed seasons color-coded by season. Please also refer to Attachment A for state-by-state maps of ozone monitors and exceedance days, Attachment B for the distribution of exceedance days by month and state, and Attachment C for detailed information regarding the AQS site ID numbers, exceedance dates, and daily 8-hour maximum values (dmax8) by state (Attachment C).

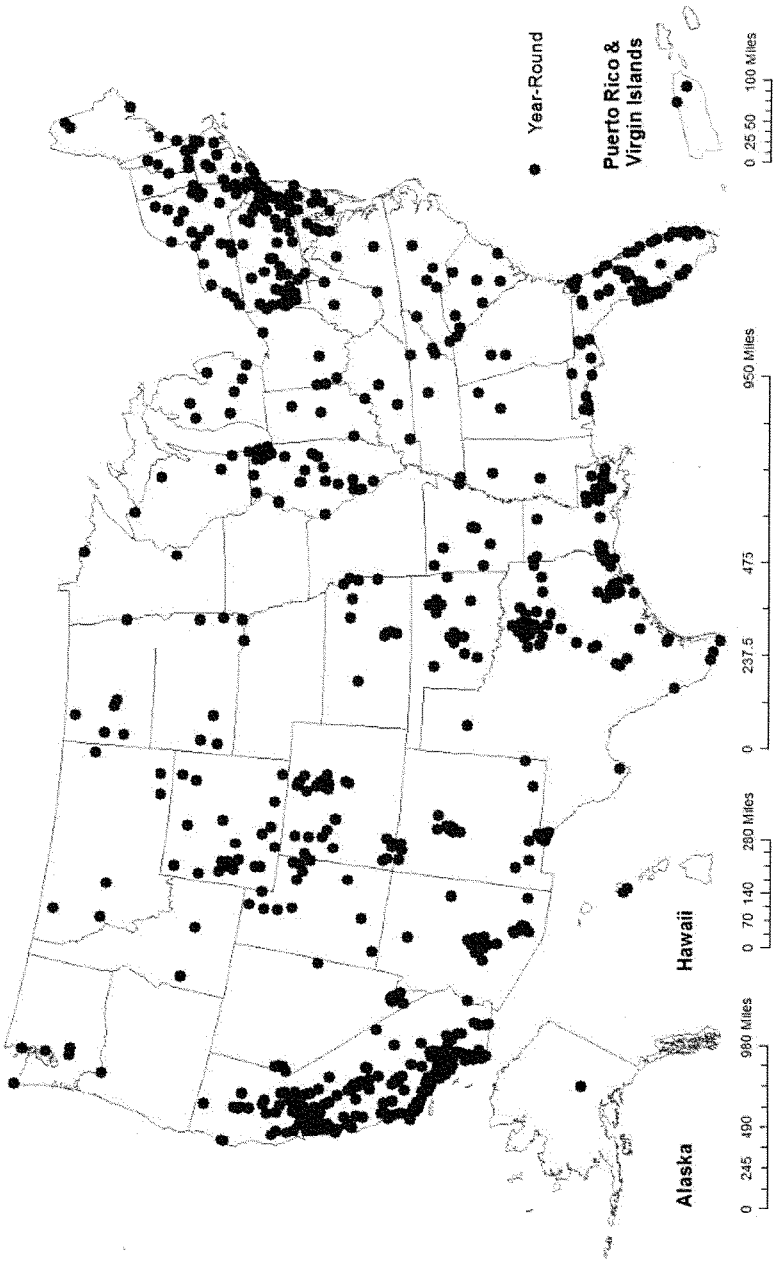

Figure 1. Map of Year-Round Monitors used in this analysis

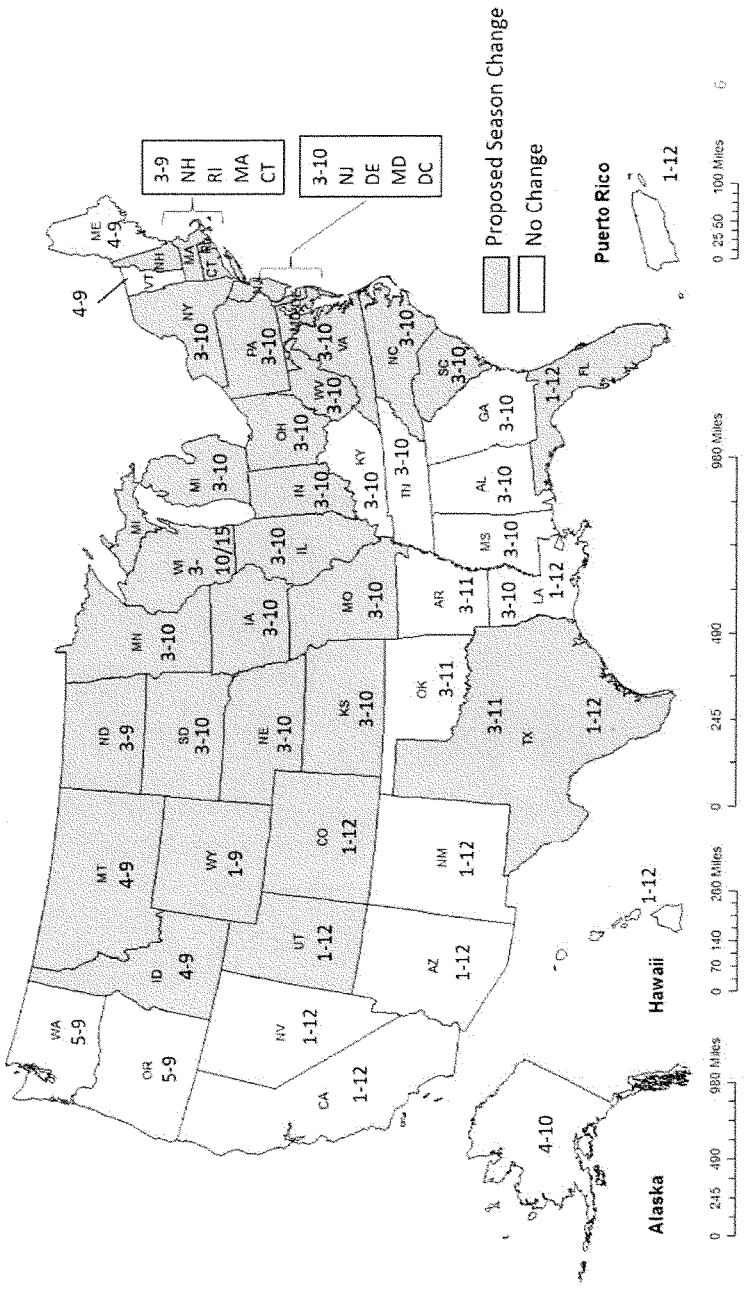

Figure 2. Proposed Changes to Ozone Seasons

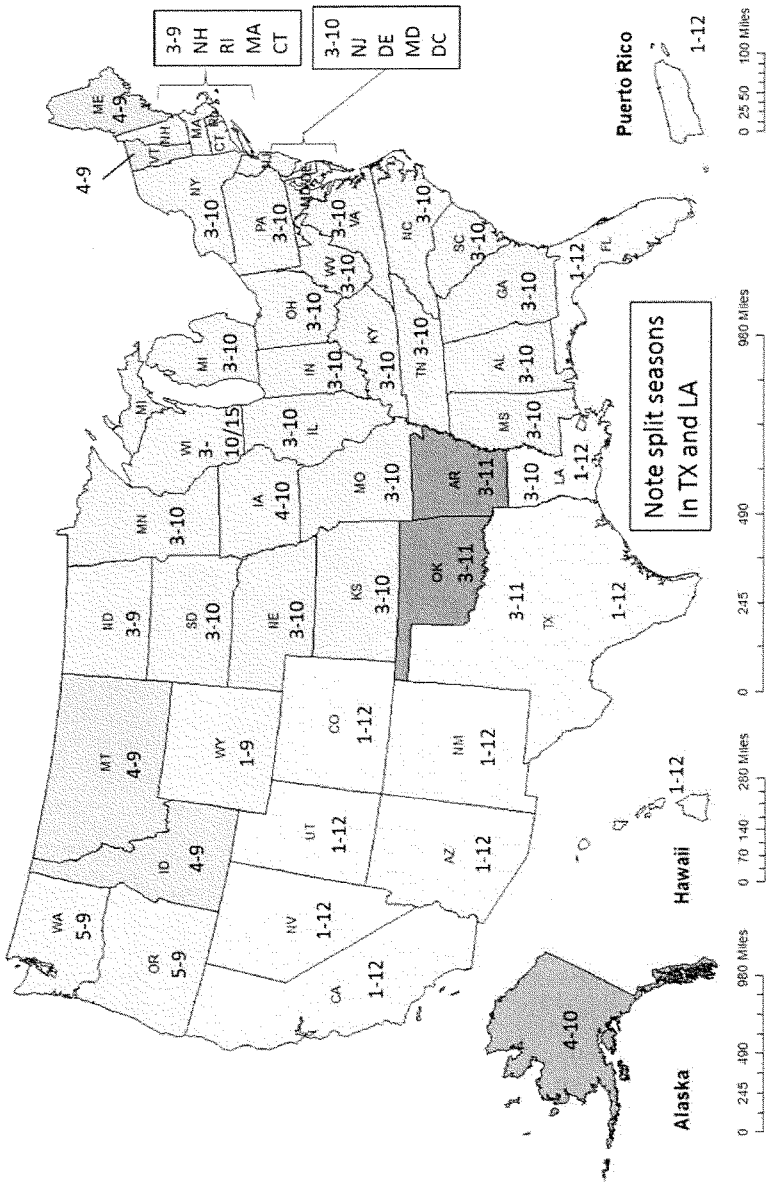

Figure 3. Map of ozone season regional consistency

Table 1. Ozone Monitoring Season Length – Proposed Changes*

State Name	Current Ozone Season	Proposed Ozone Season	Net Change (Months)
Alabama	March-October	March-October	0
Alaska	April-October	April-October	0
Arizona	January-December	January-December	0
Arkansas	March-November	March-November	0
California	January-December	January-December	0
Colorado	March-September	January-December	5
Connecticut	April-September	March-September	1
Delaware	April-October	March-October	1
District Of Columbia	April-October	March-October	1
Florida	March-October	January-December	4
Georgia	March-October	March-October	0
Hawaii	January-December	January-December	0
Idaho	May-September	April-September	1
Illinois	April-October	March-October	1
Indiana	April-September	March-October	2
Iowa	April-October	March-October	1
Kansas	April-October	March-October	1
Kentucky	March -October	March -October	0
LA AQCR 106**	January-December	January-December	0
LA AQCR 019, 022**	March -October	March -October	0
Maine	April-September	April-September	0
Maryland	April-October	March-October	1
Massachusetts	April-September	March-September	1
Michigan	April-September	March-October	2
Minnesota	April-October	March-October	1
Mississippi	March-October	March-October	0

Missouri	April-October	March-October	1
Montana	June-September	April-September	2
Nebraska	April-October	March-October	1
Nevada	January-December	January-December	0
New Hampshire	April-September	March-September	1
New Jersey	April-October	March-October	1
New Mexico	January-December	January-December	0
New York	April-October	March-October	1
North Carolina	April-October	March-October	1
North Dakota	May-September	March-September	2
Ohio	April-October	March-October	1
Oklahoma	March-November	March-November	0
Oregon	May-September	May-September	0
Pennsylvania	April-October	March-October	1
Rhode Island	April-September	March-September	1
South Carolina	April-October	March-October	1
South Dakota	June-September	March-October	4
Tennessee	March-October	March-October	0
TX AQCR 106, 153, 213, 214, 216**	January-December	January-December	0
TX AQCR 022, 210, 211, 212, 215, 217, 218**	March -October	March -November	1
Utah	May-September	January-December	7
Vermont	April-September	April-September	0
Virginia	April-October	March-October	1
Washington	May-September	May-September	0
West Virginia	April-October	March-October	1
Wisconsin	April 15-October 15	March-October 15	1.5
Wyoming	April-October	January-September	2

American Samoa	January-December	January-December	0
Guam	January-December	January-December	0
Puerto Rico	January-December	January-December	0
Virgin Islands	January-December	January-December	0

*** EPA is proposing to require O_3 monitors at NCore to operate year-round.**

**** AQCR – Air Quality Control Region**

Table 2. Number of Days ≥ 0.060 ppm Before and After the Current Ozone Season by State

State Monitoring Info								Days ≥ 0.060ppm Before Season, 2010-2013		Days ≥ 0.060 ppm After Season, 2010-2013	
State FIPS	State Name	Current Ozone Season	Proposed Ozone Season	Net Change (Months)	No. Ozone Sites	No. Year Round	% Year Round	No. days	Time Period	No. days	Time Period
1	Alabama	March-October	March-October	0	26	2	8	1	2/17	1	11/12
2	Alaska	April-October	April-October	0	5	2	40				
4	Arizona*	January-December	January-December	0	40	35	73				
5	Arkansas	March-November	March-November	0	10	9	90	1	2/13		
6	California*	January-December	January-December	0	201	172	86				
8	Colorado	March-September	January-December	5	53	34	64	60	1/7-2/28	19	10/1-12/31
9	Connecticut	April-September	March-September	1	13	3	23	3	3/19 -3/21	2	10/12 - 10/13
10	Delaware	April-October	March-October	1	7	6	86	4	3/10-3/25		
11	District Of Columbia	April-October	March-October	1	4	3	75	3	3/19-3/21		
12	Florida	March-October	January-December	4	62	59	95	13	1/24-2/28	5	11/1-11/23
13	Georgia	March-October	March-October	0	21	2	10	2	2/14-2/17		
15	Hawaii*	January-December	January-December	0	2	2	100				
16	Idaho	May-September	April-September	1	6	2	33	8	4/4-4/24	1	10/2
17	Illinois	April-October	March-October	1	44	26	59	6	2/13, 3/15-3/31	1	11/2
18	Indiana	April-September	March-October	2	46	3	7	2	3/21, 3/31	9	10/5-10/17
19	Iowa**	April-October	March-October	1	15	1	7				
20	Kansas	April-October	March-October	1	11	11	100	17	2/12-3/31	1	11/1
21	Kentucky	March -October	March -October	0	32	5	16			3	11/11-11/13
22	N. Louisiana AQCR 019, 022	March-October	March-October	0	3	3	100			1	11/1
22	S. Louisiana AQCR 106*	January-December	January-December	0	24	21	88				
23	Maine***	April-September	April-September	0	19	5	26	3	3/19, 3/12, 3/31		
24	Maryland	April-October	March-October	1	21	6	29	10	2/17, 3/10-3/30		
25	Massachusetts	April-September	March-September	1	19	5	26	5	3/7-3/31	2	10/9-10/10
26	Michigan	April-September	March-October	2	30	7	23	5	3/9-3/31	6	10/6-10/11
27	Minnesota	April-October	March-October	1	18	2	11	5	3/7-3/30		
28	Mississippi	March-October	March-October	0	12	2	17	1	2/13	1	11/2
29	Missouri**	April-October	March-October	1	25	2	8	2	3/3, 3/11		
30	Montana	June-September	April-September	2	9	7	78	9	4/20-5/17		
31	Nebraska	April-October	March-October	1	7	2	29	4	3/24-3/29		
32	Nevada*	January-December	January-December	0	37	16	43				
33	New Hampshire	April-September	March-September	1	13	7	54	13	2/17, 2/18, 3/11-3/31	6	10/1-10/25
34	New Jersey	April-October	March-October	1	17	14	82	3	3/19-3/21		
35	New Mexico*	January-December	January-December	0	27	24	89				
36	New York	April-October	March-October	1	38	34	89	16	2/17, 3/7-3/30		
37	North Carolina	April-October	March-October	1	49	7	14	17	2/17, 3/8-3/30		
38	North Dakota	May-September	March-September	2	9	8	89	12	3/8-4/23	1	10/5
39	Ohio	April-October	March-October	1	53	6	11	13	2/17, 3/7-3/31	2	11/10, 11/13
40	Oklahoma	March-November	March-November	0	33	16	48	1	1/29		
41	Oregon	May-September	May-September	0	10	1	10				
42	Pennsylvania	April-October	March-October	1	59	50	85	14	3/7-3/31		
44	Rhode Island	April-September	March-September	1	3	1	33	3	3/19, 3/20, 3/31		
45	South Carolina	April-October	March-October	1	24	9	38	23	2/21, 3/3-3/31		
46	South Dakota	June-September	March-October	4	7	7	100	31	3/5-5/30	6	10/3-10/6
47	Tennessee***	March-October	March-October	0	27	5	19	6	2/13-2/21	4	11/1-11/13
48	N. Texas AQCR 022, 210, 211, 212, 215, 217, 218	March-October	March-November	1	36	31	86			3	11/1-11/8
48	S. Texas AQCR 106, 153, 213, 214, 216*	January-December	January-December	0	47	44	94				
49	Utah	May-September	January-December	7	30	13	43	230	1/1-4/30	19	10/1-12/31
50	Vermont	April-September	April-September	0	2	2	100	1	3/31		
51	Virginia	April-October	March-October	1	30	4	13	13	2/17, 3/8-3/30		
53	Washington	May-September	May-September	0	18	5	28			2	10/27, 10/28
54	West Virginia**	April-October	March-October	1	10	2	20	2	3/20, 3/21		
55	Wisconsin	April 15-October 15	March-October 15	1.5	37	5	14	15	3/5-4/14		
56	Wyoming	April-October	January-September	2	34	24	71	55	1/29-3/31		
72	Puerto Rico*	January-December	January-December	0	2	2	100				

* Current ozone season is year-round. State not included in the ozone season analysis.
**Changed for Regional Consistency
***No Change for Regional Consistency

OVERVIEW OF EPA'S PROPOSAL TO UPDATE THE AIR QUALITY STANDARDS FOR GROUND-LEVEL OZONE

On Nov. 25, 2014, the U.S. Environmental Protection Agency (EPA) proposed to strengthen the National Ambient Air Quality Standards (NAAQS) for ground-level ozone, based on extensive scientific evidence about ozone's effects on public health and welfare. The proposed updates will improve public health protection, particularly for children, the elderly, and people of all ages who have lung diseases such as asthma. Today's proposal will expand the ozone monitoring season for many states, and will update the Air Quality Index to ensure people are notified when air quality is unhealthy. It also will improve the health of trees, plants and ecosystems.

The Clean Air Act requires EPA to set two types of outdoor air quality standards for ozone: a primary standard, to protect public health with an "adequate margin of safety," including the health of at-risk groups; and a secondary standard, to protect the public welfare. The law requires EPA to review the standards every five years. EPA last updated the standards in 2008.

States would have time to develop and implement plans to meet revised standards, and existing and proposed federal rules will help, by making significant strides toward reducing ozone-forming pollution. EPA projections show the vast majority of U.S. counties would meet the proposed standards by 2025 just with the rules and programs now in place or under way.

SUMMARY OF ACTION

- Based on an extensive body of scientific evidence, EPA is proposing to update both the primary ozone standard, to protect public health, and the secondary standard, to protect the public welfare. Both standards would be 8-hour standards set within a range of 65 to 70 parts per billion (ppb). EPA is seeking comment on levels for the health standard as low as 60 ppb. The agency will accept comments on all aspects of the proposal, including on retaining the existing standard.
- Ozone, a key component of smog, forms in the atmosphere when emissions of nitrogen oxides and volatile organic compounds "cook" in the sun. Emissions from sources such as cars, trucks, buses, industries, power plants, and products such as solvents and paints are among the major man-made sources of ozone-forming emissions.
- People most at risk from breathing air containing ozone include: children; people with asthma and other respiratory diseases; older adults; and people who are active outdoors, especially outdoor workers. An estimated 25.9 million people have asthma in the U.S., including almost 7.1 million children. Asthma disproportionately affects children, families with lower incomes, and minorities, including Puerto Ricans, Native Americans/Alaska Natives and African-Americans.
- EPA estimates that meeting the standards will yield significant health benefits valued at $6.4 to $13 billion annually in 2025 for a standard of 70 ppb, and $19 to $38 billion annually

in 2025 for a standard of 65 ppb, nationwide, excluding California. These benefits include the value of avoiding asthma attacks, heart attacks, missed school days and premature deaths, among other health effects. EPA analyzed the benefits and costs for California separately, because a number of areas in California would have longer to meet the proposed standards. Benefits of meeting the proposed standards in California add to the nationwide benefits after 2025, with values estimated at $1.1 to $2 billion annually after 2025 for a standard of 70 ppb, and $2.2 to $4.1 billion for a standard of 65 ppb.

- Existing and proposed federal rules, including the final Mercury and Air Toxics Standards, the final Tier 3 Vehicle Emissions and Fuels Standards, requirements to reduce the interstate transport of ozone, Regional Haze rules, and the proposed Clean Power Plan, will help states meet the proposed standards by making significant strides toward reducing ozone-forming pollution. EPA projections show the vast majority of U.S. counties with monitors would meet the proposed standards by 2025 just with the rules and programs now in place or under way.
- While states ultimately decide what measures to implement to meet a standard, EPA has developed illustrative measures in order to estimate costs. Those estimates are $3.9 billion in 2025 for a standard of 70 ppb, and $15 billion for a standard at 65 ppb, nationwide except for California. Estimated costs in California post-2025 are $800 million for a standard of 70 ppb and $1.6 billion for a standard of 65 ppb. More on benefits and costs
- EPA will take comment on the proposal for 90 days after it is published in the Federal Register and will hold three public hearings. The agency will issue a final decision by Oct. 1, 2015.

Proposal is based on a large body of science

- A significantly expanded body of scientific evidence, including more than 1,000 new studies since the last review of the standards, shows that ozone can cause a number of harmful effects on health and the environment.
- Exposure to ozone can cause respiratory system effects such as difficulty breathing and airway inflammation. For people with lung diseases such as asthma and COPD (chronic obstructive pulmonary disease), these effects can lead to emergency room visits and hospital admissions.
- Studies have also found that ozone exposure is likely to cause premature death from lung or heart diseases. In addition, evidence indicates that long-term exposure to ozone is likely to result in harmful respiratory effects, including respiratory symptoms and the development of asthma.

Proposed primary (health) standard

- The Clean Air Act requires EPA to set primary air quality standards to reduce risk sufficiently to protect public health with an "adequate margin of safety," including the health of at-risk groups. In making this judgment, the EPA Administrator considers factors such as the nature and severity of health effects, the size of the at-risk groups affected, and the degree of

certainty and uncertainty in the science.

- EPA's task is to set standards that are "requisite" -- neither more nor less stringent than necessary -- to accomplish this. The law does not require EPA to set primary standards at a zero-risk level.
- EPA's proposal finds that the current level of the standard – 75 ppb – is not adequate to protect public health, and it would strengthen the standard by setting the primary standard at a level within a range from 65 to 70 ppb. EPA staff experts and the agency's independent science advisors, the Clean Air Scientific Advisory Committee (CASAC), concluded that scientific evidence supports a standard within a range of 60 to 70 ppb.
- The Administrator did not include a standard of 60 ppb in the proposed range because of increasing uncertainty in the scientific evidence at lower ozone concentrations. This uncertainty reduces confidence that ozone standard levels below 65 ppb will result in additional health improvements, compared to improvements that would result from a standard in the proposed range of 65 to 70 ppb. EPA is taking comment on levels for the health standard as low as 60 ppb.
- The agency will accept comments on all aspects of the proposal, including on retaining the existing standard.

Proposed secondary (public welfare) standard

- The Clean Air Act also requires that EPA set standards to protect the public welfare. EPA's proposal would strengthen the secondary standard, also currently set at 75 ppb, to improve protection for trees, plants and ecosystems.
- New studies since the last review of the standards add to evidence showing that repeated exposure to ozone reduces growth and has other harmful effects on plants and trees. These types of effects have the potential to impact ecosystems and the benefits they provide.
- EPA is proposing that the secondary standard should provide protection against the cumulative exposures that can damage plants and trees during the consecutive three months in the growing season when daytime ozone concentrations are the highest and plant growth is most affected.
- The Agency is proposing to define this necessary protection in terms of a "W126 index" in a range of 13 to 17 parts per million-hours (ppm-hours), averaged over three years. A "W126 index," named for the formula used to calculate it, is a seasonal index often used to assess the impact of ozone on ecosystems and vegetation.
- To achieve a level of protection equivalent to 13 to 17 ppm-hours based on the W126 metric, EPA is proposing to set an 8-hour secondary standard at a level within the range of 65 to 70 ppb. EPA analyzed data from air quality monitors and found that setting a standard in a W126 form would not provide additional protection beyond an 8-hour standard.

- However, the Agency is seeking comment on setting the standard based on the W126 metric within a range of 13 to 17 ppm-hours, averaged over three years. EPA also is seeking comment on defining a target protection level in terms of a W126 index value as low as 7 to 13 ppm-hours. In addition, EPA is taking comment on retaining the existing 8-hour secondary standard.

- For more detail on the proposed standards

Protecting Air Quality: A Partnership Across Governments

- Protecting air quality is a federal/state partnership, and EPA, states and tribes have made significant progress reducing ozone. Nationwide, ozone levels have dropped by a third since 1980 at monitor sites that track ozone trends. Ozone levels declined 18 percent from 2000 to 2013. And 90 percent of areas designated as nonattainment for the 1997 ozone standard now meet that standard.

- EPA has a long history of working closely with states as they develop State Implementation Plans (SIPs) to reduce emissions of ozone precursors within individual jurisdictions. The agency will continue these collaborative efforts for any revised ozone standards, including working with California as it continues to explore regulatory strategies and technologies to reduce pollution and improve public health protection. California has faced a uniquely difficult attainment task due to the combination of adverse meteorology and topography, population growth, and the pollution burden associated with mobile sources.

- The agency also will work closely with states that may need to address relatively infrequent events when ozone formed from sources such as wildfires or stratospheric intrusions contributes to ozone exceedances.

- The agency plans to propose rules and guidance to assist areas with implementing revised standards within one year after the final standards are issued, or sooner. The agency also plans to update its Exceptional Events Rule, which outlines the requirements for excluding air quality data (including ozone data) from regulatory decisions if the data is affected by an exceptional event. The Exceptional Events rule is one of several tools available to states for addressing background ozone as they develop their clean air plans. In addition, EPA is developing guidance to address Exceptional Events Rule criteria for wildfires that could affect ozone concentrations.

- EPA projects that peak ozone levels will continue to improve over the next decade as additional reductions in ozone-forming pollutants are realized. However, research also shows that temperature and other meteorological changes associated with the changing climate have the potential to offset some of the future improvements in ozone air quality, along with public health improvements that would result -- underscoring the need to address both ozone and climate change.

- In June 2013, President Obama issued the Climate Action Plan, which directed EPA and other federal agencies to take a series of actions to reduce carbon pollution, prepare the U.S. for the impacts of climate change, and lead international efforts to address global

climate change. EPA is taking several actions to cut carbon pollution from passenger cars and trucks, cut methane emissions from the oil and gas sector and landfills, and cut potent HFCs from industrial sources.

- In addition, in June 2014, EPA proposed the Clean Power Plan to cut carbon pollution from power plants, while maintaining an affordable, reliable energy system. Actions to reduce carbon pollution under the proposed plan also would reduce emissions of ozone- and particle-forming pollutants by about 25 percent in 2030. Learn more about the Clean Power Plan.
- Today's proposed updates also include changes to monitoring requirements, including extending the ozone monitoring season for 33 states to match the times of year when data show ozone can approach unhealthy levels, and to alert the public. The agency also is proposing to:
    - Streamline and modernize the Photochemical Assessment Monitoring Stations (PAMS) network to use monitoring resources most efficiently. The PAMS network measures ozone, the pollutants that form it, and meteorology in order to better understand ozone formation and to evaluate national and local ozone-reduction options; and
    - Update the Federal Reference Method for ozone to include an additional method for measuring ozone in the outdoor air, which will provide flexibility and choice to state, local and tribal air agencies.
- The proposal also would update the Air Quality Index, EPA's color-coded tool for communicating air quality to the public, to reflect changes to the ozone health standard.
- In addition, to ensure a smooth transition to the new standards, EPA is proposing to grandfather preconstruction permitting applications that have made substantial progress through the review process at the time final standards are issued.
- As required by the Clean Air Act, EPA would make attainment/nonattainment designations for any revised standards by October 2017; those designations likely would be based on 2014-2016 air quality data.
- States with nonattainment areas would have until 2020 to late 2037 to meet the proposed health standard, with attainment dates varying based on the ozone level in the area. Most states are familiar with this process and can build off work they are already doing to reduce pollution to help them meet the standards.
- The Clean Air Act does not specify deadlines for states to meet secondary ozone standards. EPA and states determine that through the implementation planning process.
- Existing and proposed federal rules will help states meet the proposed standards by reducing ozone-forming pollution. These rules include: the final Mercury and Air Toxics Standards, requirements to reduce the interstate transport of air pollution, Regional Haze

regulations, the proposed Clean Power Plan, and the final Tier 3 Vehicle Emissions and Fuels Standards. Other rules include: Light-Duty Vehicle Tier 2 Rule, the Mobile Source Air Toxics Rule, the Light-Duty Greenhouse Gas/Corporate Average Fuel Efficiency Standards, the Heavy-Duty Vehicle Greenhouse Gas Rule, the Reciprocating Internal Combustion Engines (RICE) NESHAP, and the Industrial/Commercial/Institutional Boilers and Process Heaters MACT and amendments.

Benefits and Costs

- EPA's proposal is about setting a health standard and determining that level. By law, EPA cannot consider costs in doing that. However, to inform the public, EPA analyzes the benefits and costs of implementing the standards as required by Executive Orders 12866 and 13563 and guidance from the White House Office of Management and Budget.
- Reducing pollution to meet the ozone standard will reduce both ozone and particle pollution. EPA estimates that reducing pollution to meet the standards in 2025 will yield annual health benefits of $6.4 to $13 billion annually for a standard of 70 ppb, and $19 to $38 billion annually for a standard of 65 ppb, except for California. This includes the value of preventing harm to health that includes, among other effects:
    - 710 to 4,300 premature deaths;
    - 790 to 2,300 cases of acute bronchitis in children;
    - 1,400 to 4,300 asthma-related emergency room visits;
    - 320,000 to 960,000 asthma attacks in children;
    - 65,000 to 180,000 days when people miss work; and
    - 330,000 to 1 million days when children miss school.
- Costs are estimated at $3.9 billion in 2025 at a standard of 70 ppb, and $15 billion at a standard at 65 ppb nationwide, excluding California. EPA has analyzed costs and benefits for California separately, because a number of California counties would have longer to meet the proposed standard, based on their ozone levels. A number of California counties likely would have attainment dates ranging from 2032 to late 2037.
- Benefits of meeting the proposed standards in California add to the nationwide benefits after 2025, with the value of the additional benefits ranging from an estimated $1.1 to $2 billion at a standard of 70 ppb to $2.2 to $4.1 billion for a standard of 65 ppb. This includes the value of preventing, among other effects:
    - 110 to 430 premature deaths;
    - 67 to 130 cases of acute bronchitis in children;
    - 340 to 740 asthma-related emergency room visits;
    - 99,000 to 210,000 asthma attacks in children;

  - 110,000 to 230,000 days when children school; and
  - 5,500 to 11,000 days when people miss work.
- Estimated costs of meeting the proposed standards in California post-2025 are $800 million for a standard of 70 ppb, and $1.6 billion for a standard of 65 ppb.

FOR MORE INFORMATION

- To read the proposed rule and additional fact sheets, visit http://www.epa.gov/glo/actions.html
- For instructions on submitting comments, see: http://epa.gov/glo/pdfs/20141125fs-comment.pdf
- For your local air quality forecasts and information on current air quality, visit www.airnow.gov

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Growth Responses of Trees to Tropospheric Ozone: Alternatives in Dose-Metrics to EPA's Proposed W126 Secondary NAAQS

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Presentation to USDA-Agriculture Air Quality Task Force, Tallahassee, Florida, March 9-11, 2010

OUTLINE

- What is the current Secondary Standard?
- What is the EPA's proposed standard?
- How is the proposed standard calculated?
- What are the limitations of the proposed standard?
- What are the alternative exposure-metrics?
- What would be a desirable exposure-metric and why?
- Summary

What is the current Secondary Standard?

- "Secondary same as primary"
- "...the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (effective May 27, 2008)"

Quoted from: http://www.epa.gov/air/ozonepollution/standards.html

EPA's Proposed Secondary Standard

- "...a concentration-weighted form commonly called W126, which uses a sigmoidal weighting function to assign a weight to each hourly O_3 concentration within the 12-hour daylight period (8 am to 8 pm)."
- This daily ozone index is defined as follows:

$$daily\ W126 = \sum_{i=8am}^{i<8pm} w_{C_i}\ C_i,\ where\ C_i = hourly\ O_3\ at\ hour\ i,\ and\ w_c = \frac{1}{1+4403e^{-126C}}$$

Quoted from FR Vol. 75, No. 11, January 19, 2010/Proposed Rules p. 2999.

Where did it come from: How is it calculated?

Lefohn, A.S., Runeckles, V.C. 1987. Establishing a standard to protect vegetation-ozone exposure/dose considerations. Atmos. Environ. 21, 561-568.

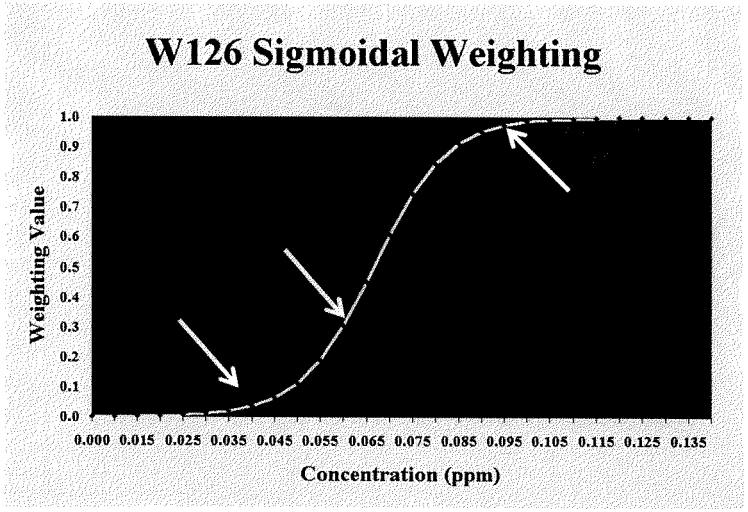


Image source: www.asl-associates.com

Limitations of the proposed standard
Look Rock, GSM NP, TN

Some limitations

1. Greatest weighting given to highest O_3 concentrations
2. Weighting decoupled from known plant physiology
3. Exponent and constant 126; "subjectively determined to develop a weighting function..."*
4. W126 claims integration of uptake, O_3 exposure defense?
5. Developed under a different O_3 climate in California in the 1980's

*Quoted from: How the W216 exposure index was developed; www.asl-associates.com

Some limitations (cont'd)

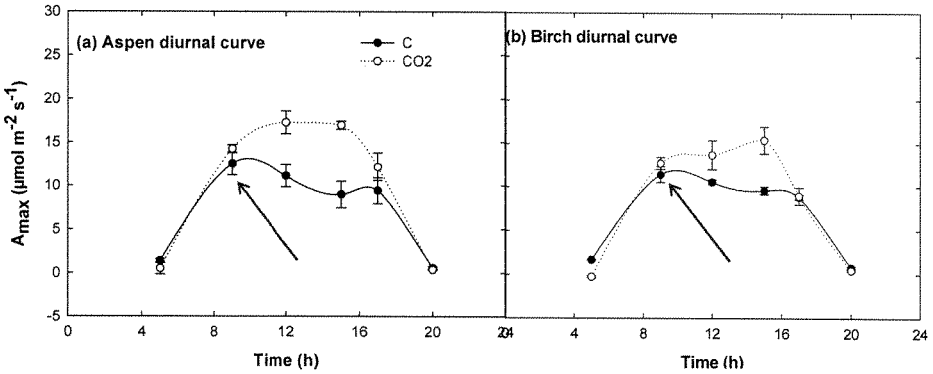
6. Developed largely from OTC experiments
7. Statistical fit forced on biological response
8. Degree of W126 biological association not demonstrated
9. Empirical, controlled, free-air evaluation using 5 years of data with maturing trees shows lack of W126 biological association with two species, 5 genotypes
10. Mathematically too complex: utility in standards?

1. Weighting of highest O_3 concentrations

- Krupa, Nosal, Legge 1998. Environmental Pollution 101, 157-160.
  - "...daily peak (Highest) hourly O_3 values not as important as moderate to higher concentrations in eliciting negative crop biomass responses."
- Krupa et al. 1995. Environmental Pollution 87, 119-126.
  - "...cumulative frequency of occurrences of hourly ozone concentrations 50-87 ppb in the USA ...best predictors of negative crop biomass responses."

2. Lack of synchrony in O_3 exposure and plant uptake

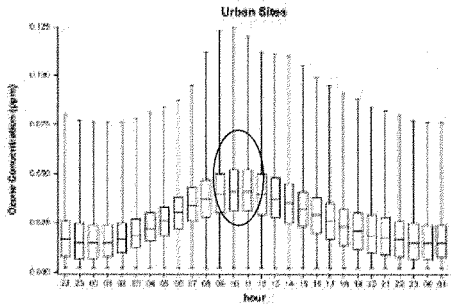
- Grünhage *et al.* 1994. Environmental Pollution 85, 125-129.
  "atmospheric conditions that facilitate the daily occurrences of peak (highest) O_3 concentrations in general do not coincide with the conditions that promote plant uptake."



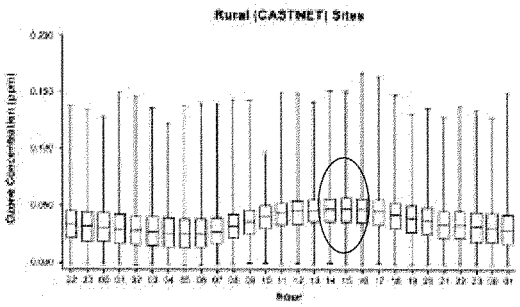
Darbah, Sharkey, Calfapietra, Karnosky 2010. Differential response of aspen and birch trees to heat stress under elevated carbon dioxide. Environmental Pollution (April, 2010)

K. E. Percy
Air Quality Effects Consulting Ltd.

When are diurnal O_3 concentrations highest?



1000-1100h

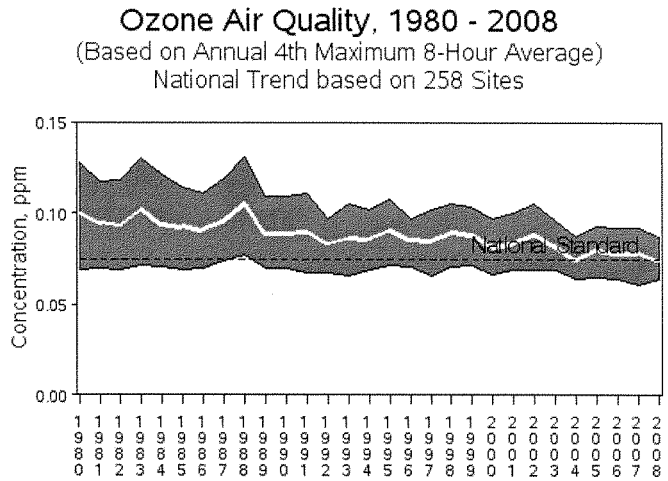


1400-1600h

Message: Highest conductance coincides with lowest O_3 concentrations; decoupling especially prominent at rural locations!

Pinto *et al.* 2007. Characterization of surface ozone concentrations in the United States. Ninth Conference on Atmospheric Chemistry, AMS.87th Annual Meeting, San Antonio.

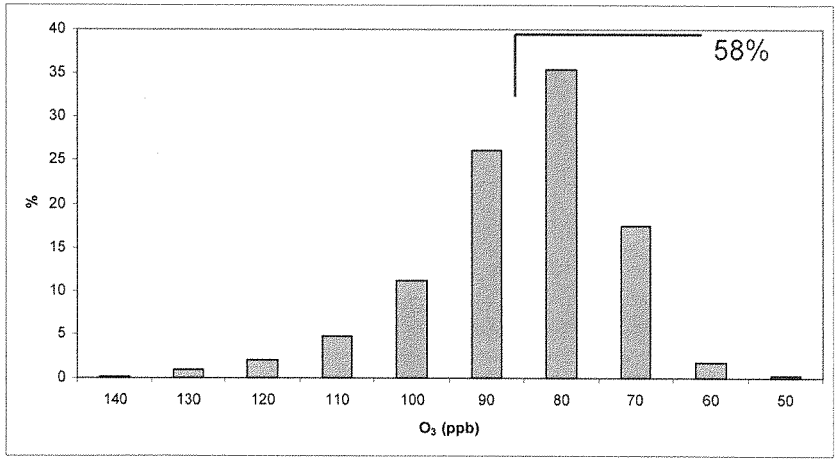
5. Peak concentrations reduced since 1980



1980 to 2008 : 25% decrease in National Average

Data source: http://www.epa.gov/airtrends/ozone.html

1987 versus today: 2008 O_3 reality for the 1st max. 8-hour value at 1,201 stations?



Data source: http://iaspub.epa.gov/airsdata/ADZQS.monovals

6. Applicability to risk assessment?

- Section AX9-5-4-5 Scaling Experimental Data to Field Conditions [natural areas]
  www.epa.gov/sab/casac_ozone_casac-06-003.pdf
  - **"This does not mean to suggest that OTC results are not good science but rather that the extrapolation of the OTC results to 'quantitatively' reflect the response of the vegetation in the ambient environment is questionable"**

  Manning et al. 2004. Environmental Pollution 132, 503-508

  "...we were not able to use the OTC method to assess the impact of ambient ozone on growth of young apple trees in Amherst. Ma."

Applicability to risk assessment?

- Manning, W.J. 2003. Detecting plant effects is necessary to give biological significance to ambient ozone monitoring data and predictive ozone standards. Environmental Pollution 126, 375-379
  - **"Ground proofing…If this is not done, then the standards have no biological significance and are only exercises in air quality assessment."**

7.Biological association not confirmed

- "...the W126 was judged to be the more biologically relevant cumulative, seasonal form..."
  - Yes, but only compared to the SUM06
- No biological associations or evaluation of performance under field (chamber-less) conditions are provided for the W126 in 1997 and 2007 Staff Papers
- Peer-reviewed study available June 2009 demonstrates statistical significance without biological meaning

Alternative metrics
Photo: ozone.ring Aspen FACE

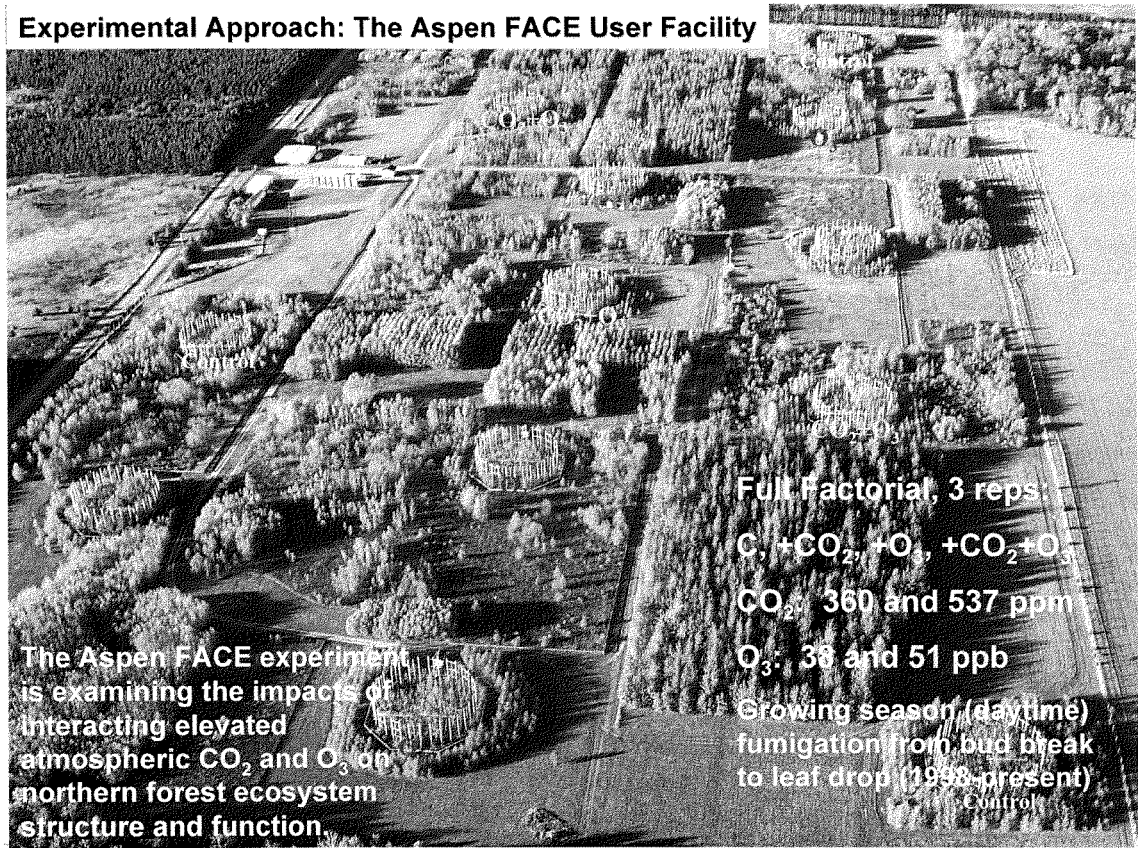
Other O_3 exposure metrics

- 1 hour maximum concentration
- AOT40[1]
- SUM06[2]
- N100[3]
- EPA Primary with modified averaging time and co-factors

Musselman, Lefohn, Massman, Heath 2006. A critical review and analysis of the use of exposure- and flux-based ozone indices for predicting vegetation effects, Atmospheric Environment 40, 1869-1888.

Percy, Karnosky 2007. Air quality in natural areas: interface between the public, science and regulation. Environmental Pollution 149, 256-276.

Experimental Approach: The Aspen FACE User Facility



The Aspen FACE experiment is examining the impacts of interacting elevated atmospheric CO_2 and O_3 on northern forest ecosystem structure and function.

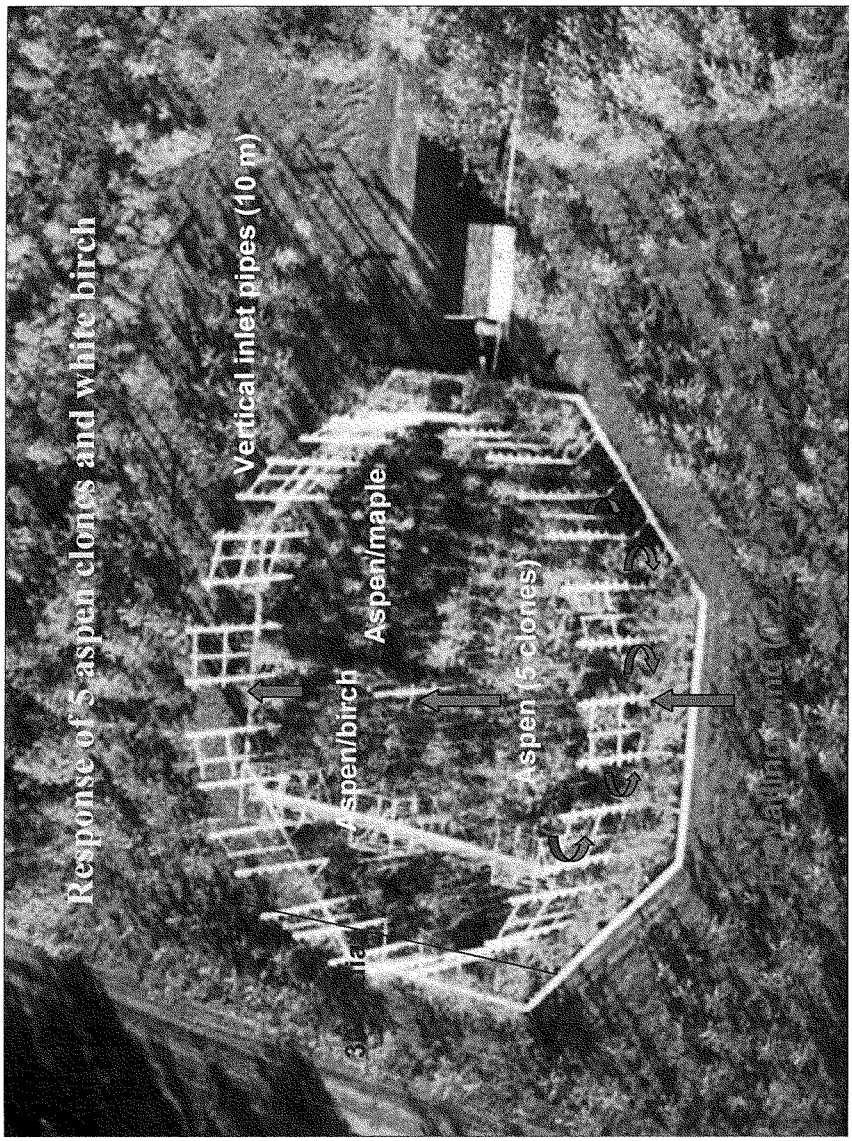
Full Factorial, 3 reps:

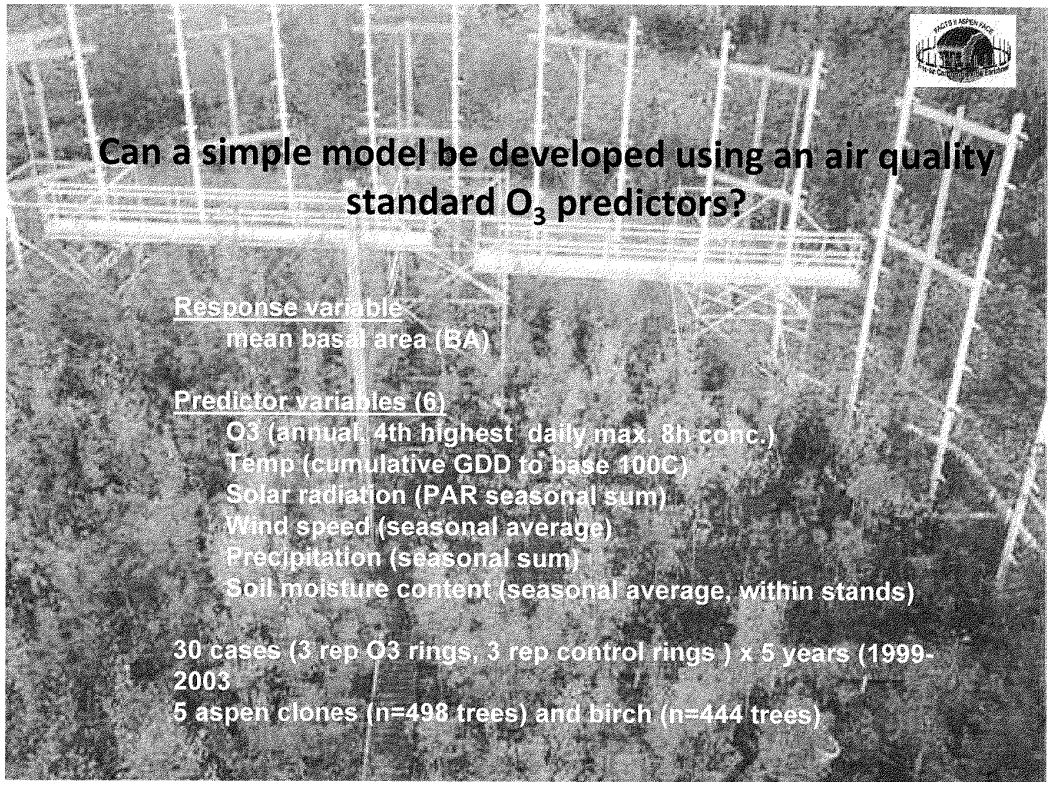
C, $+CO_2$, $+O_3$, $+CO_2+O_3$

CO_2: 360 and 537 ppm

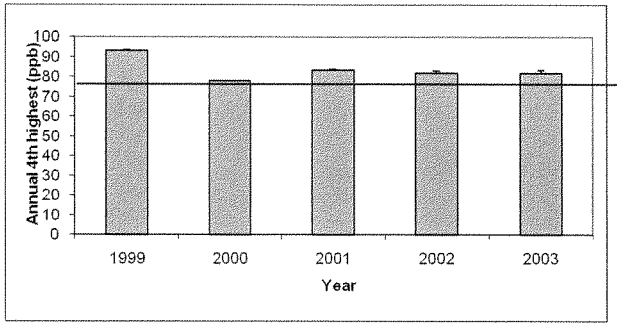
O_3: 38 and 51 ppb

Growing season (daytime) fumigation from bud break to leaf drop (1998-present)

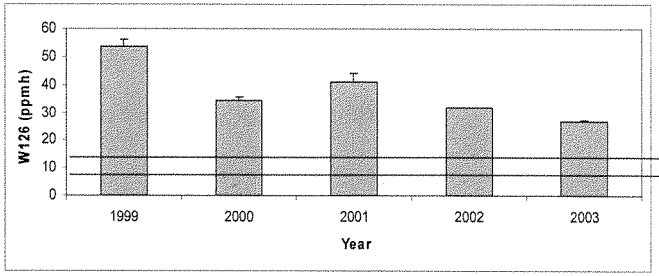

Response of 5 aspen clones and white birch
Vertical inlet pipes (10 m)
Aspen/birch
Aspen/maple
Aspen (5 clones)
1
2
3
4
5


Can a simple model be developed using an air quality standard O_3 predictors?
Response variable
mean basal area (BA)
Predictor variables (6)
O3 (annual, 4th highest daily max. 8h conc.)
Temp (cumulative GDD to base 100C)
Solar radiation (PAR seasonal sum)
Wind speed (seasonal average)
Precipitation (seasonal sum)
Soil moisture content (seasonal average, within stands)
30 cases (3 rep O3 rings, 3 rep control rings) x 5 years (1999-2003
5 aspen clones (n=498 trees) and birch (n=444 trees)

Aspen FACE O_3 exposure 1999-2003



annual Primary



W126

Step 1. Results : Full regression model

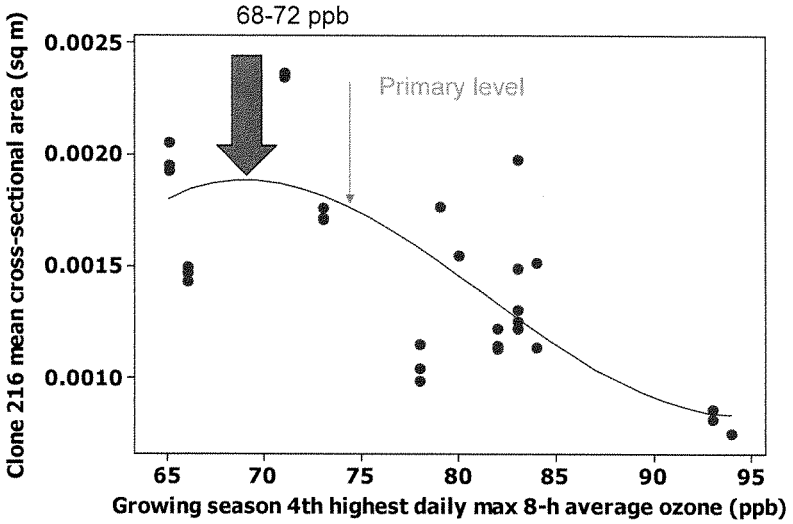
- All predictors including *4th highest daily maximum 8 hour O_3*, wind speed (WS), precipitation, growing degree days (GDD), relative humidity (RH), soil moisture content (SMC) and solar radiation (PAR)

  - Very high degree of goodness of fit
  - Highly significant (p = 0.0000)
  - R-squared Adjusted ranged between 61.5% and 94.6%

Step 2. Refining for greater utility: Results from best subsets regression

- annual 4th highest daily maximum 8 hour ozone concentration (Primary Standard form), WS and GDD.
  - very high degree of goodness of fit
  - Highly significant (p=0.000)
  - R-sq between 68% and 89%.
  - O_3 contribution to growth 6.8% clone 8L, 28.6% clone 271, 47.4% clone 216
  - **Makes biological sense!!!**

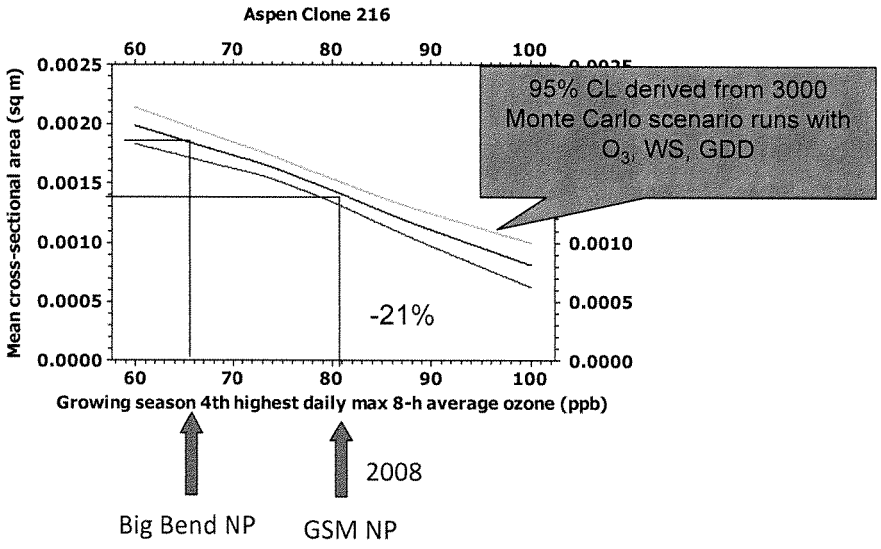
What 8-hour level might be protective?



Percy, Nosal, Heilman, Sober, Dann, Legge, Karnosky. 2007. New exposure-based metric approach for evaluating O_3 risk to North American aspen forests. Environmental Pollution 147, 554-566.

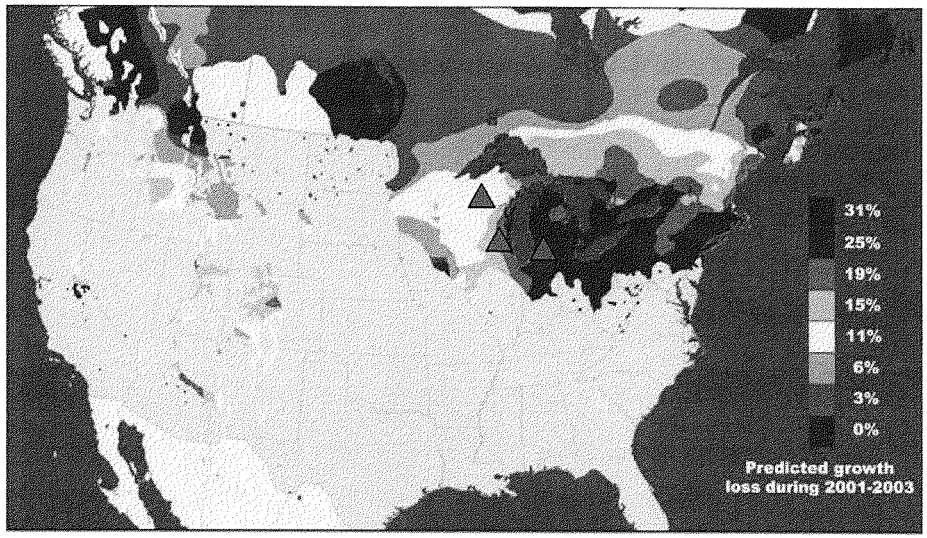
K. E. Percy
Air Quality Effects Consulting Ltd.

Modified primary exposure-response function



$Y = 0.00684 - 0.000031$ 4th highest $O_3 - 0.00551$ WS $+ 0.000003$ GDD

Predicted aspen growth loss during 2001-2003



We have measured response close to predicted using common genetic material from Aspen FACE in 3 growth/biomass trials▲

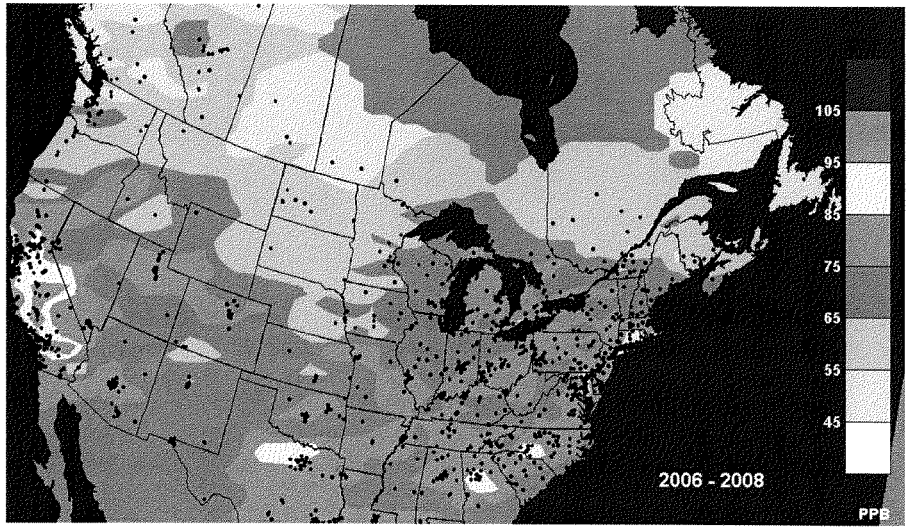
Evaluation of O_3 metrics as single predictors of basal area growth over five years

	Aspen clone			white birch
O_3 index	8L	271	216	
4th highest[a]	0.354(0.078)	0.454(0.021)	0.479(0.017)	0.119(0.112)
SUM06[b]	0.228(0.078)	0.228(0.160)	0.163(0.187)	0.031(0.251)
AOT40[c]	0.375(0.067)	0.213(0.138)	0.190(0.159)	0.000(0.877)
Max1h	0.371(0.069)	0.197(0.152)	0.250(0.109)	0.331(0.015)
W126[d]	0.647(0.006)	0.618(0.003)	0.648(0.002)	0.376(0.009)

Data are R sq. adj. (*P* value)

Percy, Nosal, Heilman, Sober, Dann, Karnosky 2009. Ozone Exposure-Based Growth Response Models for Trembling Aspen and White Birch. pp 263- 287 In A.H. Legge (ED.) Developments in Environmental Science, Volume 9, Elsevier.

Summary



4th highest daily maximum 8-hour O_3 averaged over 3 years (T. Dann)

Chronology of a Proposed Rule

- 1997 Staff Paper
  - "...biological basis for cumulative seasonal form not in dispute"
- 1998 Final Rule
  - set Secondary same as Primary
  - 8-hour, 0.080 ppm O_3 (0.084)
- 2008 Final Rule

  "...not adequate information to establish a separate secondary standard based on other effects of O_3 on public welfare."

  retain Secondary same as Primary

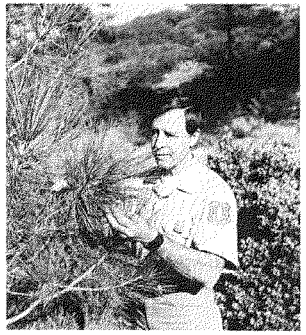
  lower level to 0.075 ppm O_3

Chronology

- April 2008 CASAC letter to Administrator
  - "…sincerely hopes that, in the next round of NAAQS review, the Agency will be able to support and establish a reasonable and scientifically defensible cumulative form for the secondary standard (Henderson, 2008)"
- PR 2010 [FR Vol. 75, No. 11, Tuesday January 19, 2010]
  - "…reconsideration of the 8-hour secondary standard set in the final rule…purpose of determining whether, and, if so, how to revise the form, averaging time and level of the standard…"
  - "…reaffirms conclusions made in the 1997 review…"

We have been at this a long time!

Dr David F. Karnosky



Dr. Paul R. Miller

Karnosky, Skelly, Percy, Chappelka 2007. Perspectives regarding 50 years of research on effects of tropospheric ozone air pollution on U.S. forests. Environmental Pollution 147, 489-506

So what has changed?

- Little funding since 1996 Criteria Document so little new policy-relevant exposure-response science to inform
- Not much has changed since 1997 Final Rule
  - No empirical exposure response evidence demonstrating W126 biological association outside of chambered studies (OTC-NCLAN)
- However,
  - One free-air multi-year study demonstrates that W126:
    - significantly overestimates negative effects
    - does not account for natural toxicological response (hormesis)
    - Does not represent measured O_3 sensitivity differences between species and aspen genotypes

More recently…

- New science funded mainly by DOE resulted from a requirement (influential end-user of O_3 endpoint response data) for "real-world" experiments for risk assessment
- Key peer-reviewed literature on metric performance not cited, or possibly not fully considered
  - Provisional Assessment (EPA/600/R-09/101) September 2009 did not cite June 2009 peer-reviewed chapter with W126 evaluation from Aspen FACE

Question : Should statistical fit, mathematics, or O_3 exposure - plant response inform a decision on the Secondary Standard?

Form	Target value (ppm)	Counties Not Attaining	Proportion (%) of Counties with ≥ 1 monitor
4th highest	75	322	47.7
	70	515	76.3
	65	608	90.1
	60	650	96.3
W126	15	196	29.0
	7	579	85.8

Data source: www.asl-associates.com; maps provided to ASL by EPA

<u>One Option:</u> The annual 4th highest daily maximum 8-h average O_3 concentration has:

- a high degree of statistical significance and goodness of fit
- more biological association with an economically and ecologically relevant biological endpoint (growth)
- significant biological association with two species, 5 genotypes over 5 years under free-air conditions, large inter-annual climate variation, stand dynamics, pest activity

The annual 4th highest daily maximum 8-h average O_3 concentration:

- works with 2 co-predictors (GDD, WS) routinely measured and with mechanistic basis related to O_3 flux
- Includes 95% limits for uncertainty analysis
- requires a change in averaging time (to annual) and addition of two geographically widespread, co-measured with O_3, mechanistically-based variables related to O_3 flux

Thank you
kepercy@shaw.ca
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American Forest & Paper Association

AMERICAN WOOD COUNCIL

March 17, 2015

Environmental Protection Agency
EPA Docket Center (EPA/DC)
Mailcode 68221T
Attention Docket ID No. EPA–HQ–OAR–2008-0699
1200 Pennsylvania Avenue, NW.
Washington, DC 20460

Re: Comments on Proposed National Ambient Air Quality Standards for Ozone, Docket ID No. EPA-HQ-OAR-2008–0699

Dear Sir or Madam:

We are writing to offer the comments of the American Forest & Paper Association (AF&PA) and American Wood Council (AWC) on EPA's proposal to revise the primary National Ambient Air Quality Standards (NAAQS) for ozone, as published on December 17, 2014, 79 Fed. Reg. 75233 (the "proposed ozone NAAQS").

AF&PA serves to advance a sustainable U.S. pulp, paper, packaging, and wood products manufacturing industry through fact-based public policy and marketplace advocacy. AF&PA member companies make products essential for everyday life from renewable and recyclable resources and are committed to continuous improvement through the industry's sustainability initiative - *Better Practices, Better Planet 2020*. The forest products industry accounts for nearly 4 percent of the total U.S. manufacturing GDP, manufactures approximately $210 billion in products annually, and employs nearly 900,000 men and women. The industry meets a payroll of approximately $50 billion annually and is among the top 10 manufacturing sector employers in 47 states.

AF&PA's sustainability initiative - *Better Practices, Better Planet 2020* - is the latest example of our members' proactive commitment to the long-term success of our industry, our communities and our environment. We have long been responsible stewards of our planet's resources. Our member companies have collectively made significant progress in each of the following goals, which comprise one of the most extensive quantifiable sets of sustainability goals for a U.S. manufacturing industry: increasing paper recovery for recycling; improving energy efficiency; reducing greenhouse gas emissions; promoting sustainable forestry practices; improving workplace safety; and reducing water use.

AWC is the voice of North American wood products manufacturing, representing over 75 percent of an industry that provides approximately 400,000 men and women

with family-wage jobs. AWC members make products that are essential to everyday life from a renewable resource that absorbs and sequesters carbon. Staff experts develop state-of-the-art engineering data, technology, and standards for wood products to assure their safe and efficient design, as well as provide information on wood design, green building, and environmental regulations. AWC also advocates for balanced government policies that affect wood products.

AF&PA's and AWC's members operate facilities whose emissions are subject to regulation under the Clean Air Act ("CAA"); in fact, CAA compliance often represents a significant portion of operating costs at those facilities. In addition, AF&PA and AWC members' facilities use large amounts of purchased electricity (although they also generate much of their own electricity), and so their costs are indirectly affected by CAA regulations that impose costs on electric power companies. And since transportation costs for raw materials like wood chips and chemicals and delivery costs for products like paper and wood products are a significant portion of AF&PA and AWC's members' raw material costs and of the final cost to purchasers of their products, CAA regulations that increase transportation costs or interfere with highway construction can have an important impact on AF&PA and AWC members as well.

I. Overview

AF&PA and AWC support clean air and realistic, science-based air quality standards. However, the health effect evidence for ozone has not changed significantly since EPA tightened the ozone NAAQS in 2008, so a further change is not justified. EPA continues to rely on a limited subset of studies that reinforce their conclusions while ignoring or giving little weight to peer-reviewed scientific studies that support a position that current standards are adequately protective. . Specifically, there is a lack of definitive evidence linking low levels of ozone exposure – those below the current standard - to adverse health impacts. The evidence on which the proposal relies today is no stronger than it was the last time the standard was reviewed in 2008.[1] Furthermore, the new conclusions are not consistent with the majority of the science on the subject.[1,2] EPA's analyses show that few (if any) people would be adversely affected by ozone at the current standard.[3]

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[1] Gradient (Cambridge, MA) "Long-Term Ozone Exposure and Mortality." Report to Utility Air Regulatory Group. (April 2013); Gradient (Cambridge, MA) "Short-term Ozone Exposure and Mortality." Report to American Forest and Paper Association (December 20, 2013); Gradient (Cambridge, MA) "Long-Term Ozone Exposure and Respiratory Morbidity." Report to American Forest and Paper Association (December 20, 2013).

[2] Honeycutt, Dr. Michael, "Will EPA's Proposed New Ozone Standards Provide Measurable Health Benefits?", National Outlook, Texas Commission on Environmental Quality (TCEQ) PD-020/14/07 (October 2014)

[3] US EPA. August 2014. "Health Risk and Exposure Assessment for Ozone (Final Report)." EPA-452/R-14-004a-e.

Second, a more stringent NAAQS is not needed to push further improvements in ozone levels. Ambient ozone concentrations in the United States already have dropped substantially over the past 40 years, while the population and economy have grown. Ambient ozone will continue to decrease, as a result of the continued implementation of the 1997 ozone NAAQS, implementation of the 2008 ozone NAAQS (which has barely begun), and numerous other regulatory programs already in place or in progress, such as Boiler Maximum Achievable Control Technology (MACT). Nitrogen oxide (NOx) and volatile organic compound (VOC) emissions from pulp, paper and wood product mills continue to decline. In fact, NOx emissions are down by over 25% from 2000 to 2012 at pulp and paper mills.

Third, states should proceed with implementing the 2008 ozone standard first before the ozone NAAQS is tightened again. Resources should be directed to designating areas as non-attainment with the 2008 standard and identifying necessary controls of mobile and stationary sources through State Implementation Plans (SIPs). With the March 6, 2015 publication of the Implementation Rule for the 2008 ozone NAAQS, states now have the guidance they need to develop SIPs. States, EPA and regulated entities should focus on those designation and implementation efforts.

Fourth, the proposal fails to take into account the impact of background concentrations of ozone on the attainability of the standard, which is required under the Clean Air Act. U.S. ozone levels are increasingly attributable to natural sources and pollution from other countries which must be considered when setting the ozone limits. Some ozone is generated naturally from plants, fires, and migration from the stratosphere to the troposphere. The proportion of ozone coming from other countries as far away as China is steadily increasing and becoming part of the "background." In some places, background concentrations (ozone that originates from natural sources or transported international emissions) contribute to over 80% of total ozone.[4] Even the Clean Air Science Advisotry Committee noted the lack of clarity regarding how ozone standards are impacted by background concentrations.[5]

Fifth, EPA has not reliably predicted how many areas of the country would be determined to be in nonattainment with the proposed ozone NAAQS by 2018 when designations are due and therefore what economic burden adopting the proposed standard would impose on the nation. Projections of non-attainment areas by EPA in 2025 are very optimistic (for example, taking credit for the proposed Clean Power Plan/section 111(d) standards for utilities even though they are likely to change at promulgation and are legally vulnerable) and irrelevant to the states' tasks of

[4] US EPA. August 2014. "Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards." EPA-452/R-14-006

developing SIPs in the next couple of years. In addition, EPA does not know how the standard could ever be attained in many areas, such as California, using known emission controls, and thus the economic impacts EPA does predict are hopeful projections rather than reliable estimates. Even with these optimistic projections , the projected costs would make the proposed ozone NAAQS one of the most expensive regulations in Clean Air Act history.

Sixth, depending on the standard chosen and the implementation policies that are selected, the forest products industry could see costs as high as $3 billion under a tighter ozone NAAQS. A lower NAAQS will result in many more nonattainment areas putting at least five times more mills in or near these "no growth" zones. Mills seeking air quality permits to construct new projects at existing plants will be forced to consider pollution controls and find emissions offsets that may be technically infeasible or cost-prohibitive. Thus, investments that could create new jobs or maintain competitiveness are likely to be eliminated or scaled back by the tougher, proposed NAAQS.

Simply put, EPA has not yet assembled the information necessary to conclude that the proposed ozone NAAQS is required in order to protect human health or that the margin of safety EPA has applied is appropriate. EPA should evaluate the results from implementation of the existing 2008 NAAQS and other regulations before revising the ozone NAAQS yet again.

II. Revision of the Primary NAAQS Is Not Warranted

A. Background

Under CAA section 109(b)(1), EPA is to set primary National Ambient Air Quality Standards (NAAQS) at a level "requisite to protect the public health" with "an adequate margin of safety." Courts have held this to mean that the primary NAAQS must be sufficient to protect public health but not more stringent than necessary to protect public health. See *Whitman v. Am. Trucking Ass'ns*, 531 U.S. 457, 473 (2001). In other NAAQS rulemakings, EPA has indicated that it is appropriate to weigh a number of different considerations in deciding what level of a pollutant is "requisite" to protect public health and what constitutes an "adequate" margin of safety. These factors include, for example, the strength of the scientific evidence being considered, the severity of the health effects attributed to a particular concentration, the kind and degree of uncertainties involved, and the size and nature of the sensitive populations at risk.

EPA is proposing to reduce the primary ozone NAAQS based primarily on clinical studies showing respiratory effects at 0.060 to 0.080 ppm, and epidemiology studies suggesting that there may be effects of exposure to ozone concentrations below 0.075 ppm. The clinical studies, however, did not demonstrate a clear adverse health effect from exposure to ozone concentrations below 0.075 ppm, even in the extreme conditions of the clinical tests. Rather, they showed diminished lung function, according to some measures, in some individuals. The significance of those effects is unclear, however. Such uncertain observations are not a suitable basis on which to justify a conclusion that EPA needs to revise the current ozone NAAQS in order to provide adequate protection of public health, especially when viewed in the context of the achievability and societal costs of lowering the primary standard.

Also, in considering studies that subjected individuals to prolonged exposure to ozone, i.e., six-plus hours of exposure that in many cases included intermittent exercise, EPA needs to weigh the results against the probability of that kind of exposure in the real world. In other words, EPA needs to consider that it is unlikely that sensitive individuals will be exerting themselves for a prolonged period at a time and location where maximum ozone concentrations occur.

The epidemiological studies EPA suggests justify reducing the primary ozone NAAQS necessarily are a very imprecise way of assessing the level of ozone requisite for the protection of public health. It is very difficult, and in many cases impossible, to separate the observed effects of ozone and effects caused by other pollutants (or by a combination of ozone and other pollutants). Certainly the epidemiological studies EPA references as supporting a revised primary ozone NAAQS do not constitute the kind of clear evidence that would be needed to justify changing the judgments reflected in the 2008 rulemaking. If EPA wants to use empirical observations for large groups to reevaluate the appropriate level for the primary NAAQS, AF&PA and AWC suggest that a much better approach would be for EPA to study the effect that ongoing and future reductions in ambient ozone levels, as well as ambient levels of other pollutants, resulting from current NAAQS and from various other major air regulations that are coming into effect, will have on respiratory health.

B. Review of Controlled Exposure Studies

The proposal concluded that two new controlled exposure studies, by Kim *et al.* (2011) and Schelegle *et al.* (2009), support lowering the ozone standard. Kim *et al.* (2011) observed statistically significant lung function decrements and airway inflammation at 0.06 ppm. However, the mean decrements they reported across the

study population were so small (1.71% and 1.19% for FEV_1 and FVC, respectively) that they most likely indicate normal variability and are not clinically significant. Also, the severity of symptoms after ozone exposure was similar to the severity of symptoms after filtered air exposures, indicating that ozone did not cause noticeable effects (reviewed by Goodman *et al.*, 2014). These clinically insignificant data do not provide a basis for lowering the standard.

In the second study, Schelegle *et al.* (2009) reported lung function decrements and respiratory symptoms at 0.072 ppm, but lung function was restored to baseline conditions between one and four hours after exposure ended. Because ozone has an acrid odor, the participants most likely knew when they were being exposed to ozone *vs.* filtered air, and therefore may have been more likely to report symptoms after ozone exposure.

Despite this, an independent analysis found no correlation between symptoms and the magnitude of lung function decrements in these individuals. Also, Schelegle *et al.* (2009) focused on decrements greater than 10%, and while US EPA considers a 10% cutoff reasonable for moderate lung function decrements, in healthy populations a 10% decrement, and possibly even a 15% decrement, would not be noticeable (Bieke, 2007). Moreover, studies have shown that acute lung function decrements even after higher ozone exposures (~0.2 ppm) are not predictive of, or causally associated with, ozone-induced inflammation or subsequent lung injury (*e.g.*, Blomberg *et al.*, 1999).

It is also notable that in the Schelegle *et al.* (2009) study, the time period between the 0.072 ppm exposure and the control exposure was 55 days on average (ranging from 13 to 302 days). Co-exposures, seasonal changes in lung function, and the physical conditioning of subjects could have changed over this time, making it difficult to interpret results (OSHA, 2013; Pellegrino *et al.*, 2005). In addition, Schelegle *et al.* (2009) used a triangular exposure profile, where exposure is increased step-wise and then decreased step-wise to achieve a target average exposure concentration. While a triangular exposure profile is more reflective of ambient ozone fluctuations compared to a constant exposure pattern, the specific patterns chosen by Schelegle *et al.* (2009) do not reflect diurnal patterns in most cities (Lefohn and Hazucha, 2005). Taken together, all of these issues with the Schelegle *et al.* (2009) study indicate that it does not provide a basis for lowering the standard.

The proposal suggests that susceptible populations, such as asthmatics, would be more responsive to acute ozone exposure than healthy adults, but there is no evidence to support this (*e.g.*, Kehrl *et al.*, 1985; Linn *et al.*, 1983; Mudway *et al.*,

2001, as cited US EPA, 2013). Moreover, the exercise level maintained in these and other controlled ozone exposure studies is likely more strenuous and of a longer duration (*i.e.*, up to 6.6 hours) than most of the general US population experience, with the exception of some outdoor workers. These scenarios are especially unrealistic for the most sensitive populations, whose conditions would likely prevent them from performing exercise at the duration and ventilation rate required to produce these small decrements in lung function.

Finally, results of these and other controlled exposure studies cannot be directly extrapolated to the US population. These studies only evaluated a small number of people (fewer than 60), and only three to six subjects were ozone responders (*i.e.*, had an FEV_1 decrement over 10%) at each exposure level below the standard in each study. These studies involved people performing quasi-continuous exercise for an extended period of time at an intensity not likely achievable by sensitive individuals, such as asthmatics, and under exposure profiles that likely represent worst-case scenarios. It is not appropriate to base a standard to protect over 300 million people on reported effects in a few individuals under controlled experimental conditions.

The ultimate goal of the NAAQS is to protect the health of the general population, including sensitive groups, and not necessarily people who are able to perform quasi-continuous strenuous exercise for six hours or more while constantly exposed to outdoor ozone levels. It is unclear how chamber studies relate to more typical exposure conditions, even for sensitive individuals. EPA should conclude that these durations of exposure and near-continuous exercise levels limit the extrapolation of these results to the averaging time and numerical levels of the NAAQS. In addition, because compliance with the NAAQS is conservatively based on the single highest monitor in each urban area, the current 0.075 ppm standard provides population protection from daily ambient exposures well below 0.075 ppm and even down to 0.060 ppm (US EPA, 2014). Taken together, the new evidence indicates that the current standard is protective and should be retained, and that alternative proposed standards will not provide additional public health protection.

C. Review of Respiratory Studies

In 2006, EPA concluded that evidence for respiratory mortality from long-term ozone exposure was "suggestive" of causation, but in the proposed rule, the EPA Administrator concluded that the association with respiratory mortality was likely to be causal, whereas the evidence for all-cause and cardiovascular mortality were deemed to be suggestive of causation (US EPA, 2006, 2013). However, the evidence for respiratory mortality is limited, not consistent across studies, and not

consistent with the evidence for total mortality. Consequently, these data do not support lowering the primary NAAQS below the current standard of 75 ppb.

Studies of long-term exposures and respiratory mortality are far too limited to make a causal determination . Compared to studies of short-term ozone exposures and mortality, there are few studies that have evaluated mortality associated with long-term ozone exposures. Most studies that assessed cause-specific mortality have focused on cardiopulmonary mortality; we are only aware of three that have evaluated respiratory mortality on its own: Abbey *et al.* (1999), Jerrett *et al.*, and Lipsett *et al (2011)*. Only the studies by Abbey *et al.* and Jerrett *et al.* were referenced in the ISA, and EPA appeared to base its likely causal conclusion for respiratory mortality only on the inconsistent results in Jerrett *et al (2009)*.

Jerrett *et al.* (2009) evaluated total, respiratory, and cardiovascular mortality risks associated with long-term ozone exposure in single- and two-pollutant models (with $PM_{2.5}$) in the American Cancer Society cohort. Jerrett *et al.* (2009) reported small increases in mortality, particularly respiratory mortality, but the results were inconsistent across the mortality endpoints evaluated. For example, Jerrett *et al.* did not observe an association between ozone exposure and all-cause mortality or other cause-specific mortality outcomes. Notably, in their two-pollutant models that controlled for $PM_{2.5}$, Jerrett *et al.* found statistically significant *decreased* risks between long-term ozone exposure and all-cause and cardiovascular-related mortality. These findings raise questions regarding the respiratory mortality findings on which EPA relied in the proposed rule to calculate long-term risks.

In addition, this study has several shortcomings in its design and implementation. For example, it did not fully consider meteorological factors, such as temperature, or lifestyle factors, such as smoking, that may be independently linked to mortality risk. There are also significant uncertainties associated with the use of a single ozone value, averaged over both space and time, to represent ozone exposures for the entire population within each metropolitan area.

EPA acknowledged that environmental temperature and region of the country were significant modifiers of the reported ozone associations with respiratory mortality. Jerrett *et al.* (2009) reported a lack of statistically significant associations between ozone and mortality in the Northeast and Industrial Midwest, which had the most respiratory deaths, and in Southern California, which had the highest ozone concentrations. This lack of correlation suggests that something other than ozone is affecting mortality risks and further highlights a lack of clear support for ozone-induced respiratory mortality.

The findings by Jerrett *et al.* were not supported by the other two epidemiology studies that specifically evaluated respiratory mortality and long-term ozone exposures. Abbey *et al.* conducted a study of mortality in the Seventh-day Adventists cohort in California. The authors reported results for non-malignant respiratory, cardiopulmonary, and all-cause mortality that were not statistically significantly increased with long-term ozone exposures. Lipsett *et al.* (2011) investigated the association between ozone and mortality, including respiratory mortality, in a cohort of female teachers in California. For respiratory mortality, the authors also reported results that were not statistically significant.

Overall, EPA's conclusions in the proposed rule regarding long-term ozone exposure and respiratory mortality are not supported by the limited available evidence or the lack of association with total mortality. Thus, respiratory mortality risks from long-term ozone exposure do not support lowering the standard below 75 ppb.

III. Revision of the Secondary NAAQS at this Time Is Not Warranted.

Under CAA section 109(b)(2), EPA is to set secondary NAAQS at a level "requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of such air pollutant in the ambient air." Inherent in this charge is the requirement that EPA not set the secondary NAAQS at a level more stringent than "requisite." Clearly this directive must not be read literally to require EPA to set the secondary standard at a level where the pollutant would cause no adverse effect, no matter how small. In context, then, EPA must make a value judgment which necessarily involves balancing (even if not explicitly) the adverse effects predicted against the economic and technical feasibility of attaining a particular ambient concentration, i.e. the social impact of setting the secondary NAAQS at that level. EPA itself has said, in setting other NAAQS, that it can and should consider, among other things, the nature and severity of the risk involved and the strength of the data. These and similar considerations weigh against the proposed secondary NAAQS.

We support EPA's decision to not propose a distinct secondary standard in a "cumulative" form, but instead is proposing to retain the current form, which is identical to the form of the primary standard. Our analysis concludes that the cumulative W126 form of the standard evaluated in theEPA support documents, is redundant with the current primary form. We disagree with EPA that the analysis presented in the EPA support documents supports lowering the secondary standard. In fact, our analysis concludes that the current standard level is adequately protective and just meeting the current standard level will result in substantial reductions in ozone exposure and associated welfare risks. The forestry and potential biomass loss from ozone exposure have not been demonstrated below the

current concentrations so the current standard is adequately protective of trees and our fiber supply. Comments filed to the docket by the National Council for Air and Stream Improvement (NCASI) on March 4, 2015 and Gradient on March 16, 2015 provide more support for not changing the secondary standard and are hereby incorporated within our comments by reference.

IV. Grandfather Existing Permits Until Designations Are Complete

The proposed grandfathering provisions do not go nearly far enough in mitigating implementation challenges. They will provide relief to only a relatively small subset of Prevention of Significant Deterioriation (PSD) permit applicants as the majority of PSD permit applications are under development for a year or more before receiving a completeness determination or publication of draft permit. Moreover, some permit applicants who are sent back to the drawing board will be unable to establish that their facilities will not cause or contribute to a violation of the new NAAQS due to a lack of implementation tools for single source ozone impacts. Sources seeking to expand or locate even in projected nonattainment areas currently designated attainment will have to proceed under the PSD program, and will be required to demonstrate that project emissions do not cause or contribute to an exceedance of the standard. One significant problem is the ability of current EPA photochemical modeling tools to be used for site-specific impact analyses; we are concerned that the modeling tools a source would use for the "cause or contribute" analysis are likely unvalidated for use by individual sources, thus potentially inaccurate, and very time-consuming. For permit applicants in this situation, the proposed rule offers the promise, in the interim prior to the revised attainment designation, of using emissions offsets "to mitigate [the source's] adverse impact on the NAAQS and ultimately meet the PSD demonstration requirement" (*id.* at 75379). These offsets would have to be shown by the applicant "to compensate for the source's adverse impact at the location of violation" (*id.* at 75380). However, there are several concerns with the offset approach. First, using offsets to demonstrate an insignificant impact could require multiple modeling runs, which as discussed previously will be very difficult. Second, EPA has not clarified how these offsets can be generated—are they like NSR offsets that can be generated by nearby or upwind sources, or must they be internally generated? And if offsets are hard to obtain, then projects may not be able to proceed.

An offset program of this nature could theoretically be helpful if some of the modeling issues are addressed and if EPA has a very flexible offset program. The parameters of the program, however, appear not to have been adequately thought out. Where will the offsets come from? States implementing an NSR program commonly

operate offset banks, but in areas currently attaining the ozone NAAQS where most forest product mills are located, such banks are unlikely to exist and they take time and resources to establish. This problem would be exacerbated by a more stringent ozone NAAQS, which would likely result in more areas without any significant sources of ozone precursors being designated as nonattainment. Such areas, however, are exactly those places that could benefit most from economic development.

Given that all new and modified sources subject to either the PSD or NSR program must already address the current ozone NAAQS and use emissions controls that satisfy either the BACT or the even more stringent LAER requirement, a more workable solution would be to grandfather all PSD permit applications until final designations are made and approved for the new NAAQS.[5]

V. Economic and Other Consequences of Revising the NAAQS

A. Overview

EPA's assessment of the projected economic impact of imposing the proposed ozone NAAQS is woefully inadequate and basically assumes away a large portion of the tremendous costs to the American public of meeting the proposed standard (see section of Chamber-NAM coalition comments filed March 17on EPA's Regulatory Impact Analysis (RIA)).

In areas where EPA concluded that existing data show that the area would be designated nonattainment and additional reductions in ambient ozone would be required, EPA was unable in many cases to identify any pollution control measures that could be implemented to meet the proposed ozone NAAQS. In those cases, EPA simply speculated that unspecified emission reductions would somehow be identified to bring the area into attainment. But the very magnitude of the gap between engineering controls that EPA could postulate and the emission reductions necessary to attain the proposed ozone NAAQS gives an indication of how severe the economic impact would be beyond what EPA states.

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[5] As discussed above, EPA has adequately supported its decision to retain the current form of the secondary NAAQS, although EPA has not made an adequate case for lowering the level of the secondary standard. If EPA should, however, adopt a distinct secondary NAAQS (*e.g.*, one using a W126 indicator), the Associations support the reliance on the new source permitting program that has been developed for the primary NAAQS as a surrogate for a separate permitting program for the secondary NAAQS. See 79 Fed. Reg. at 75380.

B. Preliminary Projected Impacts of Proposed Ozone NAAQS on Forest Products Industry

Depending on the standard chosen and the implementation policies that are selected, the forest products industry could see costs as high as $3 billion. If a lower ozone NAAQS results in many more nonattainment areas than currently exist, businesses seeking air quality permits to construct new projects, modify or renew permits for existing plants will be forced to look at pollution controls that may be technically infeasible or cost prohibitive. Thus, investments that could create new jobs or maintain competitiveness are likely to be eliminated by the tougher proposed NAAQS. The costs of these lost opportunities are difficult to quantify but would be substantial.

AF&PA and AWC conducted a cost analysis to estimate the impacts of lowering the ozone NAAQS on the forest products industry based on possible control measures for ozone precursors (VOC and NO_x) for various types of emission units. Note that our analysis does not address any site-specific factors that might make installation of controls infeasible and assumes typical performance levels, which will also vary by site and application. The analysis considers both local and regional impacts and encompasses 186[6] pulp and paper mills and 206[7] wood products mills. Based on mill coordinates obtained from EPA databases, facilities located in or near projected ozone nonattainment counties (based on the levels of the standard that EPA is considering and recent available monitoring data) were identified. If we estimate costs based on 2009-2011 design values, there is a higher number of facilities that are in or near ozone nonattainment counties than if we use the 2011-2013 design values, which tend to be lower. Of course, the data will be different for the years that each state actually uses to designate nonattainment areas and will be influenced by factors such as weather and emission levels. Then, after a review of EPA's methodology in the RIA for the proposed revisions to the ozone NAAQS, we constructed an alternate approach for evaluating the impacts of a standard at a level of 65 ppb.

Both the implementation strategy EPA establishes and the level of the standard will impact the cost to the forest products industry. If the impacts are primarily on facilities located in or near non-attainment areas, the capital costs could be $100

[6] The mills that received the 2011 EPA pulp and paper Information Collection Request (ICR) in support of the Risk and Technology Review (RTR) of the pulp and paper NESHAP and NSPS.
[7] Identified using a 2008 EPA list of major source wood products facilities. Facilities known to no longer be in operation were not considered.

million to over $1 billion and the annual costs could be $20 to 300 million, depending on the level of the standard selected. If the impacts are more far reaching and involve reduction in transport of NO_x emissions on a regional basis from large industrial sources as we would expect given that EPA fails to find enough emission reductions in its own Regulatory Impact Analysis, the costs to the forest products industry alone could be $3 billion in capital and almost $1 billion in annual costs.

AF&PA and AWC initially developed a tiered approach to estimating impacts to forest products industry sources for 3 levels of a revised ozone standard (70, 65, and 60 ppb). The tiers in our analysis are meant to simulate the various mechanisms by which sources could have to implement measures to reduce their impact on local and regional ambient ozone concentrations. We also developed an impacts estimate assuming a more regional approach to applying controls, similar to the approach EPA used in the RIA, where it assumed emissions reductions would occur across a large portion of the country to achieve a lower ozone standard. The following paragraphs describe the analysis.

Tier 1 of our analysis focuses on sources projected to be in ozone nonattainment counties at the various levels of the standard (based on the latest available monitoring data) and applies various control measures for NO_x and VOC. Because the factors contributing to monitored ozone vary greatly by area, we made no assumptions as to what areas might have lower monitored impacts and come back into attainment over the next 5 years. Tier 2 focuses on sources within 15 km of projected nonattainment counties and applies various control measures for NO_x and VOC (e.g., where the nonattainment area would be expanded beyond the monitored county using an MSA-type approach or by focusing on large sources adjacent to the county).

We then developed a regional analysis similar to that described in the RIA for a level of the standard at 65 ppb or below. Figure 4-6 in the RIA shows the counties where EPA applied known NOx controls to sources emitting 25 tpy or more. However, EPA also indicates that in the East, they also need "unknown controls" to be able to attain a standard of 65 ppb or below and we believe there will be additional states that will require NOx controls as RACT in order to address transport concerns and/or as part of an attainment strategy for the year 2020. Therefore, our analysis applies controls in the states shown on Figure 4-6 as well as the Southeastern states of NC, SC, GA, and AL.

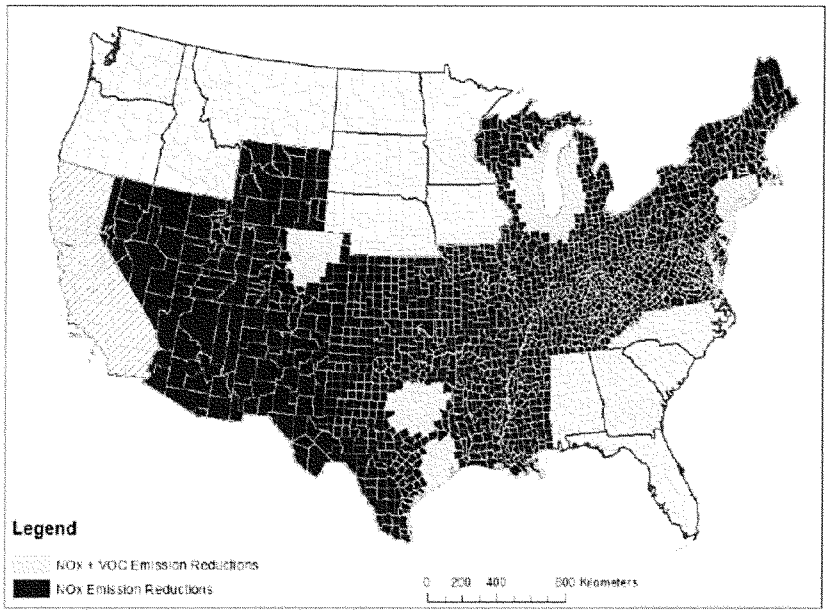

Figure 4-6. Counties Where Emissions Reductions Were Applied to Demonstrate Attainment with 65 and 60 ppb Ozone Standards in the 2025 Analyses

Table 1. The number of forest products facilities in and near projected non-attainment areas for each of the 3 levels of the standard being considered (70, 65, and 60 ppb).

Tier (Based on 2011-2013 design values)	Number of Pulp and Paper Mills (out of 186)	Number of Wood Products Mills (out of 206)
Ozone NAAQS at 70 ppb		
Tier 1 - Mills in nonattainment counties	35	4
Tier 2 – Additional mills within 15 km of nonattainment counties	19	8
Total Tier 1 and 2 mills	54	12

Tier (Based on 2011-2013 design values)	Number of Pulp and Paper Mills (out of 186)	Number of Wood Products Mills (out of 206)
Ozone NAAQS at 65 ppb		
Tier 1 - Mills in nonattainment counties	52	7
Tier 2 - Additional mills within 15 km of nonattainment counties	26	22
Total Tier 1 and 2 mills	78	29
Ozone NAAQS at 60 ppb		
Tier 1 - Mills in nonattainment counties	61	19
Tier 2 - Additional mills within 15 km of nonattainment counties	41	32
Total Tier 1 and 2 mills	102	51
Regional Analysis for an Ozone NAAQS at 65 ppb		
Mills Required to Implement Additional Controls	119	71

The sources and control strategies we identified for our tiered analysis were based on projects considered in the past by mills (e.g., as part of expansion projects, BACT analyses, or BART analyses) and review of various EPA documents that discussed candidate control measures. However, the analysis did not determine whether a control was technically or economically feasible for any specific site. The following measures for NO_x and VOC were considered in the analysis:

- NO_x controls on industrial boilers that do not already have them (based on EPA's Boiler MACT database)
  - Over-fired air for solid fuel boilers at 70 ppb
  - Oxygen trim and staged combustion air for gas and liquid boilers at 70 ppb
  - SNCR for solid fuel boilers at 65 ppb
  - Low NO_x Burners and Flue Gas Recirculation for gas and liquid boilers at 65 ppb
- Combustion controls like quaternary air to reduce NOx emissions from recovery furnaces at pulp and paper mills
- SNCR for NO_x control on energy systems at wood products plants

- Installation of an RCO at a mill to reduce VOC emissions so a project avoids NNSR

For the tiered analysis, we did not include costs for lowering NOx emissions from lime kilns because lime kilns are not typically large NO_x emitters, this technology is not likely as RACT, and many facilities have recently installed new natural gas burners in their kilns that are low-NO_x burners. We did not consider installation of retrofit catalysts on engines in our analysis because most engines at forest products facilities only operate on an emergency basis, are not large emitters of NO_x, and any existing engines would not likely be covered under RACT requirements. We also did not cost pollution prevention type activities such as reformulation of coatings. Although the cost of permitting would also increase for facilities located in new nonattainment areas, we did not include those costs in this analysis because the cost of permitting is typically much less than the cost of additional controls(even though offset costs for projects that trigger NNSR could be significant).

For the regional analysis constructed similar to EPA's, we assumed pulp and paper mill boilers would install SCR and wood products facility boilers would install SNCR. Assumptions about the feasibility and performance of NOx emission reduction from SCR and SNCR are very speculative especially for multi-fuel boilers where these controls have not been consistently demonstrated across the range of operating conditions, designs, and processes. Based on the discussion of known controls in the RIA, we also assumed some mills would install LNB on lime kilns, implement NOx reductions on recovery furnaces, install SCR on standalone NCG incinerators, install SNCR on wood products mill energy systems, and install controls to avoid NNSR. The largest impact in the regional analysis is the widespread application of SCR to pulp and paper mill boilers.

Based on the input of AF&PA and AWC member companies and a review of several published EPA and industry documents, we developed median capital and operating cost estimates for each control strategy. Capital and operating cost estimates are not intended to represent a worst case analysis. Rather, they represent median costs for the various scenarios based on published reports, industry information on specific project costs, EPA reports or control device fact sheets, actual BACT or BART analyses submitted to permitting agencies, or recent contacts with control device vendors. Annualized costs are estimated based on EPA's standard capital recovery factor and our estimated annual operating costs.

For each control strategy, we examined the probability of that strategy being implemented and we estimated the percentage of facilities in the tier that would apply the control strategy. (Of course any control strategy would have to be evaluated on

a case-specific basis.) Lowering the probability for a particular strategy lowers the estimated cost, as the total cost is calculated as follows:

Total Cost = Probability * cost per emission unit * number of units per facility * number of facilities

We estimated low probabilities for strategies that would not widely apply across the industry, that would not likely be chosen as RACT by a state, or that might not be technically feasible or pose safety issues. For example, we assigned a 10% probability that a facility might install an oxidizer to control VOC emissions and avoid non-attainment new source review because many facilities are already well controlled under MACT. We estimated low percentages of facilities that would apply a control option in cases where there may be technical feasibility issues or where we thought baseline emissions were already well controlled. For example, we estimated a low number of facilities could apply NO_x controls on recovery furnaces due to technical feasibility factors. In addition, the analysis did not distinguish the severity of the nonattainment designation. Even greater emissions reductions would be needed for mills in or near moderate, serious or severe nonattainment designations. Therefore, the cost projections are likely to be conservative.

Table 2 summarizes the cost estimates for the forest products industry for each proposed level of the standard. The cost estimate for a 60 ppb standard is dramatically higher than the other levels due to both the high number of facilities that would be in nonattainment areas and due to the more stringent (and more expensive) level of NO_x control selected for this analysis (e.g., SCR control for industrial boilers). These costs would be in addition to the capital mills are already spending to comply with Boiler MACT, which does not regulate NO_x emissions. Note that the costs in this analysis are highly dependent on the actual ozone design values since a state-by-state approach is assumed, where emissions controls are only applied in non-attainment areas as RACT or to avoid NNSR. The values reflect an analysis based on 2011-2013 design values but they would be higher if 2009-2011 data were used, for example, or if parts of the country experience warmer summers than the past three years.

Table 2. The estimated costs for each proposed NAAQS level for forest products facilities in and near projected non-attainment areas.

Tier	NAAQS set at 70 ppb	NAAQS set at 65 ppb	NAAQS set at 60 ppb
Estimated Capital Cost			
Tier 1	$66 million	$102 million	$1.1 billion
Tier 2	$57 million	$81 million	$951million
Total	**$123 million**	**$184 million**	**$2.0 billion**
Estimated Annual Cost			
Tier 1	$12 million	$65 million	$325 million
Tier 2	$12 million	$43 million	$299 million
Total	**$24 million**	**$108 million**	**$624 million**

Table 3 summarizes the cost estimates for the forest products industry assuming a regional approach to emissions control at an ozone standard of 65 ppb or below. The costs in this alternate analysis assume that widespread emissions reductions are required as an effort to reduce ozone concentrations and emissions transport over a large portion of the country (e.g., implementation of the "good neighbor" clause by states), regardless of whether sources are actually located in areas designated as non-attainment. This approach is similar to EPA's RIA approach, as mentioned earlier.

Table 3. The estimated costs of an ozone standard of 65 ppb or below based on a regional analysis

Cost	Pulp and Paper	Wood Products	Total Forest Products
Capital Cost	$2.8 billion	$87 million	$2.9 billion
Annual Cost	$950 million	$39 million	$990 million

We were not able to quantify costs for projects that are cancelled because they cannot be permitted in a non-attainment area because offsets are not available or additional controls make the project infeasible. Of course, if facilities do not go forward with projects because they cannot permit them in ozone nonattainment areas or find offsets in attainment areas, there would be lost potential economic value to companies, their communities and governments for projects that would otherwise have had a return on investment that are not conducted. These opportunity costs could be significant and could even exceed a billion dollars.

While EPA cannot consider costs when setting the NAAQS, the costs of mistakenly tightening the standard are significant when there is such scientific uncertainty. EPA's own cost benefit analysis would make the ozone rule one of the most expensive air regulations ever at over $15 billion. More complete industry assessments put the economy-wide annual cost ten times higher with significant energy cost increases and job losses (see NERA study conducted for NAM). The proposed revisions could place most of the country in nonattainment, putting five times more paper and wood product mills at risk and having to spend close to three billion dollars to comply while losing business opportunities due to permit restrictions. Our industry already has invested billions of dollars to help make our air cleaner while making products essential for everyday life.

C. PM Co-Benefits and Greenhouse Gas Disbenefits Must be Considered

A substantial portion of the benefits that EPA claims for the proposed primary ozone NAAQS comes not from reducing concentrations of ground-level ozone but from reductions in fine particulate matter that EPA speculates would be a side-effect of controls that sources would have to adopt to reduce emissions of the ozone precursor NO_x. This seemingly ignores the fact that EPA already sets primary NAAQS for $PM_{2.5}$ at a level requisite to protect public health with an adequate margin of safety. Additionally, EPA has numerous other regulatory initiatives, such as hazardous air pollutant emission standards for boilers, utilities, and others, that will produce substantial reductions in ambient $PM_{2.5}$ exposure regardless of what happens with the ozone NAAQS. There is, therefore, no sense to claiming health benefits from reductions in ambient $PM_{2.5}$ concentrations as a result of lowering the ozone NAAQS (even if those lower ambient $PM_{2.5}$ concentrations were necessarily an outcome of lowering the ozone NAAQS, which they are not).

EPA also has not given needed consideration to the effects that lowering the primary and secondary ozone NAAQS could have on greenhouse gas emissions. Often, requirements to reduce volatile organic compound emissions to try to reduce ambient ground-level ozone concentrations have translated into requirements for sources to collect and thermally oxidize those VOCs. Burning large quantities of natural gas to ensure thermal destruction of generally low-concentration, high-flow gases captured from VOC-using or –generating processes releases millions of metric tons of carbon dioxide. It is worth noting that these same controls could increase NOx emissions exactly in the areas that are VOC-rich so the additional NOx formed, even with NOx reduction strategies in place, could result in more ozone formation. This trade-off was documented during the development of the Plywood and

Composite Wood Panel MACT but ignored when setting the emission limits for VOC Hazardous Air Pollutants. Finally, a new rule that forces even more gas-burning to produce even further reductions in VOC emissions beyond those already achieved or to be achieved under the existing ozone NAAQS may not, on balance, be worth the adverse effect on greenhouse gas emissions. It would be arbitrary and capricious for EPA to impose more stringent ozone NAAQS without carefully considering this effect.

In addition, in many instances attempting to meet the new ozone NAAQS would require combustion sources to reduce their NO_x emissions. This would encourage and in some cases force sources burning solid fuel like coal or biomass, as well as those burning oil, to switch to natural gas. This would have important implications for energy supply and cost. Moreover, because burning biomass such as wood residuals does not contribute to higher atmospheric carbon dioxide concentrations, since carbon dioxide was removed from the atmosphere by the tree to form the biomass, a new regulation that has the effect of causing sources to switch away from burning biomass towards burning other carbon-based fuels will cause a net increase in atmospheric carbon dioxide. EPA has asserted that current carbon dioxide emissions have negative implications for both health and welfare, and if so such effects must not be ignored by EPA in deciding what level of ozone NAAQS is requisite to protect human health and welfare.

VI. Conclusion

As EPA and the courts have acknowledged, while "the only concentration for ozone and PM that is utterly risk-free, in the sense of direct health impacts, is zero," *American Trucking Associations v. EPA*, 175 F. 3d 1027, 1034 (D.C. Cir. 1999), the "CAA does not require the Administrator to establish a primary NAAQS at a zero-risk level," 75 Fed. Reg. at 2940, citing *Lead Industries Association v. EPA*, 647 F.2d at 1156 n.51. Rather, the "question is one of degree." *American Trucking Associations*, 175 F.3d at 1037. Thus, establishing primary NAAQS necessarily involves value judgments (which is part of the reason why EPA cannot simply defer to CASAC) and weighing the severity of a predicted health effect and the certainty of the information from which that health effect is predicted. In that regard, EPA should and must consider the context, including the societal consequences of setting the NAAQS at a particular level. The lowering of the primary NAAQS that EPA is considering would, even under the most optimistic assumptions, cost the nation $15 billion dollars a year, and as much as $140 billion according to the National Association of Manufacturers (see March 2015 NERA report). At least at the lower end of the range EPA has proposed, the NAAQS is approaching background levels, especially in parts of the country where coniferous trees emit significant amounts of VOCs. And

there is even more uncertainty as to how the proposed secondary NAAQS would compare to background levels in rural areas.

In this context, it is critical for EPA to consider the severity of the health effects and the strength of the data on which those projected effects are based. Decrements in lung function without clear health impacts, or statistical correlations of ozone levels with, e.g., emergency room visits where the population was exposed to elevated levels of other pollutants as well, does not constitute evidence of the kind of significant, likely health effects that would justify revising the NAAQS at this time, with tremendous economic and social consequences.

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In summary, in light of the significant scientific uncertainties and large economic impacts, AF&PA and AWC recommend that EPA retain the current standard of 75 parts per billion as protective of public health and not set a different secondary standard.

If you have any questions about these comments, please contact Tim Hunt, AF&PA and AWC's Senior Director, Air Quality Programs, at (202) 463-2588 or at tim_hunt@afandpa.org.

Sincerely,

Paul R. Noe
Vice President for Public Policy
American Forest & Paper Association

Robert W. Glowinski
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Gradient comments filed March 16, 2015 titled "Comments on the National Ambient Air Quality Standards for Ozone Proposed Rule" transmitted by Julie E. Goodman

AACOG
Alamo Area Council Of Governments

Air Improvement Resources Committee
8700 Tesoro Drive, Suite 700 San Antonio, Texas 78217 (210) 362-5200 fax 225-5937

Hon. Ron Nirenberg
Chair,
AIR Executive Committee
City of San Antonio
Councilman

Hon. Chris Riley
Vice-Chair
AIR Executive Committee
Alamo Area MPO,
City of Leon Valley,
Mayor

Hon. Richard L. Jackson
Wilson County
Judge

Hon. Jim Wolverton
Guadalupe County
Commissioner

Hon. Sherman Krause
Comal County
Judge

Hon. Nelson Wolff
Bexar County
Judge

Hon. Robert L. Hurley
Atascosa County
Judge

Hon. John H. Williams
Greater Bexar County
Council of Cities
Universal City
Mayor

Hon. Mike Fincke,
AACOG Board of Directors
Kendall County
Commissioner

January 28, 2015

EPA Docket Center (EPA/DC),
Mailcode 28221T,
Attention Docket ID No. OAR–2008–0699,
1200 Pennsylvania Ave. NW.,
Washington, DC 20460

Subject: National Ambient Air Quality Standards for Ozone: 40 CFR Parts 50, 51, 52, et al., Docket ID No. EPA–HQ–OAR–2008–0699

Dear Administrator McCarthy:

In response to the EPA's request for public comment on the proposed ozone NAAQS, the members of the Air Improvement Resources (AIR) Executive Committee, whose membership includes elected officials from the county and city governments of the San Antonio - New Braunfels Metropolitan Statistical Area, encourage EPA to consider the following list of recommendations for the designation process and schedule. The AIR Committee does strongly support the science-based goal of protecting the health of our citizens as our efforts and successes of recent years demonstrate, and we look forward to cooperatively working with the EPA to improve the nation's air quality and our collective public health.

1. EPA should delay nonattainment designations for the revised ozone standard until 2018 to allow regions to benefit from the implementation of federal air quality controls which will occur in 2017, such as the Tier 3 vehicle and fuel standards, increased turnover of non-road equipment to Tier 4 standards, and other federal controls.

2. Due to monitoring uncertainty, EPA should allow +15% ppb variance in the calculated design value used to determine attainment. EPA allows +/- 15% error in data accuracy for approving the calibrations of ozone monitors.

3. EPA should consider the number of exceedances allowed by other industrialized nations when implementing the ozone standard. For example, the European Union states that the maximum daily 8-hour mean concentration of ozone should not exceed 120 µg/m3 (60 ppb) on more than 25 days per calendar year averaged over three years.[1]

4. EPA should consider rigorously monitoring and evaluating data of all areas, both attainment and nonattainment areas, to understand intrastate and interstate transport and protect downwind areas that might be significantly affected by transported emissions. Transport significantly impacts local ozone concentrations. Unfortunately, the Clean Air Act relies on implementation of local strategies for an area to regain attainment, but at this time, no combination of local strategies has been demonstrated as being effective enough for the San Antonio – New Braunfels MSA to reach attainment without concurrent reductions in transport.

[1] Air Quality in Europe — 2011 report, European Environmental Agency, 11/12/2011. Online: http://www.eea.europa.eu/publications/air-quality-in-europe-2011

5. EPA should recognize the role of interstate, intrastate, and international transport in the calculations and implementation of ozone standards. While we welcome discussions with the EPA on methods to mitigate local contributions to ozone formation, we cannot enact reduction strategies which act beyond our jurisdiction. Moreover, those agencies responsible for air quality management beyond the San Antonio – New Braunfels MSA must provide appropriate reductions within their jurisdictions and authorities, as required, to assist the local nonattainment region's efforts to regain attainment status.

6. Permitting rules need to require an evaluation of ozone impacts using photochemical grid modeling. Permits should be modified or denied if adverse health impacts or violations of the NAAQS will occur either downwind or within a given attainment/nonattainment area as a result of permit action.

7. When setting the attainment date for areas downwind of other nonattainment areas, consideration should be given to allow appropriate control strategy implementation in the upwind areas as necessary to allow the downwind area to achieve compliance.

The Air Improvement Resources Executive Committee seeks to determine the most prudent path available to our region for meeting federal air quality standards. It is important to understand how the proposed O3 standard will impact San Antonio, Texas in our planning process as we work together with the EPA and TCEQ to ensure excellent air quality for our citizens with the least local cost and penalty in the process.

Sincerely,

Councilman Ron Nirenberg, City of San Antonio
Chair, AIR Executive Committee

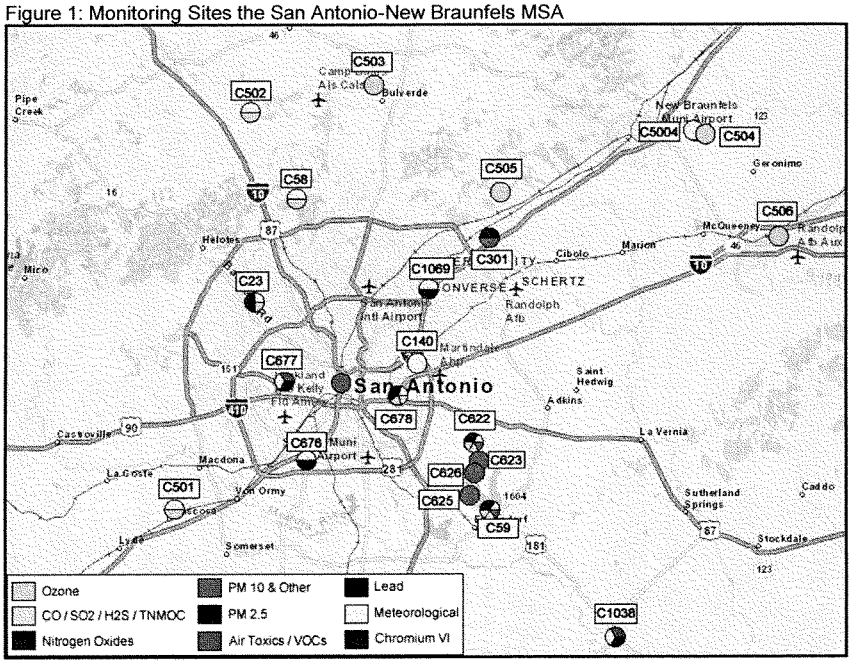
Mayor Chris Riley, City of Leon Valley
Vice-Chair, AIR Executive Committee

As supporting documentation for the list of recommendations in the AIR Executive Committee's comment letter, the information below provides the results of air quality analyses conducted for the San Antonio region. Specifically, the analyses include the current 8-hour ozone design values for San Antonio, the number of days per year each monitor exceeds the proposed ozone standard, photochemical model analysis of ozone in the San Antonio-New Braunfels MSA, the NO_X and VOC ozone precursor emission inventory of the San Antonio-New Braunfels MSA, and a 48-hour 100 meter back trajectory analysis showing potential sources of transport.

San Antonio-New Braunfels Design Value

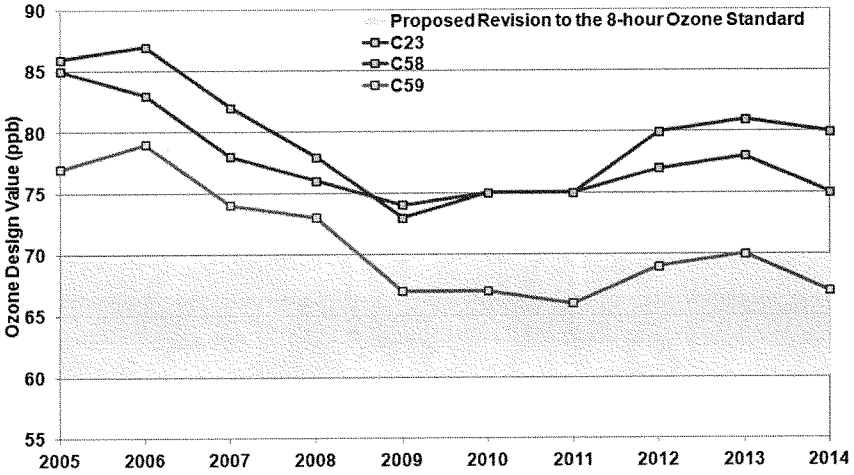
There are 20 regulatory and non-regulatory air quality monitors in the San Antonio-New Braunfels MSA that record meteorological data and air pollutant concentrations, including ozone levels (Figure 1). The data collected at these sites is processed for quality assurance by the Texas Commission on Environmental Quality (TCEQ) and is accessible via the Internet.[2] The 8-hour ozone design values at the three regulatory ozone monitors in the San Antonio-New Braunfels MSA from 2005 to 2014 are provided in Figure 2. The ozone monitors at the C58 and C23 continuous ambient monitoring stations (CAMS) consistently have the highest design values in the San Antonio region. Ozone design values have increased slightly at the C58 monitor from 2009 to 2014 and this monitor is now exceeding the 75 ppb 8-hour ozone standard.

Figure 1: Monitoring Sites the San Antonio-New Braunfels MSA



[2] TCEQ, "Air and Water Monitoring". Austin, Texas. Available online: http://www.tceq.state.tx.us/assets/public/compliance/monops/graphics/clickable/region13.gif. Accessed 06/26/13.

Figure 2: Monitored 8-Hour Ozone Design Values at C23, C58, and C59, 2005-2014

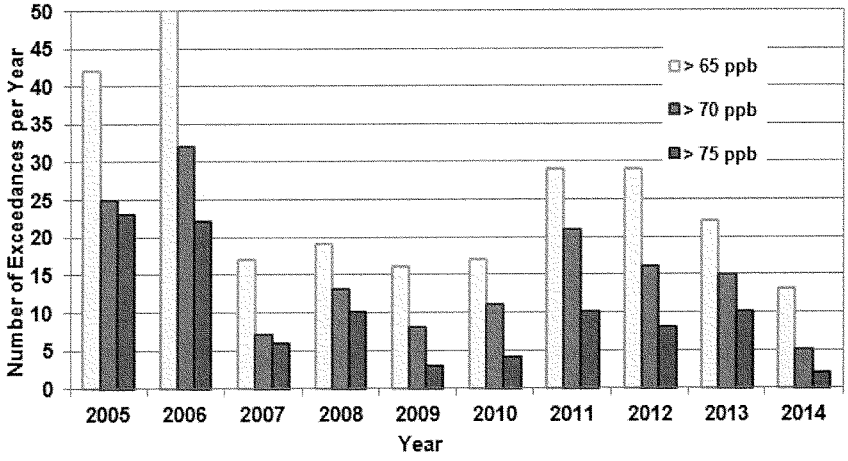


The numbers of days per year for which ozone excedances were measured in the San Antonio-New Braunfels Metropolitan Statistical Area (MSA) are provided in Figure 3. From 2008-2014, the San Antonio-New Braunfels MSA averaged 12.7 days above the 70 ppb proposed standard and 20.7 days above the 65 ppb proposed standard. Eight-hour ozone averages recorded at the CAMS 58 monitor exceeded the 75 ppb ozone standard an average of 4.1 days per year from 2008-2014. Ozone measurements at the monitor exceeded the 70 ppb proposed ozone standard an average of 9.3 days per year and exceeded the 65 ppb proposed ozone standard 17.1 days per year.

Data from the upwind monitors on high ozone days in the San Antonio-New Braunfels MSA indicated they experienced fewer days above each proposed standard than downwind monitors; nevertheless, exceedances of the proposed standards did occur. Ozone measurements at the New Braunfels monitor, CAMS 504, exceeded the proposed 70 ppb ozone standard an average of 2.3 times per year and exceeded the 65 ppb proposed standard 5.6 times per year (Table 1). This indicates that it will be difficult for the San Antonio-New Braunfels MSA to achieve the proposed standards since historical data from upwind monitors exceeds the proposed changes.

When ozone readings are reviewed at monitors outside the region, the Big Bend monitor, CAMS 67, exceeded the proposed 70 ppb standard 4.6 times on average per year and exceeded the 65 ppb proposed standard 14.7 times per year. The Big Bend monitor is not located near any large urban areas or any large Texas point source emissions.

Figure 3: Number of High Ozone Days per Year Greater than 65 ppb, 70 ppb, and 75 ppb in San Antonio-New Braunfels MSA



Ozone Analysis using Photochemical Modeling

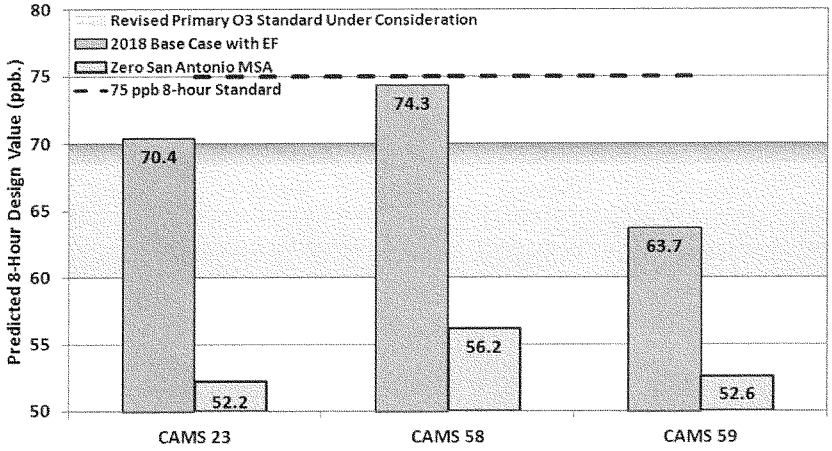
Ozone analysis was conducted using a photochemical model that simulates actual high ozone episodes which prevailed in a region over the course of several days. The modeling episode currently used for the San Antonio, Austin, and Dallas regions, and undergoing refinement by the Alamo Area Council of Governments, is based on the period of high ozone that occurred from May 31st to July 2nd, 2006. This photochemical modeling episode was chosen for the modeling effort as it represents a variety of meteorological conditions that are commonly associated with ozone exceedance days.

The June 2006 photochemical modeling episode was projected to 2012 and 2018 using updated emission inventory projections. The predicted future design value at the monitor with the highest values in the region, CAMS 58, was below the 75 ppb standard at 74.3 ppb. However, the predicted future design value was higher than either the 70 ppb or 65 ppb proposed standards. When all anthropogenic (human-made) emissions were removed from the 8-county San Antonio-New Braunfels MSA, future predicted design values at the CAMS 58 was 56.2 ppb (Figure 4).

Table 1: Number of High Ozone days per Year greater than 60 ppb, 65 ppb and 70 ppb

Year	CAMS 58			CAMS 23			CAMS 504 (New Braunfels)			CAMS 506 (Seguin)			CAMS 67 (Big Bend)		
	>60 ppb	>65 ppb	>70 ppb	>60 ppb	>65 ppb	>70 ppb	>60 ppb	>65 ppb	>70 ppb	>60 ppb	>65 ppb	>70 ppb	>60 ppb	>65 ppb	>70 ppb
2005	59	33	19	50	32	12	55	36	17	37	17	5	-	-	-
2006	55	42	27	40	23	12	45	26	13	35	22	8	-	-	-
2007	21	14	5	17	13	5	27	13	8	15	8	2	-	-	-
2008	31	14	6	29	16	11	14	9	6	13	4	1	27	7	1
2009	22	13	6	30	14	8	6	0	0	9	1	0	17	5	2
2010	26	14	9	16	7	4	7	3	0	4	1	0	28	6	0
2011	37	20	12	40	24	15	28	14	7	25	9	3	67	38	18
2012	40	29	13	40	21	13	15	5	1	17	5	4	60	24	9
2013	40	21	15	25	17	11	11	6	2	12	6	2	31	18	2
2014	33	9	4	18	6	1	6	2	0	11	1	0	19	5	0
Average (2008-2014)	32.7	17.1	9.3	28.3	15.0	9.0	12.4	5.6	2.3	13.0	3.9	1.4	35.6	14.7	4.6

Figure 4: Zero-out runs for all Anthropogenic NO_X and VOC Emissions in the San-Antonio New Braunfels MSA, 2018



Across-the-board runs were conducted by removing 25%, 50%, and 75% of the volatile organic compound (VOC) and nitrogen oxide (NO_X) emissions from the San Antonio-New Braunfels MSA in the 2018 photochemical modeling projection. Figure 5 provides the results of the across-the-board design value reduction runs for the monitor with the highest ozone design value in the San Antonio-New Braunfels MSA, CAMS 58 at Camp Bullis. The model projects that if NO_X emissions were reduced 25% and additional controls already in place or mandated by 2018 are applied to sources outside the MSA, the region would not be able to attain the 70 ppb or 65 ppb proposed standards. To reach the 65 ppb proposed standard, at least a 50% reduction in local NO_X emissions is needed. The required reductions will make it very difficult for the region to obtain the 70 ppb or the 65 ppb proposed standards.

San Antonio-New Braunfels MSA Emission Inventory

As provided in Table 2, point sources are estimated to be the largest sources of NO_X emissions in 2018 in the San Antonio-New Braunfels MSA, followed by on-road vehicles. Other sources of NO_X emissions include area emission sources and non-road/off-road emissions sources. Total NO_X emissions are projected to decrease significantly in the 8-county region from 250 tons of NOX in 2006 to 125 tons of NO_X in 2023. By far the largest anthropogenic source of VOC emissions is the area source category (Table 3). On-road and non-road sources can also emit significant amounts of VOC emissions.

Figure 5: Anthropogenic NO_X and VOC Emission Reduction in the San-Antonio New Braunfels MSA, 2018

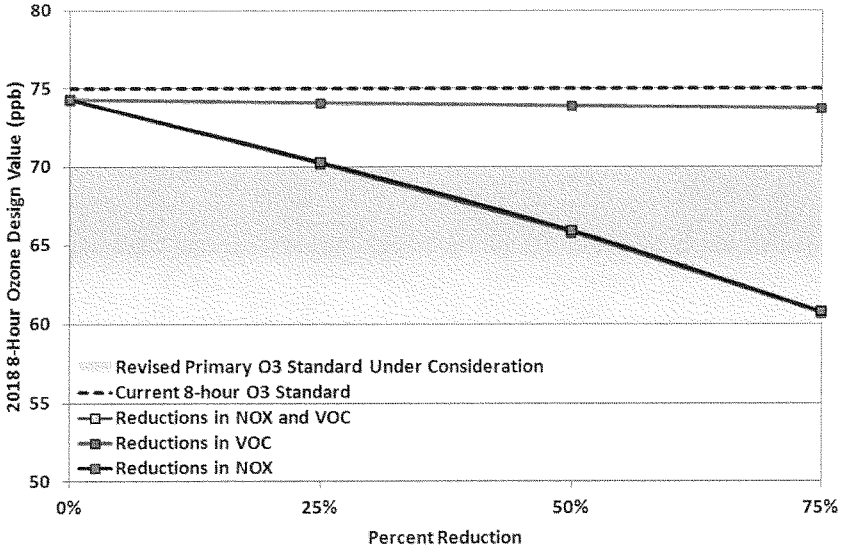


Table 2: NO_X Emissions by Source, San Antonio-New Braunfels MSA, tons/ozone season day

Emission Source	2006	2012	2018	2023
On-Road	127.9	76.7	43.2	31.9
Non-Road	25.8	19.6	11.4	8.4
Area	16.5	15.6	15.9	16.7
Point	71.3	66.4	63.5	56.9
Off-road	8.9	8.1	7.7	7.3
Oil and Gas Equipment	-	3.9	4.1	3.6
Total	250.3	190.2	145.8	124.8

Table 3: VOC Emissions by Source, San Antonio-New Braunfels MSA, tons/ozone season day

Emission Source	2006	2012	2018	2023
On-Road	46.3	32.9	22.3	19.3
Non-Road	24.5	27.1	19.0	17.3
Area	147.2	151.3	153.8	190.2
Point	8.3	6.1	7.0	6.7
Off-road	3.4	3.3	3.5	3.5
Oil and Gas Equipment	-	3.1	7.4	7.4
Total	229.7	223.7	212.9	244.4

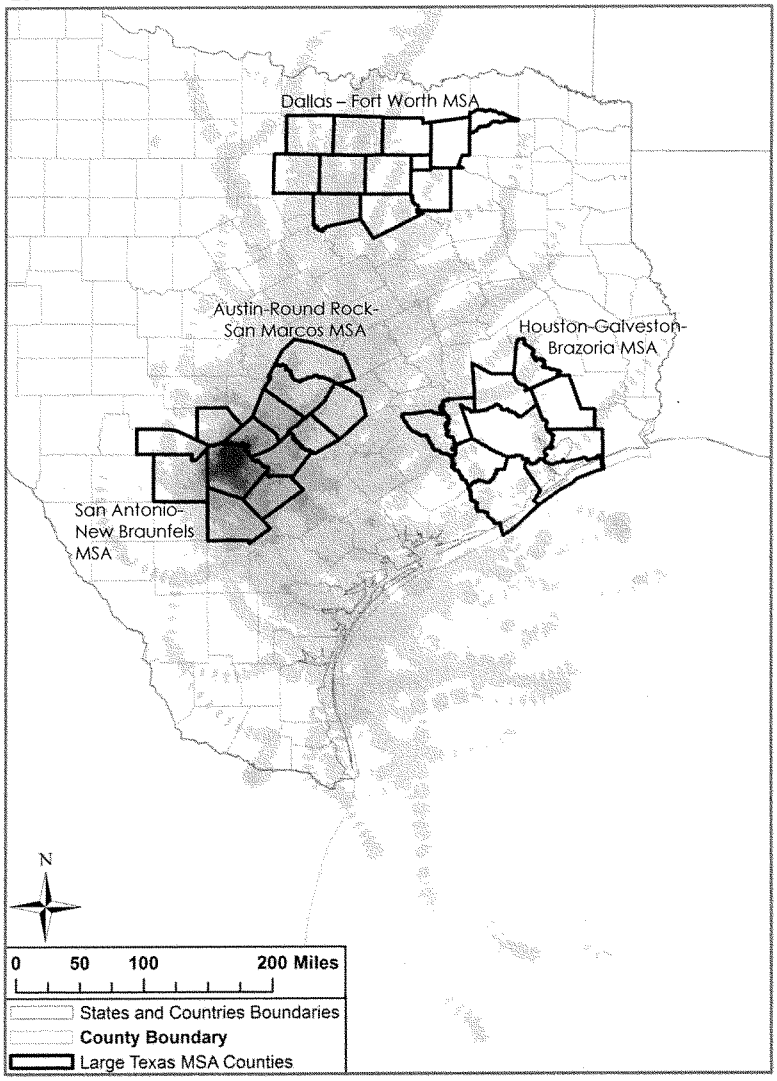
Back Trajectories Analysis

While urban areas typically have many sources of the NO_X and VOC emissions that form ozone, their air quality is also influenced by anthropogenic precursors and ozone transported from other areas, perhaps even from long distances. Tracking wind parcels coming into a region helps identify the sources of transported ozone. The Air Resources Laboratory of NOAA maintains the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model that replicates wind dynamics and allows public use via the Internet at their Realtime Environmental Applications and Display System (READY) webpage.[3] This versatile model can be run as a trajectory (parcel displacement) or air dispersion model, using either forecast or archived meteorological data. The HYSPLIT model produces air parcel positions for every hour by latitude, longitude, and height. The back trajectories needed for the analyses of transport were created using this model.

The approximate pathways of air entering San Antonio on days of interest were determined using the HYSPLIT model. Figure 6 displays air mass 100-meter back trajectory density counts over 48 hours for air parcels terminating at C58 on days with recorded 8-hour ozone greater than 65 ppb. Given a final geographic destination for an air parcel, back trajectories show the path followed by the air parcel before reaching the destination. Back trajectories track air displacement over time, distance, and emission source regions. These back trajectories demonstrate that, on high ozone days > 65 ppb, it is rare for air arriving at C58 to come from the west, northwest, or southwest. In the San Antonio region, it is common to have stagnated back trajectories on high ozone days arriving in San Antonio from the southeast in the spring and from the northeast in the fall.

[3]NOAA, Feb. 26, 2019. "Realtime Environmental Applications and Display sYstem (READY)". Available online: http://www.arl.noaa.gov/ready.html. Accessed 05/24/10.

Figure 6: Density of Hourly Back Trajectory Bin Counts on High Ozone Days > 65 ppb, 2009 – 2014



EPA United States Environmental Protection Agency

NAAQS and Other CAA Implementation Updates

Anna Marie Wood
Director, Air Quality Policy Division
WESTAR Spring Meeting
April 2015

EPA United States Environmental Protection Agency

WESTAR Overview

- Schedules for NAAQS Reviews and Implementation
- Ozone
  - 2008 Ozone NAAQS and Implementation Rule
  - 2015 Ozone NAAQS Review and Implementation Rule
- SO_2
  - 2010 1-hr SO_2 NAAQS Implementation
- $PM_{2.5}$
  - 2012 $PM_{2.5}$ NAAQS SIP Requirements and Implementation Rules
- Startup, Shutdown, and Malfunction (SSM)

NAAQS Reviews: Status Update

(as of March 31, 2015)

	Ozone	Lead	Primary NO_2	Primary SO_2	Secondary NO_2 and SO_2	PM	CO
Last Review Completed (final rule signed)	Mar 2008	Oct 2008	Jan 2010	Jun 2010	Mar 2012	Dec 2012	Aug 2011
Recent or Upcoming Major Milestone(s)[1]	August 2014 Final REAs Final PA Nov 25, 2014 Proposed rule Oct 1, 2015[2] Final rule	May 2014 Final PA Dec 2014 Proposed decision	June 2014 Final IRP January 2015 2nd Draft ISA Spring 2015 REA Planning Document	October 2014 Final IRP Summer 2015 1st Draft ISA Fall 2015 REA Planning Document	Summer 2015 Draft IRP	Winter 2015/2016 Draft IRP	TBD[3]

Additional information regarding current and previous NAAQS reviews is available at: http://www.epa.gov/ttn/naaqs/

[1] IRP – Integrated Review Plan; ISA – Integrated Science Assessment; REA – Risk and Exposure Assessment; PA – Policy Assessment

[2] Bold and underlined dates indicate court-ordered or settlement agreement deadlines

[3] TBD = to be determined

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Anticipated NAAQS Implementation Milestones (updated March 31, 2015)

Pollutant	Final NAAQS Date	Designations Effective	Infrastructure SIP Due	Attainment Plans Due	Attainment Date
$PM_{2.5}$ (2006)	Oct 2006	Dec 2009	Oct 2009	Dec 2014	Dec 2015 (Mod) Dec 2019 (Ser)
Pb (2008)	Oct 2008	Dec 2010-2011	Oct 2011	June 2012-2013	Dec 2015-2016
NO_2 (2010) (primary)	Jan 2010	Feb 2012	Jan 2013	N/A	N/A
SO_2 (2010) (primary)	June 2010	Oct 2013 (+3 rounds)	June 2013	April 2015 (2018, 2019, 2022)	Oct 2018 (2023, 2024, 2027)
Ozone (2008)	Mar 2008	July 2012	Mar 2011	Mid 2015-2016	Mid 2015-2032
$PM_{2.5}$ (2012)	Dec 2012	Early 2015	Dec 2015	Mid 2016	Dec 2021 (Mod) Dec 2025 (Ser)
Ozone (2015)	Oct 2015	Dec 2017	Oct 2018	Dec 2020-21	2020-2037

2008 Ozone NAAQS

- Revised primary 8-hour Ozone NAAQS in 2008 (75 ppb)

- Final 2008 Ozone NAAQS Classifications Rule
  - Published May 21, 2012 (77 FR 30160)
  - Established air quality thresholds for each ozone nonattainment area classification, attainment deadlines and revocation of the 1997 Ozone standards for transportation conformity
  - Lawsuit filed by NRDC, challenging end of year attainment date EPA sought to establish in Classifications Rule
  - DC Circuit issued opinion on December 23, 2014 vacated portion of the Classification Rule that sought to establish attainment date periods from the end of year; held that deadlines calculated as annual periods running from date of designations more appropriate
  - EPA addressed lawsuit in final 2008 Ozone SIP requirements Rule *(covered in upcoming slides);* established the maximum attainment date as a specific number of years from effective date of designations

2008 Ozone NAAQS: Area Designations

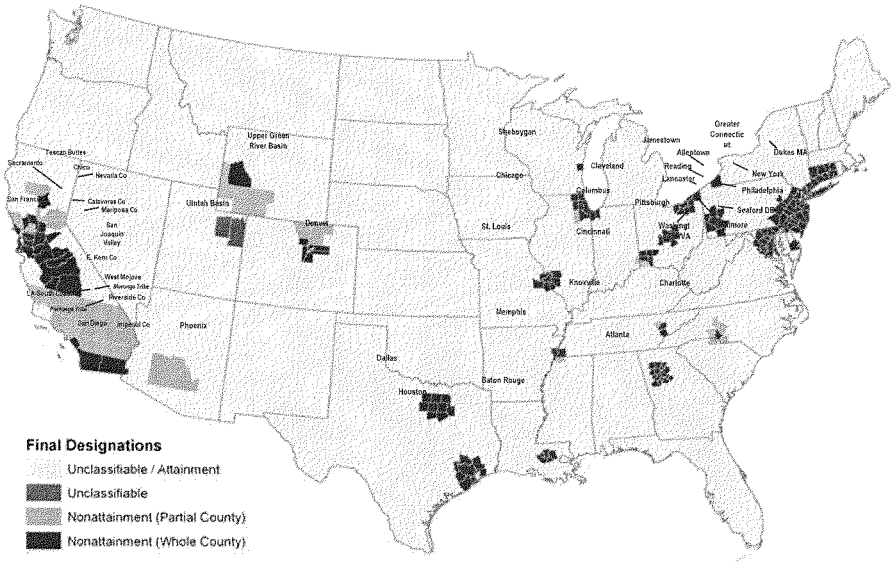
- Area designations for 2008 Ozone NAAQS effective July 20, 2012
  - 46 nonattainment areas, 1 unclassifiable area
    - 36 Marginal; 3 Moderate; 2 Serious; 3 Severe; 2 Extreme

- Attainment Dates for 2008 Ozone NAAQS (attainment date runs from effective date of designations)
  - Marginal – 3 years
  - Moderate – 6 years
  - Serious – 9 years
  - Severe – 15 years
  - Extreme – 20 years

EPA United States Environmental Protection Agency

2008 Ozone NAAQS: Area Designations

(Effective July 20, 2012)



Notes:

EPA has not designated as nonattainment any areas outside the Continental US.

Implementation of the 2008 NAAQS for Ozone: State Implementation Requirements Rule

- Official title: "Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements" *(hereafter referred to as Ozone SRR)*
  - Final Ozone SRR signed on Feb. 13, 2015; published March 6, 2015 80 FR 12264
    - effective date is April 6, 2015
  - Webinar for state, local and tribal air agencies held on Feb. 26, 2015
    - webinar slides and recording available online at www.epa.gov/groundlevelozone/actions.html
  - Significant amount of implementation detail from the Ozone SRR addressed in webinar

Implementation of the 2008 NAAQS for Ozone: State Implementation Requirements Rule

- In general, the Ozone SSR interprets applicable statutory requirements and provides flexibility (to extent possible) to states to minimize administrative burdens while developing and implementing plans to meet and maintain the NAAQS
  - Establishes due dates for attainment plans and clarifies attainment dates for each nonattainment area according to its classification (established based on air quality thresholds)
  - Revokes the 1997 ozone NAAQS as of April 6 and establishes anti-backsliding requirements for areas remaining nonattainment for the 1997 ozone NAAQS
  - Provides guidance on nearly all aspects of the attainment planning requirements for designated nonattainment areas

Implementation of the 2008 NAAQS for Ozone: State Implementation Requirements Rule

- Basic SIP components for nonattainment areas addressed in the Ozone SRR
  - Emissions Inventory and use of Air Emissions Reporting Rule
  - Reasonable further progress (RFP) plan
  - Reasonably available control technology (RACT)
  - Reasonably available control measures (RACM)
  - Attainment demonstrations
  - Contingency measures
  - NA NSR program
  - Motor vehicle emissions budget (MVEB) (CAA 176(c))
  - As applicable, a variety of area-wide mobile source and stationary control programs

Anti-backsliding Provisions for Revoked 1997 Ozone NAAQS

(Effective April 6, 2015)

- For areas that are nonattainment for both the 2008 and 1997 NAAQS, the anti-backsliding rules preserve most of the ongoing attainment planning and control obligations for the revoked 1997 NAAQS, but…
  - …grant relief from reclassification if area fails to attain
  - …remove all 1997 classification-based restrictions on NSR offset transactions between nonattainment areas
  - …allow the Administrator in certain cases to approve alternative controls that are 'not less stringent' (e.g., section 185 fee programs)
  - …provide a mechanism to close-out all 1997-based requirements through 'redesignation substitute'

Anti-Backsliding Provisions for Revoked 1997 Ozone NAAQS (con't)

- For 1997 nonattainment areas that were designated attainment for 2008 NAAQS, the anti-backsliding rules grant relief from developing maintenance plans and implementing nonattainment NSR (except in the OTR)

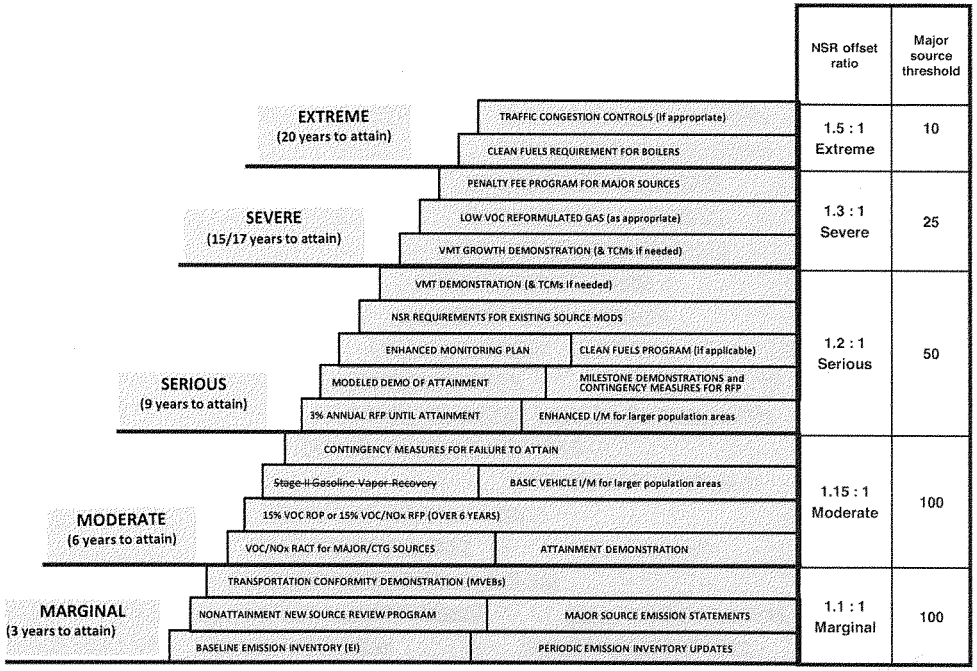
- For areas implementing maintenance plans for the 1997 NAAQS, the anti-backsliding rules grant relief from developing and submitting 2nd 10-year maintenance plans

Implementation of the 2008 NAAQS for Ozone: State Implementation Requirements Rule

- Key implementation dates:
  - Emission inventory and RACT SIPs due July 2014
  - Attainment plans and demonstrations due July 2015 (Moderate) or July 2016 (Serious and above)
  - Marginal area attainment date: July 20, 2015 (attainment to be determined by 2012-2014 air quality data)

- EPA anticipates that the Ozone SRR will serve as blueprint for the implementation provisions that would apply to any potential future ozone revisions to the Ozone NAAQS

Overview of CAA Ozone Nonattainment Area Planning & Control Requirements by Classification



2015 Ozone NAAQS: Proposal Overview

- Proposed November 25, 2014; primary ozone (O_3)NAAQS: **65 to 70 ppb** (current level is 75 ppb), taking comment on lower levels including 60 ppb and on retaining the current standard.
  - Proposed to retain the current indicator, averaging time, and form

- Proposed secondary O_3 NAAQS – 65-70 ppb, which we propose would provide the requisite protection equivalent to a seasonal W126 index of 13 to 17 ppm-hours.
  - Proposed to define the target level of protection for public welfare as W126 values within the range of 13 to 17 ppm-hrs (3-year average).
  - W126 is a seasonal index that is often used to assess the impacts of O_3 exposures on trees, plants and ecosystems
  - Analyses show that an O_3 standard with a level from 65 to 70 ppb, combined with the current averaging time and form, would provide protection equivalent to a W126 index value of 13 to 17 ppm-hrs

- Proposed updates to AQI breakpoints, based on the level of a revised primary standard

2015 Ozone NAAQS Proposal: Implementation Aspects

- Extending the monitoring season in 33 states *(Section VI.B)*
- New Federal Reference Method (FRM) for measuring ambient ozone to stay current with latest technology *(Section VI.D)*
- Revising minimum Photochemical Assessment Monitoring Stations (PAMS) network requirements to decrease overall burden and increase flexibility *(Section VI.C)*
- Instructions for data handling specific to new standard(s) *(Section V.C)*
- Grandfathering of in-the-pipeline PSD permit applications *(Section VII.D)*
- Addresses the "exceptional event" demonstration deadline to ensure air agency claims for 2013-2016 are adequately considered in area designations decisions *(Section V.E)*

2015 Ozone NAAQS: Remaining Schedule

- Proposal signed on November 25, 2014
  - *Federal Register* Notice published December 17, 2014 (79 FR 75234)
  - 90-day public comment period ended March 17, 2015
  - Held 3 public hearings
- Final rule to be signed by October 1, 2015
- Additional information and comment submission instructions at http://www.epa.gov/air/ozonepollution/

2015 Ozone NAAQS: Implementation

- Key implementation milestones for NAAQS (if revised)
  - Area designations promulgated by October 2017
  - Infrastructure SIPs due Oct 2018
  - Attainment plans due 2020-21
  - Attainment dates 2020-2037 (primary standard only)

- Implementation rules and guidance for 2015 Ozone NAAQS
  - 2015 ozone NAAQS proposal includes limited grandfathering of PSD permit applications, and process deadlines for ozone-related exceptional events demonstrations
  - Also seeking early input on other implementation issues that would be addressed in separate implementation requirement rulemaking
  - EPA looking to propose separate implementation rulemaking by October 2016 and finalize by end of 2017

What if Background Ozone Constitutes Violations of NAAQS?

- Proposal acknowledges that background ozone contributes significantly to ozone levels on some days, especially in some areas in the western U.S. (e.g., Denver)
  - Acknowledges that prescribed fire may be used to mitigate the effects of catastrophic wildfire
- At a prospective standard of 70 ppb, background ozone is unlikely to create significant implementation challenges
- Majority of current 8-hour exceedances attributable to (local and regional) manmade emissions
  - On high ozone days, about 1/3 – 1/2 of total ozone (on average) is due to background
- Influences include stratospheric ozone intrusion, wildfires and sources outside of the U.S.
  - Where this is an issue, existing CAA mechanisms help ensure fair and reasonable control requirements (Exceptional Events and 179B)
- EPA working to ensure these mechanisms are as workable as possible for states and EPA to administer

Intended Schedule for 2015 Ozone NAAQS Implementation Rules/Guidance/Tools

Action	After NAAQS Promulgation	(Actual) and Planned Dates
EPA proposes 2015 Ozone NAAQS and Monitoring, Exceptional Event Demonstration Schedule, and PSD grandfathering as part of 2015 NAAQS proposal.		(November 25, 2014)
EPA finalizes 2015 Ozone NAAQS and Monitoring, Exceptional Event Demonstration Schedule, and PSD grandfathering as part of 2015 NAAQS final.	Upon promulgation	October 2015
EPA proposes Exceptional Events Rule revisions and issues draft Wildfire/Ozone Guidance		Fall 2015
EPA issues Designations guidance	4 months	January 2016
States submit Designation recommendations	*12 months*	*October 2016*
As needed, EPA issues revised i-SIP guidance	Up to 12 months	Up to October 2016
EPA finalizes Exceptional Events Rule revisions and issues Wildfire/Ozone Guidance		Summer 2016

Intended Schedule for 2015 Ozone NAAQS Implementation Rules/Guidance/Tools
(table continued)

Action	After NAAQS Promulgation	(Actual) and Planned Dates
EPA proposes Nonattainment Area SIP rules/guidance (including classification, conformity, emission inventory, modeling [e.g., Appendix W], and nonattainment NSR provisions)	12 months	October 2016
EPA finalizes Designations, Classifications, and Attainment Dates*	24 months	October 2017
EPA finalizes Nonattainment Area SIP rules/guidance	24 months	October 2017
EPA issues final SIP templates, toolkits, etc. to assist states with development of nonattainment area plans	24 months	October 2017
States submit Infrastructure and Transport SIPs	*36 months*	*October 2018*
States submit Attainment plans	*3-4 years*	*December 2020-2021*
Nonattainment Area Attainment Dates (Marginal – Extreme)	*3-20 years*	*December 2020-2037*

* Designations can be finalized in 3 years under certain circumstances.

EPA United States Environmental Protection Agency

Progress on Ozone NAAQS Attainment

(as of March 31, 2015)

	1997 8-hr Ozone (2004 Designations)	2008 Ozone (2012 Designations)
Initial Nonattainment Areas	115	46
Areas Redesignated to Attainment	80 (prior to revocation)	0
Current Nonattainment Areas	35	46
Clean Data Determinations	24	1
Proposed Redesignations/ Redesignation Substitutes	0	0

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2010 SO_2 NAAQS Implementation

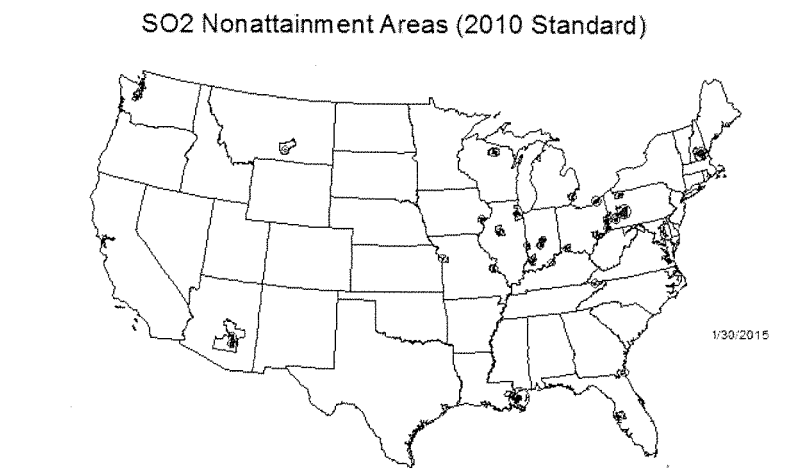
- EPA revised primary SO_2 standard on June 2010 (75 ppb/1-hour)

- 1-hr SO_2 NAAQS NA SIP elements guidance issued on April 24, 2014
  - –www.epa.gov/airquality/sulfurdioxide/pdfs/20140423guidance.pdf
  - –EPA regional offices are working to assist states with SO_2 NA areas in applying this guidance to develop SIPs, redesignation areas, etc.

- Attainment plans for 29 areas currently designated nonattainment are due April 4, 2015

EPA United States Environmental Protection Agency

2010 SO_2 NAAQS



EPA United States Environmental Protection Agency

SO_2 Data Requirements Rulemaking

- In April 2014, EPA proposed requirements for air agencies to characterize SO_2 levels near sources across the country for purposes of implementing the 1-hour SO_2 National Air Ambient Quality Standards (NAAQS)
- Proposed requirements would focus on characterizing air quality in areas with larger sources of SO_2 emissions, and include smaller sources in areas with higher population
  - Proposal included a schedule for state and tribal air agencies to characterize air quality using modeling or monitoring, and provide that air quality data to the EPA
- Final rule anticipated summer 2015
- In the meantime, EPA recommends that states consider practical issues associated with implementing the requirements as proposed

2010 SO_2 NAAQS Implementation: Designations

- Consent decree received on March 2, 2015 from U.S. District Court for Northern California "triggered" the following:
  - July 2, 2016 (The EPA must complete CD round of designations)
  - December 31, 2017 (The EPA must complete an additional round of designations)
  - December 31, 2020 (The EPA must complete all remaining designations)
  - 2017 and 2020 rounds would occur consistent with EPA's anticipated final SO_2 DRR

2010 SO_2 NAAQS Implementation: July 2, 2016 Designations

- Group 1 that EPA must designate:
  - Areas with violation of the 2010 SO_2 NAAQS (based on 2013-2015 data)
  - *Preliminarily (based on 2012 – currently available 2014 data):*
    - Chatham County, Georgia
    - Hawaii County, Hawaii
    - Iron County, Missouri
    - Williams County, North Dakota
    - Brown County, Wisconsin
    - Carbon County, Wyoming

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2010 SO_2 NAAQS Implementation: July 2, 2016 Designations

- Group 2 that the EPA must designate:
  - Areas where there are sources (electric power plants) that as of March 2, 2015, have not been "announced for retirement," and meet one of the following emissions thresholds:
    - 16,000 tons of emitted in 2012 *or*
    - *2*,600 tons of SO_2 emitted in 2012 with an average emission rate of at least 0.45 pounds of SO_2 per mmBtu
- "Announced for Retirement"
  - Any stationary source in the United States with a coal-fired unit that as of January 1, 2010, had a capacity of over five (5) megawatts (MW); and
  - That has announced as of March 2, 2015, that it will cease burning coal at that unit through a company public announcement, public utilities commission filing, consent decree, public legal settlement, final state or federal permit filing, or other similar means of communication.
- Yields 68 sources in 24 states

July 2, 2016 Designations: Schedule

Milestones and Schedule for Completing the July 2, 2016, Round of SO_2 Designations	
Milestone	Date
Court Order	March 2, 2015
Impacted states may submit updated recommendations and supporting information for area designations to the EPA	No later than September 18, 2015
The EPA notifies impacted states concerning any intended modifications to their recommendations (120-day letters)	On or about January 22, 2016, but absolutely no later than 120 days prior to final designations (March 2, 2016)
The EPA publishes public notice of state recommendations and the EPA's intended modifications and initiates 30-day public comment period	On or about February 3, 2016
End of 30-day public comment period	On or about March 4, 2016
Impacted states provide additional information to demonstrate why an EPA modification is inappropriate	On or about April 8, 2016
The EPA promulgates final SO_2 area designations (no later than 16 months from Court Order)	No later than July 2, 2016

December 31, 2017 Designations: Impacted Stakeholders and Schedule

- By December 31, 2017, EPA must complete an additional round of area designations addressing areas where air agencies have not installed and begun operating a new SO_2 monitoring network meeting the EPA's specifications referenced in the Agency's anticipated final rule titled, "Data Requirements Rule for the 1-hour SO_2 primary NAAQS" (Data Requirements Rule)

Milestone	Date
States submit air quality modeling results for selected areas (per the Data Requirements Rule)	01/13/2017
The EPA notifies states concerning any intended modifications (120-day letters)	No later than 09/01/2017
The EPA signs a notice promulgating final SO2 area designations per the court's order.	No later than 12/31/2017

December 31, 2020 Designations: Impacted Stakeholders and Schedule

- The EPA must promulgate designations for any remaining undesignated areas for the 2010 SO_2 NAAQS by December 31, 2020

Milestone	Date
States begin operating new monitoring network (per proposed Data Requirements Rule)	01/01/2017
States certify 2019 monitoring data to calculate the 2017 – 2019 design value	05/01/2020
The EPA notifies states concerning any intended modifications to their recommendations (120-day letters)	No later than 09/02/2020
The EPA signs a notice promulgating final SO2 area designations, per the court's order	No later than 12/31/2020

SO_2 Designations: Additional Information

- Information at www.epa.gov/so2designations/ includes:
  - Fact Sheet
  - Schedule for completing designations
  - Final court order
  - Sources exceeding the criteria established in the court's order
  - Locations of ambient air quality monitors with a preliminary violation of the 2010 SO_2 NAAQS
  - Updated guidance for designations issued on March 20, 2015
  - Technical support and assistance documents

Progress on 2010 SO_2 NAAQS Attainment

(as of March 31, 2015)

	2010 SO_2 (2013 Designations)
Initial Nonattainment Areas	29
Areas Redesignated to Attainment	0
Current Nonattainment Areas	29
Clean Data Determinations	0
Proposed Redesignations	0

2012 $PM_{2.5}$ NAAQS

- Final $PM_{2.5}$ NAAQS rule signed December 14, 2012
  - Revised the primary annual $PM_{2.5}$ standard to 12 $\mu g/m^3$
  - Retained secondary annual $PM_{2.5}$ standard of 15 $\mu g/m^3$ and 24-hr $PM_{2.5}$ standards of 35 $\mu g/m^3$
  - EPA also made updates and improvements to monitoring network that include relocating a small number of monitors to measure $PM_{2.5}$ near heavily traveled roads in areas with populations ≥1 million
    - These relocations will be phased in over two years (2015-2017) and will not require additional monitors

- U.S. Court of Appeals, D.C. Circuit issued its decision on May 9, 2014 regarding lawsuit challenging the final $PM_{2.5}$ NAAQS
  - Court denied petitions for review on all accounts

2012 $PM_{2.5}$ NAAQS Implementation

- January 2013 DC Circuit decision regarding litigation on 2007 $PM_{2.5}$ implementation rule and 2008 NSR rule for $PM_{2.5}$
  - Court held that EPA must implement $PM_{2.5}$ NAAQS under subpart 4
- EPA issued final deadline and classifications rule issued on June 2, 2014 (79 FR 31566). The rule:
  - Classified areas designated nonattainment for the 1997 and/or 2006 $PM_{2.5}$ standards as "Moderate"
  - Set new deadline of December 31, 2014, for states to submit attainment–related and nonattainment NSR SIP submissions required under subpart 4 as needed
  - Directed states to existing EPA guidance (1992 General Preamble and 1994 Addendum) to better understand subpart 4 requirements
- Petition for review filed July 31, 2014, by WildEarth Guardians in D.C. Circuit Court of Appeals on deadline/classifications rule
  - Petitioners filed opening brief on January 16, 2015
  - EPA's response is due in early April 2015

2012 Annual $PM_{2.5}$ NAAQS: Designations

- December 18, 2014 – Administrator signed final area designations for most areas of the country (based on 2011-2013 data)
  - Final designations published in Federal Register on January 15, 2015
  - Effective date for designations is April 15, 2015 (90 days)
  - Supplemental final signed March 31, 2015 changed designation of several areas to attainment based on early-certified 2014 data showing attainment

- Final designation decisions include 9 nonattainment areas involving 4 states, plus several unclassifiable areas
  - 1 tribal area designated separate unclassifiable/attainment
  - 3 Unclassifiable areas: IL (+2 IN + 4 MO counties/1 city in MO), PR, USVI

2012 Annual $PM_{2.5}$ NAAQS: Designations (con't)

- States with nonattainment areas must submit attainment plan within 18 months of the effective date of designation (by October 15, 2016)
  - Attainment deadline is no later than 6 years from the effective date of designation (by April 15, 2021, using 2018-2020 data)
- EPA deferred final decisions for up to 1 year for several areas
  - 5 Deferred areas: FL, TN (-3 counties), 3 GA areas
- Remainder of 2015 – review certified 2014 data and preliminary 2015 data in deferred areas and take action as appropriate

$PM_{2.5}$ NAAQS Implementation: SIP Requirements NPRM

- On March 10, 2015, EPA issued its proposed rule for SIP requirements that would apply to current and future $PM_{2.5}$ nonattainment areas
  - Published on March 23, 2015 (80 FR 15340)
  - Public hearing scheduled for April 29, 2015 in Washington, DC
  - Public comment period closes on May 29, 2015
  - Finalize in late 2015/early 2016

- Webinar for state, local and tribal air agencies held on March 18, 2015
  - Webinar slides and recording available online at www.epa.gov/pm/actions.html
  - Significant amount of implementation detail from the proposal addressed in webinar

$PM_{2.5}$ NAAQS Implementation: SIP Requirements NPRM

- The proposal:
  - Takes comment on approaches to clarify nonattainment implementation requirements according to subpart 4 of part D of Title I of the CAA, consistent with January 2013 D.C. Circuit Court decision
  - Would apply to all 2012 $PM_{2.5}$ NAAQS nonattainment areas, areas designated for the 1997 and 2006 $PM_{2.5}$ NAAQS, and any additional areas designated nonattainment for these or future revised $PM_{2.5}$ NAAQS
  - Addresses how subpart 4 court decision affects nonattainment NSR permitting requirements (e.g., with respect to major source threshold, precursors, etc.)

$PM_{2.5}$ NAAQS Implementation: SIP Requirements NPRM

- Proposal addresses a number of requirements including:
  - Attainment plan due dates, attainment dates and attainment date extension criteria for Moderate and Serious nonattainment areas
  - Determination criteria for Reasonably Available Control Measures (RACM) for Moderate areas and Best Available Control Measures (BACM) for Serious areas
  - Plans for demonstrating reasonable further progress and for meeting periodic quantitative milestones
  - Criteria for reclassifying a Moderate nonattainment area to Serious

- EPA is also proposing:
  - Options for air agencies to demonstrate that one or more $PM_{2.5}$ precursors do not contribute significantly to $PM_{2.5}$ levels in a particular nonattainment area
  - Options for revoking the 1997 primary annual $PM_{2.5}$ standard of 15 micrograms per cubic meter ($\mu g/m^3$)

Schedule for 2012 $PM_{2.5}$ NAAQS Implementation Rules/Guidance/Tools

Action	After NAAQS Promulgation	(Actual) and Planned Dates
EPA promulgates 2012 $PM_{2.5}$ NAAQS rule and Monitoring, Exceptional Event Demonstration Schedule, and PSD guidance or rule as part of NAAQS rule	N/A	**(Dec 2012)**
EPA issues Designations guidance	4 months	**(April 13)**
States submit Designation recommendations as needed	12 months	**(Oct 2013 – March 2014)**
EPA finalizes $PM_{2.5}$ area designations	24 months	**(Dec 2014)**
EPA proposed nonattainment area SIP rules or guidance (e.g., modeling, emission inventory and permit modeling guidances)	12 months	**(March 2015)**
Effective date of EPA designations	27 months*	April 2015
EPA issues final nonattainment area SIP rules or guidance (e.g., modeling, emission inventory and permit modeling guidances)	27 months*	Early 2016
EPA and/or air agencies issue final SIP templates, toolkits, etc. to assist states with development of nonattainment area plans	27 months*	Sept 2016
States submit Attainment plans	45 months	Sept 2016

* Designations can be finalized in 3 years under certain circumstances.

Progress on $PM_{2.5}$ NAAQS Attainment

(as of March 31, 2015)

	1997 $PM_{2.5}$ (2005 Designations)	2006 $PM_{2.5}$ (2009 Designations)
Initial Nonattainment Areas	39	32
Areas Redesignated to Attainment	26	8
Current Nonattainment Areas	13	24
Clean Data Determinations	11	13
Proposed Redesignations	2	6

EPA United States Environmental Protection Agency

SSM SIP Call: Recap of Proposals

- In 2011, EPA entered into a settlement agreement to take final action on a Sierra Club petition for rulemaking concerning SIP provisions for treatment of excess emissions occurring during periods of startup, shutdown and malfunction (SSM)
- In February 2013, EPA proposed SIP calls to 36 states with certain SSM-related SIP provisions
  - Proposal restated and invited public comment on EPA's SSM Policy as it applies to State Implementation Plans, with one change regulating affirmative defense (AD) provisions
- In September 2014, EPA issued a supplemental proposal to address "affirmative defense" provisions for malfunctions
  - SNPR addressed a 2014 DC Circuit decision on EPA's cement NESHAP and its implications for SIPs and how specific SIPs may be affected
  - SNPR affected provisions in SIPs for 17 states

SSM SIP Call: Toward Final Rulemaking

- Pursuant to the settlement agreement, final rule to be signed May 22, 2015
- As proposed, the deadline for state action to remove provisions from their rules and make corrective SIP submissions will be 18 months after the final action
- Link to EPA's webpage specific to this rule is at www.epa.gov/airquality/urbanair/sipstatus

EPA
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Environmental Protection
Agency

QUESTIONS OR COMMENTS

Fact of the Day: Asthma Rates Have Increased While Ozone Levels Have Fallen

More deaths for poor when income declines

By Karen Kerrigan

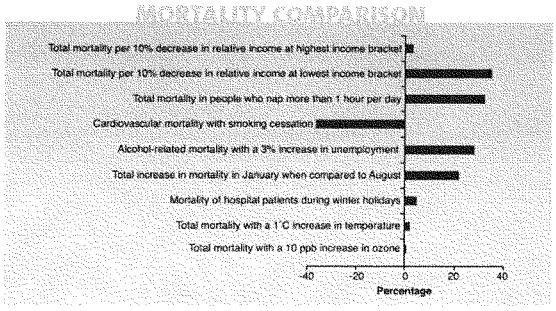
The Environmental Protection Agency (EPA) often invokes asthma as the reason to lower national ambient air quality standards for ozone. Ozone, EPA asserts, can worsen the condition for asthma sufferers, especially children. But as Texas state toxicologist Dr. Michael Honeycutt shows, asthma rates have been increasing, yet ozone levels have been declining. For these and other reasons Honeycutt says "there will be little to no public health benefit" if EPA lowers current ozone standards.

In the October edition of *Natural Outlook*, a monthly newsletter published by the Texas Commission on Environmental Quality, Honeycutt also notes something startling about EPA's own analysis: It shows that lowering ozone concentrations in some cities would actually *increase* mortality. "Either this indicates that lowering the ozone standard defeats its stated purpose of protecting human health," Honeycutt wrote, "or it indicates that something is wrong with the EPA's interpretation of the data. Either way, it's not a good argument for lowering the ozone standard."

Of course EPA is not eager to have this information in the public domain, so, as Honeycutt points out, it is buried deep in EPA's technical documents. "Further," he wrote, "the EPA is not very forthcoming about the increased deaths. It's not mentioned in the executive summary of their policy analysis, but it's found on page 115 of Chapter 3, more than one third of the way through the 597-page document."

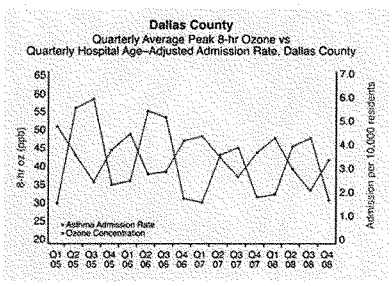
Honeycutt also discovered that only "1 out of 12 studies considered by the EPA showed an association between long-term exposure to ozone and early death (after considering other pollutants)." As he noted, "This single study is used by the EPA as evidence that long-term exposure to ozone causes mortality." And as he pointed out, "this study did not show higher mortality in Southern California, where some of the highest ozone levels in the country are measured."

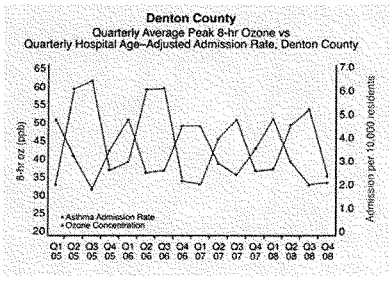
To get a comparative sense of the harm posed by ozone, Honeycutt compiled the chart below. "Many factors influence mortality," he wrote, "and the effect of an increase in ozone by 10 ppb is tiny in comparison to these other influences." As one can readily see, those in the lowest income bracket are far more likely to die from a 10 percent decrease in relative income than from a 10 parts per billion increase in ozone. By the same token, ozone total mortality doesn't come close to the "total mortality in people who nap more than 1 hour per day."



Many factors influence mortality, and the effect of an increase in ozone by 10 ppb is tiny in comparison to these other influences.

If that doesn't demolish the case for lowering current ozone standards, the charts below provide a powerful illustration of Honeycutt's points about asthma and ozone. As you can see, 8-hour ozone concentrations in Dallas County went down, yet the incidence of asthma went up. Moreover, hospital admittances for asthma were highest in winter, when ozone concentrations "are normally lowest."





Data collected from Texas hospitals indicates that admissions for asthma are actually highest in the winter, when ozone concentrations are normally lowest. This casts further doubt on the EPA's assertion that ozone is an important driver of asthma symptoms.

Honeycutt sums up his case this way: "There should be no doubt that lowering the standard will result in health benefits, but that is not the case for this consideration of the ozone standard. How can the EPA in good conscience make a policy decision this expensive when the data are so contradictory that their own modeling predicts more deaths in some areas from lowering the standard?"

Good question. It's time for EPA to re-evaluate the science of ozone and avoid lowering the standard, an action that, according to NERA Economic Consulting, could cost the economy $270 billion annually and destroy thousands of jobs. That's bad for the economy, bad for small businesses, and bad for public health.

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OKLAHOMA DEPARTMENT OF TRANSPORTATION

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VIA ELECTRONIC SUBMITTAL (www.regulations.gov)

March 17, 2015

Dockets Management Facility
US Department of Transportation
1200 New Jersey Avenue SE
Washington DC. 20590

Subject: Comments from Oklahoma Department of Transportation
EPA Docket ID Number EPA-HQ-OAR-2008-0699; FRL-9918-43-OAR

Dear Administrators:

The Oklahoma Department of Transportation (Oklahoma DOT) is writing this comment letter in response to the Federal Register notice of proposed rulemaking (NPRM) dated December 17, 2014, regarding 40 CFR Parts 50, 51, 52, 53, and 58: National Ambient Air Quality Standards for Ozone.

Three areas within the state of Oklahoma that represent the greatest percentage of population have a combined total of thirteen air quality monitors. These areas are represented by metropolitan planning organizations (MPOs) designated by the Governor of Oklahoma for transportation planning purposes: the Association of Central Oklahoma Governments (ACOG) in the Oklahoma City metropolitan area; the Indian Nations Council of Governments (INCOG) in the Tulsa metropolitan area; and the Lawton Metropolitan Planning Organization (LMPO). Each of these MPOs continues to do an excellent job of providing leadership in maintaining compliance with the current ozone standards. The metropolitan areas have proactively engaged in efforts to educate the public and minimize emissions through efforts such as, but not limited to, the Air Quality Compact, Chamber of Commerce work sessions, and promoting non-motorized transportation.

Oklahoma DOT supports improving air quality in Oklahoma and is committed to protecting public health and welfare for those citizens that are impacted by elevated levels of ozone. The State of Oklahoma prides itself in the commitment made by its communities toward maintaining attainment of the current National Ambient Air Quality Standards (NAAQS). With the Environmental Protection Agency's (EPA) proposed lowering of the 8-hour primary standard to the 0.065 to 0.070 ppm range, a large majority of Oklahoma's 77 counties will be impacted, and at least 16 of Oklahoma's 77 counties will be at risk of being designated as nonattainment of the NAAQS for ground-level ozone.

Oklahoma DOT recognizes that EPA's proposed action results from extensive scientific evidence and expert advisement regarding the effect ground-level ozone has on public health and welfare. Lacking expertise in the area of research associated with NAAQS, Oklahoma DOT is not commenting on the science. Oklahoma DOT supports an air quality index (AQI) which "protects public health with an adequate margin of safety, including the health of at-risk groups". However, Oklahoma DOT suggests that there is a serious underlying problem in the constraints defined in Clean Air Act (CAA), which ties a national health standard to an unfeasible implementation timeline. Therefore, Oklahoma DOT recommends that future amendments are essential to the severely outdated CAA.

EPA's analysis found that only 9 counties outside of California would violate the 70 ppb standard in 2025, and only 68 counties outside of California would violate the 65 ppb standard in 2025 due to

federal regulations and programs underway. Some of these include the final Mercury and Air Toxics Standards, the final Tier 3 Vehicle Emissions and Fuels Standards, the Mobile Source Air Toxics Rule, requirements to reduce the interstate transport of ozone, and the Regional Haze rules. Oklahoma DOT agrees with AASHTO that EPA should use all regulatory flexibilities available within existing law to defer the imposition of transportation conformity requirements on areas that EPA's own modeling shows will come into compliance with the NAAQS without any additional actions being taken. If the transportation conformity requirements cannot be entirely deferred in these areas, EPA should allow a streamlined process for making conformity determinations in those areas, given that additional actions are not needed to achieve the NAAQS or demonstrate conformity.

The Oklahoma DOT offers the following observations concerning the proposed rulemaking:

- Rural areas do not have the resources to achieve sufficient reductions of pollutants. The proposed action would be detrimental to social and economic development for rural areas across the state of Oklahoma.

- The full impact of current federal rules and regulatory programs has not been realized at the local level. EPA's own analysis predicts continued air quality improvements and declining ozone levels from the rules and programs already underway.

- Most major metropolitan areas and several rural Oklahoma counties will be designated nonattainment under the proposed action, adding a significant burden to already strained resources at the state and local levels. Given the fact that EPA's own projections show that all counties in Oklahoma would meet the 70 ppb standard in 2025 *without any additional action being taken*, and only one county would violate the 65 ppb standard in 2025 (Oklahoma County has a projected three-year average of 66 ppb), the reduction of the standard at this time seems premature. In an environment that espouses long term planning, this seems contradictory and an unnecessary use of resources.

For reasons mentioned above, Oklahoma DOT strongly recommends that EPA retain the existing primary and secondary NAAQS for ozone at 0.075ppm, to provide the time needed for the consideration and implementation of the regulatory air quality improvement rules and programs already underway.

Oklahoma DOT also urges EPA to consider a programmatic approach to exceptional events that includes an extended schedule vs. the current very tight schedule. EPA could choose to designate areas with outstanding exceptional events as "unclassifiable" and make a final designation after the exceptional event packages are complete.

Thank you for the opportunity to comment on this important topic.

Sincerely,

John R. Bowman, P.E.
Director of Capital Programs

cc Director
Deputy Director
Chief Engineer

CHEMISTRY COUNCIL OF NEW JERSEY

March 10, 2015

The Honorable Gina McCarthy
Administrator
U.S. Environment Protection Agency
Attn: Docket ID No. EPA-HQ-OAR-2008-0699

Dear Administrator McCarthy:

As an association representing the business of chemistry in New Jersey, including manufacturers large and small, we are deeply concerned about the harmful impact that the Environmental Protection Agency's (EPA) proposed rule to make ozone standards more stringent could have on the still struggling economy. Ozone standards at the levels considered in EPA's proposal could push much of the country into "nonattainment" – where local communities face burdens to commercial and industrial activity not only vital to creating jobs, but also to providing tax revenue that support important local services like public safety and education. This proposal's hardship to the American worker is real and immediate, while the benefits are unverified and uncertain. Therefore, we strongly urge you to retain the current ozone standard when finalizing this proposal.

We all value clean air. The managers and employees of the companies we represent, as well as their families, all breath the same air. We are proud that emissions of ozone-forming emissions have been cut in half since 1980, leading to a 33% drop in ozone concentrations. Moreover, EPA just updated ozone standards six years ago. The implementation of the current ozone standards are behind schedule due to EPA effectively suspending their implementation from 2010-2012 while the Agency unsuccessfully pursued reconsideration. This country can expect to see even greater reductions in ground-level ozone as states make up lost ground in putting the current standards into effect.

Indeed, states are currently committing substantial resources – both in time and money – towards achieving emissions reductions under those current ozone standards. Yet despite over three decades of cleaner air, and before states can catch up with EPA's delays in implementing existing ozone standards, EPA is now proposing a new stringent range of standards from 70 to 65 parts per billion that would bring vast swaths of the country into nonattainment. In some areas, this proposed range is at or near the level of background ozone that is naturally occurring or internationally transported, pushing even remote counties far from industrial activity into nonattainment. According to EPA's own data, even the pristine Grand Canyon and Yellowstone National Parks would fail the proposed ozone standards.

If finalized, EPA's proposed stringent ozone standards could limit business expansion in nearly every populated region of the United States and impair the ability of U.S. companies to create new jobs. This is of great concern to the business of chemistry, given that the shale gas revolution is driving a historic expansion in American chemistry. More than $137 billion in new chemistry industry investment is planned or underway, thanks to plentiful and affordable supplies of natural gas and natural gas liquids. Fully 60 percent is foreign direct investment. The 224 projects – new plants, expansions, and factory restarts – could create and support more than 700,000 jobs by 2023. They will also generate increased GDP, tax revenue, and access to innovative new products, such as plastics and insulation products, which help save energy in vehicles, homes, and businesses. The energy savings result in lower emissions of greenhouse gases and ozone precursors such as NO_x.

The business of chemistry is a vital component of New Jersey's economy. It is a $25 billion industry, making New Jersey the ninth largest chemistry producing state. Chemical products remain the state's largest export, accounting for 23.3 percent of all exports, equaling $8.6 billion. Thus the business of chemistry is the largest manufacturing sector in the state, providing more than 50,000 high paying jobs, averaging a salary of $124,750 per year.

A lower ozone standard could impede manufacturing growth in many areas of the country. EPA's proposed range would immediately add red tape to companies seeking to grow even in areas that can attain those standards. The Clean Air Act carries even stiffer consequences for nonattainment areas, directly impacting economic vitality of local communities and making it difficult to attract and develop business. Increased costs associated with restrictive and expensive permit requirements would likely deter companies from siting new facilities in a nonattainment area.

According to the National Association of Manufacturers, the new rules could cost New Jersey $86 billion in gross state product loss from 2017 to 2040, more than 51000 lost jobs per year, and $52 billion in total compliance costs. Not only would these new standards have a devastating impact on New Jersey's business of chemistry, but the state's economy as a whole would suffer.

Companies building a new facility or performing major modifications to certain existing facilities resulting in increased ozone concentrations in, or near, a nonattainment area will be required to meet the most stringent Clean Air Act standard by installing the most effective emission reduction technology regardless of cost. As well, states are mandated to offset any ozone-forming emissions from new projects or projects undergoing major modifications by reducing emissions from other existing sources in a nonattainment area. New facilities and expansions in nonattainment areas cannot proceed until emissions are offset. Offsets are not always readily available, and increase in price as they become scarce. Nonattainment designation also has profound impact on infrastructure development vital to the business community. Beginning one year from the date of the nonattainment designation, federally-supported highway and transit projects cannot proceed in a nonattainment area unless the state can demonstrate that the project will cause no increase in ozone emissions.

These restrictions do not disappear when an area finally comes into attainment. Instead, former nonattainment areas face a legacy of EPA regulatory oversight. Before a nonattainment area can be re-designated to attainment, EPA must approve an enforceable maintenance plan for the area that specifies measures providing continued maintenance of ozone standards and contingency measures to be implemented promptly if an ozone standard is violated.

Against these economic consequences, scientific uncertainties regarding the benefits of more stringent ozone standards have increased. Indeed, stringent ozone standards may have severe unintended consequences for public health. Studies show that by increasing the costs of goods and services such as energy, and decreasing disposable incomes, regulation can inadvertently harm the socio-economic status of individuals and, thereby, contribute to poor heath and premature death. As a representative of businesses employing needed jobs in our communities, we believe these scientific uncertainties should be better explored in order to best allocate resources in a manner that strengthens both the economy and the environment.

The air is getting cleaner, and current ozone standards need an opportunity to work. Even the New Jersey Department of Environmental Protection stated in a Trends Report that "it is virtually certain that ozone levels are lower today than they were a decade ago" (Ozone, Environmental Trends Report, NJDEP, Office of Science, October 2012). Therefore, in light of the economic hardship, reduction in funding for crucial civic services, and uncertain benefits all related to the stringent ozone standards that EPA is now considering, we call on EPA to retain the existing ozone standards in the final rule.

Sincerely,

Hal Bozarth
Executive Director

March 1, 2015

The Honorable Gina McCarthy, Administrator
U.S. Environmental Protection Agency
Attn: Docket ID No. EPA-HQ-OAR-2008-0699

Dear Administrator McCarthy:

As trade associations representing a wide range of businesses that employ thousands in Connecticut, we are very concerned about the harmful impact EPA's proposed ozone rule will have on employers here. According to EPA's own data, the proposed 65-70 ppb standard is unobtainable in much of Connecticut, even by 2025. Therefore, we strongly urge you to retain the current ozone standard (75 ppb)---and not go any lower---because a lower standard is just not practical. As you know, we have cut our ozone emissions here enormously since the 1980's.

If finalized at a level lower than 75 ppb, EPA's standard could limit business expansion, impair the ability of local companies to create new jobs, and create more regulatory red tape. Regulators at the Connecticut Department of Energy & Environmental Protection would be forced to issue new regulations and control strategies which we expect would severely impact companies that currently operate or wish to expand their facilities here, as well cars, trucks and buses. Increased costs make us a less attractive place to do business. The Clean Air Act also carries stiff consequences for non-attainment areas such as Connecticut.

The non-attainment designation also has a profound impact on infrastructure development: Beginning one year from the date of non-attainment designation, federally-supported highway and transit projects cannot proceed in a non-attainment area such as Connecticut unless the state can demonstrate that the project will not cause any increase in ozone emissions.

EPA just updated its ozone standard six years ago, so a re-write isn't necessary. That standard is behind schedule due to EPA suspending its implementation, but once promulgated, we will see even greater ozone reductions as states make up lost ground when the current 75 ppb standard actually becomes effective. We all value clean air, and implementing the 75 ppb standard in full will give us an air quality standard we can be proud of.

The air is getting cleaner and the current 75 ppb ozone standard needs an opportunity to work. In light of economic hardship and uncertain benefits related to the stringent standard EPA is considering, we ask you to retain the existing 75 ppb ozone standard in the final rule.

Sincerely,

Eric Brown, Associate Counsel
Connecticut Business & Industry Association

William Ethier, Chief Executive Officer
Home Builders & Remodelers
Association of Connecticut

Michael J. Riley, President
Motor Transport Association of Connecticut

Christian A. Herb, President
Connecticut Energy Marketers
Association

Michael J. Fox, Executive Director
Gasoline & Automotive Service Dealers
Of America, Inc.

Jean M. Cronin, Executive Director
Connecticut Bus Association

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The Energy & Environment Legal Institute

Submits:

Comments on
Proposed Rule: National Ambient Air Quality Standards for Ozone
78 Fed. Reg. 75,234 (December 17, 2014)

Submitted Electronically to:
U.S. Environmental Protection Agency

Air Docket:
EPA-HQ-OAR-2008-0699

March 16, 2014

INTRODUCTION

The Energy and Environment Legal Institute (E&E Legal) is a 501(c)(3) organization engaged in strategic litigation, policy research, and public education on important energy and environmental issues. E&E Legal seeks to address and correct onerous federal and state governmental actions that negatively impact energy and the environment. E&E Legal advocates responsible resource development, sound science, respect for property rights, and a commitment to markets as it holds accountable those who seek excessive and destructive government regulation that's based on agenda-driven policy making, junk science, and hysteria.

SUMMARY OF COMMENTS

EPA's proposed ozone rule will cause more harm than it will prevent. The Agency has long held that "those who bear a regulation's compliance costs may also suffer a decline in their health status, and if the costs are large enough, these increased risks might be greater than the direct risk-reduction benefits of the regulation." That is the case for the ozone proposal. None of the three proposals has a benefit to society, considering exclusively the health effects of the proposed alternatives. Specifically, the regulatory alternatives will cause more premature death than they will prevent. Because the estimated premature death avoided is more than 98 % of the estimated benefit of the proposals, and because the loss of disposable income will cause from 17 to 31 times more premature death than the rules will prevent, the rules have no benefit to society and do not protect human health. For this and other reasons discussed below, EPA should withdraw its proposal.

COMMENTS

I. EPA has conflated $PM_{2.5}$ controls with a rule on Ozone.

Based on EPA's own data, and taking the most generous estimate of ozone benefits, the costs exceed the benefits, ranging anywhere from half a billion dollars for a 70 parts per billion standard to $19 billion for a 60 parts per billion standard.

The benefits only outweigh costs if taking into account $PM_{2.5}$ co-benefits. $PM_{2.5}$ co-benefits, assuming the highest levels of benefits, account for anywhere between 70–75% of the total benefits, depending on the standard. In other words, for the proposed ozone standard, ozone benefits are only about a quarter of the benefits.

While the EPA has constantly used $PM_{2.5}$ co-benefits to improperly justify a seemingly endless amount of regulations that have nothing to do with the reason for the regulations, using $PM_{2.5}$ co-benefits to make the case for an ozone standard is particularly egregious.

The EPA has a very clear and direct means to address $PM_{2.5}$ through the National Ambient Air Quality Standards process, and that, not surprisingly, is through the $PM_{2.5}$ standard. The ozone standard is a distinct standard that is supposed to be focused on ozone.

To sell a more stringent ozone standard, the EPA lists a series of alleged facts in its "By the Numbers" document that will scare the public into thinking a more stringent standard is necessary. For example, according to the EPA, setting the ozone standard to 70 parts per billion or 65 parts per billions would avoid:

- 65,000–180,000 missed work days; and
- 790 to 2,300 cases of acute bronchitis among children

Neither of these alleged facts, however, are based on reductions in ozone. They are based exclusively on assumed $PM_{2.5}$.

The public is being led to believe that reducing ozone achieves these health benefits. In reality, much of these alleged benefits have nothing to do with an actual reduction in ozone. These numbers, assuming the facts listed are reasonable estimates, should also be put in perspective. For example, the EPA claims making the standard more stringent would avoid 1,400 to 4,300 asthma-related emergency room visits. Given that there are about 1.8 million such visits in a year, the reduction amounts to eight-hundredths of one percent to two-tenths of one percent (0.08% to 0.2%) a minuscule impact at best. Further, these numbers are based on both reductions in $PM_{2.5}$ and ozone, not on ozone alone. Taking ozone alone, the evidence EPA has cited (and discussed below) could even be used to suggest that small ozone exposures improve asthma conditions. And, as discussed below, ozone alone is not well associated with asthma.

EPA controls $PM_{2.5}$ through a NAAQS. If EPA believes it necessary to further reduce $PM_{2.5}$, it should do so through revision of the $PM_{2.5}$ NAAQS. But, EPA had the opportunity to further reduce the $PM_{2.5}$ standard and did not. In part, this is because $PM_{2.5}$ has a threshold of effect. EPA's use of the ozone rule to address PM2.5 if inappropriate. EPA cannot consider additional reductions in $PM_{2.5}$ as co-benefits as EPA has already determined that the residual $PM_{2.5}$ concentrations in the ambient air, after implementation of the $PM_{2.5}$ NAAQS, do not constitute a significant threat to human health and the environment. If EPA did believe these exposures constituted as significant threat to human health, EPA should have promulgated a significantly lower $PM_{2.5}$ NAAQS. Because EPA had the opportunity to do so, but chose not to do so, EPA is not now able to claim additional threat that should be avoided as it does in the ozone proposa.

II. The Ozone Regulatory Alternatives' Benefits are Negative and will cause more death that they would prevent.

Reductions in premature deaths attributed to coincidental reductions in ozone and fine particulate ($PM_{2.5}$) pollution account for more than 98% of the estimated health benefits of the proposed rule.[1] The bases for these estimates are fatally in error. A proper analysis shows the regulatory alternatives cause more premature death than they prevent.

[1] See, RIA ES-22.

A. Benefits are Over-Estimated

EPA claims that $PM_{2.5}$ pollution currently kills thousands of Americans annually, deaths that would be avoided by the proposed rule, but these estimates are based on cherry-picked studies and extrapolation of health effects below the lowest $PM_{2.5}$ concentrations associated with mortality in epidemiological studies.[2] Such claims also conflict with toxicological studies,[3] which indicate that current $PM_{2.5}$ concentrations in U.S. cities are too low to cause significant disease or death.[4]

The rule's purported health benefits for ozone reduction are even less plausible, since asthma prevalence – especially childhood asthma rates — increased since 1980[5] while, according to EPA, ozone concentrations declined by 25%.[6] The link between asthma and ozone is simply not credible based on this single fact, a fact EPA does not and cannot dispute and has never been able to explain away.

B. EPA Fails to Count Premature Deaths the Rule will CAUSE

EPA's analysis callously ignores the health-wealth relationship of the proposed ozone regulatory alternatives. EPA helped lead research into the relationship between health and disposable income, commissioned studies on how to apply this knowledge and like other agencies has used this analytical method routinely. That it has not done so in this rule is a fatal flaw of its analysis of the health consequences of the regulatory alternatives. Failure to examine this aspect of the health effects of this rule constitutes arbitrary and capricious behavior that requires EPA to conduct the analysis and reoffer the rule for public comment, or more appropriately, withdraw the regulatory proposal.

Amongst the 121.1 million families in the United States (under-counting families that are not legally in residence), over nine million (9,200,000) families have pretax annual incomes of less than $10,000, averaging about $5,000 a year.[7] These families are typically minorities or the

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[2] *See* Attachment C, Goodman, J. "EPA's Assessment of Health Benefits Associated with $PM_{2.5}$ Reductions for the Final Mercury and Air Toxics Standards" available at file:///D:/1%20E&E%20Legal/111d%20Project/111d%20comments/HHRG-112-IF03-WState-JGoodman-20120208.pdf.

[3] *See* Attachment D, Schwartz, J. "Where the Bodies are Buried", available at http://johnlocke.org/site-docs/research/schwartz-tva.pdf.

[4] *See* Attachment E, Green, L.C. & Armstrong, S.R. "Particulate matter in ambient air and mortality: toxicologic perspectives" Regul Toxicol Pharmacol. 2003 Dec;38(3):326-35, abstract available at http://www.ncbi.nlm.nih.gov/pubmed/14623483.

[5] *See* Attachment F, Akinbami, L.J., et al, "Asthma Prevalence, Health Care Use, and Mortality: United States, 2005–2009" National Health Statistics Reports No. 32, available at http://www.cdc.gov/nchs/data/nhsr/nhsr032.pdf.

[6] *See* Attachment G, EPA, "National Trends in Ozone Levels" available at http://www.epa.gov/airtrends/ozone.html.

[7] U.S. Census Bureau 2012 data.

elderly on fixed income. To ignore the consequences of the rule on these families is tantamount to complete failure to examine the environmental equity of the rule. Based on the analysis below and the likelihood that premature deaths will arise within these subpopulations, the rule is both racist and ageist. As discussed below, the 60 ppb rule would consume 60 percent of that average income, a massive amount that these families cannot avoid. The health consequences of losing that amount of disposable income is significant.

The implications of cost increases on the poor are well known. The challenges these very poor families face is legend. [8]

- 28 percent did not make their full mortgage or rent payment.
- 4 percent were evicted from their home or apartment.
- 4 percent had a foreclosure on their mortgage.
- 11 percent moved in with friends or family.
- 3 percent moved into a shelter or were homeless.

They faced other significant financial problems as well.

- 15 percent got a payday loan in the past five years.
- 3 percent were forced into bankruptcy in the past year

Faced with decreased disposable income, low income persons go without food, medical care and prescription drugs. They become sick more often than those who can absorb the increases in energy bills.[9]

- 32 percent went without food for at least one day.
- 42 percent went without medical or dental care.
- 38 percent did not fill a prescription or took less than the full dose of a prescribed medication.
- 24 percent had someone in the home become sick

And, of those that become sick, some die prematurely simply because they no longer had the disposable income to pay for health care. This is the health-wealth relationship at its core.

EPA has examined this "health-wealth" relationship. Lutter and Morrall explain that

> [r]egulations to promote health and safety that are exceptionally costly relative to the expected health benefits may actually worsen health and safety, since compliance reduces other spending, including private spending on health and safety. Past studies relating income and mortality give estimates of the income loss that induces one death--a value that

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[8] NEADA 2008 NEAS, http://neada.org/wp-content/uploads/2013/05/2008-NEA-Survey-Executive-Summary.pdf.

[9] *Id.*

we call willingness-to-spend (WTS)--to be around $8.5 million ($US 2006).[10]

The U.S. Environmental Protection Agency has applied this principle to economic analyses, stating: "people's wealth and health status, as measured by mortality, morbidity, and other metrics, are positively correlated. Hence, ***those who bear a regulation's compliance costs may also suffer a decline in their health status, and if the costs are large enough, these increased risks might be greater than the direct risk-reduction benefits of the regulation.***"[11] This, of course, is exactly what the NEADA 2008 Survey found and which the analysis herein documents as well.

EPA failed to estimate the number of premature deaths associated with the loss of disposable income due to its proposal. EPA should have updated and used the U.S. Office of Management and Budget (OMB) federal estimate of one premature death for every $85.5 million

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[10] Lutter, R. and Morrall, J.F., "Health-Health Analysis: A New Way to Evaluate Health and Safety Regulation", Journal of Risk and Uncertainty Vol. 8-1 pp. 43-66 (1994). There is an extensive academic literature regarding the effect of loss of wealth on health. *See, e.g.*, Ralph L. Keeney, "Mortality Risks Induced by Economic Expenditures", *Risk Analysis* 10(1), 147-159 (1990); Krister Hjalte et al. (2003). "Health–health analysis—an alternative method for economic appraisal of health policy and safety regulation: Some empirical Swedish estimates," *Accident Analysis & Prevention* 35(1), 37-46; W. Kip Viscusi "Risk-Risk Analysis," *Journal of Risk and Uncertainty* 8(1), 5-17 (1994); Viscusi and Richard J. Zeckhauser, "The Fatality and Injury Costs of Expenditures", *Journal of Risk and Uncertainty* 8(1), 19-41 (1994); U.S.EPA, Economic Analysis and Innovations Division, "On the relevance of risk-risk analysis to policy evaluation," August 16, 1995, http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0311-1.pdf/$file/EE-0311-1.pdf (accessed January 23, 2011); Arnold, F.S. (1995), Economic Analysis of Environmental Policy and Regulation, (John Wiley and Sons, Inc.: New York); Chapman, K.S., and G. Harihan (1994) "Controlling for Causality in the Link from Income to Mortality", Journal of Risk and Uncertainty, 8(1), 85-93; Graham, J., B. Hung-Chang, and J.S. Evans (1992) "Poorer Is Riskier", Risk Analysis, 12(3), 333-337; Keeney, R.L. (1994) "Mortality Risks Induced by the Costs of Regulations", Journal of Risk and Uncertainty, 8(1), 95-110; Lave, L.B. (1981). The Strategy of Social Regulation: Decision Frameworks for Policy, (The Brookings Institution: Washington, DC); Peltzman, S. (1975) "The Effects of Automobile Safety Regulation", Journal of Political Economy, 83(4), 677-725; Portney, P.R., and R.N. Stavins (1994) "Regulatory Review of Environmental Policy: The Potential Role for Health-Health Analysis", Journal of Risk and Uncertainty, 8(1), 111-122; Smith, V.K., D.E. Epp, and K.A. Schwabe (1994) "Cross-Country Analyses Don't Estimate Health-Health Responses", Journal of Risk and Uncertainty, 8(1), 67-84; Wildavsky, A. (1980). "Richer is Safer", The Public Interest, 60, 23-39.

[11] U.S.EPA, Economic Analysis and Innovations Division, "On the relevance of risk-risk analysis to policy evaluation," August 16, 1995, http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0311-1.pdf/$file/EE-0311-1.pdf (accessed January 23, 2011).

($US 2006) in reduction of disposable income.[12] In addition to OMB, the EPA, the Food and Drug Administration (FDA), and the Occupational Safety and Health Administration (OSHA) use this methodology to understand the degree to which their regulations induce premature death amongst those who bear the costs of federal mandates.[13]

The reduction in premature fatalities that EPA claims the rule will produce accounts for over 98% of total monetized benefits in EPA's benefits analysis. Asthma exacerbations accounts for <<1% of the total.[14] As discussed below, EPA did not balance this benefit with the negative benefit of premature deaths caused by loss of disposable income resulting from implementation of the rule. Table 1 summarizes the net premature deaths caused by the three regulatory alternatives.

Table 1
Premature Deaths Avoided and Caused by the Regulatory Alternatives
For the period through 2025 (Total U.S.)†

	60 ppb	**65 ppb**	**70 ppb**
Premature Death **Avoided**	10,000 (3,300 to 18,000)	5,000 (1,800 to 12,000)	1,800 (1,100 to 4,100)
Premature Death **Caused**			
EPA Estimate	46,000	18,000	4600
NERA Estimate	310,000	120,000*	31,000*
Ave. Net Premature Deaths Caused by the Rule	**178,000 (36,000 to 300,000)**	**64,000 (13,000 to 115,000)**	**17,800 (2,400†† to 29,200)**

†California premature deaths avoided are prorated to 2025.
* Based on the ratio of EPA to NERA estimates for 60 ppb.
†† This net prevention of premature death is an extreme value as it is based only on EPA's estimated direct costs. Use of an integrated macroeconomic model to project related losses in disposable income would likely raise this number significantly. Each of the EPA estimates reflect this gross underestimation.

NERA Economic Consulting, a firm identical in nature to those used by EPA to conduct the Agency's regulatory impact assessment, estimates significantly larger adverse impacts than does the Agency for a 0.06 ppm (60 ppb) standard.[15] The NERA-estimated loss in average annual household consumption (disposable income), applicable to the 121.1 million U.S. households is $2,175 (7% discount rate) for the period through 2025. Reflecting the integrated macroeconomic effects of this rule, the reduction in disposable income through 2025 would equal $2.7 Trillion for

[12] The dollar value of expenditures that induce one premature death was inflated to 2006 dollars using the Bureau of Labor Statistics CPI Inflation Calculator.

[13] *See* notes 10 & 11, *supra* and associated text.

[14] EPA Regulatory Impact Analysis Table 5-22, note (b).

[15] NERA Economic Consulting, "Economic Impacts of a 65 ppb National Ambient Air Quality Standard for Ozone" available at: http://www.nam.org/Issues/Energy-and-Environment/Ozone/Economic-Impacts-of-a-65-ppb-NAAQS-for-Ozone-(NERA).pdf.

a standard set at 60 ppb. This loss in disposable income will result in 310,000 premature deaths, applying a conservative estimate of one premature death for every $8.5 Million (in $2006) in lost disposable income. See Table 1.

EPA did not apply an integrated macroeconomic analysis within its regulatory analysis, did not calculate the cost per household of the regulatory alternatives, and did not calculate the premature deaths caused by the loss of disposable income. Rather, it estimated the present value (in $2006) of direct costs. Although this would be a gross underestimate of actual lost disposable income, Table 1 uses that direct costs as an extreme lower-bound estimator of premature deaths costs by the regulatory alternatives. Using that estimator, the 60 ppb alternative would result in 46,000 premature deaths. Similar extreme lower bound estimates for the other regulatory alternatives are also gross underestimates, likely to be roughly 4 to 8 times too low, because the direct cost does not capture the multiplier effects within the economy that significantly reduces disposable income.

The number of premature deaths caused by loss of disposable income is well in excess of the number of premature deaths EPA claims will be prevented by the rule. A gross assumption that the same ratio of effects at the 60 ppb level also applies to the 65 and 70 ppb alternatives again results in more death caused than death prevented and, on average, by a very wide margin.

Former EPA economic analysts describe a rule with these kinds of disproportionate impacts as a "rule with blood on its hands."[16]

EPA's failure to fully examine the adverse effects on human health associated with the proposed rule requires EPA to withdraw the rule and more properly analyze the actual harm its proposal will cause.

III. FEV_1 Studies, including the Kim and Adams Studies Do Not Support a Reduction in the Standard.

EPA relies changes in FEV_1 as the basis for concluding that very low ozone levels (<75ppb) impose a significant risk to health in children, citing to Kim, et. al, "Lung Function and Inflammatory Responses in Healthy Young Adults Exposed to 0.06 ppm Ozone for 6.6 Hours", American Journal of Respiratory and Critical Care Medicine Vol 183, 1215 (2011) and Adams "Comparison of Chamber 6.6-h Exposures to 0.04–0.08 PPM Ozone via Square-wave and Triangular Profiles on Pulmonary Responses," Inhalation Toxicology, Vol. 18, No. 2 , pp 127-136 (2006). Reliance on these studies is inappropriate.

EPA conflates a statistically significant difference between exposed and unexposed subject with a significant increase in risk. While Kim and Adams saw very small, if statistically significant, differences between the two test samples (a mere 1.7% and 2.8%, respectively), the magnitude of the actual decrement in FEV_1 values is too small to be meaningful. EPA has ignored the fact that FEV_1 is variable both within groups and in individuals. Only changes greater than

[16] Personal communication with Dr. David W. Schnare, former Chief of the Economic, Legislative and Policy Analysis Branch of the Office of Groundwater and Drinking Water.

5% are considered significant changes in health status. See, e.g., Pellegrino, et al, "Interpretative strategies for lung function tests," Eur. Respir. J. Vol. 26, pp. 948-68 (2005).

In Kim, only 6 of 59 subjects had a greater than 5% reduction in FEV_1 and of these, three had a reduction of greater than 10%, one of which was -17%. Additionally, one subject had a 15% increase in FEV_1. These five subjects are clear outliers and should have been rejected. Had they been rejected, the differences found would not be statistically significant. In nearly 90% of the subjects, the suggested effects of ozone were within normal variation and cannot be characterized as adverse. Indeed, 17 of the 59 subjects (29%) had positive FEV_1 values. Using the presumption of effect applied by Kim, these 17 subjects "benefited" from the ozone exposures. Using a Wilcoxon Sign Rank test and all the data, the effect of the 0.06 ppm (60 ppb) ozone exposures is not statistically significant and EPA can put no reliance on the Kim paper using standard scientific principles and under EPA's own data quality act guidances.

The Balmes study further demonstrates that FEV1 is not correlated with measures of inflammation and thus a presumption of adverse health effect from ozone, on the basis of a decrement in FEV1, is inappropriate. See, J R Balmes, L L Chen, C Scannell, I Tager, D Christian, P Q Hearne, T Kelly, and R M Aris "Ozone-induced decrements in FEV1 and FVC do not correlate with measures of inflammation." American Journal of Respiratory and Critical Care Medicine, Vol. 153, No. 3 (1996), pp. 904-9.

IV. Ozone, alone, does not cause Asthma.

Kim must be weighed against other studies of children and when done is found to be an outlier, probably because the data it used contained outliers. For example, "Despite occasional high levels of central-site O_3 (8-hr maximum O3 90th percentile, 83.9 ppb), O_3 was not associated with percent predicted FEV_1." Delfino, et. al, "FEV_1 in asthmatic children and airborne PM," Environmental Health Perspective Vol. 112 (8), (2004).

In fact, asthma severity is not associated with FEV_1 and "FEV_1 % predicted did not differ by level of asthma severity." Bacharier, et.al, "Classifying Asthma Severity in Children, mismatch between symptoms, medication use, and lung function," Am J Respir Crit Care Med Vol 170. pp 426–432 (2004),

A one hour exposure to 120 ppb ozone does not cause any significant respiratory effects in healthy or asthmatic adolescents. See, Koenig, et al, "Acute effects of 0.12 ppm ozone or 0.12 ppm nitrogen dioxide on pulmonary function in healthy and asthmatic adolescents," Am. Rev. Respir. Dis. Vol. 132(3):648-51 (1985). Other studies have found similar results. See, Holz, et al, "Ozone-induced Airway Inflammatory Changes Differ between Individuals and Are Reproducible," American Journal of Respiratory and Critical Care Medicine, Vol. 159, No. 3, pp. 776-784 (1999) and Chen, et al, "Effect of ozone exposure on airway responses to inhaled allergen in asthmatic subjects," Chest. Vol. 125(6):2328-35 (2004).

There is mixed evidence that high ozone days increase the number of hospitalizations for asthma, and several multi-city studies show no relationship: Schildcrout et al, "Ambient Air

Pollution and Asthma Exacerbations in Children: An Eight-City Analysis," Am. J. Epidemiol. 164 (6): 505-517 (2006); and, O'Connor et al, "Acute respiratory health effects of air pollution on children with asthma in US inner cities" Journal of Allergy and Clinical Immunology , Volume 121 , Issue 5 , 1133 – 1139 (2008).

Over the last ten years, the incidence of asthma has increased[17], whereas, and according to EPA itself, the ambient concentrations of ozone have decreased.[18] If asthma incidence was associated with ozone concentrations, then the incidence should be going down, not up.

Altogether, there is very little evidence that people with asthma are more sensitive to ozone. However, there are many other known triggers for asthma, including cold dry air, allergens, tobacco smoke, dust mites and mold. The Centers for Disease Control have information about these triggers: http://www.cdc.gov/asthma/triggers.html. All but cold dry air are controlled under the NAAQS for $PM_{2.5}$. Thus, even if ozone exacerbates effects from PM 2.5, the way to control any asthma hazards is through control of $PM_{2.5}$, especially in light of EPA's arguments that $PM_{2.5}$ is lethal at any dose.

Finally, clinical studies using direct exposure to ozone and epidemiological studies that assume ozone exposures equal to those measured at monitors do not replicate actual human exposures. Several national studies have shown that actual personal exposure is much lower than the concentrations of ozone that the EPA is considering for a new, lower standard (Meng et al 2012). This is also true for outdoor workers. For example, a study by O'Neill et al 2003 reported that outdoor workers in Mexico City experienced average personal ozone exposures that were 60% lower than ambient monitor levels. In addition, there is a protective ozone standard already in place for outdoor workers in the United States. Thus, the studies like Kim and Adams and the epidemiological studies that estimated human exposure from levels measured at monitors over-estimate the dose-response relationship and must be discounted. Only those studies using personal exposure data have sufficient scientific utility as the basis for EPA regulations and none of those studies support a standard less than the current standard (and do not actually support the current standard either). In fact, the EPA scientific advisory committee that reviewed the Agency's ozone assessment stated:

> The Ozone Staff Paper should consider the problem of exposure measurement error in ozone mortality time-series studies. It is known that personal exposure to ozone is not reflected adequately, and sometimes not at all, by ozone concentrations measured at central monitoring sites....Therefore, it seems unlikely that the observed associations between short-term ozone concentrations and daily mortality are due solely to ozone itself."

CASAC ozone review panel – June 5, 2006

Applying the weight of the evidence approach EPA states is uses, the Agency must conclude that asthmatics are not necessarily more sensitive to ozone than non-asthmatics.

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[17] CDC, "Asthma Facts, CDC's National Asthma Control Program Grantees" (July 2013), available at: http://www.cdc.gov/asthma/pdfs/asthma_facts_program_grantees.pdf and included in this comment by reference.

[18] EPA, National Trends in Ozone Levels (2014). Available at http://www.epa.gov/airtrends/ozone.html.

V. Ozone concentrations below 75 ppb are not associated with increased Mortality.

The relationship between long-term ozone exposure and mortality has been investigated in at least 12 epidemiology studies. When considering other potential causes of mortality, such as other air pollutants, ***only one*** of those studies showed a statistically significant (but very small) effect of ozone on mortality.

Table 2
Studies examining the relationship between long-term ozone exposure and mortality, while considering other air pollutants

Statistically Significant Effect	NO Statistically Significant Effect
Jerrett et al 2009	Abbey et al 1999 http://www.nejm.org/doi/full/10.1056/NEJM199312093292401
	Lipfert et al 2000 http://informahealthcare.com/doi/abs/10.1080/713856640
	Pope et al 2000 http://jama.jamanetwork.com/article.aspx?articleid=194704
	Chen et al 2005 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1314912/
	Jerrett et al 2005 http://journals.lww.com/epidem/pages/articleviewer.aspx?year=2005&issue=11000&article=00004&type=abstract
	Lipfert et al 2006a http://informahealthcare.com/doi/abs/10.1080/08958370600742946
	Lipfert et al 2006b http://www.sciencedirect.com/science/article/pii/S1352231005008459
	Krewski et al 2009 http://pubs.healtheffects.org/view.php?id=6
	Smith et al 2009 http://informahealthcare.com/doi/abs/10.1080/08958370903161612
	Wang et al 2009 http://www.ncbi.nlm.nih.gov/pubmed/?term=Long-term+exposure+to+gaseous+air+pollutants+and+cardio-respiratory+mortality+in+Brisbane%2C+Australia

Different cities have different associations between short-term exposure to ozone and mortality, and very few of those associations are positive. This has been shown by many studies (Smith et al 2009, Bell et al 2004, Bell et al 2005, Zanobetti & Schwartz 2008). Of those cities that

do show an association with mortality, there is no correlation between a positive association of ozone with mortality, and the ambient concentrations of ozone in that city:

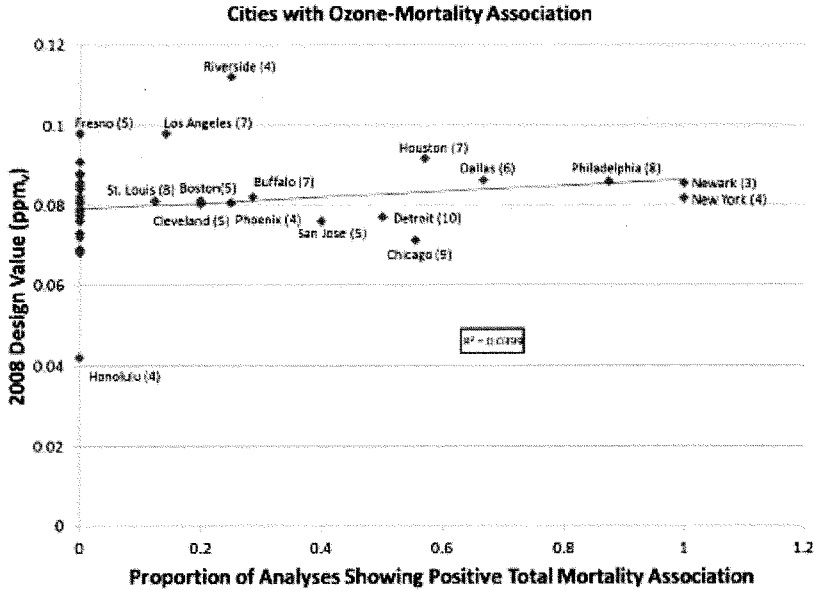

Figure 1. *Graph comparing the proportion of studies that have shown a positive association between ozone and mortality for a particular city (number of studies shown in parentheses next to the city name), compared to the 2008 ambient concentrations of ozone in those cities.*

Even when a positive association is observed between short-term mortality and ozone concentration, that association is very small when considering other factors that affect mortality, such as socioeconomic status, temperature, time of year, and even napping:

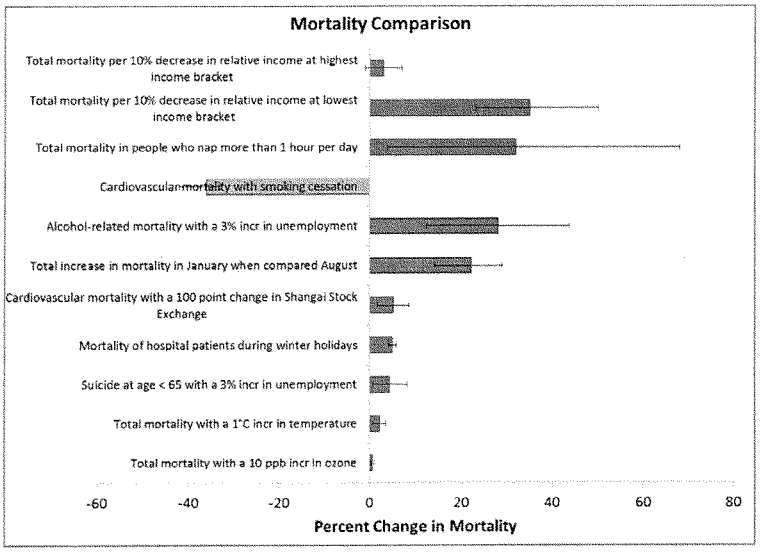

Figure 2: *Graph comparing the percent change in mortality caused by different stimuli. The reference table for this figure is at the end of this document.*

Statistic	Reference (s)	Pubmed ID
Total mortality per 10% decrease in relative income at highest income bracket	Elstad et al 2006. Eur J Public Health. Associations between relative income and mortality in Norway: a register-based study	16476681
Total mortality per 10% decrease in relative income at lowest income bracket	Elstad et al. 2006	16476681
Total mortality in people who nap more than 1 hour per day	Leng et al 2014. Am J Epidemiol. Daytime napping and the risk of all-cause and cause-specific mortality: a 13-year follow-up of a British population	24685532
Cardiovascular mortality with smoking cessation	Critchley & Capewell 2003. JAMA. Mortality risk reduction associating with smoking cessation in patients with coronary heart disease: a systematic review	12837716
Alcohol-related mortality with a 3% incr in unemployment	Stuckler et al 2009. Lancet. The public health effect of economic crises and alternative policy response in Europe: an empirical analysis	19589588
Total increase in mortality in January when compared August	Van Rossum et al 2001 Int J Epidemiol. Seasonal variation in cause-specific mortality: are there high-risk groups? 25-year follow-up of civil servants from the first whitehall study	11689530
Cardiovascular mortality with a 100 point change in Shangai Stock Exchange	Ma et al. 2011 Eur Heart J. Stock volatility as a risk factor for coronary heart disease	21196446
Mortality of hospital patients during winter holidays	Phillips et al 2004. Circulation. Cardiac mortality is higher around Christmas and New Year's than at any other time: the holidays as a risk factor for death	15596560
Suicide at age < 65 with a 3% incr in unemployment	Stuckler et al 2009	19589588
Total mortality with a 1°C incr in temperature	Martiello & Giacchi 2010. Scand J Public Health. High temperatures and health outcomes: a review of the literature	20688791
Total mortality with a 10 ppb incr in ozone	All year studies referenced in Table 6-27 (page 6-222) from the EPA Ozone 2013 Integrated Science Assessment	http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492

Based on the EPA's analysis, lowering the ozone standard would ***increase*** overall mortality in certain U.S. cities, including Houston. These numbers were not presented in the main text, but could be found in Appendix 7 of the EPA Ozone HREA (see Final HREA, Appendices 7-9). This result is not discussed in the executive summary for the EPA Ozone Policy Assessment, although it was briefly mentioned on page 3-115 of that document, as well as on pages 7-69 – 7-70 of the HREA.

The idea that mortality increases with decreasing ozone doesn't make logical sense, and shows that the EPA models and assumptions are flawed. Consider Table 2, below, an example of EPA's analytical approach as applied to Houston, Texas.

Table 3
Number of Premature Mortalities Predicted by EPA to Occur in Houston (2009 simulation year, mortality per 100,000 people)

	Presented by EPA in Chapter 7	Based on Full Analysis found in Appendix 7 going from 2009 ozone levels to standard level
Meeting Current Standard (75 ppb) from Present Day Ozone Levels	*Not presented*	47 more deaths
Going from 75 ppb to 70 ppb	1 more death	48 more deaths
Going from 75 ppb to 65 ppb	3 fewer deaths	44 more deaths
Going from 75 ppb to 60 ppb	12 fewer deaths	35 more deaths

Because mortality has little connection to ozone concentration (and doesn't take into account personal exposure), it should not be the basis of a new, lower national standard for ozone.

CONCLUSION

For the reasons offered above, EPA should withdraw its proposed rule.

Respectfully submitted:

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722 12th St. NW, 4th Floor
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March 17, 2015

Docket ID No. EPA–HQ–OAR–2008–0699
Environmental Protection Agency
EPA Docket Center (EPA/DC)
Mailcode 28221T
1200 Pennsylvania Ave. NW
Washington, DC 20460.

Re: Proposed Rule for National Ambient Air Quality Standards for Ozone

In December 2014, the Environmental Protection Agency (EPA) proposed new National Ambient Air Quality Standards (NAAQS) for ground-level ozone. The EPA proposed to revise the primary standard (intended to protect public health) to a level within the range of 0.065 to 0.070 parts per million (ppm) and to revise the secondary standard (intended to protect public welfare) to within the same range. The secondary standard would be set to provide ozone levels that would offer similar protection to a standard, in terms of a 3-year average W126 index value, at or below a range of 13-17 ppm-h (EPA, 2014a).

Secondary Ozone Standard

The secondary standard is intended to protect ecosystems and ozone-sensitive plants. Currently, the secondary ozone standard is equal to the primary standard and is based on short-term (8-hour) average concentration measurements. However, scientists have shown that a cumulative index of exposure is better correlated with adverse plant growth effects than the 8-hour average concentration used to protect against human health effects (Lefohn and Jones, 1986; Lefohn et al., 1988; Grünhage and Jäger. 1994; Krupa et al., 1994 and 1995; Heath et al., 2009; and others).

Since the 1997 ozone NAAQS review, EPA Staff have considered implementing a secondary ozone standard having a cumulative form such as the W126 index. The agency's most recent policy assessment suggested adoption of a W126 index-based secondary standard with a level in the range of 7–15 ppm-hours for a new secondary ozone standard (EPA, 2014b). The proposed rule suggests a standard for the 3-year average of the 4th highest 8-hour daily maximum ozone concentration at a level of 0.065 to 0.070 ppm to provide a comparable level of protection to a 3-year average W126 index value of 13-17 ppm-h (EPA, 2014a). At the core of this proposal is the assumption that the W126 index provides the most biologically relevant indicator of plant impacts from ozone uptake, which may not be the case.

There is significant evidence in the scientific literature indicating that cumulative exposure to ozone is likely more important than peak concentrations when assessing impacts on plants but that high exposures are important in predicting plant responses (Lefohn and Jones, 1986; Lefohn and Runeckles, 1987; Lefohn et al., 1988; Lefohn and Foley, 1992; and others). The W126 index was developed by Dr. Allen S. Lefohn in 1985 as a sigmoidally weighted, cumulative exposure index that gives greater weight to high ozone concentrations (Lefohn and Runeckles,

1987; Lefohn et al., 1988). The W126 index form of the secondary standard is determined by multiplying a sigmoidal weighting value (W_i) at a specific one-hour average concentration (C_i, ppm) by the one-hour average concentration and then summing over all concentrations. The sigmoidal weighting function takes the form:

$$W_i = \frac{1}{1 + M \times e^{-(A \times C_i)}} \quad (1)$$

where "M" and "A" are empirical constants of 4403 and 126 ppm^{-1}, respectively. The indicator is then calculated as:

$$\text{W126 Index} = \sum (W_i \times C_i) \quad (2)$$

EPA Staff decided it is appropriate to cumulate daily exposures for the 12-hour period from 8:00am to 8:00pm during the three-month period with the greatest index values (USEPA, 2014b).

The values of "M" and "A" were subjectively determined to provide significant weighting to hourly values above 0.040 ppm (i.e., values near background levels) and to provide high weighting to hourly concentration values above 0.10 ppm (ASL & Associates , 2010). W126 values were compared to results for soybean and winter wheat yields from chamber studies conducted as part of the National Crop Loss Assessment Network (NCLAN), which provided much of the support for its use (Lefohn et al., 1988). At the time of its publication, Lefohn et al. (1988) stated support for the arbitrary coefficients of the W126 index were based on a small subset of data and for which it was uncertain whether the data were representative of other crops or vegetative species. Furthermore, in analyzing the NCLAN data, all differences in yield were considered to result from differences in ozone exposure. Agronomically important covariates such as differences in precipitation and temperature were not considered (Lefohn et al., 1988).

The most recent policy assessment places great emphasis on ozone effects to tree species, for which the W126 index was not developed. In fact, based on three years of physiological measurements on ponderosa pine, Panek (2004) documented that stomatal conductance of ozone was strongly correlated with leaf water potential ($R^2 = 0.82$) which closely followed the dynamics of stomatal conductance. Peak ozone uptake occurred in early summer and did not correspond to periods of peak ozone concentration. Panek (2004) therefore concluded that cumulative metrics based on ozone concentrations, including the W126 index, were <u>not</u> appropriate for plants in the studied region.

The results of Panek (2004) indicate important differences in plant *exposure* to ozone and plant *uptake* of ozone. Ozone effects on plants are initiated in leaves when the gas enters through the stomates and disrupts cellular processes, resulting in suppression of growth and yield of many crops. Non-stomatal ozone deposition may be large, but its phytotoxic effects are likely small, although effects on epicuticular wax and subsequent interactions between leaves and the atmosphere are unknown. Ozone impairs growth primarily by inhibiting net photosynthesis and perhaps translocation processes, which limit availability of photosynthate needed for biomass production. Ozone results in lower carbon fixation due to inhibition of ribulose bisphosphate carboxylase (Rubisco) activity in the chloroplasts of leaves with the result that:

- Allocation of carbon and energy resources to detoxification and repair processes in ozone-stressed plants likely detracts from growth as well.
- With less carbon available, plants produce fewer branches, leaves, roots, flowers and fruit.
- Ozone exposure also accelerates plant senescence, reduces leaf longevity, decreases water use efficiency, and inhibits pollen tube growth (Knighton, 2006).

There is often an out-of-phase relationship between plant conductance and ozone concentration such that plant exposure and plant uptake of ozone are not equivalent (figure 1; Heath et al., 2009). Furthermore, temporal ozone concentration profiles can vary significantly between locations strongly affected by urban centers and more remote sites (Lefohne and Jones, 1986; Lefohne and Lucier, 1991). The W126 index gives increased weight to high ozone concentrations, but it does not consider stomatal conductance nor plant defenses and their respective diel patterns, which will also influence plant responses to ozone exposure (Massman et al, 2000).

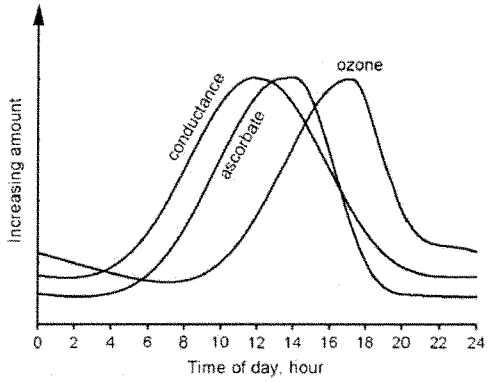

Figure 1. Conceptual temporal relationship among ozone stomatal conductance, ozone concentration, and apoplastic ascorbate (i.e., surrogate for plant defense against ozone). The curves illustrate the phasing relationship among the three processes (Heath et al., 2009).

Additional biologically-relevant factors for plants that are not addressed by a W126 index-based standard include:

- Consideration of the period of time between high ozone exposures, which affects a plant's ability to repair damage from ozone exposure (Mancicni, 1983; Lefohn and Runeckles, 1987), an.
- Consideration of night-time exposure when plant defenses may be at their lowest, which even Dr. Lefohne acknowledges may be important (Winner et al., 1989; Lefohne and Foley, 1992; Matysek et al., 1995; Lee and Hogsett, 1999; Musselman and Minnick, 2000; Grulke and Retzlaff, 2001).

In the 2014 policy assessment, EPA Staff assert that the W126 is the "more biologically relevant cumulative, seasonal form" of a long-term exposure index, but the W126 index was compared only to threshold metrics such as the SUM06 metric, ignoring other possible metrics such as 1-hour maximum concentrations, AOT40, N100, flux methods, or even the EPA primary standard with modified averaging time and co-factors (EPA, 2014b). In fact, based on a five-year study at the Aspen FACE facility using aspen and birch trees, a plant growth model of mean basal area was well predicted (adjusted R^2 from 61.5 to 94.6%; $p < 0.0005$) by the 4th highest daily maximum 8-hour O_3 concentration along with six other meteorological and agronomic predictors (i.e., wind speed, precipitation, growing-degree days, relative humidity, soil moisture, and solar radiation) (Percy et al., 2009). Reducing the regression to a more usable form, mean basal area can be predicted using 4th highest daily maximum 8-hour concentration (the primary standard form), wind speed and growing degree days (adjusted R^2 from 68 to 89%; $p < 0.0005$), and the regression model makes biological sense, unlike the W126 index, which is purely a statistical regression with no basis in plant physiology (Percy et al., 2007).

Unlike the W126 index, a standard based on the 4th highest daily maximum 8-hour average ozone concentration has a high degree of statistical significance and goodness of fit while also having greater biological association with the economically and ecologically relevant endpoint of plant growth. Furthermore, unlike the W126 index, for which there has been no empirical response evidenced demonstrating a biological association outside of chambered studies[1], a standard incorporating daily maximum 8-hour average concentrations, wind speed, and growing degree days has been shown to have significant biological association with two species (and five genotypes) of trees over five years, under free-air conditions characterized by large inter-annual climate variation, stand dynamics, and pest activity (Percy et al., 2007, 2009).

The W126 index gives greatest weight to the highest concentrations of ozone (i.e., predicts greatest impacts from highest ambient concentrations), but there is a significant body of scientific literature (all of which was unaddressed by EPA staff in the policy assessment) supporting the position that moderate levels of exposure may be more important at predicting plant response than peak values.

EPA Staff have proposed using the W126 index and accumulating daily exposures for the 12-hour period from 8:00am to 8:00pm during the three-month period with the greatest index values. However, this approach is decoupled from known plant physiological responses in which plant stomata will close during the hottest parts of the day to minimize moisture loss, effectively limiting gaseous exchange between plants and the atmosphere. During the peak ozone season, plants will often experience exposure during off-peak concentration hours. In experiments on permanent grasslands, Grünhage and Jäger (1994) found that, "atmospheric conditions that facilitate the daily occurrences of peak (highest) O_3 concentrations in general do not coincide with the conditions that promote plant uptake." The authors showed that ozone concentrations between 46 and 85 ppb had a greater phytotoxic potential and were more important at predicting plant response to ozone than concentrations above 85 ppb.

[1] Grunhage and Jager (1994) found that dose-response relationships established using chamber experiments overestimate negative impacts of ozone exposure relative to open-air experiments that better mimic ambient conditions.

Krupa et al. (1993) found that moderate ozone concentrations were more injurious to ozone-sensitive tobacco plants than peak concentrations. In other studies, Krupa et al. (1994 and 1995) found that hourly concentrations of ozone between 50 and 87 ppb were the best predictor of adverse plant responses while concentrations above 100 ppm were particularly poor predictors of crop yield reductions. This led the authors to the conclusion that cumulative frequencies of occurrences of intermediate hourly ozone concentrations were much better predictors of negative crop biomass responses than the statistically forced W126 index. Krupa et al. (1998) reported that "...daily peak (highest) hourly O_3 values not as important as moderate to higher concentrations in eliciting negative crop biomass responses."

Using data from both US and German air quality monitoring sites, Grünhage et al. (1997) found that 37-54% of the total daily ozone uptake by plants occurred before noon, when ozone concentrations were low to moderate rather than later in the afternoon when ozone concentrations peaked. The authors showed that, for sites with distinctive diurnal patterns of ozone concentrations, the W126 index (as well as the AOT40 and SUM06 indices) did not adequately address ozone-induced adverse plant responses during hours when plants are sensitive to ozone uptake.

As can be seen in Pinto et al. (2007), highest rates of ozone conductance often coincide with the lowest O_3 concentrations, particularly in rural locations where a protective secondary standard would be most desirable for protecting ozone-sensitive species. As pointed out by Manning (2003), "Ground proofing [of ozone uptake metrics] must be done to verify and validate plant injury predictions. If this is not done, then the standards have no biological significance and are only exercises in air quality assessment."

The position that cumulative moderate ozone concentrations may be more important than peak ozone concentrations makes sense when considering that maximum stomatal conductance is more likely to occur during periods of moderate ozone concentration rather than maximum ozone concentrations, which often occur at times when stomata are closed. Furthermore, Runeckles (1992) found that sufficiently high ozone concentrations within the plant canopy may induce stomatal closure, which would further reduce the effective dose of ozone. However, this position was not explored by EPA staff in the policy assessment leading to the proposed rule. Given the substantial debate within the scientific community regarding whether it is peak concentrations (characterized effectively by the W126 index) or moderate concentrations (poorly represented by the W126 index) that most affect plant responses, it is inappropriate to set a new NAAQS aimed at protecting plant s against adverse effects from ozone without substantively addressing this issue. At this time, there is insufficient justification to set a secondary NAAQS for ozone based on a W126 index (or a 4th highest concentration expected to be as protective as a given level of the W126 index) when it is highly likely, based on plant physiology and a substantial body of scientific literature, that it is, in fact, cumulative exposure to *intermediate* concentrations of ozone rather than *peak* exposures that most affect plant growth.

RECOMMENDATION: The USDA Agricultural Air Quality Task Force (AAQTF) recommends that EPA work with USDA Staff to identify a secondary ozone standard form that is more biologically-relevant than the W126 index and to consider the full suite of ozone effects research on crops and forest systems that may affect the level of a proposed standard before revising the secondary ozone NAAQS.

Ozone Standards and Fire

EPA has also proposed to tighten the 8-hour primary ozone standard to within the range of 0.065 to 0.70 ppm and to extend the ozone monitoring season in some areas. Such changes could have deleterious impacts on the ability of the US Forest Service and other public land management agencies as well as private land owners to use prescribed fire to manage fire-dependent ecosystems, including forests, range, and certain cropping systems. Prescribed fire is an essential tool for managing fuel loads to prevent wildfires from becoming unmanageable, and they are essential to promote healthy ecosystems, particularly in areas with ecosystems that are naturally fire-dependent.

There is no doubt that fire, whether prescribed or accidental, produces high ozone and $PM_{2.5}$ concentrations. However, carefully managed prescribed fire can prevent greater exposures to these pollutants and protect communities against loss of life and property by preventing or controlling the size and intensity of wildfires. The AAQTF Air Quality Standards Committee is concerned that tightening the primary standard for ozone and simultaneously increasing the duration of ozone monitoring seasons will hamstring the ability of land managers to use this vital tool to protect public health and welfare through prudent ecosystem and fuels management.

In addition to altering the ability land managers to utilize prescribed fire, tightened ozone standards will exacerbate the importance of ozone contributions from wildfires to concentrations measured at ambient monitoring locations. Impacts from wildfire, which are considered to be part of natural, background sources, can easily send ozone concentrations over NAAQS levels, requiring state and local regulatory agencies to submit exceptional event applications in which they must demonstrate that a given ozone exceedance was the result of wildfires and not local, anthropogenic sources. Tightening the primary ozone standard will increase the frequency with which such applications will be made under EPA's Exceptional Events Rule (EER).

While the EER has been in place since 2007, it has been inconsistently applied by the various regions, leading to the need for guidance from EPA regarding what must be included in an EER application. The sole example of an exceptional event cited by EPA in the agency's policy assessment relied on regression modeling, back trajectories, and satellite imagery, all of which are expensive and challenging. It is estimated that each application under the EER costs state or local air pollution regulatory agencies on the order of $500,000. Furthermore, based on information provided by EPA, only one example of an EER application for ozone from a wildfire and three from prescribed fires (from Kansas and South Carolina) have been approved by the agency since 2007.

RECOMMENDATION: The AAQTF Air Quality Standards Committee recommends that that EPA consider the impacts of the proposed ozone standard on the use of prescribed fire and the potential impact on affected communities if fire-dependent ecosystems are not able to be managed with this essential tool. Furthermore, the Committee recommends EPA estimate the number of Exceptional Event applications it expects to receive relating to prescribed fire and wildfire and develop a process to ensure timely processing of these applications using a fair and equitable process throughout the country.

Setting Levels for the Primary and Secondary Standards

Standard levels should consider not only the health and welfare effects of ambient concentrations but also the portion of measured concentrations originating from background conditions, international transport, and stratospheric ozone (i.e., "policy-relevant background" or "PRB").

There is confusion among EPA staff and CASAC as to the relevance of the PRB and how it is to be used in the independent scientific process in the setting of new standards. On December 3, 2009, CASAC member, Dr. Michelle Bell, offered the following to then Administrator Jackson about establishing PRB levels:

> *"Establishing the policy relevant background (PRB) level... is by no means trivial, and the draft Review Plan acknowledges some of these limitations. The Plan notes that greater emphasis will be placed on understanding the contribution of different components that contribute to PRB.... However, given the complexities of establishing a PRB and the wide range of approaches available, it would be helpful to have more information on how the PRB will be determined and how sensitivity analyses might be conducted."*

During the May 19-20, 2011 Clean Air Scientific Advisory Committee (CASAC) meeting, EPA stated that, based on the use of GEOS-Chem Model, the agency had determined background ozone concentrations to be in the range of 15-35 ppb. A number of researchers contend that frequent occurrences of ozone greater than or equal to 50 ppb occur at both high- and low-elevation monitoring sites across the United States due to transport from the stratosphere to the lower troposphere, thereby increasing the background levels of ozone. These ozone concentrations appear to be related to stratospheric transport occurring during the springtime and sometimes in the summertime. Also missing in EPA's equation is the impact of the long-range transport of Eurasian biomass burning and wildfires in the US and the ability to affect background ozone concentrations (ASL & Associates, 2010).

If the actual background level of ozone is higher than EPA estimates with the GEOS-Chem model (or another tool used to establish PRB), results may overestimate human health and vegetation risks and present inaccurate information to the public and policymakers. The range of background concentrations is used in the EPA's risk assessment for both humans and vegetation and provides the baseline for assessing the amount of emission reductions required to attain a specific ozone level within the standard.

RECOMMENDATION: The AAQTF recommends that the EPA quantify uncertainties in PRB estimates of ozone and the potential impacts of inaccurately estimating the PRB on potential non-attainment areas and the cost of implementation for both a proposed primary and secondary standard.

Conclusions

The EPA's proposed revisions to the ozone NAAQS have the potential to dramatically impact agricultural production and processing operations in the US. The Air Quality Standards Committee of the USDA Agricultural Air Quality Task Force believes that the new proposed standards:

- Do not adequately address the biological relevance of the W126 index that undergirds the proposed changes to the secondary ozone standard nor adequately address the substantial body of scientific literature supporting the idea that cumulative exposures to intermediate levels of ozone may be better correlated to adverse plant growth than peak ozone concentrations.

- Do not adequately consider the potential impacts of revised standards on the use of prescribed fire to manage fire-dependent ecosystems, including forest, range, and certain cropping systems, or the potential impacts on public health and welfare if fire is no longer able to be used to manage fuel loads and maintain healthy ecosystems.

- Fail to address the uncertainties in PRB levels and the resulting impacts on potential non-attainment areas and the cost of implementation for both a proposed primary and secondary standard.

From these deficiencies, the Air Quality Standards Committee recommends the following courses of action for EPA:

- Work with USDA Staff to identify a secondary ozone standard form that is biologically-relevant rather than the statistically forced W126 index and to consider the full suite of ozone effects research on crops and forest systems that may affect the level of a proposed standard before revising the secondary ozone NAAQS.

- Consider the impacts of the proposed ozone standard on the use of prescribed fire and the potential impact on affected communities if fire-dependent ecosystems are not able to be managed with this essential tool. Furthermore, the Committee recommends EPA estimate the number of Exceptional Event applications it expects to receive relating to prescribed fire and wildfire and develop a process to ensure timely processing of these applications using a fair and equitable process throughout the country.

- Quantify uncertainties in PRB estimates and the potential impacts of inaccurately estimating the PRB on potential non-attainment areas and the cost of implementation for both a proposed primary and secondary standard.

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April 23, 2015

Chairman Bridenstine
Environment Subcommittee
U.S. House of Representatives Science, Space, and Technology Committee
2319 Rayburn Office Building
Washington, DC 20515

Dear Chairman Bridenstine,

The EPA's recent proposed rule regarding National Ambient Air Quality Standards (NAAQS) for ground level ozone (Docket ID No. EPA–HQ–OAR–2008–0699) has prompted concern among many in the agriculture community regarding the impacts of potentially tighter ozone standards on agricultural production activities and ecosystem conservation as well as the proposed form of a secondary standard. As Chair of the Air Quality Standards Committee of the Agricultural Air Quality Task Force (a federal advisory committee within USDA), I am familiar with the proposed standard and the scientific review conducted by EPA to support its proposed revisions. It is well accepted that cumulative ozone exposure is damaging to plants and that the current form of the ozone standard (4th highest 8-hour concentration) is not well suited to protect vegetation. As the agency has done in previous reviews of the ozone standard, EPA has again proposed a secondary standard having the form of the W126 Index. While this form of the standard provides a cumulative measurement of ambient ozone concentrations around a plant, it is simply a statistical construct with no basis in the physiological process of ozone uptake that leads to plant damage. In both 2010 and 2015, the USDA Agricultural Air Quality Task Force submitted public comment to EPA discouraging use of the W126 Index and encouraging adoption of a more biologically-relevant form of the standard. (Comments submitted in 2015 are enclosed.) While it is possible to select values of the W126 index that can increase protection of ozone-sensitive ecosystems, such an approach would fail to address the fundamental drivers of such damage and, as such, can be erroneously applied to allow attainment of a standard without commensurate protection of the ecosystems the standard is intended to safeguard.

In addition to issues related to the form of the standard, the Agricultural Air Quality Task Force is concerned about the impacts of a tighter ozone standard on the use of prescribed fire. Prescribed fire is an essential tool for managing fuel loads to prevent wildfires from becoming unmanageable, and they are essential to promote healthy ecosystems, particularly in areas with ecosystems that are naturally fire-dependent. There is no doubt that fire, whether prescribed or accidental, produces high ozone and $PM_{2.5}$ concentrations. However, carefully managed prescribed fire can prevent greater exposures to these pollutants and protect communities against loss of life and property by preventing or controlling the size and intensity of wildfires. The Task Force is concerned that tightening the primary standard for ozone and simultaneously increasing the duration of ozone monitoring seasons will hamstring the ability of land managers to use this vital tool to protect public health and welfare through prudent ecosystem and fuels management.

Based on these and other concerns, the Agricultural Air Quality Task Force adopted the following resolution on April 22, 2015 at our meeting in Knoxville, Tennessee:

Due to:

- **Unaddressed uncertainties in potential health and welfare impacts of reducing ground level ozone concentrations,**
- **Negative economic benefits of a tightened standard for ozone (when these benefits are disassociated with reduced $PM_{2.5}$ concentrations expected from the proposed rule),**
- **Failure to fully implement the 2008 ozone standard, and**
- **The impacts of a lower standard on the use of prescribed fire in agriculture and forestry management,**

It is inappropriate, at this time, to lower the National Ambient Air Quality Standards for ground level ozone as proposed by EPA in the Proposed Rule for National Ambient Air Quality Standards for Ozone (Docket IF No. EPA-HQ-OAR-2008-0699).

Ambient, ground-level ozone certainly impacts many aspects of agriculture and forestry and is a concern to the agricultural community. Since its passage in 1970, the Clean Air Act has prompted tremendous reductions in ozone concentrations that have been beneficial to public health and welfare. While the benefits of these previous reductions in ozone concentrations are clear, the marginal benefits of further tightening standards for ozone concentrations are less certain. Therefore, it is critical that:

1. The basis for any additional regulations of ground level ozone be based on the biological drivers of ozone damage (to people or plants) rather than "convenient" statistical surrogates such as the W126 Index, and

2. The impacts of tightened standards on the use of prescribed fire in fire-dependent ecosystems are carefully considered.

Sincerely,

Wm. Brock Faulkner

Wm. Brock Faulkner, Ph.D., PE

WESTERN STATES AIR RESOURCES COUNCIL

WESTAR

March 16, 2015

U.S. Environmental Protection Agency
EPA Docket Center (EPA/DC)
Mail Code: 28221T
1200 Pennsylvania Avenue N.W.
Washington, D.C. 20460

Attn: Docket ID No. OAR-HQ-OAR-2008-0699

Dear Sir or Madam:

The Western States Air Resources (WESTAR) Council, an association of 15 western state air quality managers, appreciates the opportunity to comment on the proposed National Ambient Air Quality Standard (NAAQS) for ozone. WESTAR recognizes EPA's statutory responsibility to research and propose revisions to the primary and secondary ozone NAAQS to provide requisite protection of public health, with an adequate margin of safety, and public welfare. Some individual WESTAR member states will provide their comments on the level and form of the standard separately. Our comments focus on implementation issues that are of particular concern to WESTAR members: background and transported ozone; rural area nonattainment; the available policies for addressing nonattainment issues, including exceptional events, rural transport areas, and international transport; implementation of the proposed secondary standard; and procedures to avoid double-counting of ozone episodes.

Whatever level EPA chooses for the ozone standard, implementation in the west will require a much better understanding of the role of background and transported ozone, and we request that EPA provide the resources needed to advance our knowledge in these areas. In addition, we call on EPA to improve upon the tools states may use to address areas that violate the standard due to sources over which they have little or no control.

Background levels of ozone in remote locations, including many intermountain national parks, are consistently above the NAAQS proposed by EPA. In many of these areas, very little

of the ozone can be attributed to emissions from the areas with the violating monitor(s). This situation exists because ozone nonattainment planning policies and strategies have historically been focused on solving urban ozone exceedances.

Ozone exceedances in areas like these remote western national parks originate from a mix of anthropogenic and non-anthropogenic sources. That source mix, transport of pollutants over the complex terrain common in western states, and the role of natural events such as wildfires and stratospheric intrusions are just a few examples of scientific issues that are not well understood. We agree with the Clean Air Scientific Advisory Committee (CASAC) in its recommendation "that EPA facilitate research to better characterize background levels." We call on EPA to work with western states to develop an applied research strategy in addition to workable ozone nonattainment implementation approaches.

Making the right choices about how to improve air quality in ozone nonattainment areas will depend on how well we understand the science, and our understanding of the science needs to improve. Given the absence of industrial development in numerous areas of the intermountain west, nonattainment area controls simply will not work to achieve attainment. Neither will interstate contribution reductions be sufficient in many areas to reduce ozone to levels below the proposed standard.

In its proposal, EPA suggests that these background contributions can be addressed by existing "regulatory relief" options, including the exceptional events policy. We believe however, that EPA downplays the ongoing significance of background ozone in the west and overstates the capability of the tools available to adequately address the regulatory requirements imposed on states. The tools available to states to account for non-anthropogenic ozone treated as exceptional events are administratively burdensome and fraught with problems of second-guessing, often due to a lack of reliable supporting data. We appreciate that EPA recognizes this and intends to make improvements to the regulatory requirements to make it work better. Nonetheless, a fundamental lack of data on emissions and the challenges of routinely monitoring the atmospheric circumstances causing exceptional events, combined with the fact that exceptional events identified by EPA do not have a solid scientifically-based definition, will continue to plague efforts to account for them. Every hour spent analyzing pollution that cannot be controlled to satisfy EPA's administrative requirements is just that: administrative overhead that does nothing to improve air quality.

Additionally, EPA points to rural transport and international transport provisions of the Clean Air Act as means to effectively address domestic anthropogenic ozone within a jurisdiction's authority. In fact, these options will do little to address many of the nonattainment issues western states will face under a more stringent ozone standard. We discuss our concerns about these implementation options in more detail in the attachment.

In 2007, WESTAR commented that EPA needed to provide funding to help states understand ozone background and transport in the west. At that time, we noted that EPA had

provided substantial funding to support ozone analysis in the eastern U.S., and with that extraordinary support, was able to help the eastern states develop the ability to understand the origin of ozone precursors, ozone formation and the fate of ozone with a level of confidence to develop and implement meaningful and effective regulatory programs to improve air quality. Once again, we urge EPA to make a similar commitment to the west. Without such assistance, western states will continue to have limited tools to accomplish what the Clean Air Act was intended to do: improve air quality.

Sincerely,

Eric Massey, President
Western States Air Resources Council

WESTAR Comments on the Proposed Revision to the National Ambient Air Quality Standards for Ozone, Docket No. OAR-HQ-OAR-2008-0699

COMMENT 1: Background and transport in the west is not well understood

There are significant uncertainties about the origin, magnitude, frequency, duration, and geographic distribution of ozone in the west. Transported background ozone or the precursor pollutants that cause ozone may originate in another state, in Mexico, Canada, or Asia. It may be transported down from the stratosphere. It may be the product of wildfires. Characterizing multiple 'natural' events (wildfires, stratospheric intrusions), occurring with varying intensities, and sometimes overlapping over space and time will require resources beyond the states' limited means. Implementing a more stringent ozone standard in the west will require a much better understanding of the role of background and transported ozone, and we call on EPA to provide the resources we will need to advance our knowledge in these areas.

If EPA adopts a standard in the proposed range of 65 to 70 parts per billion, it is inevitable that new non-attainment areas will be designated in the west. Some of these areas will also inevitably be designated predominantly as a result of ozone transported from outside the non-attainment area boundaries. In a recent assessment[1] of ozone monitoring data, it was estimated that background ozone concentrations - non-anthropogenic background and transported anthropogenic ozone combined - ranged from 47 ppb to 68 ppb at six western cities during ozone episodes.

There are also indications that these background and transported levels are increasing. **Figure 1** is an example of increasing ozone levels in two western national parks. Several researchers have suggested that these increases may be due to increases in ozone transported from Asia.[2,3] A contributing factor may also be increases in wildfire across the west and emissions growth in Mexico and Canada.

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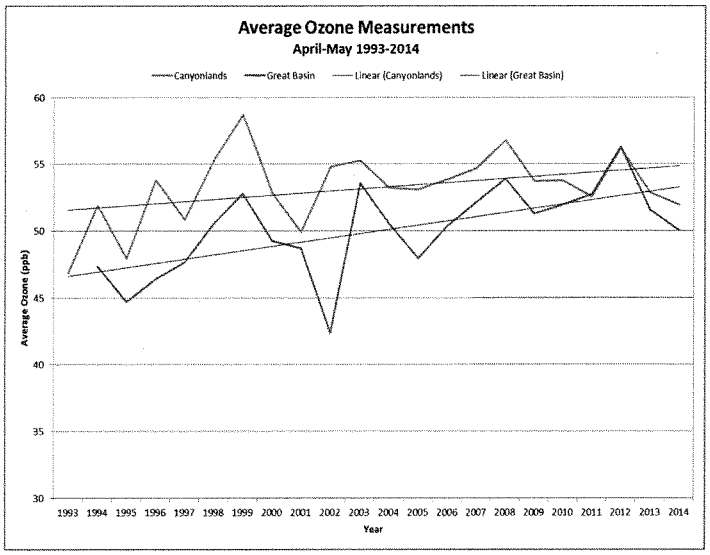
[1]Regional and Local Contributions to Peak Local Ozone Concentrations in Six Western Cities. Sonoma Technologies, May, 2006.

[2] Cooper, OR; Parrish, DD; Stohl, A; Trainer, M; Nedelec, P; Thouret, V; Cammas, JP; Oltmans, SJ; Johnson, BJ; Tarasick, D; Leblanc, T; Mcdermid, IS; Jaffe, D; Gao, R; Stith, J; Ryerson, T; Aikin, K; Campos, T; Weinheimer, A; Avery, MA. (2010). Increasing springtime ozone mixing ratios in the free troposphere over western North America. Nature 463: 344-348.

[3] Lin, M., et al. (2012) ,Transport of Asian ozone pollution into surface air over the western Unites States in spring, J. Geophys. Res., 117, doi:10.1029/2011JD016961.

Figure 1: Monitored ozone trends at Canyonlands and Great Basin National Parks (Hourly average of all values for April and May)



EPA identified the highest background levels at high-elevation sites in the western U.S.[4] In its analysis of non-anthropogenic background concentrations, EPA notes that "the highest background episodic concentrations are typically associated with stratospheric intrusions or wildfires."[5] With regard to stratospheric intrusions, EPA says: "It should be noted that there is considerable uncertainty in the magnitude and distribution of this potentially important source of tropospheric O_3."[6] And, with regard to ozone from wildfires "estimating contributions from wildfires is subject to considerable uncertainty."[7]

Background and transported ozone is of particular concern in many western states, including the states of Idaho, Wyoming, South Dakota, Nevada, Utah, Colorado, Arizona and New Mexico. In these states, 'seasonal mean' background ozone was reported by EPA to be

[4] Integrated Science Assessment (US EPA 2013, Section 3.4)
[5] Ibid, Appendix 2A, 2A-14.
[6] Integrated Science Assessment at 3-34.
[7] Ibid, 3-35.

between 30 and 35 ppb.[8] These values represent 'natural background' absent anthropogenic ozone; in other words, these values do not include ozone generated by human activity in the United States or outside its borders.

However, there is a significant difference when considering ozone on the basis of a 'seasonal mean' as compared to considering ozone on the basis of actual exceedances of the standard, which EPA acknowledges is more relevant from a regulatory standpoint. These differences can be dramatic, as demonstrated by Zhang, et al. (see **Figure 2**).[9]

Figure 2: Excerpt from Zhang demonstrating differences comparing seasonal averages to peak ozone values.

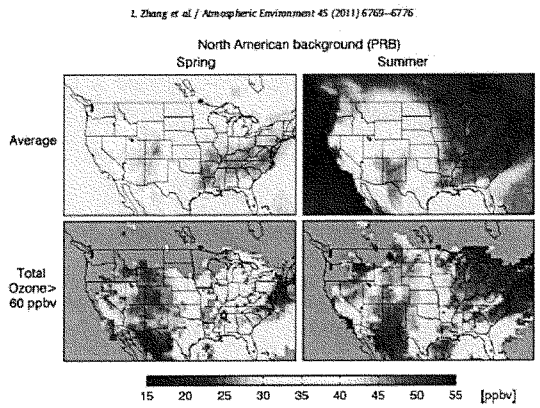


Fig. 6. North American background (PRB) ozone concentration in surface air for spring and summer 2006. The top panels show seasonal means while the bottom panels show the means for days with total ozone > 60 ppbv. Gray areas in the bottom panels had no days with total ozone >60 ppbv.

[8] Figure 2-6 Map of 2007 CMAQ-estimated Seasonal Mean of 8-hour Daily Maximum Ozone from Natural Background (ppb) based on Zero-Out Modeling. Regulatory Impact Analysis. Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards (USEPA 2014c).

[9] Zhang, L; Jacob, DJ; Downey, NV; Wood, DA; Blewitt, D; Carouge, CC; Van Donkelaar, A; Jones, DBA; Murray, LT; Wang, Y. (2011). Improved estimate of the policy-relevant background ozone in the United States using the GEOS-Chem global model with 1/2° × 2/3° horizontal resolution over North America. Atmos Environ 45: 6769-6776. http://dx.doi.org/10.1016/j.atmosenv.2011.07.054.

Table 1 provides another example from recent EPA modeling[10] of the importance of considering ozone exceedances in the form of design values instead of seasonal averages. The table includes both anthropogenic ozone from outside the U.S. and 'natural background'. It shows that sources outside the control of state regulatory authorities cause more than three quarters of the ozone at some sites that would violate the low range of the proposed standard.

Table 1: Modeled percent background and non-US ozone (ppb) at western sites with average design values above 65 ppb and total background values above 75 percent.

		Design Values						
State	**County**	**2018 Average (ppb)**	**2018 Max (ppb)**	**Other (ppb)**	**Biogenic (ppb)**	**Boundary Conditions (ppb)**	**Total Background (ppb)**	**Background % of Avg Design Value**
Nevada	Clark	70.0	70.7	2.0	2.3	52.8	57.1	82%
New Mexico	Dona Ana	69.3	70.3	16.6	4.9	34.8	56.3	81%
Arizona	Cochise	69.2	70.1	4.2	2.9	56.4	63.5	92%
Nevada	Clark	68.7	68.7	1.8	2.6	51.3	55.7	81%
Nevada	White Pine	68.6	70.5	4.9	2.2	52.6	59.7	87%
Arizona	Coconino	68.4	69.4	2.5	2.2	53.0	57.8	84%
New Mexico	Dona Ana	68.3	72.9	18.8	4.6	34.2	57.6	84%
Utah	Washington	68.1	69.3	2.5	3.1	48.5	54.0	79%
Arizona	La Paz	67.6	68.3	1.7	2.8	48.2	52.7	78%
New Mexico	Bernalillo	66.7	68.5	2.7	2.6	49.5	54.8	82%
Utah	Utah	66.4	69.3	1.1	2.3	50.5	53.8	81%
Utah	Carbon	66.2	66.2	0.8	1.9	50.5	53.2	80%
Utah	Utah	65.9	66.6	1.1	2.5	48.8	52.4	80%
New Mexico	Bernalillo	65.8	66.7	5.4	3.9	41.1	50.4	77%
Utah	San Juan	65.7	66.0	1.1	2.2	52.3	55.6	85%
Arizona	Coconino	65.1	65.8	1.6	1.7	54.8	58.1	89%
Utah	Duchesne	65.1	65.1	0.8	1.6	52.9	55.3	85%
New Mexico	Dona Ana	65.1	66.4	15.6	4.6	32.7	52.9	81%

Source: Air Quality Modeling Technical Support Document for the 2008 Ozone NAAQS Transport Assessment, Office of Air Quality Planning and Standards, U.S. EPA, January 2015

Given the remoteness of some western sites and the absence of local sources of anthropogenic ozone and precursors, it is largely unknown what portion of ozone measured at these sites is from anthropogenic emissions either domestically, from Asia, Mexico, or Canada, from biogenic emissions, wildfire, or stratospheric intrusions. While estimates have been made

[10] Air Quality Modeling Technical Support Document for the 2008 Ozone NAAQS Transport Assessment, Office of Air Quality Planning and Standards, U.S. EPA, January, 2015.

to apportion the sources of ozone in the west, there is a significant degree of uncertainty in these estimates. It is critical that EPA recognize that unique approaches to developing successful control strategies will be required in the west.

In summary, based on the seasonal and episodic nature of background and transported ozone in the west and the importance of long-range transport in producing ozone levels in the range of the proposed standard, our understanding of the origin, magnitude, frequency, duration, and geographic distribution of ozone in the west needs to improve for states to determine whether an area is in or out of attainment based on controllable anthropogenic sources and to assess the effectiveness of control strategies with confidence.

COMMENT 2: Nonattainment in rural areas will pose significant challenges.

EPA's assumptions in its Regulatory Impact Analysis (RIA) about workload for state and local air programs are not realistic for many western states. While some western states have been addressing state-wide ozone levels for many years, other states will be facing new issues as they determine how to reduce ozone levels both inside and outside of their major population centers. It will require a tremendous effort to improve the technical information (inventories, models, etc.), educate local governments, including rural communities about new requirements, and develop control strategies. In addition, it will require a significant effort to determine what emission sources are affecting regional background ozone levels and the degree to which interstate and international transport and background are contributing to the problem. The eastern U.S. has been evaluating these issues for many years through the Ozone Transport Commission (OTC), the Ozone Transport Assessment Group (OTAG), and other regional analysis efforts. EPA needs to undertake similar efforts for understanding ozone in the west.

Many of these rural areas within the west that will be grappling with nonattainment for the first time have very few, if any, major sources and have very limited capability to address the requirements that are triggered by a nonattainment designation, including general conformity, transportation conformity, and control strategy development. Limited resources and the lack of local emissions, resulting in limited offsets for these areas, will impede many rural communities from effectively managing air quality and successfully attaining the ozone standard through their own means. The western region of the U.S. also has extensive federal lands in close proximity to many of these rural areas, thus making general conformity an onerous task for not only rural communities, but also for state air programs and federal land managers. General conformity is a new hurdle for many western rural areas that may never have dealt with this issue on the federal, state or local levels. EPA needs to be mindful of the limitations that currently exist and the resources that will be needed in developing these sorts of initiatives for the western states.

While WESTAR would welcome updates to the approach used by EPA to designate Rural Transport Areas to more appropriately address rural communities in the west, rural transport areas will still need to meet requirements for marginal ozone areas, including a baseline emissions inventory, source emission statements, nonattainment new source review (NSR), and transportation and general conformity. As we discuss in Comment 3, this does not provide regulatory relief for many rural areas that are slightly above the standard due to pollution transported from outside the area. These requirements apply over a 20 year time period for rural areas with few or no emissions sources and lightly populated areas. This may foreclose any new economic development opportunities for these areas which may already be struggling. A rural transport designation would still impose a significant workload and resource constraint on these areas.

COMMENT 3: Improved tools are needed to address violations caused by uncontrollable sources

The successful implementation of any ozone standard will require EPA to develop a better understanding of the unique constraints that affect the western U.S from attaining or maintaining the ozone NAAQS. These constraints include natural background, transported ozone within rural areas, and international transport. It is essential that EPA take the initiative to fully research and address these constraints. Inaction by EPA will result in failure for many areas within the western U.S to attain or maintain the ozone NAAQS. The current EPA tools available to the western states to address natural background, transported ozone within rural areas, and international background do not and cannot effectively address these constraints and, in most cases, require states to spend additional resources on efforts that provide little to no improvement in air quality or assist in attainment of the ozone NAAQS. In actuality, these tools either saddle areas with the burden of a nonattainment designation for emissions that are outside of their control or force states to develop costly demonstrations for exceptional events that are not exceptional in nature or occurrence.

WESTAR understands that EPA is limited by the Clean Air Act as to how violations of the NAAQS standards can be addressed, but the following summaries outline the limitations of the current tools available to states to address uncontrollable violations of the NAAQS and how these tools fail to address the constraints currently facing the western region of the U.S. WESTAR urges EPA to develop and implement policies, strategies and planning tools that provide the western states with the means to address nonattainment violations of the ozone standard in ways that account for and address these constraints.

A. Exceptional Events

1. *Resources.*

Under section 319 of the Clean Air Act, the highest priority of implementing the Exceptional Events Rule is to protect public health, regardless of the source of air pollution. Although WESTAR supports this guiding principal, past experience shows that a large portion of state and local air quality management agencies' resources have been consumed by investigating, analyzing and preparing demonstrations for suspected exceptional events. Due to the intense amount of work required to prepare these demonstrations, few resources are left to focus on providing public health protections. Furthermore, Congress adopted revisions to section 319 to avoid nonattainment designations or continued nonattainment where the associated regulatory and planning requirements are not appropriate due to data affected by exceptional events.

In its proposal, EPA states that "as the levels of alternative prospective standards are lowered, background will represent increasingly larger fractions of total O_3 levels" largely affecting rural locations in the west (79 FR 75383). Consequently, the use of exceptional event demonstrations to exclude data affected by wildfire and stratospheric ozone intrusion will increase. Indeed, a study conducted in the late spring and early summer in Clark County, Nevada, at an elevation of approximately 9,000 feet (~2.7 km) reports: "The number of exceedance days in Clark County during the 43-day LVOS field campaign would have increased from 3 to 14 if the NAAQS had been 70 ppb instead of 75 ppb, and from 3 to 25 if the NAAQS had been 65 ppb. In other words, exceedances of the NAAQS generated by high background concentrations and stratospheric intrusions would have occurred on 60% of the days during LVOS, making these events the rule rather than the exception."[11]

In order for states to utilize the provisions of the Exceptional Events Rule in a practical fashion, EPA must streamline the onerous process, provide the tools and guidance required to prepare demonstrations, and respond to demonstrations in a timely fashion.

Modeling of exceptional events will likely play a large role in meeting the rule's technical requirement to demonstrate that there would have been no exceedance or violation but for the event. Many air quality agencies do not have the expertise to run models for exceptional events, nor do they have the staffing levels required to maintain an updated emissions inventory for modeling. Most western states would likely need to hire additional staff or contract the work out, both difficult processes in a time of constrained budgets, tight deadlines and increased workloads.

[11] Langford, A.O., et al., An overview of the 2013 Las Vegas Ozone Study (LVOS): Impact of stratospheric intrusion and long-range transport on surface air quality, Atmospheric Environment (2014)

As evidence that the Exceptional Events Rule offers states regulatory relief, EPA provides two examples of recently approved demonstrations, one for stratospheric ozone intrusion and one for wildfire impacts. This limited number of examples provides states little confidence that their efforts to prepare a demonstration will result in concurrence by EPA. States' previous experience with exceptional event demonstrations have shown that EPA regional office reviews are not consistent with one another, nor are the reviews by the same regional office consistent from year to year. EPA is also suffering from constrained resources and has been slow to act on exceptional event submissions. Timely action is critical because it affects states' area designations and planning process. Therefore, it is imperative that EPA issue a revised Exceptional Events Rule that streamlines the demonstration process with clearly defined requirements and timelines to provide certainty to the planning process. In addition, concurrent guidance should be issued on preparing exceptional events caused by wildfires and stratospheric ozone intrusion.

2. Timelines.

EPA has codified a schedule for the flagging and submission of demonstrations for exceptional events in 40 CFR 50.14. In Section V(E) of the preamble, they state: "Under the generic flagging schedule in 40 CFR 50.14(c)(2)(iii), a state must initially notify the EPA that data have been affected by an event by July 1 of the calendar year following the year in which the event occurred. This is done by flagging the data in AQS and providing an initial event description. According to the generic demonstration schedule in 40 CFR 50.14(c)(3)(i), the state must also, after notice and opportunity for public comment, submit a demonstration to justify any claim within 3 years after the quarter in which the data were collected. This section of the regulation also states that if the EPA must make a regulatory decision based on the data, the state must submit all information to the EPA no later than 1 year before the decision is to be made."

EPA also states that "These generic deadlines in the Exceptional Events Rule apply to data influencing redesignation efforts or other regulatory decisions made by the EPA after the EPA promulgates initial area designations for a new or revised NAAQS. However, these same generic deadlines in the Exceptional Events Rule may not work well with the timing of the initial area designation process and schedule under a new or revised NAAQS" (79 FR 75353).

To meet the designations schedule, EPA has proposed a schedule table for exceptional event demonstrations:

10/1/2015	New NAAQS promulgated
10/1/2016	Area designation recommendations due to EPA
10/1/2017	Final area designations promulgated by EPA
7/1/2016	Flagging of 2013, 2014 and 2015 data due
10/1/2016	Demonstrations for 2013-15 events due
5/31/2017	Flagging of 2016 data due
5/31/2017	Demonstrations for 2016 events due

While most ozone exceedances occur during the summer months during wildfire seasons, some areas of the west are influenced by stratospheric ozone intrusions, typically occurring in the late winter and spring. With long-term drought conditions, wildfires also occur during non-summer months, influencing ozone levels at those times as well. As a result, and as EPA has noted, the timeline for developing demonstrations for exceptional events for area designations is extremely tight. For 2016 data, the timeframe is as short as 3-4 months for developing a demonstration as there is a 30-day public comment period prior to submittal to EPA. If 2017 data may potentially be considered, as EPA has indicated in the preamble, a further tightened timeframe would be untenable to many agencies when a public comment period is included.

State agencies are doing more with fewer staff these days. Adding the burden of an extremely shortened timeframe for exceptional event demonstrations is not feasible. We encourage EPA to consider revisions to the Exceptional Events Rule and applicable guidance to avoid this situation occurring now and in the future.

Implementation of the proposed ozone NAAQS and associated use of the Exceptional Events Rule will require more resources than most western states currently have. EPA must insure adequate federal funding to provide the human, financial and technical resources to enable states to abide by our regulatory obligations and fulfill our mission to provide healthful air and afford public health protections.

B. Rural Transport Areas

EPA contends that the CAA provision for treatment as a rural transport area can provide relief to rural areas from the more stringent requirements of higher nonattainment area classifications. However, even if rural areas are able to utilize the RTA relief mechanism, rural transport areas must still meet the requirements for marginal ozone nonattainment areas, including a baseline emissions inventory, source emission statements, nonattainment new source review with offset requirements, and transportation and general conformity (see WESTAR Comment 2). This does not provide regulatory relief for many rural areas that are slightly above the standard due to pollution transported from outside the area.

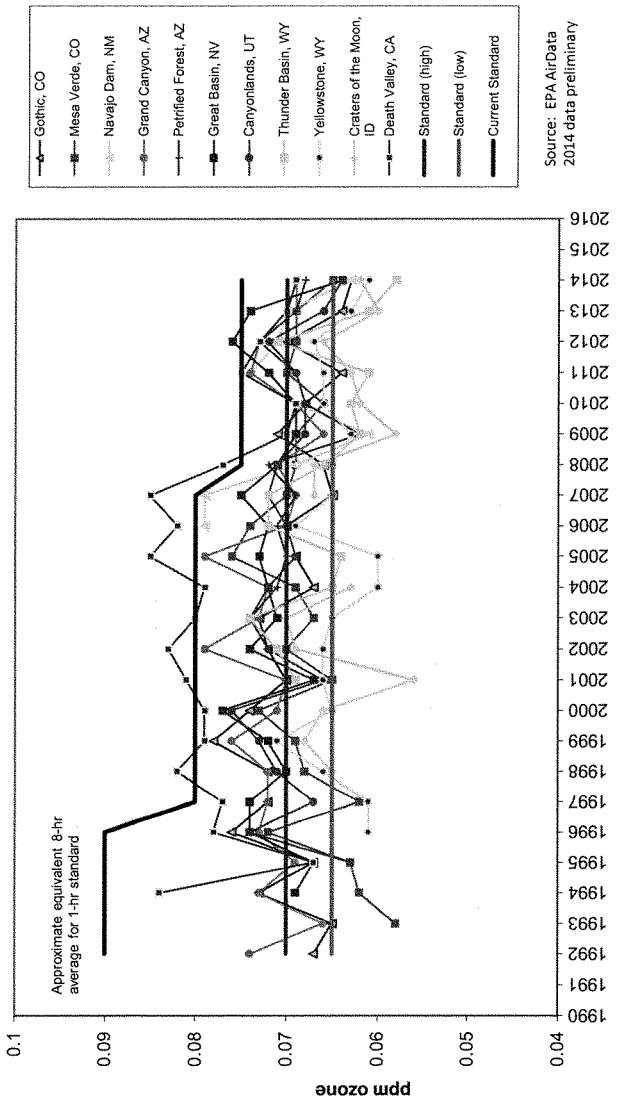
Nevertheless, WESTAR understands that EPA is limited by the CAA as to how violations of the NAAQS can be addressed, and so we offer the following observations on the limitations of the RTA tool and recommend ways to make it more meaningful.

1. *Interpretation of the Clean Air Act (CAA).*

There are numerous national parks in the west with monitors that regularly record concentrations of ozone that exceed the proposed standard range of 60 to 70 parts per billion (ppb), and even exceed the existing standards of 75 ppb. **Figure 3** shows the fourth high daily maximum ozone value at 11 rural monitors in the west from 1990 to 2014. The graph shows that despite significant reductions in ozone precursors from anthropogenic sources since the CAA Amendments of 1990, monitored ozone levels at rural sites in the intermountain west have not been decreasing. Indeed, if the standard were set to 65 ppb, it is possible that all 11 of the national parks/forests/wilderness areas in the figure would become nonattainment.

EPA's own modeling for the proposed rulemaking shows that the largest seasonal average values of background ozone occur in the intermountain west. See Comment 1 on background levels in the west. The notice of proposed rulemaking (NPR) states, ". . . there can be events where O_3 levels approach or exceed the concentration levels being proposed in this notice (i.e., 60-70 ppb) in large part due to background sources. These cases . . . typically result from stratospheric intrusions of O_3, wildfire O_3 plumes, or long-range transport of O_3 from sources outside the U.S." (79 FR at 75382). The NPR goes on to state EPA's view that these events are relatively infrequent. *Id.* EPA states that "the CAA contains provisions that can be used to help deal with certain events, including providing varying degrees of regulatory relief for air agencies and potential regulated entities." *Id.* One such "regulatory relief" tool – treatment as a rural transport area (RTA) – is specifically intended to provide relief to rural areas from the more stringent requirements of higher nonattainment area classifications.

Figure 3. Fourth High, Daily Maximum Ozone Values at Rural Monitors



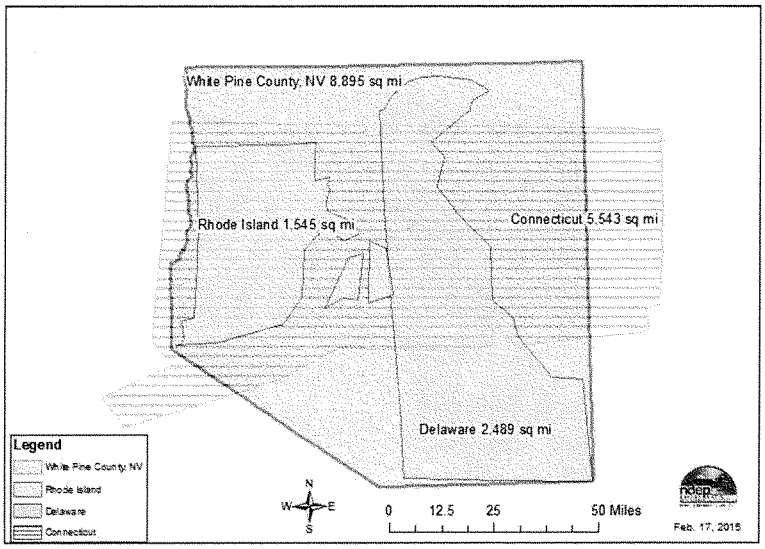
CAA §182(h) provides that an ozone nonattainment area may be treated as an RTA if local VOC (and NOx, where relevant) emissions do not contribute significantly to ozone in the area or other areas. It further says if an RTA does not include and is not adjacent to a Metropolitan Statistical Area (MSA) or a Consolidated Metropolitan Statistical Area (CMSA), as defined by the U.S. Census Bureau, it will be considered to have fulfilled CAA requirements for marginal areas. The term CMSA was retired by the Census Bureau in 2003 and, accordingly, EPA has elected to interpret the CAA references to both MSA and CMSA to refer the definition of MSA.[12]

The general concept of an MSA, according to the Census Bureau, is "that of a core area containing a substantial population nucleus, together with adjacent communities having a high degree of economic and social integration with that core." United States Census Bureau, *About Metropolitan and Micropolitan Statistical Areas* (last revised Feb. 26, 2013) *available at* http://www.census.gov/population/metro/about/. Thus, the intent of the CAA is to provide relief to rural nonattainment areas that have insignificant local sources of ozone or precursors and do not contain and are not adjacent to a substantial population center and its nearby related communities.

Many counties in the west satisfy this intent, but are disqualified because of their large size. For example, White Pine County, Nevada, is almost 9,000 square miles in area, larger than several eastern states: Rhode Island, Delaware, Connecticut and New Jersey. *See* **Figure 4**. White Pine County has a total population of about 10,000 and is not an MSA; but it is adjacent to the Salt Lake City MSA, which encompasses 7,843 square miles (close to the size of New Jersey). The area of the Salt Lake City MSA plus the area of all adjacent counties is 46,023 sq. miles, about the size of the entire state of Pennsylvania. The vast majority of this area is sparsely populated List of US States by Size (last viewed Feb. 2, 2015), *available at* http://state.1keydata.com/states-by-size.php.

[12] February 13, 2015 pre-publication copy of EPA's 2008 SIP implementation rule, "Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements." (http://www.epa.gov/airquality/ozonepollution/actions.html#feb2015i, last viewed 3/4/2015.)

Figure 4. Relative Size of White Pine County, Nevada, to Rhode Island, Delaware and Connecticut



The Great Basin National Park CASTNET monitor has had a design value greater than 70 ppb since 1997 with the exception of three years, which had values of 69 and 70 ppb. The Park is 174 miles from Salt Lake City, the nearest "core area containing a substantial population nucleus." The next largest population center, Tooele with a population of about 32,000, is 141 miles from the monitor. Similarly, Gunnison County, Colorado, has a population of 15,500 and is 3,260 square miles in area, larger than both Rhode Island and Delaware. EPA's "Gothic" CASTNET ozone monitor is located in Gunnison County and has a current design value of 65 ppb. Gunnison County is adjacent to the Grand Junction MSA which is in Mesa County, with a population of 147,500 and an area of 3,341 square miles. The areas of the Grand Junction MSA plus the area of all adjacent counties is 21,191 sq. miles, close to the size of the entire state of West Virginia. The border between Gunnison and Mesa Counties is only 6 miles in length. The CASTNET monitor is 85 miles from the core of the Grand Junction MSA, with mountains between.

WESTAR recognizes that EPA must abide by the CAA, but we urge EPA to take practical considerations into account in the implementation of the revised NAAQS. If evaluation demonstrates that local VOC and NOx is not significantly contributing to the rural area itself, or

other population centers, then it clearly meets the CAA intent of an RTA and should be designated as such. WESTAR urges EPA to interpret the CAA according to the intent of the Act; otherwise, use of the RTA provision as a relief mechanism for rural nonattainment areas in the western U.S. will be ineffectual at best.

2. *Need for RTA Guidance.*

The NPR promotes the use of the CAA RTA provision as a regulatory relief mechanism for rural areas. However, historically EPA has recognized very few areas as ozone RTAs; these were for the 1979 ozone NAAQS. Furthermore, EPA has not issued separate written guidance to elaborate on the interpretation of these CAA qualification criteria. 79 FR 75384.

It is vital for the western states that EPA issue guidance with criteria for demonstrating that an area is an RTA and for addressing the issue of the large size of counties, and consequently MSAs, in the west. The NPR indicates that EPA intends to issue boundary area guidance within four months after the final NAAQS is promulgated. RTA guidance should be issued at the same time or earlier.

The NPR points to draft guidance that EPA developed in 2005, 'Criteria for Assessing Whether an Ozone Nonattainment Area is Affected by Overwhelming Transport', noting that it could be useful in developing the technical information to support a request for treatment as an RTA.[13] 79 FR at 75384. It could also be useful to EPA in developing guidance for states to use in demonstrating that an area is an RTA. The draft guidance proposes a weight of evidence approach to demonstrate that 1) the area is rural, 2) the contribution of local emissions is relatively minor, and 3) emissions from within the area do not significantly contribute to ozone in other areas. It addresses regional transport of ozone into a rural area. In addition, background sources of ozone such as stratospheric intrusions, wildfire ozone plumes or long-range transport of ozone from sources outside the U.S., which are significant factors in the western U.S., are an integral part of the analysis. These background sources contribute to exceedances of the NAAQS, but are not under states' control.

EPA boundary guidance for RTAs must also address the western states' issue related to the large size of western counties. On December 4, 2008, EPA issued guidance listing nine factors[14] to be considered in determining nonattainment area boundaries for the 2008 ozone

[13]In implementing the 1997 ozone NAAQS, EPA established an "overwhelming transport" classification for rural nonattainment areas. Even though the classification was overturned by the court, the concept remains valid and is embodied in the CAA as the RTA provision.

[14] Air quality data; emissions data (location of sources and contribution to ozone concentrations); population density and degree of urbanization (including commercial development); traffic and commuting patterns; growth rates and patterns; meteorology (weather/transport patterns); geography/topography (mountain ranges or other air basin boundaries); jurisdictional boundaries (e.g., counties, air districts, existing nonattainment areas, Reservations, metropolitan planning organizations); and level of control of emission sources.

NAAQS area designations. EPA's April 16, 2013 boundary guidance for the 2012 $PM_{2.5}$ NAAQS lists five factors.[15] EPA should consider using these previous guidance documents together with historical determinations of RTA boundaries to develop a list of recommended factors for defining the boundary of an RTA. EPA cites two examples of historical RTA designations in the NPR (Essex County, New York and Smyth County, Virginia) (FR 79 at 75384). It is essential for EPA to look to these in preparing an updated guidance for RTA designations. Both designations had boundaries limited to the parts of the county that were being effected by the long range transport of ozone from well outside of EPA's presumptive nonattainment area boundary.

The revised guidance should also offer a method for adjusting the Census Bureau definition of MSA to more closely reflect the "core area containing a substantial population nucleus, together with adjacent communities having a high degree of economic and social integration with that core" (Census Bureau definition) in areas where the county boundaries are not representative of the true populated area. The term "adjacent" could be defined under this approach to include a reasonable buffer around the populated area rather than relying on county boundaries. This approach would meet the intent of the CAA to allow the designation of RTAs in rural areas in a more consistent manner throughout the country. If the boundaries of the enormous MSAs and areas adjacent to the MSAs in the west can be reduced, then perhaps the RTA tool might be a viable way to avoid the requirements of higher nonattainment area classifications.

C. Clean Air Act Section 179B

One of the mechanisms that EPA references to address high background levels of ozone in the intermountain west is CAA Section 179B. Section 179B of the CAA applies to international transport of air pollution, which may contribute to high background levels for certain international border regions. Section 179B allows EPA to approve a SIP that does not demonstrate attainment or maintenance of the NAAQS as long as all required measures have been implemented if the state demonstrates that the plan would have met the standard "but for" the impact of international emissions. Section 179B provides some regulatory relief by preventing automatic bump ups to higher nonattainment classifications and sanctions for not attaining the standard. It is disappointing, however, that EPA has presented CAA Section 179B as a viable tool to address high background levels of ozone, when in actuality it leaves communities with significant burdens to implement regulatory requirements that may have little environmental benefit.

[15] Air quality data; emissions and emissions-related data; meteorology; geography/topography; and jurisdictional boundaries.

Western states have some experience with international transport and the limitations of Section 179B. An example of this was the 179B, 1-hour ozone nonattainment area in Sunland Park, New Mexico. Sunland Park, New Mexico is located in the Paso del Norte air shed, which includes El Paso, Texas, Ciudad Juarez, Mexico, and Sunland Park, New Mexico. This small community with a population of 13,000 only contributes roughly three (3) percent of the total ozone precursor emissions within the Paso del Norte air shed. This area had almost no control over the emissions that caused the area to be designated nonattainment, but was still required to abide by the nonattainment requirements under the CAA including general conformity, nonattainment NSR, and transportation conformity although these requirements provided limited, if any benefit in reducing ozone levels within the Paso del Norte air shed.

There is also the question as to how this provision would relate to international transport from countries that do not border the U.S., such as China. As research has shown, the U.S., particularly the western region, is impacted by transported ozone pollution from Asia. Even more concerning, that impact is increasing by approximately 0.63 ppb per year[16]. EPA states in their supporting materials for the proposed ozone rule that most areas will be attaining a standard of 70 ppb or 65 ppb for ozone by 2025 through existing and proposed federal rules for VOCs and NOx emissions. This statement is difficult to believe in areas where international transport from Asia is a significant contributor to ozone levels. Quantifying the impact of emissions due to global transport will also be challenging for states and could require technical expertise and global analyses that states do not have the resources to complete. EPA would need to develop 179B guidance that specifically addresses global transport from Asia and provide global modeling and technical assistance to states, otherwise a 179B demonstration may not be possible for qualifying states to complete.

It would benefit the western states as well as EPA, if EPA would take the initiative to fully research and address the issue of high background ozone concentrations in the intermountain west because existing tools such as CAA Section 179B were not designed to address such a widespread problem that states have no ability to address.

COMMENT 4. Implementation guidance will be needed if EPA promulgates a distinct secondary standard

WESTAR recognizes EPA's statutory responsibility to research and propose revisions to the secondary ozone NAAQS to provide requisite protection of public welfare. If EPA promulgates a new distinct secondary standard, western states will be faced with a complex regional scale problem affecting a vast geographical area without the capacity to evaluate the

[16] Cooper et al., 2010 Nature

underlying causes and effects, much less assess the most cost-effective solutions to address the problem.

EPA proposes that "ambient O_3 concentrations resulting in cumulative seasonal O_3 exposures of a level within the range from 13 ppm-hrs to 17 ppm-hrs, in terms of a W126 index averaged across three consecutive years, would provide the requisite protection against known or anticipated adverse effects to the public welfare."[17] EPA proposes a secondary standard that is the same as the primary standard based on a demonstration that an improvement in the primary standard will result in corresponding improvements in the W126 metric. However, EPA solicits comment on an alternative approach of revising the secondary standard to an average W126 value within the range of 13 to 17 ppm-hours, averaged across three consecutive years. EPA further contends that such a secondary standard, "...would be directly linked to ozone exposures to which vegetation are most responsive and thus might be expected to provide some confidence that such exposures of concern would be controlled." [18]

Further research is needed to characterize the sensitivity of vegetation in high-altitude areas to ozone. A growing body of research indicates that stratospheric intrusions and mixing between the stratosphere and troposphere are common occurrences in high altitude, mountainous areas. Forests and other vegetation in these high altitude areas may therefore be less sensitive to ozone than vegetation in lower altitude areas that has not adapted to this natural occurrence of ozone. Research is also needed to characterize the sensitivity of vegetation in desert areas where plants are adapted to respire during the night when temperatures are lower and less water is lost in the process. A metric that excludes nighttime ozone levels may not be protective in desert areas.

There are significant implementation issues that need to be addressed before EPA considers an alternative proposal that establishes a secondary standard using the W126 metric.

A. Growing season.

The W126 air quality metric is used to assess cumulative impacts of ozone exposure on ecosystems and vegetation. As discussed in the proposed regulation (FR 79, page 75315), "...plant sensitivity to ozone varies with the time of day and plant development stage..." EPA has previously concluded that the consecutive 3-month period within the ozone season with the highest W126 index value (e.g. maximum 3-month period) would, in most cases, likely coincide with the period of greatest plant sensitivity on an annual basis (FR 75, page 3013, January 19, 2010). The alternate W126 metric is based on the 3 consecutive month period within the ozone season with the maximum index value and does not account for situations where the three highest months do not coincide with the period of greatest plant sensitivity. For example, in the

[17] 79 FR 75349, December 17, 2014.
[18] 79 FR 75349-75350, December 17, 2014.

Upper Green River Basin in Wyoming and the Uinta Basin in Utah, the highest ozone values occur during the winter months when vegetation is dormant and often covered in snow. Temperatures in these areas are frequently below freezing during these elevated ozone episodes. A similar circumstance occurs in desert areas where vegetation is dormant during hot, dry periods in the summer, especially during the daylight hours that are the focus of the W126 metric.

If EPA finalizes the secondary standard using the W126 metric, WESTAR requests that EPA reconsider the methodology used to select the consecutive 3-month period that is part of the form of the standard. The proposed rule, as written, uses the 3-month period with the highest W126 index value in the alternative approach. While this approach would coincide with periods of greatest plant sensitivity in most cases, some areas could be designated nonattainment for the secondary ozone standard due to high ozone values monitored during times when vegetation is dormant. The methodology needs to include a mechanism to consider the growing season in an area. WESTAR proposes two potential mechanisms to address this problem.

Option 1: WESTAR recommends that EPA allow states, with approval of the Regional Administrator, to use an alternate 3 month period that is within the growing season in that state when the 3 highest months do not correspond to a time period when vegetation is biologically active. Allowing states the ability to provide a demonstration of an alternate time period that is within the growing season in that state would provide the flexibility needed to effectively implement the W126 secondary ozone standard as required by the Clean Air Act. As the intent of the proposed rule for the secondary standard is to provide protection for vegetation, it is reasonable and appropriate that the EPA provide this flexibility.

Option 2: Another approach would be for EPA to establish a secondary standard ozone season that is distinct from the ozone monitoring season and that corresponds to time periods when vegetation is biologically active in a state, or a sub-region within a state. Federal Land Managers (FLMs) have botanists on staff with the expertise to provide EPA the necessary information needed to establish a distinct growing season in the final rule.

These alternative approaches would provide states that experience unique ozone episodes under extreme heat, cold, or other extreme events, the ability to implement measures that protect biologically active vegetation impacted by ozone during a true and distinct growing season. Under these alternative approaches, areas would not be designated nonattainment based on ozone values outside of the established secondary standard ozone season. EPA's establishment of a distinct growing season for the secondary standard would ensure that the intent of the CAA for the secondary standard is being met.

B. Modifications to AQS.

The W126 metric is extremely difficult to calculate. It is not currently possible to determine attainment status under a potential W126 standard using the Standard Reports available in EPA's AQS tool. States must calculate the W126 level based on hourly values, using the W126 calculation methodology described in EPA's previous proposal to revise the ozone standard, published on January 19, 2010. The complicated methodology increases the probability of errors when done independently by individual states. Alternatively, states may forgo this complicated calculation, leaving them without a clear indication of monitored W126 values. EPA needs to include a calculation of W126 in AQS as soon as possible so that states can adequately comment on the proposed secondary standard and begin planning to implement a potential new secondary standard.

C. Exceptional events criteria.

EPA needs to establish criteria for flagging exceptional events under a W126 metric. Ozone from stratospheric intrusions, wildfires, and lightning contribute to high background ozone levels throughout the western US. EPA has established a process for states to identify ozone exceedances that are affected by these exceptional events and to flag those data for exclusion from regulatory consideration. It is not clear how this process would work for a seasonal standard using the W126 metric. The W126 metric is a cumulative value over 3 months, but the value for an individual day is very small. The W126 metric also adds increasing weight to hourly concentrations from about 40 ppb to 100 ppb. What criteria would be used to determine when an exceedance had occurred that could be flagged? Would flagged data shift the 3-month period that is used to evaluate compliance with the standard? Would data be flagged separately for the primary and secondary standards? If not, how would states resolve different criteria for identifying exceedances under the primary and secondary standards?

WESTAR states are concerned that exceptional events under the W126 metric could occur frequently, requiring inordinate resources to demonstrate the impact of these events under the exceptional events rule. For example, during a high fire year lower level impacts could occur for months at a time interspersed with higher impacts due to local fires or changing wind patterns. States do not have the resources that would be needed to develop the frequent exceptional events demonstrations that would be required.

D. Planning guidance

States do not have experience implementing a distinct secondary standard. If EPA decides to promulgate a distinct secondary standard, they would need to develop guidance for

how to develop a plan for a secondary standard and how that plan would differ from a plan for the primary standard. States would also require additional resources to develop a SIP under a distinct secondary standard beyond what would be required for the primary standard. This SIP would likely need to address the effects of ozone on vegetation and may apply in areas that are attainment for the primary standard where the SIP could not build on technical work completed for the primary standard SIP. It is difficult to quantify the additional resources that would be required because states do not have experience with developing a SIP for a secondary standard.

COMMENT 5. Revise procedure for determining maximum 8-hour average concentrations

WESTAR supports EPA's proposed procedure for determining daily maximum 8-hour average ozone concentrations based on 17 consecutive 8-hour periods in each day to avoid overlapping 8-hour periods over two separate days. WESTAR had previously commented on this issue[19] and supports EPA's proposal to resolve the problem of double-counting ozone episodes.

[19] Western States Air Resources Council, March 26, 2010, page 10. "In areas affected by ozone transport, the highest ozone concentrations often occur in the middle of the night. An 8-hour average that begins at 11:00 pm would be counted as an exceedance on the first day, while the 8-hour average that begins at midnight (that overlaps the previous average by 7 hours) would be counted as an exceedance on the second day. Thus, a single plume of ozone lasting for a few hours could penalize a State with two exceedance days instead of one, even if the high ozone did not span both sides of midnight, simply because the monitor records the effects of a transported plume rather than a locally-generated plume that is typically formed during daylight hours."

Interesting Facts About Ozone

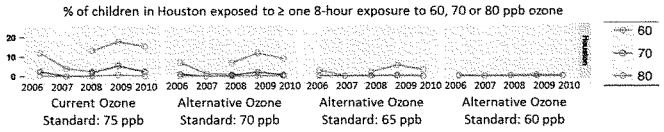
The EPA is considering lowering the national ozone standard. This is based primarily on two health effects: a decrease in lung function, and premature mortality (dying sooner than you should). The EPA sets standards that are protective of public health, including presumed sensitive subpopulations, such as people (particularly children) with asthma. The following interesting facts address the relationship between ozone and these health effects. For general information about ozone and ozone monitoring go to https://www.tceq.texas.gov/airquality/monops/ozonefacts.html.

FEV1 and Lung Function:

- The EPA is considering lowering the ozone standard to 60 ppb averaged over an 8 hour period[1]. This is based in part on data from studies that exposed human volunteers to 60 ppb ozone, while they were exercising at high intensity for 50 minutes of every hour for 6.6 hours. In one study (Adams 2006) these volunteers had an average 2.8% decrease in forced expiratory volume for 1 second (FEV_1) with ozone exposure, and in another study, the volunteers had a 1.75% decrease in FEV_1 (Kim, 2011). However, the American Thoracic Society and the European Respiratory Society (ATS/ERS) together published that the daily variation in FEV_1 for a healthy person is 5% (Pellegrino et al 2005). Therefore, the effects of ozone at 60 ppb were *within normal variation* and cannot be characterized as adverse.

- In addition, the ATS/ERS states that changes in FEV_1 correlate "poorly with symptoms and may not, by itself, accurately predict clinical severity or prognosis for individual patients." This group requires that reversible loss of lung function *in conjunction with* symptoms (such as coughing and pain with deep inhalation) should be considered adverse. The EPA should consider both FEV_1 and symptoms when judging effects on lung function, but in recent reviews has only used FEV_1.

- Based on computer-generated models, the EPA estimates that < 20% of children in urban areas will be exposed at least once per year to 60 ppb ozone for 8 hours, and few if any will be exposed to at least one 8 hr period of 70 or 80 ppb ozone (EPA ozone Health Risk and Exposure Assessment). This is true even if the current 75 ppb ozone standard is maintained:



EPA Ozone HREA 2nd Draft, pg 5-30

Figure 1. *Percent of children in Houston who will be exposed at least once per year to 60 (red line), 70 (green line) or 80 (blue line) ppb ozone for 8 hours while exercising. This was modeled using the data from 2006 – 2010, assuming that the city met the current ozone standard (75 ppb) or one of the alternate standards (70, 65 or 60 ppb).*

[1] The standard will take the form of the annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years.

- Therefore, even if the ozone standard is not changed, few if any children will be exposed to 80 ppb ozone for 8 hours (a dose that shows some adverse clinical effect). A few children will be exposed to 70 ppb ozone for 8 hours (there is debatable evidence for clinically adverse effects at this dose), and some children could be exposed to 60 ppb for 8 hours, but (as stated above) there is no concrete evidence that this dose causes any adverse effects on lung function.

Asthma:

- A one hour exposure to 120 ppb ozone does not cause any significant respiratory effects in healthy or asthmatic adolescents (Koenig et al 1985). Other studies have found similar results (Holz et al 1999, Chen et al 2004). **This means that asthmatics are not necessarily more sensitive to ozone than non-asthmatics.**

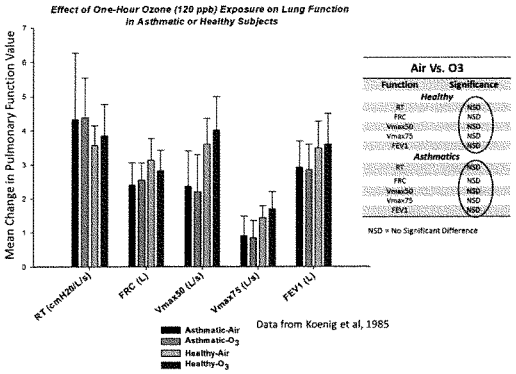


***Figure 2**. Changes in different pulmonary values after healthy or asthmatic subjects were exposed to 120 ppb ozone for one hour. The figure to the right shows that there is no statistically significant difference between people exposed to filtered air or to ozone, or between healthy and asthmatic subjects.*

- There is mixed evidence that high ozone days increase the number of hospitalizations for asthma, and several multi-city studies show no relationship: Schildcrout et al 2006 and O'Connor et al 2008. And in fact, analysis in Texas shows that there is an increase in asthma hospitalizations (blue line) in the winter, when ambient ozone concentrations (red line) are low:

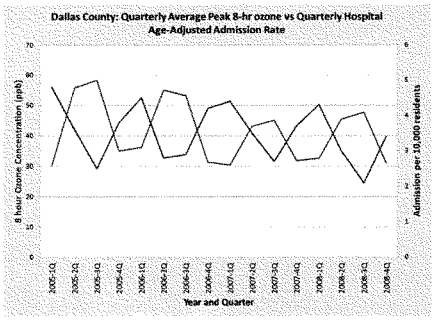


***Figure 3**. Plot of time in yearly quarters from 2005 – 2008, against 8 hour ozone (left y-axis, red line) and hospital admissions per 10,000 residents (right y-axis, blue line). It shows that in quarters where mortality is high (during the winter), ozone is low.*

- Over the last ten years, the incidence of asthma has increased, whereas the ambient concentrations of ozone have decreased. If asthma incidence was associated with ozone concentrations, then the incidence should be going down, not up.
- Altogether, there is very little evidence that people with asthma are more sensitive to ozone. However, there are many other known triggers for asthma, including cold dry air, allergens, tobacco smoke, dust mites and mold. The Centers for Disease Control have information about these triggers: http://www.cdc.gov/asthma/triggers.html.

Personal Exposure:

- Personal exposure to ozone (the amount of ozone that a person actually breathes) is much lower than the ozone concentrations measured at monitors, because people spend most of their time indoors, and indoor ozone concentrations are very low. This has been shown by a number of studies, including Lee et al 2012, who measured the levels of outdoor, indoor and personal ozone concentrations for a group of children in Tennessee:

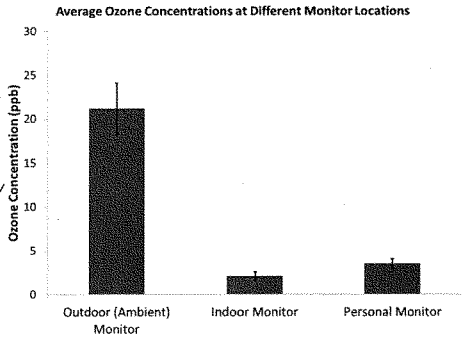


Figure 4. *Concentrations of ozone in Tennessee measured at an outdoor ambient monitor, measured using an indoor monitor, or measured using a personal monitor being worn by the study subjects.*

- Several national studies have shown that actual personal exposure is much lower than the concentrations of ozone that the EPA is considering for a new, lower standard (Meng et al 2012). This is also true for outdoor workers. For example, a study by O'Neill et al 2003 reported that outdoor workers in Mexico City experienced average personal ozone exposures that were 60% lower than ambient monitor levels. In addition, there is a protective ozone standard already in place for outdoor workers in the United States.

- Epidemiological studies that connect ozone and mortality assume that people are exposed to outdoor levels of ozone all the time. If personal exposure were used instead, all of the mortality would occur at levels of ozone that are well below background. Therefore, the mortality seen in these studies is likely attributable to another cause, or to natural random variation in daily mortality rates.

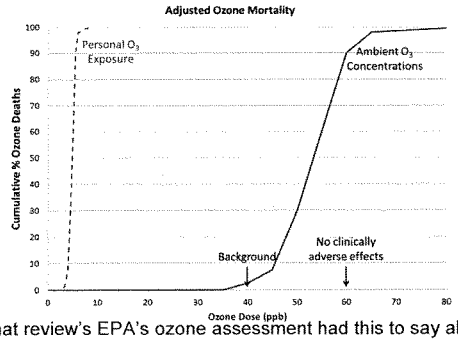


***Figure 5**. Concentration-Response curve for short-term mortality of ozone based on ambient monitoring data (blue line), or personal exposure data (red line). Exposure to 60 ppb ozone does not cause adverse respiratory effects and 40 ppb ozone is considered to be background.*

- The scientific advisory committee that review's EPA's ozone assessment had this to say about mortality and personal exposure:

  "The Ozone Staff Paper should consider the problem of exposure measurement error in ozone mortality time-series studies. It is known that personal exposure to ozone is not reflected adequately, and sometimes not at all, by ozone concentrations measured at central monitoring sites....Therefore, it seems unlikely that the observed associations between short-term ozone concentrations and daily mortality are due solely to ozone itself." CASAC ozone review panel – June 5, 2006

Mortality:

- The relationship between long-term ozone exposure and mortality has been investigated in at least 12 epidemiology studies. When considering other potential causes of mortality, such as other air pollutants, ***only one*** of those studies showed a statistically significant (but very small) effect of ozone on mortality.

Table 1: Studies examining the relationship between long-term ozone exposure and mortality, while considering other air pollutants

Statistically Significant Effect	NO Statistically Significant Effect
Jerrett et al 2009	Dockery et al 1993
	Abbey et al 1999
	Lipfert et al 2000
	Pope et al 2000
	Chen et al 2005
	Jerrett et al 2005
	Lipfert et al 2006a
	Lipfert et al 2006b
	Krewski et al 2009
	Smith et al 2009
	Wang et al 2009

- Different cities have different associations between short-term exposure to ozone and mortality, and very few of those associations are positive. This has been shown by many studies (Smith et al 2009, Bell et al 2004, Bell et al 2005, Zanobetti & Schwartz 2008). Of those cities that do show an association with mortality, there is no correlation between a positive association of ozone with mortality, and the ambient concentrations of ozone in that city:

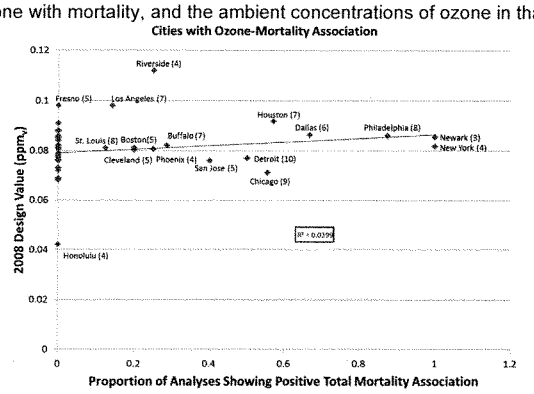


Figure 6. *Graph comparing the proportion of studies that have shown a positive association between ozone and mortality for a particular city (number of studies shown in parentheses next to the city name), compared to the 2008 ambient concentrations of ozone in those cities.*

- Even when a positive association is observed between short-term mortality and ozone concentration, that association is very small when considering other factors that affect mortality, such as socioeconomic status, temperature, time of year, and even napping:

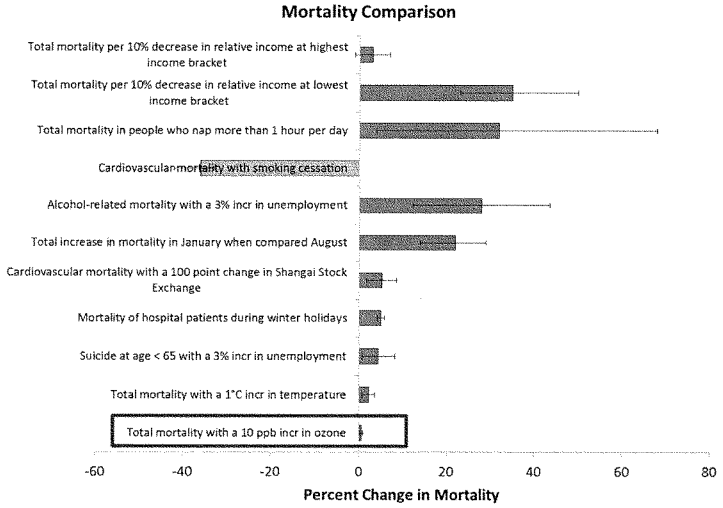


Figure 7: *Graph comparing the percent change in mortality caused by different stimuli. The reference table for this figure is at the end of this document.*

- Based on the EPA's analysis, lowering the ozone standard would ***increase*** overall mortality in certain U.S. cities, including Houston. These numbers were not presented in the main text, but could be found in Appendix 7 of the EPA Ozone HREA (see Final HREA, Appendices 7-9). This result is not discussed in the executive summary for the EPA Ozone Policy Assessment, although it was briefly mentioned on page 3-115 of that document, as well as on pages 7-69 – 7-70 of the HREA. The idea that mortality increases with decreasing ozone doesn't make logical sense, and shows that the EPA models and assumptions are flawed.

Table 2: Number of Premature Mortalities Predicted by EPA to Occur in Houston (2009 simulation year, mortality per 100,000 people)		
	Presented by EPA in Chapter 7	Based on Full Analysis found in Appendix 7 going from 2009 ozone levels to standard level
Meeting Current Standard (75 ppb) from Present Day Ozone Levels	*Not presented*	47 more deaths
Going from 75 ppb to 70 ppb	1 more death	48 more deaths
Going from 75 ppb to 65 ppb	3 fewer deaths	44 more deaths
Going from 75 ppb to 60 ppb	12 fewer deaths	35 more deaths

- Because mortality has little connection to ozone concentration (and doesn't take into account personal exposure), it should not be the basis of a new, lower national standard for ozone.

Difficulties with Implementing the Ozone Standard:

- Background ozone is ozone produced naturally, or transported from other countries. These background ozone levels can be greater than 40 ppb, and can contribute >80% of the measured ozone in an area (from the EPA Ozone Policy Assessment).

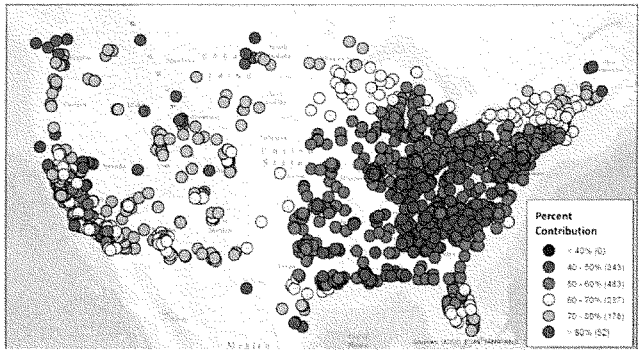


Figure 2-12. Map of apportionment-based U.S. background percent contribution to seasonal mean O_3 based on 2007 CAMx source apportionment modeling.

Figure 8. *Map of the contribution of background ozone to total ozone across the United States (based on 2007 data and modeling).*

- When making judgments about the risks of ozone and the benefits of reducing ozone, the EPA used calculations that unrealistically assume that ozone could be reduced to 0 ppb. Instead, they should use background ozone levels as their baseline, because it is not possible to control or regulate background ozone levels.

- There is a large variation in background ozone levels in different areas of the U.S. (Figure 8 above, from the EPA ozone policy assessment). Therefore, it makes more sense to set an ozone standard that is different for different regions, and not a single national standard that doesn't consider background ozone levels.

- The chemistry of ozone is complex. Ozone is not produced directly, but instead is made when nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react with sunlight. However, NO_x can also chemically remove ozone, and so ozone levels actually decrease the closer you get to a road (vehicles are a major producer of NO_x).

- Because ozone chemistry is so complicated, decreasing NO_x can actually increase the amount of ozone in areas that are close to where the NO_x is being produced (such as in the inner cities). Conversely, areas that are far from major NO_x sources (such as the suburbs) will experience a decrease in ozone when NO_x decreases. This means that a lower ozone standard can lead to disproportionate benefits for those who live outside the cities, compared to those in the inner cities (Figure 9).

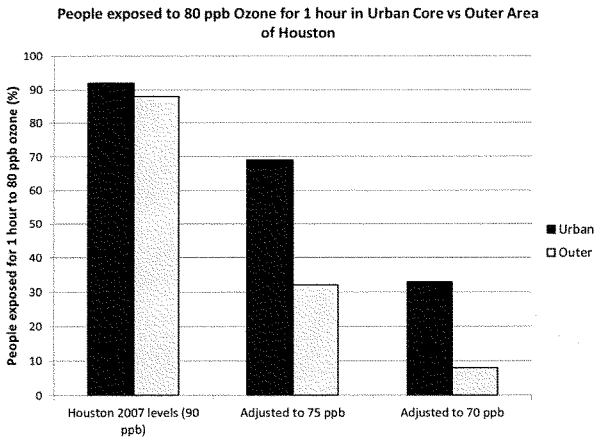


Figure 9. *Ozone levels are proportionally higher in urban compared to outlying areas, and this increases with a decreasing ozone standard. Based on Ozone HREA (Appendix 9).*

- It will be very difficult to implement a new lower ozone standard, particularly if it is set at 60 ppb. The EPA itself can only predict 1/3 of the emissions decreases, meaning that 2/3 of the pollutant decreases will have to be attained by as-yet-unknown technology. Because of this, achieving this decrease in ozone could be very expensive, and in fact is anticipated to cost $270 billion of gross-domestic product nationally, *per year*. There would also be increases in electricity costs, and an effective loss of >$1000 in household income per year in Texas.

References for Mortality Comparison Graph

Statistic	Reference (s)	Pubmed ID
Total mortality per 10% decrease in relative income at highest income bracket	Elstad et al 2006. Eur J Public Health. Associations between relative income and mortality in Norway: a register-based study	16476681
Total mortality per 10% decrease in relative income at lowest income bracket	Elstad et al. 2006	16476681
Total mortality in people who nap more than 1 hour per day	Leng et al 2014. Am J Epidemiol. Daytime napping and the risk of all-cause and cause-specific mortality: a 13-year follow-up of a British population	24685532
Cardiovascular mortality with smoking cessation	Critchley & Capewell 2003. JAMA. Mortality risk reduction associating with smoking cessation in patients with coronary heart disease: a systematic review	12837716
Alcohol-related mortality with a 3% incr in unemployment	Stuckler et al 2009. Lancet. The public health effect of economic crises and alternative policy response in Europe: an empirical analysis	19589588
Total increase in mortality in January when compared August	Van Rossum et al 2001 Int J Epidemiol. Seasonal variation in cause-specific mortality: are there high-risk groups? 25-year follow-up of civil servants from the first whitehall study	11689530
Cardiovascular mortality with a 100 point change in Shangai Stock Exchange	Ma et al. 2011 Eur Heart J. Stock volatility as a risk factor for coronary heart disease	21196446
Mortality of hospital patients during winter holidays	Phillips et al 2004. Circulation. Cardiac mortality is higher around Christmas and New Year's than at any other time: the holidays as a risk factor for death	15596560
Suicide at age < 65 with a 3% incr in unemployment	Stuckler et al 2009	19589588
Total mortality with a 1°C incr in temperature	Martiello & Giacchi 2010. Scand J Public Health. High temperatures and health outcomes: a review of the literature	20688791
Total mortality with a 10 ppb incr in ozone	All year studies referenced in Table 6-27 (page 6-222) from the EPA Ozone 2013 Integrated Science Assessment	http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492

Regulations.gov will undergo system upgrades and as a result the site will be unavailable Saturday, March 28, from 6:30am through 8am (ET).

regulations.gov
Your Voice in Federal Decision-Making

Comment submitted by Ken Merrifield, Mayor, City of Franklin, New Hampshire

This is a Comment on the **Environmental Protection Agency** (EPA) Proposed Rule: **National Ambient Air Quality Standards for Ozone**

For related information, **Open Docket Folder**

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Comment

Ms. Susan Lyon Stone
Health and Environmental Impacts Division
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Mail code C504-06
Research Triangle Park, NC 27711

Ms. Susan Lyon Stone:

The Environmental Protection Agency does not need to lower the ozone standard and should continue to work with states and localities to reach the standards set in 2008.
As of July 2014, 123 million people (40% of the United States population) live in areas classified as non attainment for the primary ozone National Ambient Air Quality Standards (NAAQS). Of these people, 105 million still live in areas deemed non attainment from 1997s ozone regulations set at 85 ppb.
Reducing the ozone standard could reduce GDP by $270 billion per year, and result in 2.9 million fewer jobs per year through 2040. Businesses might not be able to expand and federal highway funds could freeze all for a standard that does not need to be changed.

As the Mayor of Franklin, New Hampshire, our economy is already fragile and we cannot afford to lose federal highway funds in our state.

I am urging the Environmental Protection Agency not to pursue lower levels of acceptable ozone in the atmosphere. There must be a careful balance of clean air and economic growth.
Thank you for the opportunity to comment on this important matter.

Sincerely,

Ken Merrifield
Mayor
City of Franklin, New Hampshire

Atmospheric Environment 109 (2015) 279–281

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Preface

Introduction to the special issue on observations and source attribution of ozone in rural regions of the western United States

We thank Dr. Mae Gustin for initiating the concept of this special issue and inviting us to serve as Atmospheric Environment Guest Editors. In the current rulemaking activities associated with the United States EPA proposing lower National Ambient Air Quality Standards for ozone (O_3), there has been considerable attention drawn to the elevated O_3 concentrations that occur in the western U.S. (EPA, 2013; Federal Register, 2014) and the possibility of exceedances at urban and rural locations resulting from background O_3 at current and lower proposed standards. The subjects covered in this special issue are timely in regards to providing insight into the importance of the physical and chemical processes that affect the spatial distribution and temporal trends of surface and lower tropospheric O_3 across the rural western U.S.

Both the federal human health O_3 and welfare (i.e., vegetation) standards focus on controlling concentrations at the upper end of the O_3 distribution (EPA, 2014a). The current human health and welfare U.S. standards are exceeded when the 3-year average of the annual fourth-highest daily maximum 8-h concentration is greater than 75 ppb. For protection of vegetation, EPA (Federal Register, 2014) recommends the W126 exposure index (Lefohn and Runeckles, 1987; Lefohn et al., 1988), which accumulates hourly average O_3 concentrations that weight the higher levels more than the mid-level values. On November 25, 2014 (Federal Register, 2014), EPA announced that it was proposing an 8-h O_3 human health standard somewhere in the range of 65–70 ppb and would take comment on whether the standard should be set as low as 60 ppb. EPA proposed that the vegetation standard be the same as the human health standard because it assumed that a health standard in the range of 65–70 ppb would protect vegetation from O_3 W126 cumulative exposures within the range of 13–17 ppm-h. The Agency announced that it would take comment on whether a W126 standard should be established somewhere in the range of 7–13 ppm-h.

Background O_3 contributes to observed O_3 levels across the U.S. As noted by the EPA, "However, the CAA [Clean Air Act] requires the EPA to set the NAAQS [National Ambient Air Quality Standard] at levels requisite to protect public health and welfare without regard to the source of the pollutant. *API*, 665 F. 2d at 1185–86. The EPA may consider proximity to background levels as a factor in the decision whether and how to revise the NAAQS when considering levels within the range of reasonable values supported by the air quality criteria and judgments of the Administrator. *ATA III*, 283 F. 3d at 379" (Federal Register, 2014). EPA documents describing the recent proposed O_3 standard demonstrate that up until the time of this writing the Agency has not defined what role background O_3 will play in the final decision.

Global or hemispheric, background, and baseline concentrations are terms that are often used interchangeably. The term baseline concentration refers to observations of pollutants, while the term global or hemispheric background concentration refers to modeled concentrations of pollutants from particular sources. Baseline O_3 is O_3 transported into the western U.S. from all upwind sources (i.e., natural and anthropogenic) before modification by recent, localized U.S. emissions. It includes aged O_3, produced many days earlier from U.S. emissions, that is returned to the U.S. after circling the globe. Baseline O_3 can be directly observed by surface or airborne instrumentation along the west coast or U.S. political borders and can also be observed above the inland regions of the western U.S. in air masses not influenced by recent US emissions. The global or hemispheric background concentration of a pollutant is a model construct that estimates the atmospheric concentration of a pollutant due to natural or a combination of natural and anthropogenic sources. The EPA, as part of its standard-setting process, has defined background O_3 differently over the years. Prior to 2006, O_3 measurements from remote monitoring sites were used to estimate background. In 2006, the EPA (2006) used models to define background O_3 and defined background to include contributions from global anthropogenic and natural sources in the absence of North American (i.e., U.S., Canada, and Mexico) anthropogenic emissions. EPA originally referred to this definition as Policy-Relevant Background (PRB) and more recently as North American Background (NAB). In 2013, EPA (2013) introduced the terminology U.S. background (USB) O_3 by including anthropogenic contributions from Canada and Mexico. The difference associated with the hypothetical estimates of NAB O_3 and USB O_3 is small (EPA, 2013).

NAB O_3 and USB O_3 are estimated background concentrations that reflect hypothetical zero anthropogenic emissions from North America or the U.S., respectively (referred to as zero-out modeling by EPA, 2014a). Lefohn et al. (2014) and EPA (2014a) recently introduced estimates of background O_3 under current anthropogenic emission conditions using source-apportionment modeling. Lefohn et al. (2014) refer to their metric as Emissions-Influenced Background (EIB) and EPA refers to its metric as apportionment-based U.S. Background (USB_{ab}). In this special issue, Dolwick et al. (2015) describe USB and USB_{ab} background levels and their relative importance to observed O_3 levels at high- and low-elevation sites in the western U.S. The authors note that from a seasonal mean perspective, it is not uncommon for modeled daily 8-h average concentrations of USB O_3 values at monitors in the intermountain western U.S. to approach 40–45 ppb and for USB to represent 60–80 percent of total O_3. Dolwick et al. (2015) note that their analyses suggest that U.S. background can comprise a substantial portion (e.g., >75 percent) of the total daily O_3 at certain rural, high-elevation sites in the western U.S.

Background O_3 can originate from natural sources of O_3 and O_3 precursors, as well as from manmade international emissions of O_3

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precursors (EPA, 2014a). Natural sources of O_3 precursor emissions, such as wildfires, lightning, and vegetation can lead to O_3 formation by chemical reactions with other natural sources. Another important component of background is O_3 transported from the stratosphere down to the surface. Work by Baylon et al. (2015) in this special issue discusses key predictors of O_3 production associated with wildfire events observed at the Mt. Bachelor Observatory, an inland mountaintop site located in western Oregon. The relative contribution to background O_3 (as defined by the EPA) from long-range transport of anthropogenic emissions and natural stratospheric intrusions is important in assessing the degree to which international controls would be effective in reducing background O_3. Langford et al. (2015) in this special issue provide insight into the relative importance of various sources, such as stratosphere-to-troposphere transport and long-range transport from Asia. Langford et al. (2015) note that exceedances of a 65 ppb threshold generated by high background concentrations and stratospheric intrusions would have occurred on 60% of the days during their study, making exceedances due to stratospheric intrusions common rather than unusual events.

EPA (2014b) notes that background O_3, which consists of non-U.S. anthropogenic sources, such as stratospheric intrusions and international transport, peaks during the spring months. Gratz et al. (2015) present evidence in this special issue on the importance of long-range transport from Asia in influencing background concentrations. The authors calculated trends over the 10-year (2004–2013) period in spring for O_3 and carbon monoxide (CO) at the Mt. Bachelor Observatory and reported that the rise in springtime O_3 is likely associated with increasing O_3 precursor emissions in Asia and long-range transport to the western U.S. Previous work by others have shown significant median springtime O_3 increases only occurred at half of the high-elevation rural monitoring sites in the western U.S. (Cooper et al., 2012). Continuing observations and modeling are required to fully understand the impact of natural variability and Asian/U.S. emissions on broader western U.S. O_3 trends.

The transport of urban pollution to rural areas is important for nonattainment considerations in the U.S. In this issue, VanCuren (2015) discusses that transport of anthropogenic pollution eastward out of the Los Angeles megacity region to the Mojave Desert. He noted that the timing of O_3 peaks at low-altitude monitoring sites within the Mojave Desert, at distances 100–400 km from the South Coast and San Joaquin Valley O_3 source regions, did not show expected time-lag behavior observed in larger transport studies. According to the author, the discrepancy is associated with O_3 transport across the Mojave Desert that occurs in a persistent layer of polluted air in the lower free troposphere with a base level at approximately 1 km MSL. This layer impacts elevated downwind sites directly, but only influences low-altitude surface O_3 maxima through deep afternoon mixing. Pollutants in this elevated layer derive from California source regions (the Los Angeles megacity region and the intensive agricultural region of the San Joaquin Valley), from long-range transport from Asia, and transport from the stratosphere. Yates et al. (2015), in this issue, present an assessment of the seasonality and magnitude of net O_3 production within the lower troposphere above California's San Joaquin Valley (SJV) and the effects of vertical transport on surface O_3 mixing ratios in an extreme exceedance area. During extreme events above the boundary layer (e.g., stratosphere-to-troposphere transport), vertical features (areas of enhanced or depleted O_3 or water vapor) are observed in the offshore and SJV profiles at different altitudes, demonstrating the scale of vertical mixing during transport. Yates et al. (2015) conclude that their study provides a detailed observation-based analysis of O_3 in California and highlights the importance of considering O_3 transported aloft, and its impacts on ground level O_3. Burley et al. (2015), using data from passive samplers and active monitors, show that the Lake Tahoe Basin experiences elevated concentrations of surface-level O_3. Back-trajectory analysis suggests that much of the O_3 measured at Lake Tahoe results from the transport of polluted air into the Basin from upwind pollution source regions (e.g., Sacramento, San Joaquin Valley). Given the high elevation of the Tahoe Basin, the authors hypothesize that the polluted air also included O_3 transported from Asia.

As current rulemaking activities in the U.S. move from setting O_3 standards to the implementation phase, there will be considerable interest in emission control strategies for attaining the federal standards (i.e., human health and vegetation). As part of the attainment scenarios, additional research is needed to quantify the relative importance of long-range versus stratosphere-to-troposphere transport in influencing surface O_3 levels.

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March 17, 2015

The Honorable Gina McCarthy
Administrator
U.S. Environment Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Sent via Federal eRulemaking Portal: http://www.regulations.gov

Re: Comments on the U.S. Environmental Protection Agency's National Ambient Air Quality Standards for Ozone Proposed Rule (Docket ID No. EPA-HQ- OAR-2008-0699)

Dear Administrator McCarthy:

The National Association of State Departments of Agriculture (NASDA) submits the following comments in response to the Environmental Protection Agency (EPA) proposed rule published December 17, 2014 related to National Ambient Air Quality Standards (NAAQS) for Ozone.

NASDA represents the Commissioners, Secretaries, and Directors of the state departments of agriculture in all fifty states and four U.S. territories. State departments of agriculture are responsible for a wide range of programs including conservation and environmental protection, food safety, combating the spread of disease and fostering the economic vitality of our rural communities. In forty-three states, the state departments of agriculture are the lead state agencies responsible for the regulation of pesticide use under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). A number of state departments of agriculture also administer Section 402 National Pollutant Discharge Elimination System (NPDES) permitting programs for Concentrated Animal Feeding Operations (CAFO). NASDA members have an interest in this proposed rule because of these regulatory responsibilities, responsibilities related to other state regulatory activities, and as advocates for the agricultural producers and rural communities in their states.

NASDA has a number of concerns with the proposed rule which would reduce the standards for ozone from the 2008 standard of 75 parts per billion ("ppb"), down to between 70 ppb and 65 ppb—and potentially as low as 60 ppb.

NASDA is concerned this proposal moves the goal posts and negatively impacts state agencies. During the agency's 2010 reconsideration of its current 2008 ozone standard, EPA effectively stopped implementing that 2008 standard, impacting states' implementation of that standard. With this new proposal, the agency is complicating state efforts related to air quality and straining state resources.

Reducing the standard for ozone from 75 ppb to between 70 ppb and 65 ppb—or even 60 ppb—would negatively impact agricultural producers around the country. Specifically, the number of nonattainment

areas would dramatically expand under the proposal. A 60 ppb standard could increase the number of these nonattainment areas nearly threefold. The practical ramification of this is that the costs associated with agricultural production would increase. Input costs, such as for fuel and fertilizer, would increase, impacting the economic vitality of rural communities. In addition, farmers could be faced with implementing costly upgrades on equipment such as engines for irrigation systems in order to comply with restrictions resulting from an increase in nonattainment areas. Furthermore, important agricultural practices such as prescribed burning could be negatively impacted by the proposed standard.

In conclusion, NASDA is concerned the proposed ozone standard would adversely impact state governments and agricultural producers. Rather than proceeding with a revised standard, the 2008 standard should be retained. NASDA appreciates your consideration of these comments and looks forward to working with the agency on this issue in the future.

Sincerely,

Barbara L. Glenn

Barbara P. Glenn, Ph.D.
Chief Executive Officer
NASDA

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CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

BOB MARTIN
Commissioner

March 16, 2015

Environmental Protection Agency
EPA Docket Center (EPA/DC)
Mailcode 28221T
Attention Docket ID No. EPA-HQ-OAR–2008–0699
1200 Pennsylvania Ave. NW.
Washington, DC 20460

Re: Comments to National Ambient Air Quality Standards (NAAQS) for Ozone; Proposed Rule (Docket No. EPA–HQ–OAR–2008–0699; FRL–9918–43–OAR)

Dear Sir or Madam:

The New Jersey Department of Environmental Protection (NJDEP) is providing comments in this letter to the United States Environmental Protection Agency's (USEPA) proposed rule, *National Ambient Air Quality Standards for Ozone* (Docket No. EPA–HQ–OAR–2008–0699; FRL-9918-43-OAR). This rule proposes to revise the primary and secondary NAAQS for ozone.

Comment 1: USEPA should provide states with timely rules, guidance and tools necessary to implement the standard.

USEPA should not revise the ozone NAAQS unless it can also promptly provide the states with the rules, guidance and tools necessary to implement it. USEPA's rule to implement the current 75 ppb standard was only recently finalized, 7 years late and close to the deadline for the first round of Attainment Demonstration State Implementation Plans (SIPs). This delay in issuing the final implementation rule creates a burden for the states that had prepared their required air quality documents before the implementation rule was finalized because those states may now have to revise those plans to conform with the new rule. If USEPA does not promulgate an implementation rule with a new ozone standard in a timely manner, then the states will again be in a position of having to invest resources in writing plans that may not be consistent with the associated final implementation rule.

To ensure that the states meet the planning requirements of the Clean Air Act (e.g., development of infrastructure SIPs, Reasonably Available Control Technology (RACT) analyses, identification of emission reduction strategies, and an attainment demonstration SIP), the USEPA should propose an ozone NAAQS implementation rule at the same time that it promulgates a revised NAAQS and finalize it within 1 year of proposal. USEPA should be able to readily meet that deadline because much of what would be needed in a new implementation rule can be derived from USEPA's recently finalized final Implementation Rule for the 75 ppb Ozone NAAQS. It will also assist the States in implementing and attaining the standard as expeditiously as practicable.

Comment 2: USEPA should develop and implement strategies to reduce mobile source NOx emissions on a schedule that would deliver emissions reductions in advance of attainment deadlines.

If USEPA intends to promulgate a lower ozone NAAQS, then it also needs to prioritize development of new mobile source emissions strategies at the Office of Transportation and Air Quality (OTAQ) so that implementation of those new strategies will coincide with, and support, the states' attainment obligations. Mobile source emissions are the largest contributor to ozone causing pollutants. States have limited authority to directly regulate mobile sources. Because fleet turnover is slow, there is a significant lag between the time that a mobile source emission reduction strategy is implemented and the time that those strategies lead to significant emissions reductions. Therefore, USEPA has to develop mobile source strategies well in advance of the states' attainment deadlines under the Clean Air Act.

Comment 3: USEPA must develop solutions to ozone transport

If USEPA revises the ozone standard, then implementing the new standard should not divert USEPA from taking meaningful action to hold upwind states legally accountable for their contribution to ozone nonattainment in downwind states.

The CSAPR rule implemented in January 2015 is already out of date – it is based on the 1997 85 ppb ozone standard. CSAPR is not an effective ozone transport strategy at this time because the emissions caps in the rule are too high and because it fails to address high NOx emissions during ozone episodes. Until USEPA either updates CSAPR to correct these flaws or replaces CSAPR with a more effective strategy, New Jersey will continue to suffer from ozone transport and nonattainment. New Jersey's air quality is significantly impacted by ozone transport from upwind states. According to USEPA models, more than 50% of the ozone levels in New Jersey are attributable to air pollution that blows into New Jersey from upwind states.

New Jersey supports measures to protect human health and the environment from ground-level ozone. New Jersey's actions to protect its citizens from harmful levels of ozone have been successful, and New Jersey is committed to continuing that work. Other states upwind of New Jersey have not done the same and, in some cases, have increased their ozone-contributing emissions during recent ozone seasons. A new ozone standard at this time will be an expensive

paperwork exercise unless USEPA addresses transport for the current (and new) ozone standard and provides the states with implementation plan requirements simultaneously with the adoption of the new standard.

Thank you for your consideration of these comments. Please do not hesitate to contact Bill O'Sullivan, Director, Division of Air Quality, at (609) 984-1484 if you have specific questions regarding the content of this letter.

Sincerely,

Jane Herndon

Jane Herndon
Assistant Commissioner

OKLAHOMA DEPARTMENT OF TRANSPORTATION
J. Michael Patterson, Director
200 N.E. 21st Street
Oklahoma City, OK 73105-3204
(405) 522-1800

March 24, 2014

Air and Radiation Docket and Information Center
Environmental Protection Agency
Mail Code: 2822T
1200 Pennsylvania Avenue NW
Washington, DC 20460

Re: Docket ID No. EPA-HQ-OAR-2008-0699

The Oklahoma Department of Transportation (ODOT) appreciates the opportunity to provide comments on the proposed rule regarding the National Ambient Air Quality Standards (NAAQS) for primary and secondary level ozone standards proposed by the Environmental Protection Agency (EPA). ODOT is committed to protecting public health and welfare, especially for those who may suffer from diseases impacted by elevated levels of ozone and is in support of improving air quality in this region.

The state of Oklahoma prides itself in the commitment made by its communities toward maintaining attainment of the current NAAQS. With the EPA's proposed lowering of the 8-hour primary standard to the 0.060 to 0.070 ppm range, a large majority of the state's 77 counties will be impacted and at least twelve of the state's 77 counties are at risk of being designated as nonattainment of the NAAQS for ground-level ozone.

Three areas within the state of Oklahoma that represent the greatest percentage of population have a combined total of thirteen air quality monitors. These areas are represented by metropolitan planning organizations (MPOs) designated by the Federal Highway Administration for transportation planning purposes: the Association of Central Oklahoma Governments (ACOG) in the Oklahoma City metropolitan area; the Indian Nations Council of Governments (INCOG) in the Tulsa metropolitan area; and the Lawton Metropolitan Planning Organization. Each of these MPOs continues to do an excellent job of providing leadership in maintaining compliance with the current ozone standards.

With the impact of extreme summertime weather patterns and other factors, such as transport, the larger urban areas in Oklahoma have continued to be proactive within their respective areas to maintain attainment of the current NAAQS. However, the rural areas that would now be affected by the proposed lower standards will suffer significant economic impacts and have fewer options than the urban areas for achieving sufficient reductions of pollutants.

The Oklahoma Department of Transportation offers the following comments concerning the proposed rulemaking:

- EPA should consider providing methods that can be used to achieve the new NAAQS and be more flexible with rural areas to lessen social and economic impacts. Rural areas do not have the resources to achieve sufficient reductions of pollutants, therefore before enforcement of such stringent requirements as are being proposed rural communities must be equipped with the tools to help them meet the proposed lower standards.

- EPA should address the issue of ozone transport, prior to implementing new NAAQS. Interstate transport of ozone affects many areas across the state of Oklahoma and regional or national controls are needed to address this problem.

- EPA should continue to offer programs such as Ozone Advance and delay any designation of participating communities.

- EPA should pursue more aggressively improvements in vehicle fleet conversions as a long-term solution to the problem, *e.g.,* new technologies and fleet turnover. Such improvements will provide the biggest opportunity to reduce ozone from mobile source emissions.

- EPA should consider strengthening national measures that affect ozone emissions nationwide, e.g., regulatory requirements for power plants, mileage/emissions requirements on motor vehicles, and uniform cleaner fuels. The problem EPA is trying to solve is a national problem and solutions should emanate from the federal level rather than from the urban and rural areas across the country.

In conclusion, the ODOT respectfully request development of a new national approach to improve the nation's air quality. The national approach should focus on improving air quality and lowering emissions by the development of tools that will offer solutions nationwide, e.g., power plant standards, mileage/emissions requirements on motor vehicles, cleaner fuel standards, and improvements in fleet conversions.

Sincerely,

J. Michael Patterson
Executive Director

JP/LC

Oregon
Kate Brown, Governor

Department of Environmental Quality
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(503) 229-5696
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TTY 711

March 16, 2015

U.S. Environmental Protection Agency
EPA Docket Center (EPA/DC)
Mail Code: 28221T
1200 Pennsylvania Avenue N.W.
Washington, D.C. 20460

Attn: Docket ID No. OAR-HQ-OAR-2008-0699

Dear Sir or Madam:

Oregon appreciates the opportunity to comment to the U.S. Environmental Protection Agency (EPA) on the reconsideration of the National Ambient Air Quality Standard (NAAQS) for ozone. Oregon supports the use of a health science based approach for establishing the ozone NAAQS at a level necessary for the protection of public health and welfare.

Ozone levels in urban areas of Oregon have decreased significantly since the 1990s due to successful State and federal pollution control strategies. Oregon continues to work to reduce ozone levels using regulatory opportunities to control emissions of ozone precursors, and in addition to implement innovative approaches to improve air quality, such as smart growth policies and the renewable energy portfolio.

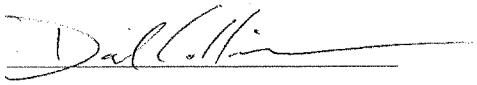
Oregon supports lowering the ozone standard following the advice of the Clean Air Scientific Advisory Committee (CASAC) to provide adequate public health and welfare protection. However, lowering the standard could increase implementation challenges and costs in Oregon. The issue of background ozone will be particularly important for implementing a lower NAAQS in Oregon. Background ozone, including ozone caused by natural events such as wildfires and long-range transport, contributes considerably to measured levels of ozone in Oregon. Our concern is that in the future these background levels are likely to increase.

For example, wildfires are more prevalent and rampant when summers are warmer. Climate change is predicted to bring higher summertime temperatures to Oregon potentially increasing the incidence of these wildfires. The primary regulatory tool available to states for addressing wildfire impacts affecting nonattainment designations is the EPA exceptional events policy that may exclude the effect of these impacts. To date, most exceptional events in Oregon have involved wildfires' influence on particular matter ($PM_{2.5}$). Unlike $PM_{2.5}$ which decreases with the distance, ozone is a secondary pollutant formed in the atmosphere from pre-cursor

emissions from the wildfire, and ozone levels can increase as the plume moves further from its source. Oregon is concerned about the challenges involved in demonstrating and quantifying ozone impacts from wildfires, particularly as these impacts may affect areas whose ambient levels are near the NAAQS. The impacts from wildfires often last for extended periods of time with varying impacts on ozone levels. It will be very burdensome for Oregon to create ozone exceptional events demonstrations for wildfire impacts due to the frequency and size of wildfires in Oregon and due to extremely complex role of wildfires in ozone production. We ask EPA to streamline and simplify requirements for exceptional events demonstrations and to provide resources and tools to characterize the effects of the wildfires on ozone levels in Oregon.

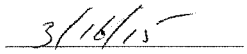
Another concern for Oregon is the background from long-range transport of ozone or ozone precursors. Decades long measurements at the Mt. Bachelor Observatory in central Oregon show an increase in ozone levels that scientists attribute to pollution transported from East Asia. The rate of increase in ozone at Mt. Bachelor is comparable, over the same time period, to the rate of decrease in the Portland area where the State and community worked hard to accomplish lower emissions and better air quality. Quantifying the impact of this transport from Asia will present challenges for Oregon as we do not have adequate resources to thoroughly evaluate regional and international ozone transport into Oregon. We ask that EPA develop guidance that addresses ozone transport from Asia and provide technical assistance to states dealing with this issue.

In summary, Oregon welcomes EPA's proposal to lower the ozone NAAQS, based on advice provided by the Clean Air Act Science Advisory Committee, in order to provide adequate protection to human health and welfare. With the lower ozone standard Oregon and other states in the West will face unique implementation challenges. Mainly these challenges come from the inadequate understanding of background ozone and lack of tools to deal with emissions sources that are outside of the state's control. We recommend that EPA develop thorough guidance and tools to address the exceptional events criteria for wildfires and long-range transport.



David Collier, Air Quality Manager

Oregon Department of Environmental Quality



Date

EPA predicts that lowering ozone levels in Houston will result in increased premature deaths

Natural OUTLOOK
PD-R20140-87 OCTOBER 2014

WILL EPA'S PROPOSED NEW OZONE STANDARDS PROVIDE MEASURABLE HEALTH BENEFITS?

Xenix articles continue 10/2/2014

By Dr. Michael Honeycutt
Director, TCEQ Toxicology Division

The EPA is considering lowering the existing national eight-hour ozone standard from its current level of 75 parts per billion (ppb) to a much lower range, between 70 and 60 ppb. However, after an in-depth review of the EPA's analysis, as well as a thorough study of the relevant scientific literature, the TCEQ has concluded that there will be little to no public health benefit from lowering the current standard.

Surprisingly, the EPA's own modeling in 12 cities across the country indicates the net result will be *increased* mortality in some areas, including Houston and Los Angeles. The EPA did not perform the analysis for other cities in Texas.

There is no doubt that, at some higher level, ground-level ozone is harmful to human health. The question is, has the EPA adequately demonstrated that lowering the ozone standard to 70–60 ppb would actually have health benefits? We think that the EPA's process of setting ozone standards has not scientifically proven this, and that further lowering of the ozone standard will fail to provide any measurable increase in human health protection.

The EPA's own modeling in its Health Risk and Exposure Assessment (HREA)

Getting to Know Dr. Michael Honeycutt, Director, Toxicology Division

Dr. Michael E. Honeycutt is a dedicated, distinguished scientist who has served the people of Texas through his work for the Toxicology Division of the TCEQ since 1996. He has served as director of the division since 2009.

He is a dedicated family man. He and wife Lucinda have been married for 27 years and have two sons: Ethan, a sophomore at UT Dallas, and Adam, a senior at Pflugerville High School. They have lived in Pflugerville for 18 years, where he is active in his church and in the Boy Scouts. His hobby is woodworking, although he admits it's hard to find time to pursue it as much as he would like.

Dr. Honeycutt joined the TCEQ after working for the U.S. Army Corps of Engineers in Mississippi. He has a bachelor's degree and Ph.D. in toxicology from the University of Louisiana at Monroe.

Dr. Honeycutt is a full member of the Society of Toxicology, a worldwide professional and scholarly organization of scientists from academic institutions, government, and industry representing the great variety of scientists who practice toxicology in the U.S. and abroad.

Continued on page 2

Number of Premature Deaths in Houston Predicted by EPA

	Net Impact on Mortality
Meeting current standard (75 ppb) from present day ozone levels	47 more deaths
Going from present levels to 70 ppb	48 more deaths
Going from present levels to 65 ppb	44 more deaths
Going from present levels to 60 ppb	35 more deaths

This table, which was made using EPA's own modeling, indicates that reducing ozone in the Houston area will actually result in *increased* premature deaths. Whether this predicted result is factual, or if it just highlights flaws in the EPA's interpretation of the data, it casts doubt on the science being used to justify EPA's proposed lower ozone standards.

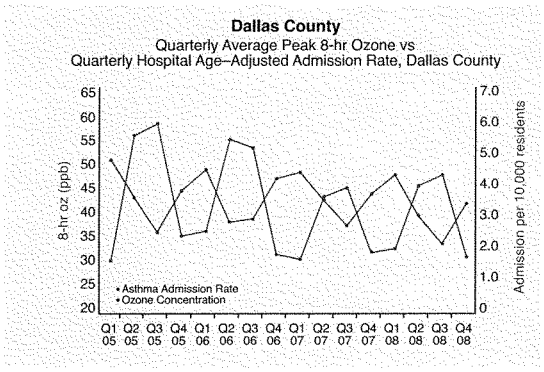
Based on 2009 data—*EPA, Final Health Risk and Exposure Assessment*, Appendix 7, p. 7B-2

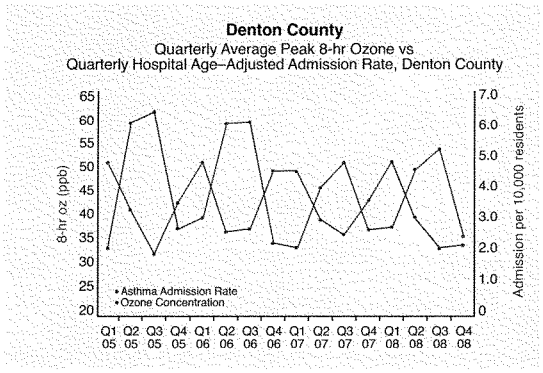
indicates that lowering ozone concentrations would actually result in more deaths in some cities (Appendix 7, page 7B-2 of the HREA). Either this indicates that lowering the ozone standard defeats its stated purpose of protecting human health, or it indicates that something is wrong with the EPA's interpretation of the data. Either way, it's not a good argument for lowering the ozone standard.

Further, the EPA is not very forthcoming about the increased deaths. It's not mentioned in the executive summary of their policy analysis, but it's found on page 115 of Chapter 3, more than one third of the way through the 597-page document.

The EPA's proposed lower ozone standard derives much of its claimed benefits from associating ozone with worsening asthma. The problem with this association is that asthma diagnoses are increasing in the U.S., yet nationwide, air quality is improving. If asthma were actually tied to ozone, you would expect to see the instances of asthma decreasing, not increasing. In fact, data from Texas hospitals show that asthma admissions are actually highest in the winter, when ozone levels are the lowest.

The evaluation of the proposed ozone standard was performed by the TCEQ





Data collected from Texas hospitals indicates that admissions for asthma are actually highest in the winter, when ozone concentrations are normally lowest. This casts further doubt on the EPA's assertion that ozone is an important driver of asthma symptoms.

Getting to Know Dr. Michael Honeycutt, Director, Toxicology Division (continued)

He has co-authored scientific articles on a wide variety of toxicological subjects in a number of scientific journals, and is cited three times in the Encyclopedia of Toxicology. Dr. Honeycutt has given invited testimony before the U.S. House of Representatives four times, and has appeared before the Texas Legislature numerous times.

He frequently participates on committees, boards, workshops and panels, and has presented at dozens of symposia and conferences across the United States.

"I consider myself extremely lucky to be leading our team of 15 toxicologists," he said. "No state has a more dedicated, distinguished team of scientists committed to serving its citizens. The excellence of their work in setting safe exposure levels for a wide variety of chemicals and compounds is recognized when these levels are adopted by many other states and countries."

"I love my job," he said. "As a scientist, I love following the facts to a conclusion, even if it is contrary to accepted wisdom."

Dr. Honeycutt says his data aren't always welcome. "I was cussed out by the mayor of a West Texas town when I told him to shut down the town's water supply because of contamination. And I pushed the agency to do a large-scale monitoring survey in the Barnett Shale when I saw a couple of benzene readings that were concerning to me."

"I always tell people, 'Show me where I'm wrong,' and I'm willing to accept it if they do. That's the definition of science. I also love the fact that I'm expected to interpret data objectively. I don't have to hype data in hopes of getting a grant or donations to fund my position," said Dr. Honeycutt.

Toxicology Division, which consists of 10 Ph.D. and five master's level scientists. Our scientists specialize in toxicology and risk assessment related to air contaminants, and set guidelines and toxicity factors that are adopted by many different states and countries.

The sciences (toxicology, molecular biology, biochemistry, cell biology, chemistry, just to name a few) used to set the EPA's standards are complex and technical. Toxicology Division members Stephanie Shirley (Ph.D., UT MD Anderson Cancer Center, molecular carcinogenesis), Sabine Lange (Ph.D. UT MD Anderson Cancer Center, biochemistry and molecular carcinogenesis), Neeraja Erraguntla (Ph.D., LSU, physiology, pharmacology and toxicology), and I immersed ourselves in ozone toxicology and epidemiology. We presented a paper titled "A Toxicological Review of the Ozone NAAQS" at various professional meetings, and are helping prepare ground-breaking analyses of the ozone data for publication in peer-reviewed journals.

Below are a few facts and simplified explanations of the TCEQ's conclusion that a lower ozone standard is not justified.

You can find links to other references and ozone information at <www.tceq.texas.gov/goto/ozone-science>.

Sensitivity of Asthmatics to Ozone:

- Exposure of human volunteers to ozone showed similar lung effects in asthmatics and in non-asthmatic subjects. Additionally, children are no more sensitive to ozone than are young adults.

Mortality Caused by Long-term Exposure to Ozone:

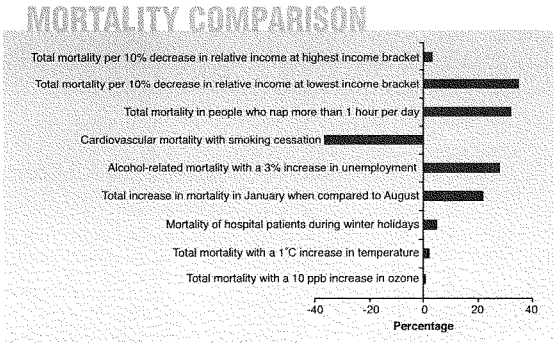
- Only 1 out of 12 studies considered by the EPA showed an association between long-term exposure to ozone and early death (after considering other pollutants). This single study is used by the EPA as evidence that long-term exposure to ozone causes mortality. Interestingly, this study did not show higher mortality in Southern California, where some of the highest ozone levels in the country are measured.

Ambient Ozone Concentrations Don't Represent Real-world Exposure:

- Ozone is an outdoor air pollutant, because systems such as air conditioning remove it from indoor air. Since most people spend more than 90 percent of their time indoors, we (and the people in the epidemiology studies used to justify lowering the standard) are rarely exposed to significant levels of ozone.
- Even people who work outdoors are exposed to, at most, 60 percent of the ozone concentration that is measured at an ambient monitor. Additionally, there are ozone standards particularly for workers to ensure that they are protected.
- For ozone to cause a slight change in lung function in clinical studies, people need to be exposed to outdoor levels of ozone for hours while vigorously exercising (example: 6 hours of bicycling). These changes in lung function are often so small that they are within a person's *normal* daily variation.
- Epidemiology studies show an association between a person's likelihood of dying, and the outdoor concentrations of ozone in the days before (or the day of) a person's death. However, we spend most of our time indoors (particularly people who are near death), so the people in the studies were exposed to levels of ozone that are far below those that cause any clinical effect.

Problems with Implementing a New Ozone Standard:

- Some places in the U.S. have background levels of ozone that account for up to 80 percent of total ozone. Background ozone occurs naturally, or is transported from other countries. The EPA does not take this into account when making the rule.
- Ozone is not produced directly, but instead forms when other chemicals (particularly nitrogen oxides) react with sunlight. However, ozone chemistry is complicated, and the same nitrogen oxides that produce ozone can also react with existing ozone to remove it from the air. So places that have high nitrogen oxide production (such as areas



Many factors influence mortality, and the effect of an increase in ozone by 10 ppb is tiny in comparison to these other influences.

near roads), often have lower ozone levels.

- Because ozone chemistry is complex, lowering ozone-producing chemicals in the cities would decrease ozone in the suburbs, but could increase ozone in the inner-cities (because there will be a decrease in the nitrogen oxides that can remove ozone). This means that, according to EPA predictions, those living in the inner cities could bear more health burdens, while people on the outskirts enjoy the predicted benefits.

Proponents of lower ozone standards sometimes advance the argument that even if the lower standards are not scientifically justified, what is it going to hurt to have cleaner air? The answer is, why regulate something that is not really going to have a benefit? That effort should be put into regulating something that will have a benefit—perhaps air toxics—perhaps figuring out what is causing increased reported rates of asthma—perhaps looking at indoor air quality, which probably has a bigger impact on health than outdoor air quality, because data shows Americans likely spend at least 90 percent of their time indoors.

There are costs to regulation. Increased regulatory costs make nearly all goods and services more expensive, particularly energy. There is a real, human cost resulting from higher energy bills, especially in Texas. For poor Texans (and many poor Texans are elderly Texans), being able to keep their home cool on hot and humid summer days has a real health benefit.

If an area violates an ozone standard, it is in nonattainment, and new regulations are imposed, with the goal of bringing those areas into attainment. Those regulations and the expenses they impose make it more difficult and more expensive for many existing businesses and industries to operate, and those costs are eventually passed on to the consumer.

Being in nonattainment also means that new businesses that produce qualifying emissions may have to purchase emissions offsets to open their doors, or consider opening their business in another area that is in attainment.

If the EPA decides the new ozone standards should be at the lower end of the range, close to 60 ppb, it is likely that areas like El Paso; San Antonio; Victoria; the Tyler region in East Texas; the I-H 35 corridor between San Antonio and Dallas-Fort Worth, including Austin and Waco; Beaumont and Port Arthur; parts of the Panhandle and Rio Grande Valley; and Big Bend National Park would be in nonattainment.

For the DFW and Houston-Galveston-Brazoria areas, which are already in nonattainment, and already heavily regulated, reaching attainment would become even more difficult and further impact economic growth. All residents of these areas would be affected.

A study commissioned by the National Association of Manufacturers found that, in a scenario where new ozone standards constrained natural gas production, electricity prices could increase by 15 percent for residential customers and 23 percent for industrial customers. The study found that the new ozone standards could reduce U.S. GDP by $270 billion per year and result in 2.9 million fewer job equivalents per year on average through 2040.

The Clean Air Act, which sets air quality standards for six pollutants including ozone, is the only federal environmental law that expressly forbids the EPA from considering the feasibility and costs of attaining a standard. In my mind, that should set the bar higher for the science. This is particularly the case with ozone, because the economic costs would be enormous, and the standard will be almost unachievable even if the public is able to bear those costs. There should be no doubt that lowering the standard will result in health benefits, but that is not the case for this consideration of the ozone standard. How can the EPA in good conscience make a policy decision this expensive when the data are so contradictory that their own modeling predicts more deaths in some areas from lowering the standard?

I'm often asked, wouldn't it be easier to just accept what the EPA does? Isn't it a lot of trouble to try to affect the direction of the EPA's 16,000 employees and $8 billion budget? Yes, of course that would be easier, but it wouldn't be the right thing to do.

Environmental regulations should be based on sound science. If they are not, then it opens the door for regulations that are based on politics, or on other reasons that do not benefit the public. The TCEQ has been provided with the expertise and funding to do research and science to assure that regulations are effective and beneficial to the environment and to public health. That is what the legislature and the people of Texas task us to do, and we take that task very seriously.

Information Online

EPA's Health Risk and Exposure Assessment
www.epa.gov/ttn/naaqs/standards/ozone/s_o3_2008_rea.html

EPA's Policy Assessment
www.epa.gov/ttn/naaqs/standards/ozone/s_o3_2008_pa.html

Asthma Information
www.cdc.gov/asthma/pdfs/asthma_facts_program_grantees.pdf

Ozone Levels/Trends
www.epa.gov/airtrends/ozone.html

A Toxicological Review of the Ozone NAAQS
www.tceq.com/assets/public/implementation/tox/ozone/superconference.pdf

Links to Additional Ozone Information
www.tceq.texas.gov/assets/public/implementation/tox/ozone/ozone_science.pdf

NAM Economic Report
www.nam.org/Special/Media-Campaign/EPA-Overregulation/Ozone-Regulations.aspx

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degree horizontal grid resolution). The lateral boundary conditions from the global model were used as inputs for the regional simulation. Four scenarios were modeled:

- a 2007 base case simulation which was also the basis of the air quality modeling performed for the 2nd draft ozone REA and is described in more detail in Appendix 4b of EPA (2013b)
- a natural background run with anthropogenic ozone precursor emissions[10] removed in both the global and regional models[11]
- a North American background run with anthropogenic ozone precursor emissions removed across North America in both the global and regional model simulations
- a U.S. background run with anthropogenic ozone precursor emissions removed over the U.S. in both the global and regional model simulations

The source apportionment modeling was also based on a regional scale air quality model (CAMx at 12 km horizontal grid resolution) that used the same lateral boundary conditions from the 2007 base global modeling scenario. EPA used the Anthropogenic Precursor Culpability Assessment (APCA) tool in this analysis. The APCA tool attributes ozone production to manmade sources whenever ozone is determined to result from a combination of anthropogenic and biogenic emissions (Environ, 2011). The APCA methodology calculates natural ozone as the production resulting from the interaction of biogenic VOC with biogenic NOx emissions. Eleven separate source categories were tracked in the EPA source apportionment analysis, including five boundary condition terms and six in-domain sectors:

- Boundary condition terms:[12]
  - Northern edge
  - Eastern edge
  - Southern edge
  - Western edge
  - Top boundary

[10] In the global model, only emissions from natural sources were used (i.e., VOC, NO_X, CO) and methane was reset to pre-industrial levels (700 ppb) to reflect natural contributions. In the regional modeling, the methane levels were left unchanged.

[11] Note that methane is not modeled as an explicit species in CMAQ but instead is treated as having a constant concentration. Therefore, although methane was reduced to pre-industrial levels in the global GEOS-Chem run used to create boundary conditions, methane was assumed to be equal to modern-day levels in the CMAQ model runs. Since methane reactions occur on relatively long timescales, this discrepancy is not expected to have a large impact on modeled background ozone levels.

[12] It should be noted that although boundary conditions are treated as part of apportionment-based USB for this analysis, in some cases they may be influenced by US anthropogenic emissions that are advected out of the model domain and recirculated back into the U.S. This is not expected to make a substantial impact on results.

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journal homepage: www.elsevier.com/locate/atmosenv

Recent tropospheric ozone changes – A pattern dominated by slow or no growth

S.J. Oltmans [a,b,*], A.S. Lefohn [c], D. Shadwick [d], J.M. Harris [b], H.E. Scheel [e], I. Galbally [f], D.W. Tarasick [g], B.J. Johnson [b], E.-G. Brunke [h], H. Claude [i], G. Zeng [j], S. Nichol [k], F. Schmidlin [l], J. Davies [g], E. Cuevas [m], A. Redondas [m], H. Naoe [n], T. Nakano [n], T. Kawasato [n]

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HIGHLIGHTS

- O_3 at mid-latitudes of the N.H. is flat or declining in the last 10–15 years.
- O_3 in S.H. subtropics and mid-latitudes increased earlier but has leveled off.
- 15-year moving trends reveal changes in both high and low O3 concentrations.
- Precursor (NO_x) reductions in Europe and N.A. likely contribute to O_3 decline.

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ABSTRACT

Longer-term (i.e., 20–40 years) tropospheric ozone (O_3) time series obtained from surface and ozonesonde observations have been analyzed to assess possible changes with time through 2010. The time series have been selected to reflect relatively broad geographic regions and where possible minimize local scale influences, generally avoiding sites close to larger urban areas. Several approaches have been used to describe the changes with time, including application of a time series model, running 15-year trends, and changes in the distribution by month in the O_3 mixing ratio. Changes have been investigated utilizing monthly averages, as well as exposure metrics that focus on specific parts of the distribution of hourly average concentrations (e.g., low-, mid-, and high-level concentration ranges). Many of the longer time series (~30 years) in mid-latitudes of the Northern Hemisphere, including those in Japan, show a pattern of significant increase in the earlier portion of the record, with a flattening over the last 10–15 years. It is uncertain if the flattening of the O_3 change over Japan reflects the impact of O_3 transported from continental East Asia in light of reported O_3 increases in China. In the Canadian Arctic, declines from the beginning of the ozonesonde record in 1980 have mostly rebounded with little overall change over the period of record. The limited data in the tropical Pacific suggest very little change over the entire record. In the southern hemisphere subtropics and mid-latitudes, the significant increase observed in the early part of the record has leveled off in the most recent decade. At the South Pole, a decline observed during the first half of the 35-year record has reversed, and O_3 has recovered to levels similar to the beginning of the record. Our understanding of the causes of the longer-term changes is limited, although it appears that in the mid-latitudes of the northern hemisphere, controls on O_3 precursors have likely been a factor in the leveling off or decline from earlier O_3 increases.

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1. Introduction

Recently, particular attention has focused on tropospheric ozone (O_3) as a climate forcing constituent (Shindell et al., 2012) and as an impediment to attainment of air quality standards (McDonald-Buller et al., 2011). In addition tropospheric O_3 plays a key role in the oxidative chemistry of the atmosphere through its participation in the production of the hydroxyl radical (Levy, 1971). A recent report (HTAP, 2010) has reemphasized the importance of the long-range transport of pollution-produced O_3 to the hemispheric O_3 background concentration. Two workshops (Logan et al., 2010; Schultz et al., 2011) have emphasized the need for a more systematic assessment of tropospheric O_3 changes. Several publications have presented results on O_3 changes in Europe and mid-latitudes of the Northern Hemisphere (N.H.) (Logan et al., 2012; Parrish et al., 2012) as well as broader regional changes (Oltmans et al., 1998, 2006; Vingarzan, 2004). Oltmans et al. (2006) noted that continental Europe and Japan showed significant increases in the 1970s and 1980s but that tropospheric O_3 amounts appeared to have leveled off or in some cases declined in the more recent decades. Logan et al. (2012) described the decrease in O_3 over Europe since 1998, with the largest decrease during the summertime. Using Zugspitze data for 1978–1989 and the mean time series from three Alpine stations since 1990, Logan et al. (2012) found that the O_3 increased substantially in 1978–1989 (i.e., 6.5–10 ppb but began to exhibit a reduced rate of increase in the 1990s (i.e., 2.5–4.5 ppb) with decreases in the 2000s (i.e., 4 ppb) in summer with no significant changes in other seasons. Overall in summer no trend was noted for the 1990–2009 period.

This work updates through 2010 the temporal trends at background O_3 monitoring sites around the world in both the Northern and Southern Hemispheres. Background O_3 is defined differently by various researchers (McDonald-Buller et al., 2011). Zhang et al. (2011), using a model, estimated background by eliminating precursor sources in North America. Here it is used in a more general way to describe conditions where local or identifiable regional sources are not prominent or have been excluded. An example is the use of downslope (nighttime) observations at Izana and Mauna Loa as representative of free tropospheric O_3 at the altitude of the station. In addition, characteristic trends are investigated at sites that are not necessarily considered to be background O_3 monitoring sites (e.g., Whiteface Mountain, New York and several US National Park locations) but are in key locations that have particularly long, continuous records. A number of representative ozonesonde locations that have long records provide key information on tropospheric O_3 changes above the boundary layer. These sites extend the time period of tropospheric O_3 observations and provide information on the representativeness of the surface trends for lower tropospheric O_3 changes in general. The earliest ozonesonde records date from the late 1960s or early 1970s, while a number of other sites begin in the 1980s. In addition to length of record, the ozonesonde locations have been chosen for broad representativeness of a region. As with surface locations, a selection of sites is chosen rather than a comprehensive analysis of every available location. This work represents an extension and update of earlier studies (Oltmans et al., 1998, 2006) that also focused on providing a broad geographic perspective on O_3 changes.

Information on the pattern of changes is provided by the distribution of hourly average concentrations as higher hourly average O_3 concentrations are reduced as a result of lowering NO_x emissions. Lefohn et al. (1998) noted that as O_3 levels improved (i.e., the environment experienced lower O_3 exposures) due to reduced emissions, reductions in the number of high hourly average concentrations, as well in the number of low hourly average

Table 1
Location of surface and ozonesonde stations.

Station	Lat.	Lon.	Elev (m)	Period	Type
Resolute, NWT, Canada	74.7N	95.0W	64	1981–2010	Ozonesonde
Barrow, Alaska, USA	71.1N	156.6W	11	1973–2010	Surface
Denali NP, Alaska, USA	63.7N	149.0W	661	1987–2010	Surface
Churchill, Manitoba, Canada	58.8N	94.1W	35	1981–2010	Ozonesonde
Edmonton, Alberta, Canada	53.6N	114.1W	766	1981–2010	Ozonesonde
Goose, Newfndlnd, Canada	53.3N	60.3W	44	1979–2010	Ozonesonde
Mace Head, Ireland	53.2N	9.54W	25	1988–2010	Surface
Glacier NP, Montana, USA	48.5N	114.0W	976	1989–2010	Surface
Hohenpeissenberg, Germany	47.8N	11.0E	975	1966–2010	Ozonesonde
Zugspitze, Germany	47.4N	11.0E	2962	1978–2010	Surface
Whiteface Mtn., NY, USA	44.4N	73.9W	1484	1973–2010	Surface
Sapporo, Japan	43.1N	141.3E	19	1967–2010	Ozonesonde
Lassen NP, Calif., USA	40.5N	121.6W	1756	1987–2010	Surface
Boulder, Colorado, USA	40.0N	105.0W	1745	1985–2010	Ozonesonde
Rocky Mtn., NP, CO, USA	40.3N	105.6W	2743	1989–2010	Surface
Pinedale, Wyoming, USA	42.9N	109.8W	2388	1989–2010	Surface
Ryori, Japan	39.0N	141.8E	260	1991–2010	Surface
Wallops Isl., Virginia, USA	37.9N	75.5E	13	1971–2010	Ozonesonde
Tsukuba (Tateno), Japan	36.1N	140.1E	31	1968–2010	Ozonesonde
Tudor Hill, Bermuda	32.3N	64.9W	30	1988–2010	Surface
Izaña, Tenerife, Spain	28.3N	16.5W	2800	1988–2010	Surface
Naha, Japan	26.2N	127.7E	27	1989–2010	Ozonesonde
Minamitorishima, Japan	24.3N	154.0E	8	1994–2010	Surface
Hilo, Hawaii, USA	19.7N	155.1W	11	1982–2010	Ozonesonde
Mauna Loa, Hawaii, USA	19.5N	155.6W	3397	1973–2010	Surface
Matatula Pt., Am. Samoa	14.3S	170.6W	82	1976–2010	Surface
Pago Pago, American Samoa	14.5S	170.5W	10	1995–2010	Ozonesonde
Cape Point, South Africa	34.4S	18.5E	230	1983–2010	Surface
Cape Grim, Australia	40.7S	144.7E	104	1982–2010	Surface
Baring Head, New Zealand	41.4S	174.9E	85	1991–2010	Surface
Lauder, New Zealand	45.0S	169.7E	370	1986–2010	Ozonesonde
Syowa, Antarctica	69.0S	39.6E	21	1966–2010	Ozonesonde
South Pole, Antarctica	90.0S	–	2840	1975–2010	Surface
				1986–2010	Ozonesonde

concentrations occurred. The reduction in the number of low hourly average O_3 concentrations was associated with lack of NO_x scavenging (US EPA, 1996). Lefohn et al. (1998) noted that as the site air quality improved, the distribution of the hourly average concentrations appeared to move from both the high end as well as the low end of the distribution toward the center (i.e., 30–60 ppb). In our analysis of the O_3 time series, we use a number of techniques, some of which were employed in previous research efforts (Oltmans et al., 2006; Lefohn et al., 2008; Oltmans et al., 2008; Lefohn et al., 2010). Using the monthly average concentrations, a linear regression that simultaneously estimates contributions for seasonality and various types of temporal trend is used. An autoregressive time series model (Harris et al., 2001) is applied to each site evaluating the changes in monthly average concentrations to estimate O_3 temporal trends at individual sites. In addition, changes in the peak, mid-level (50–99 ppb), and low hourly average O_3 values (<50 ppb) were investigated using two exposure metrics and the quantification of the monthly changes in the distribution of hourly average concentrations. We have characterized the trends in the distribution of the hourly average mixing ratios in intervals to better understand the changes in interval frequency over time. With a lifetime of 10–30 days, the local tropospheric O_3 signal will include a hemispheric component. Superimposed on this signal will be distinct regional characteristics resulting from O_3 precursor emissions and variations in long-range transport (including stratospheric exchange). The analysis presented in this study characterizes O_3 changes within various geographic regions as a way of organizing the presentation of the changes. The characterization of changes in the frequency of high-, mid-, and low-level hourly average concentrations over time provides investigators with quantitative information for assessing possible physical processes associated with observed changes.

2. Tropospheric ozone time series

2.1. Data sets

The O_3 time series sites considered here are listed in Table 1 with relevant information on the location, altitude, and length of the record. The data have been gleaned from a number of sources, including the World Data Centre for Greenhouse Gases (WDCGG), the World Ozone and Ultraviolet Radiation Data Centre (WOUDC), and the US EPA Air Quality System (AQS) data base. A number of the data sets have been updated through 2010 by authors participating in this study. Data quality control has been carried out by the institution responsible for managing the measurement program at the individual locations. A number of the surface and ozonesonde sites are World Meteorological Organization (WMO) Global Atmosphere Watch (GAW) locations and follow measurement procedures consistent with their recommendations (Smit et al., 2007; Galbally and Schultz, submitted for publication). However, detailed methodological records, including a history of changes, are not widely available. The national air quality data measurements follow procedures established by national agencies, such as the US EPA. The uniformity of the procedures and the homogeneity of the time series are not, however, assured over the multi-decade series considered here. For many of the time series used in this study, the participating authors have provided additional information on the time series characteristics so that these data are at a quality level deemed appropriate for the analysis carried out here.

2.2. Analysis approaches

Ozone changes are considered over several time periods to assess the way such changes have evolved over time and to place the most recent time period (15–20 years) in perspective. The longest ozonesonde records considered here go back at least 40 years, while several of the surface records are over 35 years in length. For the three long ozonesonde records (Hohenpeissenberg, Wallops Island, and Tsukuba), the record is analyzed over 40 years. For the surface O_3 series with records between 32 and 35 years, the entire record has been used. Where the time series are at least 30 years in length, trends for periods of 30 and 20 years are considered. The uniform periods of 30 years and 20 years allow comparison of the changes among the sites as well as assessment of recent changes provided by running 15-year trends of the W126 metric (Lefohn and Runeckles, 1987; Lefohn et al., 1988). The W126 index accumulates the weighted hourly average concentration over the entire distribution for a specified period, with the result that the middle and upper portions of the distribution are accentuated (Fig. 1a). An additional exposure metric, the W_Low, has been developed for this analysis to assess changes in the lower mixing ratio range (i.e., <50 ppb) that may be associated with reductions in anthropogenic emissions. Unlike the W126 metric, the W_Low metric places greater weight on the lower portion of the distribution (Fig. 1b). In this analysis, the focus is on whether increasing or decreasing trends are observed in the W_Low index. An increase in the W_Low index implies that the frequency of hourly average concentrations is increasing at the lower hourly average mixing ratios (i.e., <50 ppb), while a decrease in W_Low index implies that the frequency of hourly average concentrations in the low end is decreasing, with the result that the concentrations are shifting from the low to the mid-level range. As a confirmation that the W_Low index is characterizing the shifts properly, the change in the hourly

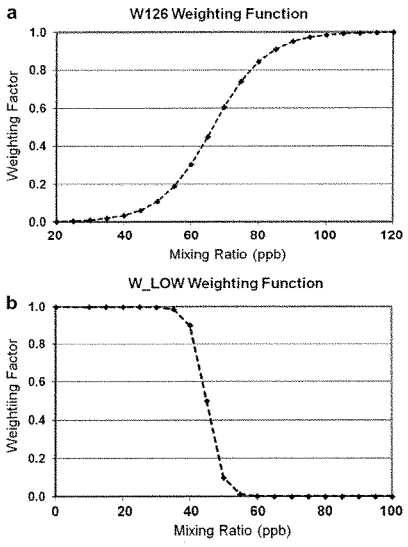

Fig. 1. Form of the weighting function for computing the 24-h (a) W126 and (b) W_Low exposure metrics for each month from the hourly average O_3 mixing ratios.

average mixing ratios using 10 ppb intervals is characterized over the period of record. This information is used to identify statistically significant trends for each month by characterizing the changes in frequency within each of the 10 ppb increments (i.e., bin) of the distribution. For both the W126 and W_Low metrics, the accumulation is performed over a 24-h period.

2.3. Trend computation

Several approaches were used to determine the changes with time in the O_3 time series. These methods have been described in detail in earlier publications (Oltmans et al., 2006; Lefohn et al., 2010) but are briefly summarized here. The data from each location are treated as individual time series because we are looking for a pattern across monitoring sites within a specific region to investigate whether similar patterns of change exist within a region. Therefore, the data from multiple sites are not combined. The time series is not considered to be a continuous series when multiple consecutive years are missing. Varying data capture criteria were used depending on the analysis approach. These are noted below in describing the results from the various analyses.

Using monthly average concentrations, the overall O_3 trend is computed in a two-step process (Harris et al., 2001). Monthly values at sites with a very small diurnal variation, observed at some island and higher-altitude locations, are constructed from daily 24-h averages. For continental boundary layer locations, where urban nighttime loss is significant and in some cases daytime regional enhancements are present, an 8-h daytime average (1100–1800 LST) is used. For Mauna Loa, Hawaii and Izaña (Canary Islands), where a significant mountain wind regime prevails, the nighttime (0000–0800 LST) downslope data are taken as most representative of the troposphere at the altitude of the station. The O_3 profile data are averaged into several layers in the troposphere; Surface-850 hPa, 850–700 hPa, 700–500 hPa, and 500–300 hPa (approximately Sfc-1.5 km, 1.5–3 km, 3–6 km, and 6–9 km).

The first step of the trend calculation uses an auto-regressive model that incorporates explanatory variables and a cubic polynomial fit rather than a straight line for better representation of the long-term variations. The explanatory variables include a seasonal component, 500 hPa and 100 hPa temperatures, QBO and ENSO indices. The model accounts for serial correlation in the O_3 data and minimizes the residual variance of the model fit by regressing to known sources of O_3 variability noted above. The second step determines the O_3 tendency (trend line) and growth rate curves (Harris et al., 2001). A bootstrap method (Harris et al., 2001) produces 100 statistical realizations of the population from which the original data were drawn by combining the tendency curve with randomly selected residuals from the curve according to month (Harris et al., 2001). The growth rate curve is obtained by numerical differentiation of the tendency curve with the 95% confidence limits determined using the standard deviation of the growth rate curves from the 100 bootstrap samples. The average O_3 growth rate, which is the average of the monthly values on the growth rate curve, is a measure of the overall change. Seasonal changes are examined by comparing the decadal seasonal variation for three periods: 2001–2010, 1991–2000 and 1981–1990. For the time series with the longest records that go back into the early 1970s, the segment from the beginning of the record (or 1971 if the record begins earlier than 1971) to 1980 was also considered.

The Theil estimate (Hollander and Wolfe, 1999) was used to estimate the trend slope for the running 15-year trends for the W126, W_Low. The Theil estimate is a non-parametric estimator that is numerically identical to the ordinary least squares (OLS) slope estimate when the OLS model assumptions are satisfied. The Theil estimate is determined as the median of slope estimates calculated as the slope of the line passing through paired points for all point pairs in the data set of interest. To test for statistical significance, Kendall's tau test (Lefohn and Shadwick, 1991; Hollander and Wolfe, 1999) was used to determine significance at the 10% level. Because the tail probability of the distribution can change abruptly from year to year, the significance level of 0.10 was selected to reflect the degree of variability for the Kendall's τ statistic over the range of years in the time series. The W126 and W_Low metrics were adjusted for missing values as follows: (1) the monthly value of each metric was calculated if at least 75% of the hourly data were available for a specific month (a corrected monthly cumulative metric was calculated as the uncorrected monthly cumulative metric divided by the fractional data capture), and (2) if a month with less than 75% data capture had the two adjacent months each having at least 75% data capture (a corrected monthly cumulative metric with less than 75% data capture was calculated as the arithmetic mean of the corrected monthly cumulative metrics for the two adjacent months). There was no restriction on the number of such interpolations during a specific year. If all of the months contained within a year or season had valid

Table 2
Surface ozone trends in %/decade and ppbv/year for three time periods: Full record, 1981–2010, and 1991–2010 (±1 Standard Error).

Station	Full record (first year)-2010			1981–2010		1991–2010	
	1st Year	%/dec	ppb yr^{-1}	%/dec	ppb yr^{-1}	%/dec	ppb yr^{-1}
Barrow	(1973)	3.50 ± 1.04	0.09 ± 0.03	1.28 ± 1.20	0.03 ± 0.03	5.00 ± 2.00	0.13 ± 0.05
Denali NP	(1987)	1.09 ± 1.19	0.04 ± 0.04			4.69 ± 1.49	0.15 ± 0.05
Mace Head	(1988)	2.47 ± 1.18	0.09 ± 0.04			0.33 ± 1.28	0.01 ± 0.05
Glacier NP	(1989)	−2.76 ± 1.19	−0.07 ± 0.05			2.79 ± 1.63	−0.07 ± 0.04
Zugspitze	(1978)	8.10 ± 0.58	0.39 ± 0.03	2.76 ± 0.67	0.14 ± 0.03	0.94 ± 0.82	0.05 ± 0.04
Whiteface	(1973)	2.10 ± 0.84	0.09 ± 0.03	1.80 ± 0.92	0.07 ± 0.04	−5.32 ± 1.43	−0.22 ± 0.06
Lassen	(1987)	4.43 ± 1.16	0.19 ± 0.05			3.01 ± 1.15	0.13 ± 0.05
RMNP	(1987)	4.70 ± 0.93	0.22 ± 0.04			6.69 ± 1.01	0.33 ± 0.05
Pinedale	(1989)	1.87 ± 0.78	0.09 ± 0.04			−0.95 ± 0.86	−0.05 ± 0.04
Ryori	(1991)	5.44 ± 10.9	0.22 ± 0.45			5.44 ± 1.09	0.22 ± 0.45
Izana	(1987)	1.98 ± 0.92	0.09 ± 0.04			3.11 ± 1.05	0.14 ± 0.05
Minamitorishima	(1994)	−10.3 ± 2.54	−0.29 ± 0.07				
Mauna Loa	(1974)	3.79 ± 0.94	0.16 ± 0.04	3.34 ± 1.00	0.14 ± 0.04	7.18 ± 1.69	0.31 ± 0.07
Samoa	(1976)	0.73 ± 1.41	0.01 ± 0.02	3.48 ± 1.81	0.05 ± 0.02	1.20 ± 2.50	0.02 ± 0.34
Cape Point	(1983)	5.70 ± 0.50	0.13 ± 0.01			7.29 ± 0.67	0.17 ± 0.02
Cape Grim	(1982)	2.51 ± 0.55	0.06 ± 0.01			3.44 ± 0.67	0.09 ± 0.02
Baring Head	(1991)	0.51 ± 1.22	0.01 ± 0.03			0.51 ± 1.22	0.01 ± 0.03
South Pole	(1975)	0.18 ± 0.54	0.01 ± 0.02	−0.22 ± 0.74	−0.01 ± 0.21	7.07 ± 0.83	0.20 ± 0.02

Table 3
Ozonesonde layer trends %/decade and ppbv/year for three time periods (±1 Standard Error). Layer 1 = Surface-850 hPa, Layer 2 = 850–700 hPa, Layer 3 = 700–500 hPa, Layer 4 = 500–300 hPa.

Station	Full record (1st year or 1971)–2010			1981–2010		1991–2010	
	1st Year	%/dec	ppb yr^{-1}	%/dec	ppb yr^{-1}	%/dec	ppb yr^{-1}
Resolute	(1981)						
1.		−2.98 ± 1.96	−0.09 ± 0.06	−2.98 ± 1.96	−0.09 ± 0.06	6.69 ± 2.75	0.21 ± 0.08
2.		0.81 ± 1.57	0.03 ± 0.06	0.81 ± 1.57	0.03 ± 0.06	9.62 ± 2.08	0.39 ± 0.09
3.		−0.07 ± 1.35	−0.00 ± 0.07	−0.07 ± 1.35	−0.00 ± 0.07	8.11 ± 1.90	0.40 ± 0.09
4.		0.10 ± 2.64	0.00 ± 0.21	0.10 ± 2.64	0.00 ± 0.21	15.00 ± 4.13	1.17 ± 0.32
Churchill	(1981)						
1.		−5.34 ± 1.18	−0.18 ± 0.04	−5.34 ± 1.18	−0.18 ± 0.04	2.82 ± 1.96	0.09 ± 0.06
2.		−2.83 ± 1.08	−0.12 ± 0.05	−2.83 ± 1.08	−0.12 ± 0.05	2.25 ± 1.85	0.10 ± 0.08
3.		−1.21 ± 1.03	−0.06 ± 0.05	−1.21 ± 1.03	−0.06 ± 0.05	5.96 ± 1.47	0.31 ± 0.08
4.		−0.72 ± 2.14	−0.05 ± 0.15	−0.72 ± 2.14	−0.05 ± 0.15	7.73 ± 2.81	0.55 ± 0.20
Edmonton	(1981)						
1.		−1.63 ± 1.80	−0.05 ± 0.05	−1.63 ± 1.80	−0.05 ± 0.05	0.57 ± 2.57	0.02 ± 0.08
2.		3.04 ± 1.11	0.13 ± 0.05	3.04 ± 1.11	0.13 ± 0.05	7.55 ± 1.50	0.31 ± 0.06
3.		2.65 ± 1.06	0.13 ± 0.05	2.65 ± 1.06	0.13 ± 0.05	9.01 ± 1.28	0.45 ± 0.06
4.		3.44 ± 1.65	0.21 ± 0.10	3.44 ± 1.65	0.21 ± 0.10	11.05 ± 2.11	0.69 ± 0.13
Goose Bay	(1981)						
1.		1.18 ± 1.58	0.04 ± 0.05	1.18 ± 1.58	0.04 ± 0.05	10.17 ± 2.02	0.32 ± 0.06
2.		1.29 ± 1.33	0.05 ± 0.06	1.29 ± 1.33	0.05 ± 0.06	9.66 ± 1/84	0.40 ± 0.08
3.		1.90 ± 1.09	0.10 ± 0.06	1.90 ± 1.09	0.10 ± 0.06	10.01 ± 1.48	0.51 ± 0.08
4.		1.95 ± 2.04	0.14 ± 0.14	1.95 ± 2.04	0.14 ± 0.14	9.63 ± 2/24	0.68 ± 0.16
Hohenpeissenberg	(1971)						
1.		4.41 ± 0.96	0.15 ± 0.03	0.51 ± 1.04	0.02 ± 0.04	1.35 ± 1.53	0.05 ± 0.05
2.		3.63 ± 0.77	0.16 ± 0.03	−1.31 ± 0.85	−0.06 ± 0.04	−2.96 ± 1.13	−0.14 ± 0.05
3.		4.87 ± 0.60	0.26 ± 0.03	−0.29 ± 0.68	−0.02 ± 0.04	−0.20 ± 0.92	−0.01 ± 0.05
4.		5.36 ± 0.77	0.34 ± 0.05	0.53 ± 0.91	0.04 ± 0.06	1.59 ± 1.43	0.10 ± 0.09
Sapporo	(1971)						
1.		11.13 ± 1.57	0.35 ± 0.05	18.77 ± 1.84	0.63 ± 0.06	4.38 ± 2.17	0.15 ± 0.07
2.		5.34 ± 1.14	0.23 ± 0.05	10.69 ± 1.29	0.48 ± 0.06	−0.39 ± 1/38	−0.02 ± 0.06
3.		4.35 ± 0.98	0.23 ± 0.05	7.04 ± 1.11	0.38 ± 0.06	1.20 ± 1.26	0.07 ± 0.07
4.		2.35 ± 1.50	0.16 ± 0.10	1.45 ± 1.49	0.10 ± 0.10	−0.46 ± 2.05	−0.03 ± 0.14
Boulder	(1979)						
2.		−7.02 ± 1.38	−0.35 ± 0.07	−4.79 ± 1.37	−0.24 ± 0.07	3.85 ± 1.69	0.19 ± 0.08
3.		−8.14 ± 1.00	−0.46 ± 0.06	−6.43 ± 0.92	−0.36 ± 0.05	1.12 ± 1.11	0.06 ± 0.06
4.		−11.74 ± 1.59	−0.72 ± 0.10	−6.34 ± 1.44	−0.38 ± 0.09	1.98 ± 2.15	0.12 ± 0.13
Wallops Is	(1971)						
1.		3.51 ± 1.42	0.16 ± 0.06	0.43 ± 1.79	0.02 ± 0.08	5.97 ± 2.35	0.27 ± 0.11
2.		1.55 ± 0.99	0.08 ± 0.05	0.18 ± 1.18	0.01 ± 0.06	6.02 ± 1.37	0.33 ± 0.07
3.		1.55 ± 0.81	0.09 ± 0.05	0.16 ± 1.12	0.01 ± 0.07	4.62 ± 1.24	0.27 ± 0.07
4.		−0.06 ± 1.28	−0.00 ± 0.09	3.05 ± 1.44	0.20 ± 0.10	1.28 ± 2.37	0.09 ± 0.16
Tsukuba	(1971)						
1.		1.75 ± 1.41	0.08 ± 0.07	4.78 ± 2.27	0.23 ± 0.11	2.01 ± 3.13	0.09 ± 0.15
2.		3.28 ± 1.11	0.16 ± 0.06	4.25 ± 1.55	0.21 ± 0.08	1.83 ± 2.30	0.09 ± 0.12
3.		3.00 ± 0.97	0.16 ± 0.05	4.19 ± 1.26	0.23 ± 0.07	3.86 ± 1.77	0.21 ± 0.10
4.		5.35 ± 1.48	0.34 ± 0.10	6.34 ± 2.06	0.41 ± 0.13	8.23 ± 5.37	0.92 ± 0.56
Naha	(1991)						
1.		5.27 ± 2.98	0.17 ± 0.10			5.27 ± 2.98	0.17 ± 0.10
2.		2.46 ± 2.55	0.09 ± 0.10			2.46 ± 2.55	0.09 ± 0.10
3.		4.50 ± 2.23	0.21 ± 0.10			4.50 ± 2.23	0.21 ± 0.10
4.		3.91 ± 1.94	0.22 ± 0.11			3.91 ± 1.94	0.22 ± 0.11
Hilo	(1982)						
1.		−1.46 ± 2.97	−0.38 ± 0.08			9.74 ± 3.65	0.25 ± 0.09
2.		1.03 ± 2.19	0.04 ± 0.08			4.09 ± 2.98	0.15 ± 0.11
3.		2.38 ± 1.65	0.11 ± 0.08			3.06 ± 2.50	0.14 ± 0.12
4.		1.91 ± 1.70	0.09 ± 0.08			1.00 ± 2.70	0.05 ± 0.13
Lauder	(1986)						
1.		6.70 ± 1.17	0.15 ± 0.03			5.11 ± 1.56	0.12 ± 0.04
2.		4.67 ± 1.04	0.14 ± 0.03			3.43 ± 1.14	0.10 ± 0.03
3.		4.46 ± 1.06	0.16 ± 0.04			5.34 ± 1.16	0.20 ± 0.04
4.		1.39 ± 1.36	0.06 ± 0.06			2.58 ± 1.43	0.12 ± 0.07
Syowa	(1971)						
1.		6.83 ± 1.33	0.15 ± 0.03	4.67 ± 1.22	0.10 ± 0.03	1.04 ± 1.55	0.02 ± 0.04
2.		2.33 ± 1.11	0.06 ± 0.03	1.10 ± 1.18	0.03 ± 0.03	2.32 ± 1.38	0.06 ± 0.03
3.		1.94 ± 0.80	0.05 ± 0.02	0.32 ± 1.24	0.01 ± 0.03	4.12 ± 1.46	0.12 ± 0.04
4.		−2.50 ± 1.26	−0.10 ± 0.05	−1.72 ± 1.77	−0.07 ± 0.07	4.50 ± 2.09	0.18 ± 0.08
South Pole	(1986)						
3.		1.93 ± 0.79	0.05 ± 0.02			2.91 ± 0.92	0.08 ± 0.03
4.		3.02 ± 1.72	0.12 ± 0.07			2.29 ± 2.32	0.09 ± 0.09

estimates (by the method described above) of the corrected monthly cumulative metric, the corrected seasonal cumulative metric was calculated as the sum of the corrected monthly cumulative metrics. Otherwise, a valid estimate of the corrected seasonal cumulative metric was not reported. To report a valid trend, the time series for trend calculations had to satisfy the following two further data capture criteria: (1) at least 11 (73%) valid years for 15-year running trend periods and (2) beginning with the last five years of record, at least three of five valid years were required within each 5-year block of years.

The monthly change in the distribution of hourly average concentrations for several monitoring sites was investigated by characterizing the median difference between each 10 ppb increment in absolute frequency except at the South Pole site, where increments of 5 ppb were used. These median differences for each increment (10 or 5 ppb) are plotted as histograms. The Theil estimate was also used to estimate the trend slope. To test for statistical significance, Kendall's tau test (Lefohn and Shadwick, 1991) was used to determine significance at the 10% level for the specified increments.

3. Results

In this section, results from the analysis of the time series in broad geographical regions are considered. In some cases these groupings might be expected to produce similar changes and thus, the consistency of the changes or the geographic scope of the changes can be assessed. The linear trend estimates from the regression model for each location are provided in Table 2 (surface sites) and Table 3 (ozonesondes). Trends are given for three periods; 1971–2010 (or the beginning of the record if after 1971), 1981–2010, and 1991–2010. For the O_3 profile data the trends are given for each layer. Both the percentage change (in %/decade) and the mixing ratio change (ppb yr^{-1}) are shown with plus/minus one standard error. Trend estimates exceeding two standard errors are deemed statistically significant.

3.1. North polar

Polar latitudes of the N.H. (north of 65N) are not usually considered as a likely region for significant local photochemical tropospheric O_3 production, although biomass burning related to boreal fires can have an impact (Stohl et al., 2007; Oltmans et al., 2010). However, transport from the stratosphere or lower latitudes along with the possible influence of rapid climate change are potential sources of longer-term changes. At Barrow, Alaska (71N) the 38-year record shows a modest increase of 3.5 ± 1.0%/decade with most of that occurring in the first and last decade of the record (Fig. 2 and Table 4). However, changes for individual months from one decade to another are smaller than the variations within a decade (Table 4). The largest change appears to have occurred during summer and autumn months between the initial period (1973–1980) and the subsequent decade (1981–1990). During the 30-year period (1981–2010) covered by the Resolute, Nunavut ozonesonde record, there was no significant change at Barrow, which is consistent with the profile measurements at Resolute (Fig. 3), where no significant overall change is present. Over the last two decades, both locations show a positive trend that is not statistically significant, which primarily reflects the lower values in the 1980s to the mid 1990s. The running 15-year trends of the W126 metric for the Barrow site (Fig. 2c) illustrates the statistically significant change in the early years but no further statistically significant trends during the later years. These sites illustrate the decadal variations that influence the trend calculations when considering different time periods even though the records are relatively long (Logan et al., 1999, 2012).

3.2. Mid-latitudes of the N.H

The mid-latitudes of the N.H. are a zone of high population and industrial and transportation activity encompassing Europe, North America, and Asia. Several recent studies have investigated changes in this latitude band (Parrish et al., 2012) or a particular region

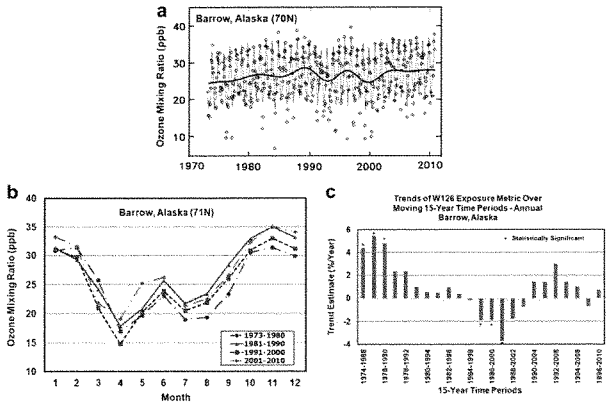

Fig. 2. a) Monthly mean, model fit and smooth trend curve of the O_3 mixing ratio at Barrow, Alaska. b) The seasonal variation at Barrow for 10-year periods. c) Moving 15-year trends at Barrow of the W126 exposure metric. Significant trends are marked with an asterisk.

Table 4
Mean and standard deviation for each month for multiple time periods.

MN	Barrow							
	1973–1980		1981–1990		1991–2000		2001–2010	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	30.87	2.49	31.41	2.95	30.99	2.72	33.13	1.81
2	31.19	2.07	29.37	4.51	29.77	2.52	31.77	1.93
3	25.47	4.56	24.40	3.84	21.25	5.70	21.76	2.67
4	16.96	5.39	17.91	6.23	14.80	5.49	19.15	3.91
5	19.88	4.65	20.86	3.74	20.27	6.79	25.24	4.95
6	23.11	1.81	25.68	2.79	23.37	3.78	26.44	2.17
7	19.10	2.05	21.74	1.60	20.67	2.78	21.35	1.11
8	19.36	1.47	23.34	1.62	21.92	4.09	22.56	1.61
9	23.46	2.50	28.41	2.80	26.10	3.38	26.62	3.32
10	30.19	2.98	32.88	1.77	30.81	2.85	32.31	2.41
11	31.46	2.09	34.98	2.35	32.97	3.37	35.12	1.79
12	29.84	2.47	33.14	1.89	31.09	3.02	34.13	1.48

MN	Zugspitze					
	1981–1990		1991–2000		2001–2010	
	Mean	SD	Mean	SD	Mean	SD
1	36.46	4.78	42.64	3.13	44.52	2.03
2	40.14	5.07	45.83	3.03	46.53	2.29
3	46.42	5.47	49.36	2.37	51.60	1.89
4	53.80	6.56	56.48	3.29	58.02	1.99
5	55.80	6.95	58.13	3.80	57.30	2.18
6	54.14	4.98	58.10	3.76	57.42	3.18
7	54.62	4.11	57.99	5.13	57.11	4.71
8	53.57	4.34	56.18	2.02	54.24	5.52
9	46.41	1.79	48.82	2.93	48.49	3.47
10	40.97	2.21	44.66	2.29	45.21	2.00
11	39.18	2.89	41.93	2.62	42.10	1.53
12	37.28	2.83	41.09	1.84	42.63	1.74

MN	Westman Islands			
	1992–1997		2003–2010	
	Mean	SD	Mean	SD
1	38.40	1.85	41.50	1.86
2	41.32	1.52	43.02	0.98
3	44.50	1.89	46.25	0.72
4	45.34	1.65	47.08	1.59
5	42.60	2.11	43.36	2.85
6	33.40	2.81	36.89	1.59
7	29.42	1.89	30.87	2.15
8	29.20	2.29	32.33	3.57
9	33.04	4.38	35.09	1.41
10	35.72	1.71	37.43	1.11
11	37.72	1.39	38.56	1.56
12	38.25	2.16	40.05	0.71

MN	Bermuda			
	1992–1997		2003–2010	
	Mean	SD	Mean	SD
1	37.34	4.87	43.10	1.52
2	38.93	2.62	47.54	2.69
3	43.73	4.65	50.01	2.51
4	45.78	4.09	50.98	2.66
5	39.50	4.13	43.90	5.09
6	28.25	3.18	32.11	4.12
7	22.79	3.53	24.46	3.12
8	22.66	2.99	27.56	2.78
9	25.17	6.64	28.76	3.54
10	34.73	3.33	36.53	7.21
11	37.47	3.75	39.94	4.22
12	38.10	3.62	41.20	2.99

MN	Mace Head (12–19 LST)					
	1988–1995		1996–2002		2003–2010	
	Mean	SD	Mean	SD	Mean	SD
1	34.25	4.18	34.11	4.94	38.10	2.90

Table 4 (*continued*)

MN	Mace Head (12–19 LST)					
	1988–1995		1996–2002		2003–2010	
	Mean	SD	Mean	SD	Mean	SD
2	36.21	2.93	41.54	3.14	39.25	1.79
3	41.33	3.52	42.57	3.66	45.38	2.10
4	44.25	2.14	45.61	2.32	48.11	1.33
5	45.15	2.25	45.69	1.05	45.13	3.31
6	36.11	2.38	38.37	2.27	38.50	3.04
7	33.11	3.23	31.57	1.80	32.91	2.45
8	32.95	3.54	32.16	1.70	32.17	1.90
9	35.70	2.65	34.89	3.36	35.71	1.51
10	32.97	3.03	36.06	2.89	35.96	0.97
11	31.99	4.01	35.93	5.83	38.27	1.92
12	31.54	5.06	33.14	4.75	35.78	1.39

MN	Ižana (00–08 LST)					
	1988–1995		1996–2002		2003–2010	
	Mean	SD	Mean	SD	Mean	SD
1	40.95	2.00	45.23	3.07	43.94	1.45
2	40.99	1.36	46.29	3.91	44.94	2.57
3	44.83	2.18	50.27	2.98	48.26	1.84
4	51.10	4.02	55.29	4.77	54.55	2.37
5	52.69	2.98	55.44	4.35	55.31	4.89
6	52.86	3.59	55.30	3.73	54.82	3.35
7	45.88	3.50	55.73	3.92	50.23	4.37
8	42.00	3.31	48.80	3.17	46.51	5.15
9	40.05	3.11	41.41	3.32	41.62	2.69
10	36.34	2.35	41.23	3.56	39.64	3.60
11	38.19	1.71	41.87	2.28	41.75	2.40
12	38.61	1.56	43.54	2.94	43.56	1.36

MN	Denali NP (12–19 LST)					
	1988–1995		1996–2002		2003–2010	
	Mean	SD	Mean	SD	Mean	SD
1	31.62	2.38	34.79	3.99	33.85	2.61
2	33.89	3.03	37.82	3.32	37.72	3.29
3	37.36	1.67	41.26	5.68	39.04	1.84
4	41.96	1.62	43.84	5.33	45.76	2.45
5	38.74	1.02	42.37	4.96	43.66	2.46
6	30.57	1.42	34.11	2.21	33.36	3.90
7	26.15	2.97	24.40	2.40	25.81	3.74
8	23.44	2.27	22.41	2.77	24.33	4.01
9	26.79	1.66	25.81	2.86	26.69	1.74
10	27.66	2.73	29.11	2.37	27.69	2.79
11	30.19	2.37	31.21	3.70	31.58	2.67
12	32.30	1.43	32.01	5.57	34.64	2.57

MN	Lassen NP (12–19 LST)					
	1988–1995		1996–2002		2003–2010	
	Mean	SD	Mean	SD	Mean	SD
1	35.67	2.55	37.89	2.42	38.60	3.12
2	38.97	2.18	40.19	1.78	41.49	2.08
3	39.44	5.49	40.90	6.40	45.39	3.04
4	42.60	2.64	46.13	3.74	48.18	2.31
5	44.42	3.18	47.94	4.48	48.31	3.94
6	45.23	4.63	49.54	3.15	50.00	5.24
7	49.86	5.98	55.31	2.67	55.36	3.32
8	52.58	3.96	56.01	4.23	53.78	4.91
9	48.56	3.37	49.26	5.89	48.66	3.90
10	40.61	4.06	42.51	4.27	39.51	3.10
11	33.14	4.58	35.30	3.89	34.64	2.07
12	33.83	3.89	36.69	3.47	37.67	1.86

MN	Mauna LOA (00–08 LST)							
	1973–1980		1981–1990		1991–2000		2001–2010	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	36.63	3.46	41.06	3.54	42.08	3.85	43.23	2.43
2	39.57	2.73	41.81	4.49	43.03	3.40	44.15	4.13
3	46.14	4.77	49.45	5.04	49.00	5.24	46.02	6.34
4	48.51	5.06	53.45	5.90	57.48	3.72	53.25	7.08

Table 4 (*continued*)

MN	Mauna LOA (00–08 LST)							
	1973–1980		1981–1990		1991–2000		2001–2010	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
5	45.26	4.94	51.43	5.34	49.61	5.62	48.55	7.33
6	40.39	5.15	41.44	5.24	43.43	4.83	43.02	4.88
7	35.53	4.53	37.72	4.26	38.82	5.31	40.36	4.82
8	33.04	5.79	35.24	2.78	35.32	5.16	39.06	4.08
9	31.27	4.32	32.71	4.02	35.76	7.85	38.95	4.16
10	32.49	3.01	33.89	4.48	35.68	4.81	41.43	4.15
11	34.40	4.89	34.13	3.95	35.17	4.65	40.53	3.67
12	35.47	3.27	39.29	3.31	39.27	5.32	41.66	5.94

within this band (Logan et al., 2012; Cui et al., 2011; Cooper et al., 2010; Parrish et al., 2009; Tanimoto et al., 2009).

3.2.1. Western Europe

In Western Europe there are a multiplicity of locations and measurement platforms (aircraft, high-altitude surface, and ozonesondes) that have longer-term tropospheric O_3 records. A number of the measurement locations are in relative proximity to each other providing an opportunity to determine the consistency of the longer-term changes within this region. An extensive analysis of the long-term changes and the consistency of the results has been carried out by Logan et al. (2012). Over the multiple decades considered, different trends were deduced that were not always consistent. Some of these differences were ascribed to possible problems with the data record itself, although it was not always possible to identify the cause of the problem. In this study, the data from Zugspitze, which is the longest Alpine surface O_3 record, have been selected because of their use in previous studies (Oltmans et al., 1998, 2006) and consistency of the record with those of nearby sites (Logan et al., 2012). The ozonesonde measurements at Hohenpeissenberg have used the same type of ozonesonde (Brewer-Mast) and only modest changes in preparation procedures (Attmannspacher and Dütsch, 1978; Claude et al., 1987; WCRP, 1998) procedures over the long period of observations (40 years for this analysis), although differences from other long-term records in Europe have been noted (Logan et al., 2012). The time series of the Hohenpeissenberg ozonesonde monthly mean mixing ratios in the 700–500 hPa (~3–6 km) layer (Fig. 4a) shows increases from the beginning of the record that are seen throughout the troposphere (Fig. 4b) that, however, plateau by the mid-1980s so that the 30-year trend (Fig. 4b) is zero. At Zugspitze, on the other hand, O_3 continues to increase significantly into the late 1980s and plateaus (i.e., flattens) in the early 1990s (Fig. 4c and d), with the result that there is a significant increase over the past 30 years, which differs from the pattern at Hohenpeissenberg. A closer look at the pattern of change for Zugspitze shows that non-significant trends are observed beginning with the 15-year period 1988–2002 until 1993–2007, while significant decreasing trends are observed for the last three 15-year periods (i.e., 1994–2008, 1995–2009, and 1996–2010) (Fig. 4d). Over the period of record, there is an indication that the frequency of the lower hourly average concentrations (20–40 ppb) has shifted upward (i.e., 50–70 ppb) (Fig. 4e). The running 15-year W_Low metric illustrates that the shifting of the frequency of the lower to the mid-level concentrations was statistically significant from the beginning of the record until the 15-year period 1990–2004 (Fig. 4f). For the 15-year periods starting in 1993–2007, the frequency of the mid-level concentrations begins to shift toward the lower concentrations as indicated by an increase in the W_Low values along with the decrease in the higher concentrations indicated by the decrease in the W126 trends. Together these changes suggest that the entire distribution is shifting downward, which could be indicative of a decline in the regional background. The seasonal pattern at Zugspitze shows increases in all months from the decade 1981–1990 to the period 1991–2000 with the largest increases coming during the winter (Fig. 4g). In the most recent decade (2000–2010), the changes in all months have been small in comparison with the previous decade (Fig. 4g and Table 4). This pattern is consistent with what was seen in the changes of the W_Low metric and suggests that earlier increases included a component from the reduction in NO titration, especially during the winter, associated with NO_x reductions in Europe (http://www.eea.europa.eu/data-and-maps/indicators/eea-32-nitrogen-oxides-nox-emissions/eea-32-nitrogen-oxides-nox).

The relatively nearby locations of Hohenpiessenberg and Zugspitze should both sample predominantly free tropospheric air. The somewhat different pattern of change may result from the fact that the ozonesonde measurements at Hohenpeissenberg and the surface measurements at Zugspitze represent different measurement protocols. At Zugspitze, the surface measurements are continuous and include both day and night observations. At Hohenpeissenberg, on the other hand, the ozonesonde profiles provide a snapshot every few days and are made during a fixed time of day. It has also been found that the sonde profile and mountain surface measurements do not always observe the same air mass even at sites in close proximity to each other, and this is more likely to occur during the summer (Brodin et al., 2011). Sampling the Zugspitze time series for only the days when the Hohenpeissenberg sonde measurements were made does not resolve the differences (J. Logan – private communication, 2012).

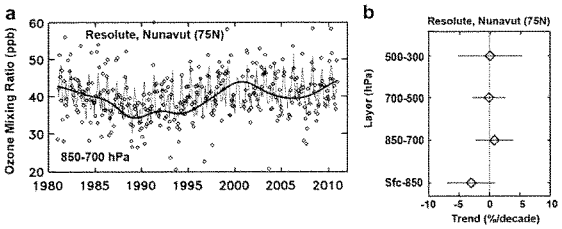

Fig. 3. Monthly mean (black diamonds), model fit (red line) and smooth trend curve (blue line) for the O_3 mixing ratio in the 850–700 hPa (~1.5–3 km) layer from ozonesondes at Resolute, Nunavut. b) Trend with altitude (diamond) of O_3 at Resolute for the period 1981–2010 and ±2 standard errors (horizontal bar). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

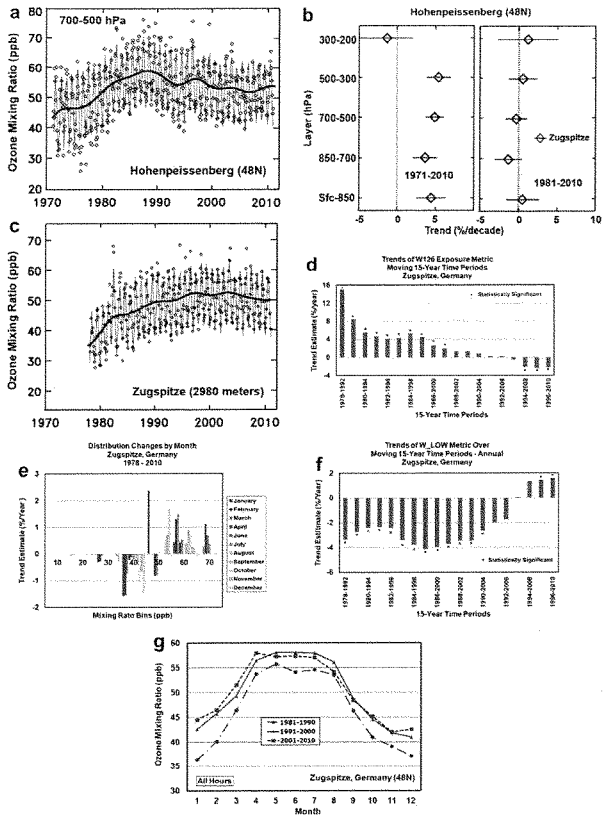

Fig. 4. a) Monthly mean (black diamonds), model fit (red line) and smooth trend curve (blue line) for the O_3 mixing ratio in the 700–500 hPa (~3–6 km) layer from ozonesondes at Hohenpeissenberg, Germany. b) Year-round linear trend of the monthly mean O_3 (diamond) and ±2 S.E. (horizontal bar) in layers in the troposphere at Hohenpeissenberg for 1971–2010 and 1981–2010. c) Monthly mean, model fit and smooth trend curve of the O_3 mixing ratio at Zugspitze, Germany. d) Moving 15-year trends at Zugspitze of the W126 exposure metric. Significant trends are marked with an asterisk. e) Change in occurrence of O3 values in 10 ppb bins for months with significant changes. f) Moving 15-year trends at Zugspitze of W_LOW. Significant trends are marked with an asterisk. g) The seasonal variation of surface O_3 at Zugspitze for three periods (1981–1990, 1991–2000, and 2001–2010).

As noted above, there have been modest changes in sonde preparation procedures at Hohenpeissenberg, and there are indications that there have been some minor changes in sonde manufacture over the long period of record (WCRP, 1998). Even so, important tentative conclusions can be drawn from the measurements at these two sites. Over the entire period of record, year-round O_3 mixing ratios have increased significantly (more than 5%/decade) throughout the troposphere since the beginning of ozonesonde measurements in the late 1960s. Similarly, over the entire period of record, the surface measurements that begin in the late 1970s also capture this significant overall increase. Also, though there are differences in details of the pattern of change, over the past two decades O_3 mixing ratios have leveled off or have shown small but statistically significant decreases.

3.2.2. *North Atlantic*

Two sites in the North Atlantic have continuous measurements with nearly 25 years of observations, while at two other sites the measurements span a similar period but have a significant period without measurements in the middle of the record. The high-altitude site at Izaña in the Canary Islands and the low-elevation site at Mace Head, Ireland both have year-round

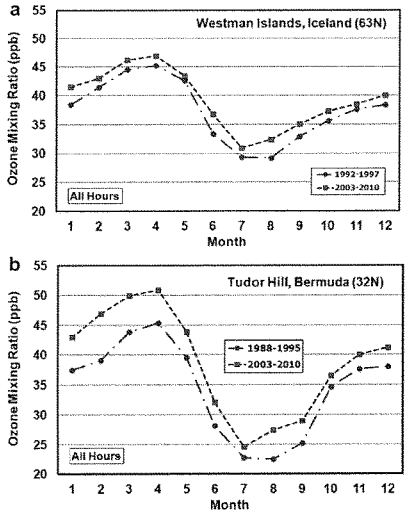

Fig. 5. The seasonal variation of O_3 for various time periods at two sites in the North Atlantic: a) Westman Islands, Iceland and b) Tudor Hill, Bermuda. The length of the time periods varies between 6 and 8 years depending on the data record and overall length of the record.

measurements beginning in 1988 that are amendable to time series analysis. The sites at Bermuda and Iceland provide snapshots for 6–8 year periods at the beginning and end of 1988–2010 (Fig. 5). These two sites exhibit increases from the earlier time period to the later period that include most months of the year. Though the differences between the earlier and later periods for individual months are not significant, the differences through the full year are significant. However, without a continuous time series it is not possible to determine the progression of these changes.

Derwent et al. (2007) indicate that Mace Head shows increasing values from its inception in 1987 until the late 1990s with a flattening observed thereafter. This is the pattern shown in Fig. 6, although it should be kept in mind that Fig. 6 analysis is based on all daytime data and has not been screened for background conditions as in the Derwent et al. (2007) analysis. Tripathi et al. (2010) also noted this pattern. Using monthly averages, Logan et al. (2012) indicate that there are two periods of relatively constant O_3 at Mace Head (1988–1995 and 1998–2009), with an increase in between. From the comparison of the average seasonal variation (Fig. 6b) during three time periods (1988–1995, 1996–2002, and 2003–2010), the changes occur in the winter and spring between the 1988–1995 period and the subsequent two periods. There is also an indication that the monthly average maximum concentrations may have shifted over the period of record from April–May to April. These seasonal shifts are significant as shown by the changes in the distribution (Fig. 6c) where the frequency of the lower hourly average concentrations (30–40 ppb) move upward to the 50–60 ppb bins. The running 15-year trends of the W126 metric at Mace Head (Fig. 6d) show only small non-significant positive changes with the largest increases occurring during 3 of the 15-year running periods (i.e., 1992–2006, 1993–2007, and 1994–2008). However, the running 15-year W_Low metric (Fig. 6e) shows that the frequency shift from the lower to the mid-level concentrations was most predominant during the earlier part of the record, while in the most recent 15-year period, the shift has changed direction. The trend in the W_Low (shift from lower to middle levels) reflects changes in the winter months (Fig. 6b and c) that contribute more prominently to the W_Low metric.

At the high-elevation site at Izaña, Canary Islands, the downslope (nighttime) measurements used in this analysis are generally representative of the lower free troposphere (Cuevas et al., 2012). The time series of the observations (Fig. 7a) shows a rapid increase to higher values in the mid to late 1990s. This change is reflected throughout the seasonal cycle (Fig. 7b). This is seen in the running 15-year trends for both the W126 and W_Low metrics (Fig. 7c and d) that indicate upward shifts in both the higher and lower portions of the distribution but a transition to non-significant changes in the later periods. The somewhat abrupt change in O_3 levels in the mid 1990s may reflect a shift in the phase of the North Atlantic Oscillation (NAO) altering the transport pattern to Izana (Cuevas et al., 2012). The influence of the change in the NAO phase on transport is worthy of investigation as a possible cause of changes to higher O_3 amounts at other North Atlantic sites in the mid and late 1990s.

3.2.3. Eastern North America

Four sites with longer-term records are identified in eastern North America. The Churchill (59N) and Goose, Canada (53N) sites have ozonesonde records that begin in 1980 (not shown). Similar to the other Canadian higher-latitude sites, a period of declining tropospheric O_3 amounts in 1980s to mid 1990s has been followed by a period of increasing values; thus, the overall 30-year trend is very small. The higher-elevation surface site at Whiteface Mountain, New York has one of the longer surface records extending back to 1973 (Fig. 8), although in the mid 2000s, there are some gaps in the measurement record. The longest ozonesonde record in the United States, going back to 1970, is Wallops Island, Virginia. The electrochemical concentration cell (ECC) technique has been used throughout the measurement program. The Whiteface record suggests a small overall increase (2.1 ± 1.7%/decade, 0.09 ± 0.07 ppb/decade) from the beginning of the record that results from an increase during the first 15 years of the record so that the most recent 20 years shows a decline (−5.3 ± 2.8%/decade, −0.22 ± 0.12 ppb/decade). At Wallops Island, there were very high O_3 amounts in the late 1980s, but no significant change over the 40-year period of record. The most recent decades show little change throughout the troposphere (see e.g. Cooper et al., in press).

3.2.4. Western North America

Several recent studies (Jaffe and Ray, 2007; Parrish et al., 2009; Cooper et al., 2010) have placed particular emphasis on possible changes in this region related to the impacts of growing Asian emissions of O_3 precursors (Jaffe et al., 2003; Jaffe and Ray, 2007). These emissions may not only impact the western coast of North America, but also be observed as far inland as the Rocky Mountain region (Oltmans et al., 2010). Two ozonesonde sites, Edmonton, Alberta and Boulder, Colorado have records longer than 25 years (Fig. 9). However, both locations are likely to be influenced in the lowest portion of the profile by regional pollution sources. Emphasis for these records is placed on the troposphere above the boundary layer. At Edmonton, Alberta (Fig. 9a and b) and Boulder, Colorado (Fig. 9c and d), the overall changes through the troposphere are small and computed trends are not significant. There

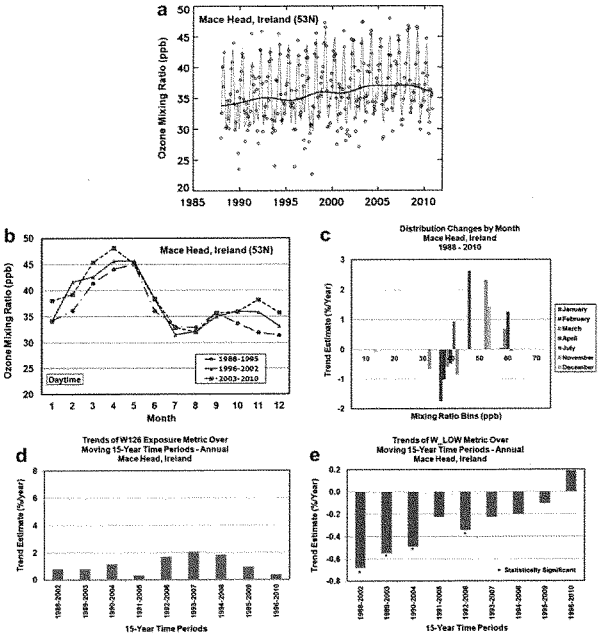

Fig. 6. a) Monthly mean, model fit and smooth trend curve of the O_3 mixing ratio at Mace Head, Ireland; b) The seasonal variation of daytime surface ozone at Mace Head for three periods (1988–1995, 1996–2002, and 2003–2010); c) Change in occurrence of O_3 values in 10 ppb bins for months with significant changes; d) Moving 15-year trends at Mace Head of the W126 exposure metric; e) Moving 15-year trends at Mace Head of the W_Low metric.

appears to be a similar pattern of change at these two sites during the overlapping period of record (Fig. 9a and c). Both records show higher values in the late 1980s, a dip in the mid 1990s and a slight increase thereafter. Although the annual variation in the 850–700 hPa at Boulder, which includes the near surface region, is larger, the correspondence of the longer time scale variations suggests that such changes occur over a broad enough scale that conclusions on changes can be drawn on a regional level.

Several relatively remote surface sites (Denali National Park (NP), Alaska; Lassen Volcanic NP, California; Glacier NP, Montana; Pinedale, Wyoming; and Rocky Mountain NP, Colorado) with records of more than 20 years that may be impacted at times by regional influences, but are likely to reflect broader scale patterns, have also been analyzed for this region (Fig. 10). The site at Denali NP is at relatively high latitude but can be influenced by flow from Asia (Oltmans et al., 2010) and so is considered here with the western North America locations. During the first one third of the record at Denali (Fig. 10a) the late winter and spring months were on average lower than during the latter two thirds of the record. The increase from the late 1980s (the beginning of the record) into the early 1990s seems to be reflected in the record at several of the western U.S. locations such as Lassen NP (Fig. 10b–f) and Pinedale (Fig. 10g) but not at Glacier NP (Fig. 10g). The running 15-year trends at Pinedale (Fig. 10e) indicate that early in the record surface O_3 may have increased but this has been followed by a consistent pattern with little or no change and most recently by statistically significant declining amounts. The W126 trend patterns at Rocky Mountain NP (not shown) over six running 15-year periods showed statistically significant positive trends during 1989–2003, 1990–2004, 1991–2005, and 1992–2006. This is similar to the results reported by Lefohn et al. (2010). Following the 1992–2006 period, the 15-year trend pattern showed non-significant trends with values close to zero for 1995–2009 and 1996–2010.

It has been shown recently that both stratospheric-tropospheric exchange (Langford et al., 2012; Lin et al., 2012a) and transport from Asia (Lin et al., 2012b) can have significant impacts on western North America, including the ability to attain air quality standards. Changes have also been noted over a longer-time horizon (Cooper et al., 2010) in the lower free troposphere above the boundary layer. It has been hypothesized that increases will continue with growing Asian emissions (Tanimoto et al., 2009). Using the entire record, at Lassen NP, the monthly means computed from daytime mixing ratios (Fig. 10b, Table 2) show a year-round increase of

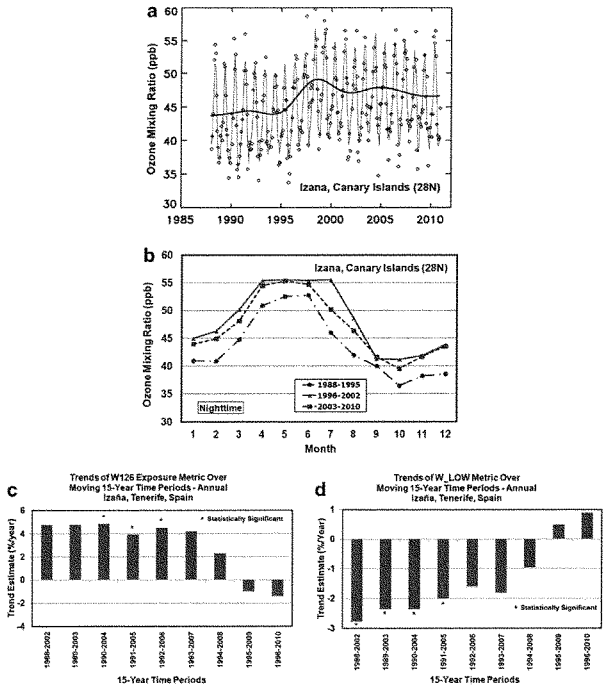

Fig. 7. a) Monthly mean, model fit and smooth trend curve of the O_3 mixing ratio at Izana, Canary Islands. b) The seasonal variation of nighttime surface O_3 at Izana for three periods (1988–1995, 1996–2002, and 2003–2010). c) Moving 15-year trends at Izana of the W126 exposure metric. d) Moving 15-year trends at Izana of the W_Low metric. Significant trends are marked with an asterisk.

4.4 ± 2.3%/decade (0.19 ± 0.10 ppb/decade). However, the figure also indicates that the pattern begins to flatten starting around 2000, continuing through the present. Because of the flattening of the trend at Lassen NP, the running 15-year trends of the W126 values (Fig. 10c) do not show any significant trends for individual 15-year periods. However, the overall pattern for the 15-year running trends suggests that there has been a declining tendency in the change. Over the period of record, there is an indication that the frequency of the lower hourly average mixing ratios (20–40 ppb) have shifted upward (i.e., 50–70 ppb). Although not statistically significant, the running 15-year W_Low metric illustrates that the shifting from the lower to the mid-level concentrations has lessened over the period of record suggesting that the influence of NO titration has weakened.

3.2.5. *Japan*

In Japan there are two long-term ozonsonde records at Tsukuba (36N) and Sapporo (43N) that exceed 40 years in length. In both cases there are significant periods of missing or very sparse measurements. Since 1991 soundings at these sites have been made weekly. Neither of these locations is free of local influences from precursor emissions, especially Tsukuba, which is near Tokyo. In addition, a surface site at Ryori, Japan (38N) has made measurements for 20 years. This site is located in a forested area on the eastern shore of Honshu Island. Although this location is impacted by regional O_3 sources, its relatively remote location and length of record in a region with few such records makes it worth examining. At Tsukuba and Sapporo, the 40-year time series (Fig. 11a and b) suggests increasing tropospheric amounts up to about 1990 and relatively little change thereafter. However in the late 1970s and 1980s, both these data sets have rather spotty records. Overall from the beginning of the record, tropospheric O_3 showed a modest increase (Fig. 11c). However, with only weekly profiles there is a large uncertainty in the estimates of these changes. The time series at Ryori (Fig. 11d), using the daytime averages (13–20 Local Time), shows a definite increase into the mid 1990s with a flattening in the record in the last 15 years. This is somewhat similar to the pattern observed in western North America but suggests more recent increases than the Japan ozonesonde data from Tsukuba and Sapporo (Fig. 11a and b).

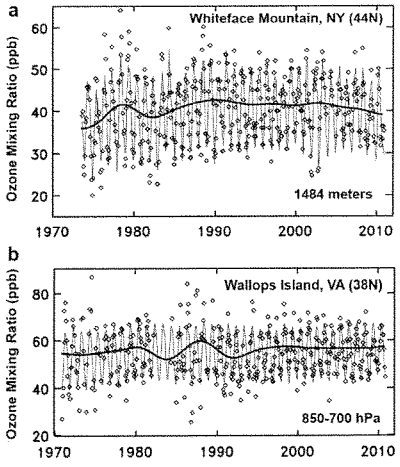

Fig. 8. a) Monthly mean, model fit and smooth trend curve of the O_3 mixing ratio at Whiteface Mountain, New York. b) Monthly mean (black diamonds), model fit (red line) and smooth trend curve (blue line) for the O_3 mixing ratio in the 850–700 hPa (~1.5–3 km) layer from ozonesondes at Wallops Island, Virginia. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

3.3. Subtropical Pacific (Hawaii)

Over the vast expanse of the North Pacific, there is only a single location with a continuous long-term measurement record. The Mauna Loa, Hawaii site (19N) at 3.4 km began surface O_3 observations in 1973 (Fig. 12a). Over the entire period of record there has been a significant year-round increase of 3.8 ± 0.9%/decade (0.16 ± 0.04 ppb/decade) and there has been a seasonal dependence to this change (Fig. 12b). The 15-year running trend based on the W126 metric (Fig. 12c), that is more heavily weighted by changes in the distribution at O_3 values greater than 50 ppb (Fig. 1a), presents a picture of an increasing trend into the earlier 2000s but a decline in this increasing pattern after that. In the earliest period, there was an increase primarily in the spring that is reflected in the W126 O_3 maximum where the higher spring values receive greater weight. In the most recent decade, the increase has come exclusively during the seasonal minimum in autumn and early winter (Fig. 12b). As was noted in an earlier analysis (Oltmans et al., 2006), this change resulted from a shift in the transport pattern with more flow from higher latitudes in the most recent period. There is a significant ENSO signal in the Mauna Loa record, with generally higher O_3 amounts during the warm phase. Both the transport-related increase in the autumn and the ENSO signal have been well reproduced in a recent model simulation (M. Lin – private communication, 2012). The warm event in 2009–2010 resulted in high O_3 readings that have had some impact on the overall trend, with the change through 2009 being about 30% less than when 2010 is included. This is also observed in the 15-year running trend pattern with the last 15-year period showing an increase above the previous 15-year period (Fig. 12c). After 1980 the surface record shows a smaller increase of 3.3 ± 1.0%/decade driven by the change in the seasonal minimum. Since 1982, a near continuous record of weekly O_3 profiles has been made from the nearby sea level site in Hilo (Fig. 12e). The ozonesonde record that reflects the period after 1980 also shows increases (Fig. 12d) but the much less frequent sampling compared to the surface data resulted in these changes being non-significant.

A station with a record a bit shorter than 20 years (1994–2010), Minamitorishima, Japan, located at 24N and about 4000 km east of southern China, may reflect flow from southern China, including the Pearl River delta and Shanghai that reaches the mid-Pacific. The time series at this site (Fig. 13a) shows a decreasing trend in the overall record. Looking at the seasonal pattern for two periods (1995–2002 and 2003–2010), however, indicates that much of this change has occurred after 2005 since the earlier period has slightly less O_3 through all months than the later period. At Naha, Japan in Okinawa, which is within 800 km of the Chinese mainland, O_3 in the troposphere may have increased (Fig. 13b) although the year-round trend estimates are not significant. The extent to which O_3 resulting from emissions in China is continuing to raise O_3 levels over the subtropical Pacific is difficult to determine from the limited measurements.

3.4. Tropical South Pacific (American Samoa)

The 35-year surface O_3 record at American Samoa shows minimal change (Fig. 14) with a small decline in the earlier portion of the record, a period of no change in the middle, and a small increase over the last 5 years. None of these changes are statistically significant. The Southern Hemisphere Additional Ozonesonde (SHADOZ) network includes measurement records of ~10–15 years in length (Thompson et al., in press and references therein). The most complete ozonesonde record is also at American Samoa and is nearly 15 years in length through 2010. Although these data were not analyzed in the same manner as the longer ozonesonde records, there appears to be little change over this period. Two other SHADOZ stations in the tropical South Pacific (Suva, Fiji and San Cristobal, Galapagos) have less complete records and have not been analyzed. The minimal change in this region appears to be consistent with the lack of O_3 precursor sources as well as the strong O_3 sink in this very low NO_x regime (MacFarland et al., 1979).

3.5. Mid-latitudes of the southern hemisphere

Two sites in the mid-latitudes of the S.H. have surface O_3 records approaching 30 years in length (Cape Grim, Australia and Cape Point, South Africa) while the ozonesonde record at Lauder, New Zealand has 25 years of profile data. All three of these sites are consistent in showing significant increases (Fig. 15a–c). Using the overlapping period from 1991 to 2010 when all of the stations have data there is an increase ranging from 7.3 ± 0.7%/decade at Cape Point to 2.8 ± 0.4%/decade at Cape Grim. At Lauder there is a significant increase of ~5% per decade throughout the lower and middle troposphere. The surface site at Baring Head, New Zealand shows an increase of similar magnitude to the change at Lauder, but with a less complete data record, so that the change is not statistically significant. The lack of a trend in the upper troposphere at Lauder suggests that changes in transport from the lower stratosphere/upper troposphere are not directly responsible for the increase lower in the troposphere. Possible transport changes within the troposphere itself, including both short and long-term changes in ENSO, are currently under investigation (Galbally et al., 2011) as cause for these changes. In the N.H. it has been shown that interannual variability, such as ENSO, can have a substantial influence on tropospheric O_3 that may lead to longer-

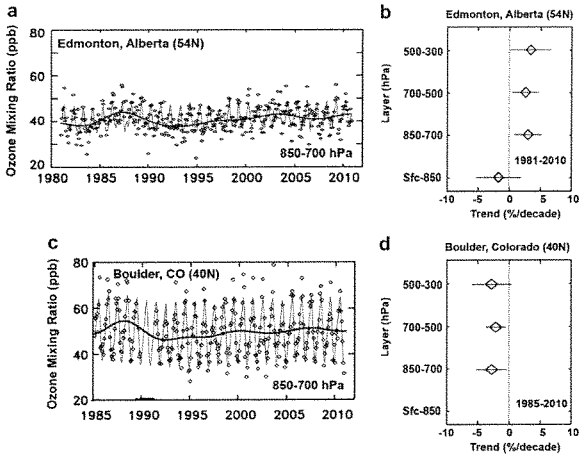

Fig. 9. a) Monthly mean (black diamonds), model fit (red line) and smooth trend curve (blue line) for the O_3 mixing ratio in the 850–700 hPa (~1.5–3 km) layer from ozonesondes at Edmonton, Alberta. b) Year-round linear trend of the monthly mean O_3 in layers in the troposphere at Edmonton. c) Monthly mean (black diamonds), model fit (red line) and smooth trend curve (blue line) for the O_3 mixing ratio in the 850–700 hPa (~1.5–3 km) layer from ozonesondes at Boulder, Colorado. d) Year-round linear trend of the monthly mean O_3 in layers in the troposphere at Boulder. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

term changes related to the frequency of the ENSO events (M. Lin – private communication, 2012; Langford et al., 1998).

3.6. South Polar (Antarctica)

Unlike the north polar region, much of the south polar region is encompassed by the Antarctic continent and surrounding permanent and seasonal ice cover. This region is also much more isolated from the influence of populated continental areas of the S.H. The continuous surface record at South Pole begins in 1975. Continuous (weekly) ozonesonde measurements at South Pole begin in 1986. At Syowa Station near the Antarctic coast ozonesonde measurements began in the mid 1960s but the record is not continuous. Continuous measurements began at Syowa in 1987. At the surface at South Pole (Fig. 16a), there is gradual decline from the beginning of the record into the mid 1990s and a slow recovery so that overall there has been no change. Ozone mixing ratios during both the seasonal maximum (winter) and minimum (late summer) follow this pattern. The overlapping continuous ozonesonde records from South Pole and Syowa beginning in 1987 show no change (Fig. 16b). From 1991 at the time of the minimum in the South Pole surface record both sonde records show a small increase at most levels that is not statistically significant. Thus the surface and sonde records are consistent in showing the gradual increase after the mid 1990s.

4. Discussion and summary

The wide spectrum of processes that influence the distribution and possible longer-term changes in tropospheric O_3 suggest that regional differences will often dominate. The approach taken in this analysis is to look at data from a variety of locations spread over a number of geographic regions. On a global basis, these rather broadly defined geographic regions each have a limited number of locations with measurement records of 20 years or longer. In the Arctic, the longest continuous records are limited to North America from Canada and Alaska. The 30-year ozonesonde record at the Canadian high Arctic site has shown a decadal decrease followed by an increase (Fig. 3a) that has been associated with changes in the stratosphere (Tarasick et al., 2005) but the overall change has been small. Kivi et al. (2007) examined several Arctic ozonesonde records, including the European Arctic, during the period 1989 to 2003 and found a significant increase during the winter and early spring months. This is consistent with the results found here and those of Tarasick et al. (2005) where O_3 increased in the 1990s and early 2000s (Table 3 and Fig. 3a). The Barrow data, during this overlapping 30-year period, generally present a similar pattern for the surface observations (Fig. 2a). Whether the significant increase at Barrow, prior to the early 1980s (Fig. 2c), is related to this decadal variability is not clear. As discussed below, several of the mid-latitude locations also showed increases in the earliest portion of the record that likely were not associated with changes in the stratosphere.

At mid-latitudes of the N.H., where the bulk of O_3 precursors are emitted, there are more numerous tropospheric O_3 measurements with extended records (Fig. 17a and b). In western Europe, the evidence appears strong that tropospheric O_3 increased substantially into the early 1990s, when restrictions on precursor emissions appear to have led to a flattening or even a decline in O_3 concentrations (Logan et al., 2012). Even over the North Atlantic, where there is evidence of earlier increases, here also a pattern is observed where increases have ceased, for example at Mace Head and Izaña. As noted in Oltmans et al. (2006), increases into the early 2000s reported by Lelieveld et al. (2004) in the 20°–40°N band over the North Atlantic are consistent with the O_3 changes seen at Izana. The lack of change seen in the 40°–60°N band over the same period reported by Lelieveld et al. (2004) is different from the increases

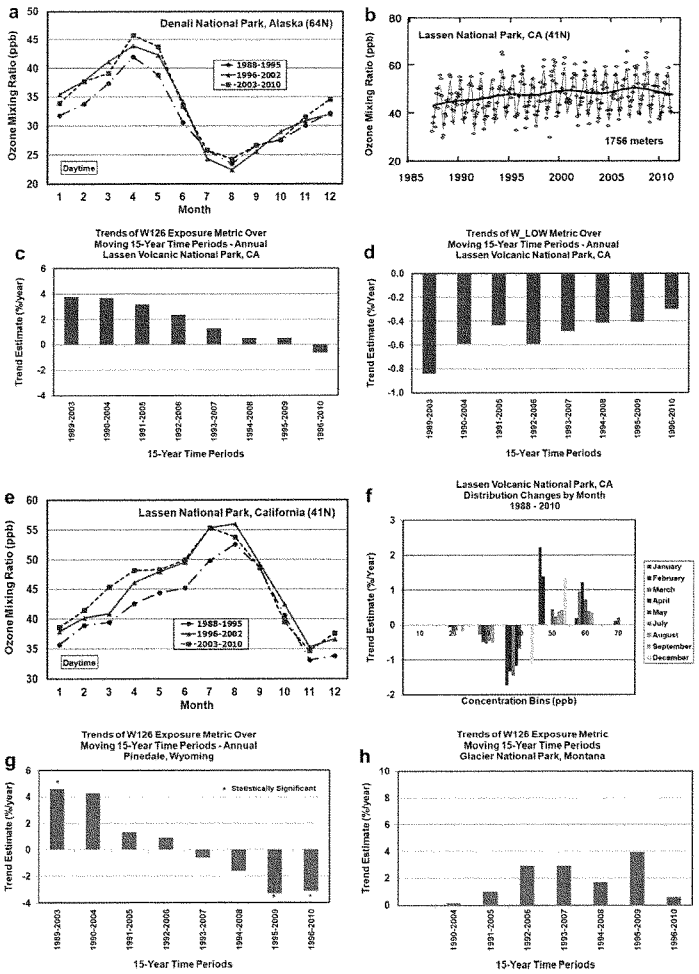

Fig. 10. a) The seasonal variation of daytime surface O_3 at Denali National Park, Alaska for three periods (1988–1995, 1996–2002, and 2003–2010); b) Monthly mean, model fit and smooth trend curve of the O_3 mixing ratio at Lassen Volcanoes NP, California; c) Moving 15-year trends at Lassen NP of the W126 exposure metric; d) Moving 15-year trends of the W_Low metric at Lassen NP. Significant trends are marked with an asterisk; e) The seasonal variation of daytime surface O_3 at Lassen NP for three periods (1988–1995, 1996–2002, and 2003–2010); f) Change in occurrence of O_3 values in 10 ppb bins at Lassen NP for months with significant changes. g) Moving 15-year trends at Pinedale, Wyoming and h) moving 15-year trends at Glacier NP, Montana of the W126 exposure metric. Significant trends are marked with an asterisk.

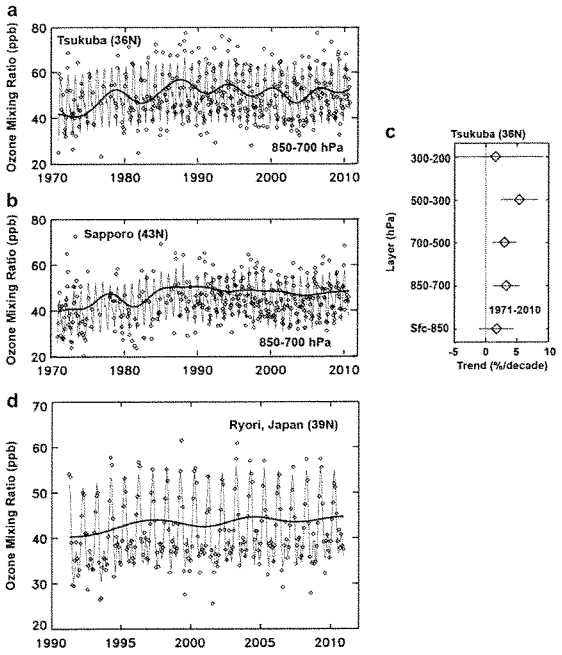

Fig. 11. Monthly mean (black diamonds), model fit (red line) and smooth trend curve (blue line) for the O_3 mixing ratio in the 850–700 hPa (~1.5–3 km) layer from ozonesondes at a) Tsukuba, Japan and b) Sapporo, Japan. c) Year-round linear trend of the monthly mean O_3 in layers in the troposphere at Tsukuba, Japan. d) Monthly mean (black diamonds), model fit (red line) and smooth trend curve (blue line) for the surface O_3 mixing ratio at Ryori, Japan. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

reported here for the North Atlantic locations, where the leveling off is more recent. In eastern North America there does not appear to be as strong a pattern of earlier increases as observed in western Europe, but at Whiteface Mountain, there is a definite flattening and decline in the last couple of decades. In western North America, the time series only extend back into the mid-1980s. At several locations, there has been no substantial change, while a few sites indicate a modest initial increase that has recently flattened. Assessing changes in Asia presents the greatest uncertainty because long records are only available from Japan. The extent to which these records reflect changes primarily in Japan or are also indicative of changes over continental East Asia is not clear. The Japanese ozonesonde records depict a pattern that is not greatly different from that observed in Europe and North America, with increases in the early portion of the record but generally flat or declining trends more recently.

Although details appear to vary between regions in the N.H., it appears that for the last 10–15 years a pattern of no substantial change is predominant. This likely reflects the reduction of precursor emissions in stable developed economies. Lefohn et al. (1998) noted that the shift from the lower concentrations upward appeared to be associated with lack of NO_x scavenging as precursors were reduced. Our current results show that over some periods the frequency of the lower hourly average concentrations is decreasing with a shift from the lower concentrations upward into the mid-level concentration range and the higher concentrations downward. The frequency of lower concentrations has decreased due to NO_x titration and higher concentrations reduced from less photochemical production as precursors are reduced. This shifting of low- and mid-level values is slowing down and in some cases, changing direction. At Mace Head, the running 15-year W_Low metric indicates that hourly average O_3 was shifting from the lower to the mid-level concentrations during the earlier part of the record (Fig. 6), slowing down for the most recent 15-year periods, and changing direction (i.e., mid-level concentrations shifting to the lower levels) for the last 15-year period. Similar patterns are observed for the sites at Zugspitze (Fig. 4) and Izaña (Fig. 7). These observations are important for assessing whether changes in the lower end of the distribution may be associated with processes related to reduced regional emissions or changes in background O_3 levels. Mace Head, Izaña, and Zugspitze show recent indications that the frequency of mid-level concentrations is shifting from the

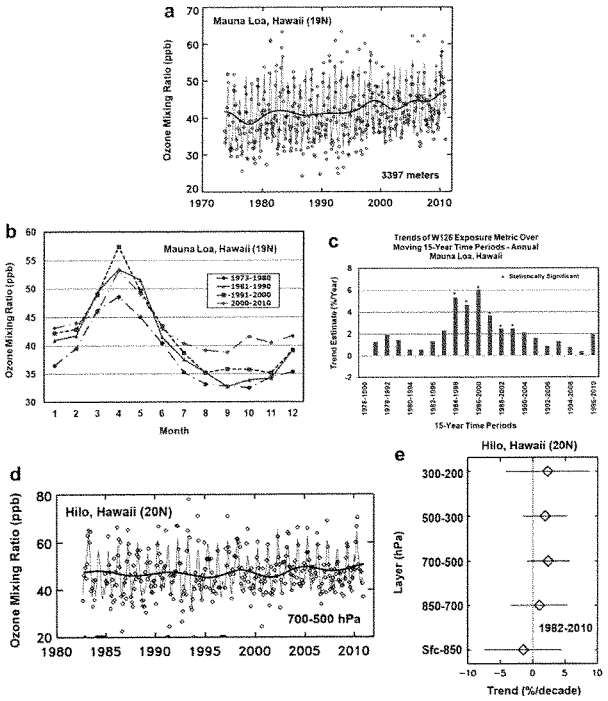

Fig. 12. a) Monthly mean (black diamonds), model fit (red line) and smooth trend curve (blue line) of the O_3 mixing ratio at Mauna Loa, Hawaii. b) The seasonal variation of surface O_3 for 10-year periods at Mauna Loa. c) Moving 15-year trends at Mauna Loa of the W126 metric. d) Monthly mean, model fit and smooth trend curve for the O_3 mixing ratio in the 700–500 hPa (~3–6 km) layer from ozonesondes at Hilo, Hawaii. e) Year-round linear trend of the monthly mean O_3 in layers in the troposphere at Hilo. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

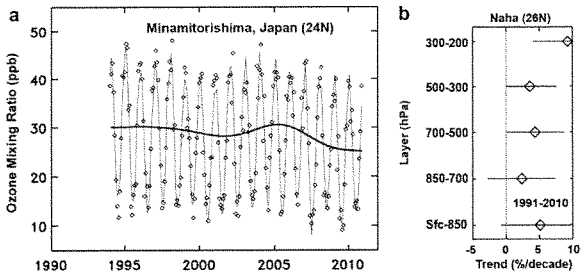

Fig. 13. a) Monthly mean, model fit, and smooth trend curve of the surface O_3 mixing ratio at Minamitorishima, Japan. b) Year-round linear trend of the monthly mean O_3 in layers in the troposphere at Naha, Japan.

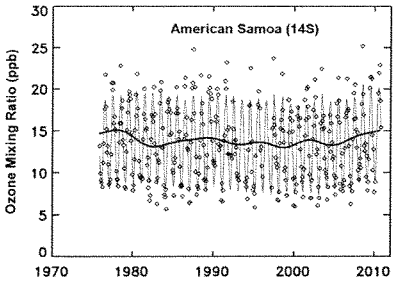

Fig. 14. Monthly mean, model fit, and smooth trend curve of the surface O_3 mixing ratio at American Samoa.

mid-level down into the lower concentrations range and may indicate a stabilizing or decline in background O_3. Were reduced NO_x scavenging or increased background O_3 responsible, one would anticipate a shift from the lower concentrations to the mid-levels.

The extent to which the stations investigated are sensitive to the impact of growing Asian emissions on the hemispheric background is unclear. Recent evidence suggests that the contributions of stratosphere-to-troposphere exchange (STE) on surface O_3 in the western US may be greater than from Asian emissions (Ambrose et al., 2011; Lin et al., 2012b). STE contributes to the variability but it is not clear to what extent it may contribute to longer-term changes. For Lassen NP, the concentration values are lower in the earlier part of the record and then begin to rise but begin to flatten by 2000. The running 15-year W126 trends at Lassen NP are not statistically significant but overall there has been a declining trend in the running 15-year periods. The lack of a statistically significant trend pattern was noted by Lefohn et al. (2010). Although not statistically significant, the running 15-year W_Low metric shows that the rate of shifting from the lower to the mid-level concentrations has lessened over the period of record. These results, coupled with those reported earlier by Oltmans et al. (1998, 2006) and recently by Logan et al. (2012) suggest that on a hemispheric scale it is currently difficult to observe the projected increases in tropospheric O_3 that models indicate may occur from growing Asian emissions. This may result from the lack of such O_3 increases or that changes resulting from precursor reductions in North America and Europe have made the influence of Asian precursor emissions more difficult to detect. Changes in hourly average O_3 distributions at the low-, mid- and high-level ranges for sites investigated in this study do not indicate that background O_3 concentrations continue to increase in the most recent decades. As indicated in our analysis and others, at many of the investigated sites earlier O_3 increases have reached a plateau and in some cases begun to decrease. Reductions in NO_x emissions of 45% in the US (http://www.epa.gov/airtrends/nitrogen.html) and ~40% in Europe (http://www.eea.europa.eu/data-and-maps/indicators/eea-

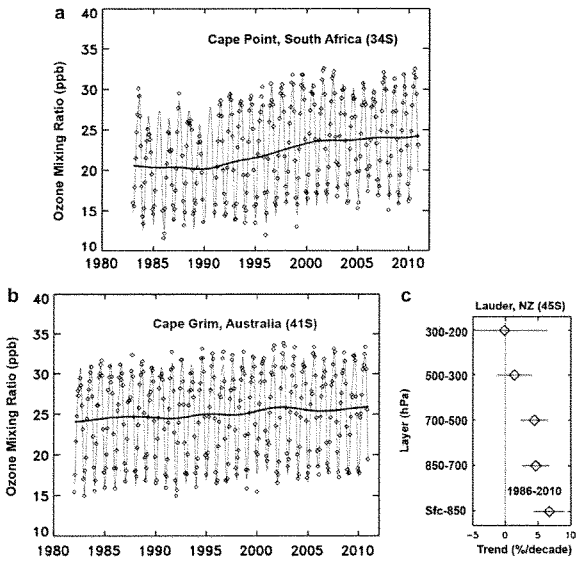

Fig. 15. Monthly mean, model fit, and smooth trend curve of the surface O_3 mixing ratio at a) Cape Point, South Africa and b) Cape Grim, Australia. c) Year-round linear trend of the monthly mean O_3 in layers in the troposphere at Lauder, New Zealand.

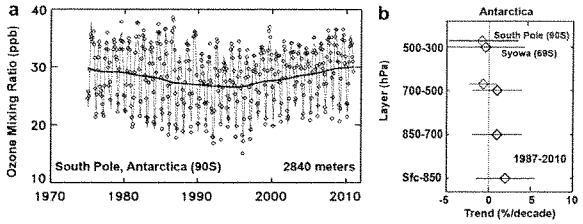

Fig. 16. a) Monthly mean, model fit, and smooth trend curve of the surface O_3 mixing ratio at South Pole, Antarctica. b) Year-round linear trend of the monthly mean O_3 in layers in the troposphere at Syowa and South Pole, Antarctica.

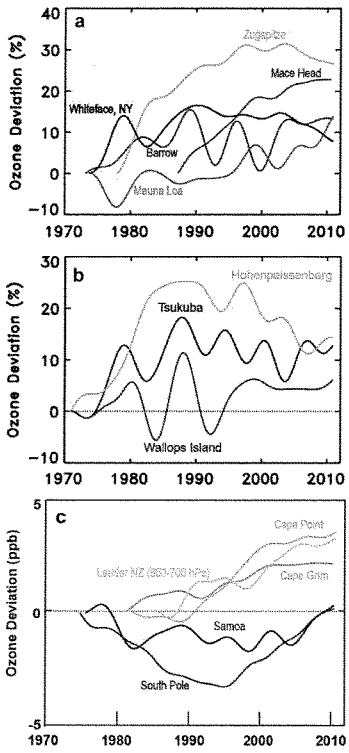

Fig. 17. a) Summary of trend of four N.H. surface O_3 locations. b) Summary of O_3 trend curves for the 850–700 hPa layer at three N.H. ozonesonde sites. c) Summary of O_3 trends for S.H. stations. The trend curves are taken from the smoothed fit to the modeled monthly residuals.

32-nitrogen-oxides-nox-emissions/eea-32-nitrogen-oxides-nox) over the past two decades suggest that background O_3 increases associated with NO_x emission increases may have peaked within the past decade. Ten to 15 year O_3 records from China (Ding et al., 2008; Wang et al., 2009, 2012) show increasing O_3 although several downwind Japanese locations do not appear to reflect these changes. With emission slowdowns in China (Lin and McElroy, 2011) and planned further reductions (www.chinadaily.com.cn/bizchina/2012-/02/01/content_14519125.htm), it will be important to monitor possible O_3 changes in China to see if what appears to be a flattening or decline of O_3 in the mid-latitudes of the N.H. is sustained.

S.H. tropical and polar locations (Fig. 17c) show decadal periods of increasing and decreasing O_3, but over the 40-year horizon there has been little overall change. In the future the SHADOZ sites in both the tropical South Pacific and South Atlantic may enable a broader perspective on changes in the tropics. At S.H. mid-latitudes there have been significant increases but over the most recent decade there is some indication that these increases have moderated (Fig. 17c). The increases reported by Lelieveld et al. (2004) in the South Atlantic into the early 2000s are consistent with the measurements at Cape Point. The inclusion of an additional decade of observations at Cape Point shows the moderation of this increase. The limited tropical data analyzed in this work does not provide additional perspective on the increases reported for the upper troposphere in the work of Bortz et al. (2006) for the nine year (1994–2003) MOZAIC record.

In order to follow future trend patterns, it will be important to use techniques that capture the time evolution of O_3 changes such as the running 15-year trend periods used here or other methods that detect these changes. In particular it will be important to determine if the widespread flattening or declining O_3 concentrations reported here reflect longer-term changes in precursor O_3 emissions.

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Methane

CH4 , natural gas, methyl hydride, biogas

SPRI Emission Reporting Threshold

10,000 Kg/yr Pollutant Emissions to Air

Disclaimer

This sheet is a generic summary, designed to give the reader a basic level of background information about the substance in question. Great care has been taken to represent as effectively and correctly as possible the broad range of (not necessarily consistent) information which is available from a variety of sources. The reader must accept therefore that this sheet has no legal status and cannot be relied upon in any legal proceedings. SEPA disclaims any responsibility or liability whatsoever for errors and omissions in this sheet.

What is it?

Methane is a colourless gas. At low concentrations it is odourless, but it has a sweet smell at high concentrations. At mixtures more than about 5-15% in air, it is explosive. It has a lifetime of around ten years because it is only very gradually destroyed by other chemicals in air. Methane is one of a group of chemicals known as the volatile organic compounds (VOCs). It is produced both naturally and from man's activities.

What is it used for?

Methane is the major constituent of natural gas which is used for domestic and commercial heating and to generate electricity in power stations. It is also used in the chemical industry to produce many more complex chemical compounds.

Where does it come from?

One of the main sources of methane into the environment is from the natural decomposition of plant and animal matter in airless conditions. This occurs in marshes, rice paddies and the guts of animals. The UK's biggest man-made source of methane is from rotting rubbish in landfills. Methane is also released during the mining and distribution of fossil fuels (coal, oil and gas).

How might it affect the environment?

On a local scale, build up of methane poses an explosion hazard which can result in evacuation of areas over old landfills or mines. Compared to other volatile organic compounds (VOCs) methane does not contribute significantly to the formation of ground level ozone or photochemical smogs. The main impact of methane is on a global scale, as a greenhouse gas. Although levels of methane in the environment are relatively low, its high "global warming potential" (21 times that of carbon dioxide) ranks it amongst the worst of the greenhouse gases.

How might exposure to it affect human health?

At normal environmental concentrations, methane has no impacts on human health. At extremely high (artificial) concentrations in an enclosed space the reduction in oxygen levels could lead to suffocation.

What steps are being taken to limit the potential impacts?

In the UK (including Scotland), emissions of methane are controlled through the regulation of volatile organic compounds (VOCs) under the National Air Quality Strategy. Internationally, the main control over methane as a volatile organic compound (VOC) is through international UNECE Convention on Long-Range Transboundary AIr Pollution and the Basel Convention concerning the transboundary movement and disposal of hazardous wastes. Also, the United Nations Framework Convention on Climate Change (Kyoto Protocol, 1997) introduced measures (such as taxes on fossil fuels) designed to achieve reduction of greenhouse gas releases. Amongst the other signatories from around the world, the UK government (including Scotland) is committed to reaching targets of reduction of methane emissions by 2008-2012.

Data Reuse Conditions

Floodline 0845 988 1188 NetRegs one scotland SCARS natural scotland Pollution Hotline 0800 80 70 60 24 Hours a day 7 days a week

TESTIMONY
OF
J. THOMAS MULLEN, PRESIDENT & CEO
CATHOLIC CHARITIES HEALTH AND HUMAN SERVICES
CLEVELAND, OHIO

Chairman Jeffords and distinguished Members of the United States Senate, Committee on Environment and Public Works:

I thank you for the opportunity to testify today regarding Senate Bill 556, referred to as the Clean Power Act. My name is Tom Mullen and I am President of Catholic Charities Health and Human Services in Cleveland, Ohio. Catholic Charities in Cleveland serves over 600,000 people annually and has an $87,000,000 annual operating budget, while employing of 1,700 people. We provide services to children and families; older adults; persons with disabilities; and those with emergency and basic transitional needs. (Last year we served over 4.5 million meals to the hungry and provided tens of thousands nights of shelter to homeless women, men and children). This service area is in the eight-county Cleveland Catholic Diocese in Northeast Ohio.

I want to acknowledge the support and involvement that Committee Member Senator George V. Voinovich has given to our communities and the people we serve in Ohio. I want to share with you today what impact that Senate Bill 556 would have on a number of the people we serve daily in Northeast Ohio.

Senator Voinovich, in the last couple of years, has convened people most directly impacted by the rise in utility costs. The elderly on fixed limited incomes and the working poor with families have made it clear to him during these meetings and to me on a daily basis that they cannot afford increases in costs for their basic needs. Many indicate that, currently, they cannot afford basic needs without either falling behind in payments and/or ignoring one of those needs like rent, utility, or health care bills.

Senate Bill 556 on the surface strives to cleanse the environment of many of the oxides and, in particular, carbon dioxide and mercury. These gases are given off through the burning of coal. I ask the Committee to carefully review the negative impact that would occur on millions of people in our country and in my state of Ohio if the bill is enacted without deeper consideration and further research.

The State of Ohio's energy production is provided by 86% use of coal. If Senate Bill 556 is enacted, the conversion to natural gas from coal would have a devastating effect on the people of Ohio and our country, particularly the poor and the elderly. The Edison Electric Institute estimates that, if enacted, the loss in America in gross domestic product by the year 2010 would be $75 billion and grow to $150 billion in 2020. In the State of Ohio, the loss would be $3 billion and grow to $6 billion by 2020.

Employment in Ohio would be dramatically impacted with job losses estimated at 25,000 by 2010 and 37,000 by 2020. With all of this, the most vulnerable of our people economically, would see their electric costs in Ohio soar to $494,000,000 in 2010 and to $1.5 billion in 2020.

The overall impact on the economy in Northeast Ohio would be overwhelming, and the needs that we address at Catholic Charities in Ohio with the elderly and poor would be well beyond

our capacity and that of our current partners in government and the private sector.

In a recent study on Public Opinion on Poverty, it was reported that one-quarter of Americans report having problems paying for several basic necessities. In this study, currently 23% have difficulty in paying their utilities – that is, one out of four Americans. If Senate Bill 556 is passed, we could see the difficulty in Cleveland reach beyond one out of two people and families not able to pay utilities. This is based on the current fact that, in Cleveland, 25.8% of people are below the federal poverty level and from the 200% increase in emergency assistance needs we are experiencing at Catholic Charities in the last 18 months. This is all without the domestic increase these same individuals and many thousands of others will experience through job loss and utility cost increase as a result of the Clean Power Act.

I want to emphasize, again, the two groups of our most vulnerable population in Ohio that would be impacted by this Bill. First, the elderly in Cleveland – approximatelyone-half (49.4%) of persons over 65 years old have incomes less that $15,000 per year. In Cuyahoga County, nearly one-third (31.5%) fall into the same category. Northeast Ohio reflects realistically what negative impact the increase in utility cost would have for all our seniors in Ohio and through similar states throughout the nation.

The second group that I have real concern for and will be hurt similarly by this is children. In Cleveland, over one-fourth of all children live in poverty and are in a family of a single female head of household. These children will suffer further loss of basic needs as their moms are forced to make choices of whether to pay the rent or live in a shelter; pay the heating bill or see their child freeze; buy food or risk the availability of a hunger center. These are not choices any senior citizen, child, or, for that matter, person in America should make.

I ask the Committee to look carefully at the ramifications of Senate Bill 556 and its impact on employment and energy costs. We have many vulnerable people in Cleveland, in Ohio, and across America who cannot carry the burden of this legislation.

Chairman Jeffords and Senators of the Committee, thank you for your time.

THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

Public Interest Comment[1] on

The Environmental Protection Agency's Proposed Rule:

National Ambient Air Quality Standards for Ozone

Docket ID No. EPA–HQ–OAR–2008–0699;

RIN: 2060–AP38

March 17, 2015

Louis Anthony (Tony) Cox, Jr.[2]

The George Washington University Regulatory Studies Center

The George Washington University Regulatory Studies Center works to improve regulatory policy through research, education, and outreach. As part of its mission, the Center conducts careful and independent analyses to assess rulemaking proposals from the perspective of the public interest. This comment on the Environmental Protection Agency's proposed rule revising National Ambient Air Quality Standards (NAAQS) for ozone does not represent the views of any particular affected party or special interest, but is designed to evaluate the effect of EPA's proposal on its statutory mandate to "protect public health."

Introduction

The Clean Air Act directs the EPA Administrator to set "primary," or health-based, NAAQS at levels that are "requisite to protect the public health … allowing an

[1] This comment reflects the views of the author, and does not represent an official position of the GW Regulatory Studies Center or the George Washington University. The Center's policy on research integrity is available at http://research.columbian.gwu.edu/regulatorystudies/research/integrity.

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adequate margin of safety,"[3] based on "air quality criteria [that] shall accurately reflect the latest scientific knowledge useful in indicating the kind and extent of all identifiable effects on public health or welfare which may be expected from the presence of such pollutant in the ambient air, in varying quantities." §108(a)(2) It further requires the Administrator to set "secondary" (welfare-based) standards based on these criteria at a level "requisite to protect the public welfare from any known or anticipated adverse effects."[4] (This comment focuses exclusively on the primary standard.)

Amendments to the Clean Air Act in 1977 (P.L. 95-95) required the Administrator to conduct a "thorough review of the criteria…and promulgate such new standards as may be appropriate," at least every five years. In setting primary standards, EPA may not consider the costs of achieving the standard.[5]

In this notice, EPA proposes to determine that the current O_3 primary standard of 0.075 ppm "is not requisite to protect public health within an adequate margin of safety"; thus, "it should be revised to provide increased public health protection."[6] EPA proposes to revise the O_3 standard to "within the range of 0.065 ppm to 0.070 ppm" in order to increase protection of public health including for populations deemed "at risk" such as children, older persons, and those with health problems.

EPA's reasoning and recommendations are presented in several key documents, including the following.

- Proposed Rule: National Ambient Air Quality Standards for Ozone, *79 Federal Register 75233 -75411*
- Final Report: Health Risk and Exposure Assessment for Ozone, *August 2014*
- Final Report: Integrated Science Assessment of Ozone and Related Photochemical Oxidants, *2013* (hereafter "ISA")

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[3] The Clean Air Act, 42 U.S.C. § 7408 (b)(1) Available at: http://www.ehso.com/ehso.php?URL=http%3A%2F%2Fwww.epa.gov/oar/caa/caa113.txt

[4] The Clean Air Act, 42 U.S.C. § 7408 (b)(2) Available at: http://www.ehso.com/ehso.php?URL=http%3A%2F%2Fwww.epa.gov/oar/caa/caa113.txt

[5] *Whitman v. American Trucking Associations, Inc.*, 531 U.S. 457 (2001) 99-1426.175 F.3d 1027 and 195 F.3d 4, affirmed in part, reversed in part, and remanded.

[6] 79 FR 75236

Executive Summary

EPA's proposed determination that existing ozone NAAQS are not requisite to protect public health with an adequate margin of safety is not justified by the evidence it presents. Nor do EPA's predictions that further reductions in ozone standards will cause future public health benefits follow from sound and reliable scientific methods of causal analysis and prediction. The U.S. EPA document entitled *Health Risk and Exposure Assessment for Ozone, Final (July, 2014): Executive Summary* states in its first paragraph that "The health effects evaluated in this HREA are based on the findings of the O_3 ISA (U.S. EPA, 2013) that short term O_3 exposures are causally related to respiratory effects, and likely causally related to cardiovascular effects, and that long term O3 exposures are likely causally related to respiratory effects." The introduction also states that "The results of the HREA are developed to inform the O_3 Policy Assessment (PA) in considering the adequacy of the existing O_3 standards, and potential risk reductions associated with potential alternative levels of the standard."

Thus, EPA positions causality and its implications for potential risk reductions as leading considerations in its proposed decision to reduce existing standards for ozone. The specific meaning of causality to which EPA refers is that it would allow readers of the policy assessment to consider "potential risk reductions associated with potential alternative levels of the standard." We assume that EPA means "caused by" rather than "associated with" here, and that they mean that their assessment and causality determination will allow interested policy makers to understand how different reductions in the ozone standard would (probably) affect future risks to human health and other endpoints of interest. This crucial claim appears to be mistaken and misleading. EPA has presented no validated causal modeling that would enable correct prediction (and uncertainty characterization) of the effects (if any) that future changes in O_3 levels might cause in future changes in health effects. Rather, EPA uses measures and models of historical associations between O_3 levels and adverse health effects as if they were known to be entirely causal. This does not provide a sound or reliable basis for risk assessment (Appendix A; Dominici et al., 2014).

EPA follows a well-developed but unreliable quantitative risk assessment (QRA) process, critically discussed in the next section and in Appendix A, that interprets statistical associations as being causal based on weight-of-evidence (WoE) considerations. As discussed in detail later, WoE considerations are not logically or practically adequate for this purpose (e.g., Goodman et al., 2013; Morabia, 2013; Rhomberg et al., 2013; Appendix A). Table 1 of EPA's ozone ISA presents these

considerations. They incorporate several formal logical fallacies, such the *ex post ergo propter hoc fallacy* that "Evidence of a temporal sequence between the introduction of an agent, and appearance of the effect, constitutes another argument in favor of causality." There is no theoretical or practical reason to suppose that EPA's causal judgments based on these WoE considerations are factually correct. Experts, like other people, typically have high confidence in their own judgments, even when these lack objective validity (Kahneman, 2011). But subjective confidence in subjective judgments should not be used in place of sound, objective scientific methods. To do so, as in EPA's risk assessment for ozone, replaces sound science with potentially arbitrary, biased, and mistaken judgments.

To obtain quantitative risk and benefit estimates, EPA applies a new quantitative model (The "MSS model") of the relation between ozone levels and decrements in lung function. This model makes predictions that depend sensitively on assumptions that are known to be incorrect (e.g., that individual variability is normally distributed) but that are made anyway for the sake of convenience. There are several key uncertainties about the model assumptions and conclusions, none of which has been quantified.

EPA also develops an approach to quantitative risk assessment based on epidemiological data in section 7.1.2 that makes the crucial error of treating the *slope* of a curve (i.e., the change in y divided by change in x) as if it showed the future changes in the variable on the y axis (health effects) that would be *caused* by changes in the variable on the x axis (exposure). This conceptual error invalidates EPA's quantitative risk and benefit predictions; it is a completely invalid interpretation of the slope of the model curve fit to past data (see Appendix A and Rothman et al., 2012).

A simple analogy may help to make this technical point clear. Dividing car accidents per year in a population by pounds of potatoes consumed per year in that population would produce a positive "slope factor" (i.e., ratio) linking these two quantities. One could meaningfully discuss the change in car accidents per unit change in potato consumption when discussing the slope of a regression curve fit to their historical values. But it would be utterly mistaken to interpret this as implying that reducing future potato consumption would *cause* a reduction in future car accidents. Figure 2 of Appendix A shows a more realistic example. EPA's risk assessment makes essentially this conceptual error, confusing the changes used to calculate slopes of exposure-response curves with the changes in health effects that causal mechanisms might cause if exposure were changed.

EPA's use of associational methods to drive key causal conclusions ignores a consensus in disciplines outside epidemiology that associational methods are unreliable, logically unsound, and inappropriate for drawing causal inferences (e.g., Dominici et al., 2014; Rothman et al., 2012; Cox and Popken, 2015). EPA's judgment that model-based associations are causal also conflicts with quantitative causal analyses of historical data. Studies that have applied formal quantitative causal analysis methods have found no detectable human health benefits caused by past reductions in ambient ozone levels (e.g., Moore et al., 2012; Cox and Popken, 2015). These studies provide no objective reason to expect that further reductions in the ozone standard will cause future human health benefits.[7]

The absence of any impact of relatively large reductions in ozone concentrations on public health outcomes in previous causal analyses suggests that there may be an exposure below which diseases do not occur, and that this threshold may be well above the current standard. If this is true, a NAAQS set higher than current levels would meet the statutory standard. This is consistent with proposed causal mechanisms involving inflammation of the lung, although such thresholds would not be apparent in population data unless errors in exposure estimates are properly modeled (Cox, 2011, 2012). EPA considers and rejects the hypothesis of an exposure threshold for adverse effects that is above current standards, but does not quantify exposure uncertainties and their effects on detection and estimation of thresholds. Such quantitative uncertainty analysis is essential for correct inferences about thresholds.

In summary, EPA's quantitative risk estimate (QRA) provides no legitimate reason to believe that the proposed action is "requisite to protect public health" or that reducing the ozone standard further will cause any public health benefits. The QRA's model-based projections to the contrary are known to rely on mistaken assumptions (for the MSS model) and mistaken interpretations of curve-fitting (for the epidemiological risk assessment in Section 7). Past data on human health before and after reductions in ozone do not reveal any such causal impacts. Given EPA's information and the unquantified model uncertainty that remains, there is no sound technical basis for asserting with confidence, based on the models and analyses in EPA's ozone risk assessment, that an ozone standard of 65 ppb would be any more protective than 70 ppb, or that 80 ppb is less protective than 60 ppb. To the contrary, available data suggest that further reductions in ozone levels will make no difference

[7] EPA's risk assessment cites a 2008 paper by Moore et al. suggesting that ozone causes harm to human health, based on untestable modeling assumptions, but does not cite the 2012 paper that superseded it, which found no causal relation between them.

to public health, just as recent past reductions in ozone have had no detectable causal impact on improving public health.

Critical Review of EPA Ozone Health Risk Assessment

EPA's approach to "causal determination" reflects a half century of departure of epidemiology from sound scientific and statistical methods of causal modeling and analysis. Starting in the 1960s, epidemiology took a turn away from other sciences and engineering disciplines by developing a unique, unproven, and logically unsound approach to assessing causation; this approach, now incorporated into weight-of-evidence systems, lacks justification by underlying principles or by demonstrated logical or practical validity (Morabia, 2013).

Following an influential essay by Hill (1965), epidemiologists began relying on their own personal judgments and consideration of various aspects of association to guess whether statistical associations might be causal. Regulatory risk assessments started substituting consensus opinions based on these guesses for more objective and accurate methods of assessing causality. This judgment-based approach, which forms the main basis for EPA's ozone risk assessment, has never been shown to necessarily or usually produce correct results (Morabia, 2013). To the contrary, empirical research on the accuracy of expert judgments has found that they are usually biased and mistaken (Kahneman, 2011). Biases toward false positives (e.g., believing that proposed actions will cause benefits that they turn out not to cause) predominate (Lehrer, 2012; Ioannadis, 2005, Lehrer, 2012, Sarewitz, 2012, Ottenbacher, 1998; Imberger et al., 2011, *The Economist*, 2013).

Comment 1: Associational methods are unreliable guides to valid causal inference

EPA experts may (and demonstrably sometimes do) consider that it "could not be more clear" that observed associations between air pollution levels and adverse health effects are causal (e.g., Harvard School of Public Health, 2002) even though more thorough and objective quantitative causal analyses would reveal that they are not – that they only reflect coincident historical trends or other non-causal explanations (e.g., HEI, 2013). In general, substituting qualitative expert judgments about whether associations are probably causal (e.g., using the "Aspects to aid in judging causality" listed in Table 1 of EPA's ozone ISA) for rigorous quantitative causal analysis (e.g., using the techniques listed in Table 1 of Appendix A) lacks justification (Morabia, 2013). It is part of the sociology of applied science that motivated reasoning, confirmation bias, wishful thinking, over-confidence in one's

own judgments, and other biases (Kahneman, 2011) can and do routinely produce confident but mistaken beliefs that causal relations have been discovered when in fact there is no objective evidence of causation; as a result, projected benefits from costly actions, based on the mistaken expert judgments, often fail to materialize after the costly actions have been taken (Lehrer, 2012; Ioannadis, 2005, Sarewitz, 2012, Ottenbacher, 1998; Imberger et al., 2011, *The Economist*, 2013).

More fundamentally, association-based methods (e.g., regression modeling, WoE judgments), relied on throughout EPA's ozone risk assessment, are not in general reliable guides to the objective truth; for example, they can enable modelers to find either statistically "significant" positive exposure-response associations or statistically "significant" negative ones, depending on their modeling choices (Dominici et al., 2014). Associational methods are not adequate or valid for allowing accurate predictions of the effects that future changes in exposures would cause in future health risks. Appendix A and its references develop this point in more detail.

Comment 2: EPA's ozone risk assessment depends on associational methods.

That EPA's ozone risk assessment depends heavily on conflating associations with causation is well illustrated by the following passages:

> "**6.2.3.2 Asthma**
>
> In reference to epidemiologic studies, the ISA states that '[t]he evidence supporting associations between short-term increases in ambient O_3 concentration and increases in respiratory symptoms in children with asthma is derived mostly from examination of 1-h max, 8-h max, or 8-h avg O_3 concentrations and a large body of single-region or single-city studies. The few available U.S. multicity studies produced less consistent associations.' (ISA, p. 6-101 to 6-102). 'Although recent studies contributed mixed evidence, the collective body of evidence supports associations between increases in ambient O_3 concentration and increased asthma medication use in children' (ISA, p. 6-109)." pp 6-7 to 6-8
>
> "**Mortality Effects**
>
> Recent multicity studies and a multicontinent study have reported associations between short-term O_3 exposure and mortality, expanding upon evidence available in the last review (see Section 6.6). These recent studies reported consistent positive associations between short-term O_3 exposure and total (nonaccidental) mortality, with associations being stronger during

the warm season, when O_3 concentrations were higher. They also observed associations between O_3 exposure and cardiovascular and respiratory mortality. These recent studies also examined previously identified areas of uncertainty in the O_3-mortality relationship, and provided additional evidence supporting an association between short-term O_3 exposure and mortality. As a result, the current body of evidence indicates that there **is likely to be a causal relationship between short-term exposures to O3 and total mortality.**"

"**6.6 Mortality**

6.6.1 Summary of Findings from 2006 O_3 AQCD

The 2006 O_3 AQCD (U.S. EPA, 2006b) reviewed a large number of time-series studies... The association between short-term O_3 exposure and mortality was substantiated by a collection of meta-analyses and international multicity studies. ... Overall, the 2006 O_3 AQCD identified robust associations between various measures of daily ambient O_3 concentrations and all-cause mortality, with additional evidence for associations with cardiovascular mortality, which could not be readily explained by confounding due to time, weather, or copollutants. ... Collectively, the 2006 O_3 AQCD concluded that "the overall body of evidence is highly suggestive that O_3 directly or indirectly contributes to non-accidental and cardiopulmonary-related mortality."

6.6.2 Associations of Mortality and Short-Term O3 Exposure

Recent studies that examined the association between short-term O_3 exposure and mortality further confirmed the associations reported in the 2006 O_3 AQCD. New multicontinent and multicity studies reported consistent positive associations between short-term O_3 exposure and all-cause mortality in all-year analyses, with additional evidence for larger mortality risk estimates during the warm or summer months (Figure 6-27 [and Table 6-42]). These associations were reported across a range of ambient O_3 concentrations that were in some cases quite low."

"**6.6.3 Summary and Causal Determination**

The evaluation of new multicity studies that examined the association between short term O_3 exposure and mortality found evidence which supports the conclusions of the 2006 O_3 AQCD. These new studies reported

> consistent positive associations between short-term O_3 exposure and all-cause (nonaccidental) mortality, with associations persisting or increasing in magnitude during the warm season, and provide additional support for associations between O_3 exposure and cardiovascular and respiratory mortality."
>
> **"7.1.2 Calculating Ozone-Related Health Effects Incidence**
>
> The C-R functions used in the risk assessment are empirically estimated associations between average ambient concentrations of O_3 and the health endpoints of interest (e.g., mortality, hospital admissions (HA), emergency department (ED) visits). ... Given a C-R function of the form shown in equation (1) and a particular difference in ambient O_3 levels, Δx, the RR associated with that difference in ambient O_3, denoted as $RR\Delta x$, is equal to $e^{\beta\Delta x}$. The difference in health effects incidence, Δy, corresponding to a given difference in ambient O_3 levels, Δx, can then be calculated based on this $RR\Delta x$... These health impact equations are the key equations that combine air quality information, C-R function information, and baseline health effects incidence information to estimate ambient O_3 health risk... "

It is clear from such passages that EPA's risk assessment makes extensive use of associations, and that it repeatedly misinterprets evidence of associations as evidence for causation. This fundamental error leads to EPA's "Causal Determination" that reducing current ambient ozone levels would improve human health.

EPA's approach to quantitative risk assessment based on epidemiological data in section 7.1.2 also mistakenly conflates association and causation, completely confusing (a) "The difference in health effects incidence, Δy, corresponding to a given difference in ambient O_3 levels, Δx" as determined by the slope of a curve fit to *past levels* of ozone and health effects incidence rates with (b) The future *change* in health effects incidence that would be caused by a future change in ambient O_3 levels.

This confusion invalidates EPA's resulting quantitative benefits assessment. As discussed in the above example of potato consumption and car accidents and as elaborated further in Appendix A (illustrated with an example of baby aspirin and heart attack risk, and in the context of Figure 2 showing a linear slope for historical data plotting cardiovascular mortality against cell phone ownership), the *slope* of an exposure-response regression curve is an entirely distinct concept from the *causal impact* of changes in exposure on changes in response. The two have no necessary relation to each other. They need not even have the same sign, e.g., a positive

exposure-response slope may describe historical data even if the causal relation between exposure and response is negative, so that reducing exposure would cause increased future risk of response.

EPA's use of associational methods to drive key causal conclusions ignores a consensus in disciplines outside epidemiology that associational methods are unreliable, logically unsound, and inappropriate for drawing causal inferences (Dominici et al., 2014; Rothman et al., 2012; Cox and Popken, 2015). As illustrated in the above passages, EPA repeatedly moves straight from reports of associations to conclusions about causation without applying any formal quantitative causal analyses or objective tests to check the validity of their conclusions (e.g., using the methods in Hernan and Robins, 2011, 2015 and in the references cited in Table 1 of Appendix A).

Comment 3: EPA has not correctly "established" or "determined" causation or demonstrated that reducing ozone standards would cause human health benefits

Although EPA presents no objective causal analysis showing that reducing current ozone standards and levels will cause (or in recent decades has caused) any human health benefits, its QRA nonetheless projects human health benefits to be achieved by proposed future reductions in ozone. To accomplish this, the ozone risk assessment applies models of how future human health benefits might change as ozone levels changed *if* there were a causal relation between them and *if* that causal relation were correctly described by the assumed models. Uncertainties about these two crucial conditions are not quantified.

No detectable causal relation between ozone reductions and human health benefits has been found in careful examinations of historical data (e.g., HEI, 2010; Moore et al., 2013; Cox and Poken, 2015), casting doubt on the validity of EPA"s assumption that such a causal relation will hold in future. As discussed in the following comments, there is little reason to have confidence that EPA's models used to quantify projected future benefits provide even approximately correct descriptions of available data.

Comment 4: EPA's risk assessment models and their conclusions and predictions depend on implausible, unverified, and inaccurate modeling assumptions.

As explained in section 6.2.4 of the risk assessment, "In this review, EPA is investigating the use of a new model that estimates FEV1 responses for individuals

associated with short-term exposures to O_3 (McDonnell, Stewart, and Smith, 2007; McDonnell, Stewart, and Smith, 2010; McDonnell et al., 2012). This is a fundamentally different approach than the previous approach, for which the E-R function is at a population level, not an individual level. This model was developed using controlled human exposure data…" The new model that EPA is investigating involves a parameter alpha2 that is assumed to more than quadruple on one's 18^{th} birthday, then more than double on one's 36^{th} birthday, and finally plummet to zero on one's 55^{th} birthday (Table 6-2, p. 6-13). Such jumps do not seem plausible.

EPA then selects two *ad hoc* functional forms (out of an infinite number of possibilities) and claims that this incorporates model uncertainty: "EPA considered both linear and logistic functional forms in estimating the E-R relationship and chose a 90 percent logistic/10 percent piecewise-linear split using a Bayesian Markov Chain Monte Carlo approach. This Bayesian estimation approach incorporates both model uncertainty and uncertainty due to sampling variability." A more sober assessment is that the correct functional forms are unknown, and that neither of the two considered forms has been shown to be even approximately correct; this enormous model uncertainty has not been correctly accounted for or quantitatively characterized in the analysis, results, or statement of conclusions (e.g., using Bayesian Model Averaging, as described in Samet and Bodurow, 2008).

Likewise, EPA states (Section 6.5.1) that "Clearly the intra-individual variability Var(å) in the MSS model is a key parameter and is influential in predicting the proportions of the population with FEV1 decrements > 10 and 15%. The assumption that the distribution of this term is Gaussian is convenient for fitting the model, but is not accurate. The extent to which this mis-specification affects the estimates of the parameters of the MSS model and its predictions is not clear."

Comment 5: EPA has not quantified crucial model uncertainties. Therefore, confidence intervals calculated assuming that the models used are correct are misleadingly narrow and EPA has provided policy makers with no basis for confident predictions about how different changes in the ozone standard would probably affect public health.

As acknowledged in EPA's risk assessment (Section 6.5.1), "Although the model does not have good predictive ability for individuals (psuedo-R2 0.28), it does better at predicting the proportion of individuals with FEV1 decrements. 10, 15, and 20% (psuedo-R2s of 0.78, 0.74, 0.68) (McDonnell et al., 2012). The clinical studies that these model estimates are based on were conducted with young adult volunteers rather than randomly selected individuals, so it may be that selection bias has

influenced the model parameter estimates. The parameter estimates are not very precise, partly as the result of correlations between the parameter estimates… The MSS model is also sensitive to the exposure concentrations, but we have not quantified that sensitivity. … We are unable to properly estimate the true sensitivities or quantitatively assess the uncertainty of the MSS model. … As discussed in Section 6.5.3 below, there are uncertainties in extrapolating the MSS model down to age 5 from the age range of 18 to 35 to which the model was fit. …[T]he uncertainty of the extension to children of the MSS model could be substantial."

Section 6.5.7 adds that "EPA staff have identified key sources of uncertainty with respect to the lung function risk estimates. These are: the physiological model in APEX for ventilation rates, the O_3 exposures estimated by APEX, the MSS model applied to ages 18 to 35, and extrapolation of the MSS model to children ages 5 to 18. … At this time we do not have quantitative estimates of uncertainty for any of these."

Comment 6: EPA has not demonstrated that its recommended reductions in the current ozone standard will cause public health benefits.

EPA's ozone risk assessment does not provide quantitative risk models and uncertainty analyses adequate to support confident or accurate predictions about the future public health consequences of different standards. In this respect, its risk assessment is crucially incomplete. Its key conclusions and recommendations are based only on expert judgments and unverified assumptions. They are not supported by causal analyses of historical data, which show no detectable human health benefits caused by substantial reductions in ozone levels (e.g., HEI, 2103; Moore et al., 2013; Cox and Popken, 2015).

In summary, EPA is using a new model that takes "a fundamentally different approach than the previous approach," and that knowingly adopts convenient but inaccurate modeling assumptions (mis-specified models), to predict substantial future health benefits from further ozone reductions. No such benefits caused by past reductions in ozone levels have been found in careful examinations of past data (HEI, 2010; Moore et al., 2013; Cox and Poken, 2015). Since the new model is known not to be valid (it is mis-specified for convenience) and key uncertainties about it have not been quantified, there is no legitimate reason for EPA or policy makers to trust its predictions that further ozone reductions will cause substantial health benefits, particularly given that empirical observation does not support causal connections between past reductions in ozone levels and these health benefits.

As a result of its use of associational models and methods and unverified and incorrect modeling assumptions and interpretations, *EPA has not established causality* for the health effects that it attributes to ambient levels of ozone. Its claims to have done so – including its "Causal determinations" – are based on applying expert judgments, which are known to be highly fallible (Kahneman, 2011), to associational studies, which are known to be unreliable and inadequate for drawing valid causal inferences (Dominici et al., 2014; Cox and Popken, 2015; Appendix A). These qualitative subjective judgments are contradicted by more objective and reproducible quantitative analyses that have found no human health benefits caused by past reductions in ozone, and that have shown that health benefits initially attributed to ozone reductions were in fact just artifacts of flawed statistical methodology (e.g., HEI, 2010; Moore et al., 2013; Cox and Poken, 2015). Hence, the risks that EPA's assessment attributes to current ambient levels of ozone are unsupported by sound, objective, and reliable analysis or by past experience.

Furthermore, EPA's ozone risk assessment has not demonstrated that these public health risks, even if they exist, would be reduced at all by reducing the current ozone standard. (It *assumes* this in fitting models to data in Section 6 and in misinterpreting curve-fitting as if it were causal modeling in Section 7, as previously discussed. But an assumption is not a demonstration.)

The risk reductions that EPA projects from the proposed reductions in ozone standards are no more than consequences of unsupported modeling assumptions. These projections, which might seem to have been refuted by past experience, are not supported by any analyses showing that past ozone reductions have caused the benefits that EPA's models would have predicted for them, or explaining why those projected benefits have not been found in practice. Rather, they substitute optimistic judgments from selected experts that benefits will occur for objective scientific analysis and factual evidence that they have not occurred in places where ambient levels of ozone have already been decreased substantially in recent decades (e.g., HEI, 2010; Moore et al., 2013; Cox and Poken, 2015; HEI, 2010).

Comment 7: EPA's ozone risk assessment can and should be improved by applying readily available formal quantitative methods of causal analysis and uncertainty characterization.

Quantitative methods for sound causal analysis and characterization of remaining uncertainties, pioneered mainly in disciplines outside epidemiology, have progressed rapidly since the 1960s. They are now readily available and widely applied in social statistics, econometrics, engineering, neuroscience, artificial intelligence, machine

learning, and statistics, among others and are increasingly being incorporated into the best practices of modern epidemiology (Rothman et al., 2012).

Appendix A outlines both the pitfalls of association-based methods, and constructive methods for more objectively and correctly assessing and quantifying causal relations from data (see e.g., Table 1 of Appendix A). A key idea is that causation is *not* primarily about statistical associations between historical levels of variables, such as exposure and health effects. Rather, it is primarily about how changes in inputs (such as exposure) propagate through a network of validated causal mechanisms to cause resulting changes in outputs (such as health effects). Appendix A discusses methods to determine, document, and quantify such genuine causal influences.

The following steps would make EPA's risk assessment for ozone more sound and useful.

1. Formally test whether there is any significant statistical association between past changes in ambient levels of ozone and changes in risks of mortality or adverse health effects after accounting for modeling biases and uncertainties (e.g., by using Bayesian Model Averaging or nonparametric methods).

2. Formally test whether past changes in ozone exposures have preceded and helped to explain the changes in public health effects that EPA's risk assessment claims they will cause. Technical methods for conducting such tests (e.g., change-point analyses, intervention analyses, Granger causality tests) are readily available and should be used.

3. Formally test whether any health effects attributed to past changes in ozone levels can be made conditionally independent of those ozone levels by conditioning on other variables (e.g., daily temperature). If not, as revealed by conditional independence tests, this would provide legitimate evidence for possible causation.

4. Present and then test explicit causal graph models for how changes in ambient ozone levels propagate along hypothesized causal paths (possibly involving changes in reactive oxygen species (ROS) and lung inflammation) to produce changes in mortality or other health effects. As mentioned by Samet and Bodurow (2008) in a report cited by EPA, one way to do this is to "... [D]raw a set of causal graphs, each of which represents a particular causal hypothesis, and then consider evidence insofar as it favors one or more of these hypotheses and related graphs over the others."

5. Use the causal graphs to identify, test, and if possible refute, non-causal explanations for statistical relations among observed variables (including exposures, health effects, and any intermediate variables, modifying factors, and confounders).

6. Show that causal mechanisms postulated in the QRA modeling hold for realistic changes in ambient concentrations, and that they exhibit stable, uniform, law-like behavior. Ideally, there should be no large unexplained heterogeneity in estimated input-output (e.g., E-R or C-R) relations, since heterogeneity should be explained by differences in input variables such as individual covariates (rather than by differences in the causal mechanism or laws through which changes in inputs propagate to produce changes in outcomes).

7. Explain why past substantial reductions in ozone levels have not led to the predicted (and often claimed) health benefits predicted by modeling assumptions and associational modeling (e.g., HEI, 2010). The failure of predicted benefits to materialize in the past is a key reason for suspecting that they may not materialize in the future, and that EPA's risk analysis modeling methods and assumptions are overly optimistic and lack predictive validity. Addressing this gap between predictions and reality is crucial for developing trustworthy causal models of how changes in ozone exposures will affect public health risks.

The following sections expand on the preceding points in the context of specific passages from the EPA risk assessment for ozone and the source documents on which it relies.

Critical Comments on EPA's Causal Determination Framework

The comments that follow are based on the principle that sound quantitative risk assessment (QRA) must be based on sound analysis of causal relations between proposed risk management actions, such as reducing the current ozone standard, and their probable consequences, such as changes in health effects. Appendix A reviews principles for how causal analysis for quantitative risk assessment *should* (and should not) be done. This covers not only pitfalls to avoid, based largely on concerns about over-reliance on expert judgments and under-reliance on more objective methods of causal analysis and modeling at IARC, EPA, OSHA, FDA, and other agencies; but also principles for valid causal analysis, inference, and quantitative risk assessment (QRA), drawn from a large technical literature on causal analysis.

EPA's "Aspects to Consider in Making Causal Judgments" Do Not Accurately Reveal Causation

Table 1 of the ozone ISA summarizes "aspects" of association that are frequently considered in making expert judgments about whether associations might be causal. EPA used them as a primary basis for its causal determinations, principle conclusions on causality, and predictions that reducing ozone standards further will cause future health benefits. These "aspects" of association are reviewed here, along with critical comments.

1. **Strength:** It is often asserted that the larger is a statistical association between exposure and response (i.e., adverse health effects), the more likely it is to be causal. Table 1 of EPA's ISA document states that "The finding of large, precise risks increases confidence that the association is not likely due to chance, bias, or other factors." This belief is unjustified. It is a form of the logical fallacy that confuses correlation and causation, modified to suggest that *strong* correlation constitutes evidence for causation. As reviewed in Appendix A (see e.g., the discussion of Figure 2), a strong association may (and often does) simply reflect strong confounding, strong modeling biases, or strong spurious correlation between causally unrelated historical trends. Nor does a stronger association necessarily imply greater probability of causality; indeed, stronger reported associations may be *less* likely to be causal, as they are more likely to reflect strong modeling biases (e.g., Ioannidis, 2005).

The practical importance of modeling choices as explanations for reported significant positive associations for ozone and health effects was highlighted in a recent study by Moore et al. (2012), who carried out a causal analysis "with the aim of estimating the extent to which reductions in ambient ozone concentrations were associated with measurable health benefits, specifically on the proportion of asthma-related hospital discharges." Unlike previous analyses that made untestable modeling assumptions, this causal analysis found no significant effects of ozone reduction on health benefits, prompting the authors to speculate that "Thus, in this ozone study, significant results from the [earlier] analysis may be a consequence of the approach taken and not solely based on the information in the data."

In EPA's ozone risk assessment, the extent to which significant associations are consequences of the modeling approaches taken, including unverified and possibly mistaken modeling assumptions, rather than reflecting information in the data, is not quantified. Thus, policy-makers have no way to know whether any of the key

conclusions and recommendations is more than a consequence of untested modeling assumptions.

Likewise, Cox and Popken (2015) applied a different causal analysis method (Granger causality testing) to time series data on ozone concentrations and mortality rates in hundreds of counties in the United States. They found a clear positive exposure-response association in regression models, consistent with EPA's findings, but no evidence that the association was causal rather than coincidental (i.e., both ozone levels and mortality rates, especially cardiovascular mortality rates, have been declining, but not because one causes the other).

Again, since EPA's ozone risk assessment treats association as causal without applying any formal quantitative tests of this assumption, it is impossible for policy makers to know whether any of the causal impacts of reducing ozone that EPA projects will actually occur. However, the findings from Moore et al. (2012) and Cox and Popken (2015) indicate that past reductions in ozone have not caused any detectable health benefits for asthma-related hospitalization or mortality risk reductions, respectively. This calls into question EPA's central assumptions that associations imply causation and that future health benefits can be achieved by reducing the current ozone standard.

For ozone, EPA and others have found that pollutant concentrations and adverse health effects are often *negatively* associated, unless modeling constraints are imposed or modeling adjustments are made to force them to be positive (Powell et al., 2012). A finding of a strong positive association made when other possibilities are eliminated via modeling provides no evidence for a true causal relation.

For example, EPA's risk assessment notes in 6.6.2.1 that "Because O_3 peaks in the summer and mortality peaks in the winter, not adjusting or not sufficiently adjusting for the seasonal trend would result in an apparent negative association between the O_3 and mortality time-series. …However, it should be noted, the majority of studies in the literature that examined the mortality effects of short-term O_3 exposure, particularly the multicity studies, used 7 or 8 df/year to adjust for seasonal trends, and in both methods a positive association was observed between O_3 exposure and mortality." Again, beginning with a negative correlation and then "sufficiently adjusting" it to make it positive raises the possibility that reported positive associations reflect the willingness of modelers to make adjustments as needed to produce them.

This does not deny the desirability and importance of adjusting for seasonality (although adjusting for daily temperatures might be more important and reduce

modeling biases due to insufficient flexibility of seasonal adjustments). But such adjustments create a strong requirement to quantify and report biases due to multiple testing (i.e., searching through multiple possible model specifications, e.g., using different lags and degrees of freedom for smoothers, until the desired result is obtained) and model specification errors. EPA's ozone risk assessment, and the key studies on which it depends (e.g., the ozone ISA) do not quantify the effects of these biases on results. Key model uncertainties are not quantified. Thus, policy makers cannot determine from EPA's risk assessment to what extent reported associations and recommendations simply reflect mistaken modeling assumptions (e.g., model selection biases and misspecification errors).

When model diagnostics are not presented and model uncertainties are not quantified, as in EPA's ozone risk assessment, it is always possible to create strong positive associations using misspecified statistical model (see Appendix A). For example, strong positive associations can be created by misspecified linear regression modeling assumptions even in purely random data where it is known that there is no causal relation (and no true associations, apart from that created by modeling) between exposure and response variables. Appendix A makes this point via a simple example using a linear regression model that is misspecified to have a zero intercept term. However, the point that modeling assumptions can create strong positive associations independent of the true empirical relation – positive, zero, or negative – between exposure and risk is much more general.

In summary, the finding of a strong association does not necessarily or usually give any support to the hypothesis that the association is causal, rather than a product of strong modeling assumptions, biases, confounding, or coincident trends.

2. **Consistency:** A second unwarranted belief is that a positive association that is consistently reproduced by different researchers is more likely to be causal than an association that has not been reproduced. As EPA states in multiple documents, including Table 1 of their ozone ISA, "The reproducibility of findings constitutes one of the strongest arguments for causality." However, consistently reproduced findings may simply reflect consistent errors and biases in modeling, or consistent failures to fully account for confounders.

For ozone and mortality, there is no consistency in exposure-response associations. As noted in EPA's ozone risk assessment (section 6.6.2.3), "Evaluation of the O_3-mortality C-R relationship is not straightforward because the evidence from multicity studies (using log-linear models) suggests that O_3-mortality associations are highly heterogeneous across regions." For older adults, "The inconsistent epidemiologic

findings for older adults parallel observations from controlled human exposure studies (Section 6.2.1.1)." For asthma, "The few available U.S. multicity studies produced less consistent associations (ISA, p. 6-101 to 6-102)." Figure 6-4 shows that different studies of campers disagree even about the signs of associations (each with 95% confidence, which suggests that the alleged 95% confidence intervals are not trustworthy, as opposite signs of association should not be observed this frequently if they were correct).

Moreover, as already discussed, there is no consistency of exposure-response relations across studies and models. Thus, Moore et al. (2012) showed that statistically significant health benefits from ozone reduction are found in models that make unverifiable assumptions, but not in models that use only realistic, empirically tested assumptions. Similarly, Powell et al. (2012) comment on the inconsistency of associations across studies (some find negative associations and others positive ones, all of which are claimed to be statistically significant) and advocate constraining studies to force a consistent finding of positive associations rather than negative ones. (Roberts (2004) recommends similar measures for similar reasons.) Clearly, consistency of positive associations that is enforced when necessary by discarding equally valid findings of negative associations cannot be correctly construed as providing any evidence for causation, let alone being regarded as "one of the strongest arguments for causality."

3. **Specificity:** Table 1 of EPA's ozone ISA report states that "Evidence linking a specific outcome to an exposure can provide a strong argument for causation." The link between asbestos exposure and mesothelioma risk is a common example. For ozone at and below currently permitted levels, no such specific outcomes are claimed, so this aspect of association does not apply. However, it is worth noting that confounding can lead to specificity of an exposure-response association even without causality.

4. **Temporality:** EPA asserts that "Evidence of a temporal sequence between the introduction of an agent, and appearance of the effect, constitutes another argument in favor of causality." However, this argument is unsound. It is a form of the *ex post* logical fallacy. Although EPA is correct that causes precede their effects, sound inference about causation requires much more of temporal order, including the following.

    a. To count as evidence that exposure causes increased risk of adverse health effects, the temporal sequence should enable health effects to be predicted better with knowledge of the exposure time series than without

it. This condition was not found to hold for ozone and mortality risks when it was formally tested using Granger causality and conditional independence tests (Cox and Popken, 2015).

b. The temporal sequence should not be due to coincident historical trends. "History" is recognized as a standard threat to valid causal inference in quasi-experiments (see Appendix A and references therein). EPA experts who have offered confident expert judgments about the causality of air pollution health effects associations while ignoring the need to refute history as an explanation have thereby reached incorrect conclusions (HEI, 2013).

c. The temporal sequence should not be due to natural variability in time series (perhaps combined with selection of time windows by modelers to give an appearance of temporality). For ozone, a well-publicized claim of a causal impact is "the reduction in the rates of childhood asthma events during the 1996 Summer Olympics in Atlanta, Georgia, due to a reduction in local motor vehicle traffic" (Buka et al., 2006). Belief in this reduction as evidence of a clear causal effect between pollution levels and asthma risk was spread by a 2001 article in the *Journal of the American Medical Association*, which reported that "During the Olympic Games, the number of asthma acute care events decreased 41.6% (4.23 vs 2.47 daily events) in the Georgia Medicaid claims file," coincident with significant reductions in ozone and other pollutants (Friedman et al., 2001).

   Unfortunately, the investigators did not formally test whether the observed reduction in asthma cases is unusual for the relevant time of year. When other investigators compared fluctuations in asthma acute care events during the 1996 Atlanta Olympics to fluctuations over the same period in other years, they "did not find significant reductions in the number of emergency department visits for respiratory or cardiovascular health outcomes in adults or children" (HEI, 2010). Although "They confirmed that Atlanta experienced a significant decline in ozone concentrations of 20% to 30% during the Olympic Games, with less pronounced decreases in concentrations of carbon monoxide, PM_{10}, and nitrogen dioxide," these significant reductions in pollutant levels were not matched by any detectable reduction in health risks: "In their primary analyses, which were adjusted for seasonal trends in air pollutant concentrations and health outcomes during the years before and after the

> Olympic Games, the investigators did not find significant reductions in the number of emergency department visits for respiratory or cardiovascular health outcomes in adults or children." In fact, the only significant effect was that "relative risk estimates for the longer time series were actually suggestive of increased ED [emergency department] visits during the Olympic Games," primarily for Chronic Obstructive Pulmonary Disease (COPD) patients (HEI, 2010).
>
> In short, although the reduction in air pollution levels during the Olympics was real and substantial (although perhaps coincidental, as similar reductions occurred at the same time in much of the region), the only significant change noted in adverse health effects, compared to other years, was a modest *increase* in emergency department admissions. The widely publicized "reduction in the rates of childhood asthma events during the 1996 Summer Olympics in Atlanta, Georgia, due to a reduction in local motor vehicle traffic" (Buka et al., 2006) appears to be an artifact of poor statistics – specifically, failing to quantify natural seasonal variability in event rates before interpreting a significant (over 40%) reduction as evidence of a causal impact.

5. **Biological gradient:** Table 1 of EPA's ISA asserts that "A well-characterized exposure-response relationship (e.g., increasing effects associated with greater exposure) strongly suggests cause and effect, especially when such relationships are also observed for duration of exposure (e.g., increasing effects observed following longer exposure times)." This is fallacious, insofar as model misspecification or a strong confounder can create a positive association between exposure (concentration and duration) and effect in the absence of any causal relation between them, as explained further in Appendix A (see e.g., the discussion of Figure 1).

6. **Biological plausibility:** For biological plausibility, Table 1 of EPA's ISA states that "A proposed mechanistic linking between an effect and exposure to the agent is an important source of support for causality, especially when data establishing the existence and functioning of those mechanistic links are available." Of course, a proposal is not by itself "an important source of support for causality" if the proposal is wrong and the proposed mechanisms do not operate in reality. Nor do "data establishing the existence and functioning of those mechanistic links" provide support for causality unless the mechanism actually operate in the setting of interest. For example, proposing a vague explanation ("hand waving") that refers to experimental data with no known

> relevance to real public health changes should not be considered "an important source of support for causality." More generally, many mechanistic proposals suggested by *in vitro* findings, high-concentration experiments, or other experiments carried out under artificial conditions may prove to be mistaken; they should not be counted as evidence for causation. Similarly, proposed mechanisms that seem plausible only because of ignorance of relevant biology and pathology should not be construed as evidence for causation.

For ozone, EPA further explains that "The O_3-induced lung function decrements consistently demonstrated in controlled human exposure studies (Section 6.2.1.1) provide biological plausibility for the epidemiologic evidence consistently linking short-term increases in ambient O_3 concentration with lung function decrements in diverse populations." This claim is problematic, in so far as both "The O_3-induced lung function decrements consistently demonstrated in controlled human exposure studies" and the "epidemiologic evidence consistently linking short-term increases in ambient O_3 concentration with lung function decrements" are in fact far from consistent; see the discussion of consistency above.

7. **Experimental evidence:** In EPA's view, "Strong evidence for causality can be provided through 'natural experiments' when a change in exposure is found to result in a change in occurrence or frequency of health or welfare effects." For ozone, such natural experiments have shown that relatively large changes in exposure (e.g., 40% reductions) have resulted in no detectable reductions in the occurrence or frequency of health effects (e.g., HEI, 2010 for the Atlanta Olympics; Cox and Popken, 2015 for U.S. counties; Moore et al., 2013 for hospitalization). It is perhaps fair to wonder whether these natural experiments should be construed as providing strong evidence *against* EPA's hypothesis that future (relatively small) reductions in ozone will cause public health benefits. EPA's risk assessment and ISA document are silent on this issue. No discussion or explanation is offered for why projected public health benefits caused by ozone reductions are not found in past data. This is an area in which research might provide answers to inform future policy. For example, if the explanation for the apparent lack of effects of previous ozone reductions on public health is that there are two main types of people in the population, insensitive or healthy people whose health does not change when ozone exposures are reduced; and very sensitive responders who continue to respond just as frequently and in the same ways even when ozone levels are reduced, then this understanding might also lead to better predictions about the public health effects (or lack of them) to be expected from future reductions in ozone levels. Understanding historical data better, and being able to explain the results of quantitative causal analyses of past

data from natural experiments, seems to be a useful prerequisite for confident forecasting about the probable effects of future policy actions.

8. **Coherence.** Table 1 of EPA's ozone ISA also explains that "An inference of causality from one line of evidence (e.g., epidemiologic, controlled human exposure [clinical], or animal studies) may be strengthened by other lines of evidence that support a cause-and-effect interpretation of the association." However, combining lines of evidence none of which suggests that reducing ozone has caused public health benefits does not strengthen an inference of causality. Conversely, a single line of evidence (e.g., natural experiments showing no detectable effects of past ozone reductions on public health) suffices to refute any number of lines of evidence that mistakenly predicted that clear public health benefits should have been seen.

9. **Analogy:** The ozone ISA's table of "Aspects [of association] to aid in judging causality" concludes with these observations: "Structure activity relationships and information on the agent's structural analogs can provide insight into whether an association is causal. Similarly, information on mode of action for a chemical, as one of many structural analogs, can inform decisions regarding likely causality."

   For ozone, the ISA presents extensive discussions of whether a mode of action involving increased reactive oxygen species (ROS) and inflammation in the lung might be plausible. However, as detailed in previous biomathematical analyses (Cox, 2011, 2012), inflammation-mediated lung diseases should be expected to have exposure thresholds below which they are not caused. Epidemiological models that do not explicitly and adequately model errors in exposure estimates, including EPA's epidemiological models for ozone health effects in Section 7, smear out such thresholds, making them appear to be smooth dose-response relations. (They also tend to inflate estimated no-observed-adverse-effects levels, so that estimated thresholds may be far higher than true ones.)

   EPA's ISA presents experimental results on lung responses to ozone in human volunteers. These results constitute overwhelming evidence that the subjects were alive, and hence had lungs that responded normally to normal challenges. But they do not analyze thresholds in the context of exposure estimation errors. Hence, they do not confront the fact that the proposed inflammation-mediated mechanisms of adverse health effects are analogous to those for other much-studied lung irritants for which exposure thresholds exist which must be

> exceeded (for both concentration and duration) to produce lung pathologies or diseases (*ibid*).
>
> In short, analogy suggests that ozone probably has no adverse health effects at concentrations and durations below certain thresholds. The absence of any impact of relatively large reductions in ozone concentrations on public health outcomes in causal analyses, previously discussed, might suggest that such a threshold may be well above the current standard.

In summary, although we disagree with EPA that subjective qualitative reflections on aspects of association should ever be used in place of rigorous causal analysis and hypothesis testing as a basis for making claims about causality in exposure-response or concentration-response relations, we also consider that the "Aspects [of association] to aid in judging causality" listed in Table 1 of the ozone ISA tend to support the view that there is no evidence of a causal relation. That a reasonable application of these aspects might lead to a finding of no evidence of causation at least as easily as to a determination of causality, as suggested by the preceding comments, highlights the subjectivity and unreliability of such WoE-based judgments and determinations.

Critique of EPA's Risk Assessment Based on Other Criteria

EPA's ozone risk assessment may also be evaluated according to the checklist for sound QRAs offered in the last part of Appendix A as an alternative to the aspect listed in Table 1 of the ozone ISA. The results are as follows.

Does EPA's ozone QRA show that changes in exposures precede the changes in health effects that they are said to cause?

Answer: No. The QRA presents no results of any formal quantitative causal analyses (e.g., change-point analyses, intervention analyses, or Granger causality tests) showing that changes in ambient O_3 exposure concentrations precede, and help to predict and explain, subsequent changes in public health effects. For mortality risks, specifically, it appears that O_3 exposures are significantly positively *associated* with both all-cause (AC) and cardiovascular disease (CVD) mortality rates in historical data for U.S. counties, but the association does not appear to be *causal*, insofar as "A causal relation between pollutant concentrations and AC or CVD mortality rates cannot be inferred from these historical data, although a statistical association between them is well supported. There were no significant positive associations between changes in $PM_{2.5}$ or O_3 levels and corresponding changes in disease

mortality rates between 2000 and 2010, nor for shorter time intervals of 1 to 3 years." (Cox and Popken, 2015)

Does the QRA demonstrate that health effects cannot be made conditionally independent of exposure by conditioning on other variables (especially, potential confounders)?

Answer: No. No conditional independence tests are presented. However, EPA's risk assessment does discuss confounding, as follows.

> "**6.6.2.1 Confounding**
>
> Recent epidemiologic studies examined potential confounders of the O_3-mortality relationship. These studies specifically focused on whether PM and its constituents or seasonal trends confounded the association between short-term O_3 exposure and mortality."
>
> "**Confounding by Seasonal Trend**
>
> The APHENA study (Katsouyanni et al., 2009), mentioned above, also conducted extensive sensitivity analyses to identify the appropriate: (1) smoothing method and basis functions to estimate smooth functions of time in city-specific models; and (2) degrees of freedom to be used in the smooth functions of time, to adjust for seasonal trends. Because O_3 peaks in the summer and mortality peaks in the winter, not adjusting or not sufficiently adjusting for the seasonal trend would result in an apparent negative association between the O_3 and mortality time-series. Katsouyanni et al. (2009) examined the effect of the extent of smoothing for seasonal trends by using models with 3 df/year, 8 df/year (the choice for their main model), 12 df/year, and df/year selected using the sum of absolute values of partial autocorrelation function of the model residuals (PACF) (i.e., choosing the degrees of freedom that minimizes positive and negative autocorrelations in the residuals). Table 6-46 presents the results of the degrees of freedom analysis using alternative methods to calculate a combined estimate: the Berkey et al. (1998) meta-regression and the two level normal independent sampling estimation (TLNISE) hierarchical method. The results show that the methods used to combine single-city estimates did not influence the overall results, and that neither 3 df/year nor choosing the df/year by minimizing the sum of absolute values of PACF of regression residuals was sufficient to adjust for the seasonal negative relationship between O_3 and mortality. However, it should be noted, the majority of studies in the

> literature that examined the mortality effects of short-term O_3 exposure, particularly the multicity studies, used 7 or 8 df/year to adjust for seasonal trends, and in both methods a positive association was observed between O_3 exposure and mortality."

This analysis is limited by the fact that it adjusts for only two confounders ($PM_{2.5}$ and seasonal effects), and not for many others (e.g., daily temperatures). Moreover, it shows that EPA readily discovers a significant *negative* association between O_3 and mortality, but then applies various statistical adjustments to get a positive association instead – but without adjusting for the resulting multiple testing and model selection biases. In this context, and in the absence of any conditional independence tests, it is not clear what causal significance, if any, the positive associations that EPA's manipulations eventually produce might have. (Adjusting for confounding by season, month, temperature, etc. is certainly sensible, but whether any association between O_3 and adverse health effects remains after conditioning on all relevant confounders has not been answered, since conditional independence test results are not reported.)

***Does the QRA present and test explicit causal graph models,* showing the results of formal statistical tests of the causal hypotheses implied by the structure of the model (i.e., which variables point into which others, as in Figures 1 or 3)?**

Answer: No

Have non-causal explanations for statistical relations among observed variables (including exposures, health effects, and any intermediate variables, modifying factors, and confounders) been identified and refuted using well-conducted and reported statistical tests?

Answer: No. As noted in EPA's ozone ISA (p. 6-220), "[M]ultiple uncertainties remain regarding the O_3-mortality relationship including: the extent of residual confounding by copollutants; factors that modify the O_3-mortality association; the appropriate lag structure for identifying O_3-mortality effects (e.g., single-day lags versus distributed lag model); the shape of the O_3-mortality C-R function and whether a threshold exists; and the identification of populations at-risk to O_3-related health effects." (Section 6.6.1). The hypothesis that modeling choices, uncertainties, and selection biases, multiple testing bias, and specification errors explain reported E-R and C-R associations has not been refuted. Neither has the hypothesis that confounders explain them.

Have any causal mechanisms postulated in the QRA modeling been demonstrated to exhibit stable, uniform, law-like behavior, so that there is no substantial unexplained heterogeneity in estimated input-output (e.g., E-R or C-R) relations?

Answer: No. To the contrary, EPA's risk assessment notes (6.6.1) that "The studies evaluated found some evidence for heterogeneity in O_3 mortality risk estimates across cities and studies" and (6.6.2.3) "Evaluation of the O_3-mortality C-R relationship is not straightforward because the evidence from multicity studies (using log-linear models) suggests that O_3-mortality associations are highly heterogeneous across regions." Thus, there is considerable unexplained heterogeneity, indicating that EPA has not yet identified stable causal relations that could be used to make valid predictions.

In summary, EPA's QRA for ozone meets none of the criteria identified in Section 1 for a sound risk assessment. As a result, we recommend that additional work be done to close the gaps just identified (e.g., perform and report conditional independence tests, Granger causality tests, causal graph modeling, correction for modeling biases and confounding (including residual confounding) by temperature and other major confounders, and resolution of heterogeneity. Doing so will provide the foundation for a QRA that produces trustworthy results rather than unjustified opinions as a basis for future regulation of O_3.

The following section discusses the above points in further detail in the context of specific passages from the EPA risk assessment for ozone and the source documents on which it relies.

Comments on Passages from EPA's Ozone Integrated Science Assessment

EPA's O_3 risk assessment relies heavily on the O_3 ISA (Integrated Science Assessment),[8] which explains its approach to determining causality as follows. We present the approach using quotes from the ISA, interspersed with comments:

> *"Using the causal framework described in the following section, EPA scientists consider aspects such as strength, consistency, coherence, and biological plausibility of the evidence, and develop causality determinations*

[8] http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492#Download

on the nature of the relationships. Causality determinations often entail an iterative process of review and evaluation of the evidence." (p. lvi)

COMMENT: The words "evidence" and "relationships" here refer primarily to *statistical associations* in *historical* data. They do *not* refer to validated causal relations, mechanisms, or laws that could legitimately be used to predict how future changes in O_3 exposure will change future health effects. The assumption that past statistical associations are the same as future causal relations lacks justification.

COMMENT: The concept of "causality determination" is flawed. It is not usually the case that a statistical association is either causal or not, and hence the presumption that there is a binary truth ("causal" or "not causal") is incorrect. Rather, statistical associations may be partly due to biases, partly to confounding, partly to modeling choices and errors, partly to coincident historical trends, partly to genuine causality, partly to neglected errors in exposure estimates, and so forth. What needs to be determined is not whether a statistical relation is causal, but what fraction of it (if any) is causal. This, EPA has neither done, nor attempted to do. Yet, it is the only thing that matters for making useful predictions about how future changes in exposure will change future health effects (if at all). Making a "determination" that a statistical association is "causal" (implicitly meaning entirely causal) and then treating it as being entirely causal without quantifying or bounding the fractions that are due to biases, confounding, coincident trends, and other non-causal sources of association, leaves uncompleted the task of informing policy makers correctly about the change in health effects that would be caused by future changes in health effects. By relying on qualitative "causality determination" and then implicitly treating associations as being 100% causal for quantitative purposes, EPA has committed a logical error and produced misleading (exaggerated, upper-bound) estimates of the health consequences of changing future O_3 exposures.

COMMENT: Notwithstanding common practice in epidemiology (but not in other fields, such as engineering or neuroscience or econometrics, where causal relations are more usually determined by objective data analysis and explicit modeling and hypothesis-testing, rather than by subjective opinions), the consideration of "aspects such as strength, consistency, coherence, and biological plausibility of the evidence" does not provide the information that is logically necessary to develop valid "causality determinations."

The weight-of-evidence considerations used by EPA (and many others) have no known validity as guides to causality (Morabia, 2013). They are not necessary or sufficient for establishing causality, or for making it plausible. They do not, for

example rule out strong confounders with time delays, or coincident (but not causal) historical trends in exposure and response, or modeling choices and biases, or many other possible non-causal explanations for strong, consistent, coherent associations that might also seem biologically plausible (especially in the absence of well-explicated, tested, and validated causal mechanisms explaining how ambient levels of exposure would create increased health effects).

On the other hand, the information that is most essential for drawing valid causal inferences—showing how changes in exposures propagate through causal mechanisms to increase mortality or morbidity rates (Freedman, 2004)—is entirely missing from these "aspects" of association. Therefore, when EPA writes that "EPA scientists consider aspects such as strength, consistency, coherence, and biological plausibility of the evidence, and develop causality determinations," they describe a process in which EPA scientists make determinations about causality that cannot be validly derived from the aspects of the data that they are asked to consider. There is no reason to regard the resulting opinions as useful guides to objective, factual truth about causality.

> *"EPA has developed a consistent and transparent basis for integration of scientific evidence and evaluation of the causal nature of air pollution-related health or welfare effects for use in developing ISAs. The framework described below establishes uniform language concerning causality and brings more specificity to the findings."*

COMMENT: EPA's "basis for integration of scientific evidence and evaluation of the causal nature of air pollution-related health or welfare effects for use in developing ISAs" is here asserted to be "consistent and transparent." But it is not. It depends essentially on the subjective judgments (via the "causality determination") of EPA-selected experts, none of whom is necessarily expert in the methodology of valid causal inference and hypothesis-testing.

The opinions of experts are subject to the same pitfalls, such as motivated reasoning, groupthink, confirmation bias, narrow framing, overconfidence (possibly ameliorated by calibration training), and so forth as the opinions of other people (Kahneman, 2011). They are not "transparent" in the sense of using independently observable and verifiable calculations to move from publicly available data to conclusions. Rather, they amount to selected experts using inscrutable judgment processes to render "causality determinations" that EPA then declares to be "consistent and transparent," although other experts (especially those trained in causal analysis) might reach vastly different conclusions.

Indeed, EPA's own experts have sometimes reached vastly different conclusions about health effects of pollutants when offering subjective judgments about causality without fear of contradiction (e.g., Harvard School of Public Health, 2002) and when re-doing their work more carefully to satisfy the rudiments of objective causal analysis, such as comparing the outcomes for relevant treatment and control groups (e.g., HEI, 2013). It is therefore misleading for EPA to characterize as "consistent and transparent" its practice of using expert judgments to obtain "causality determinations" that cannot necessarily be derived by objective data analysis of data (transparency) or replicated by others (consistency) or made consistent with any more objective, data-driven causal analysis.

> *"This standardized language was drawn from sources across the federal government and wider scientific community, especially the National Academy of Sciences (NAS) Institute of Medicine (IOM) document, Improving the Presumptive Disability Decision-Making Process for Veterans (Samet and Bodurow, 2008), a comprehensive report on evaluating causality."*

COMMENT: The Samet and Bodurow (2008) report is not a "comprehensive report on evaluating causality." It does not provide a comprehensive discussion of most methods of valid causal inference (e.g., structural equation modeling, Simon causal ordering, compositional causal modeling, causal graph models, Granger causality tests, quasi-experiment design and analysis, regression discontinuity and instrumental variables approaches, etc.) A comprehensive treatment of evaluating causality was not part of its scope or intent.

> *"This framework... describes the kinds of scientific evidence used in establishing a general causal relationship between exposure and health effects;"*

COMMENT: The term "general causal relationship" is not carefully defined. From context, it appears to mean "an opinion about whether historical statistical associations between exposure and response have certain aspects, listed in Table 1 of the ISA." It is not clear why such "general causal relationships" are emphasized in EPA's risk assessment, as they do not necessarily (or probably) predict how changes in future exposures will change future health effects. As discussed previously, the aspects of association in Table 1 of the ozone ISA are neither necessary nor sufficient to establish causation.

COMMENT: The framework does not describe "the kinds of scientific evidence used in establishing a general causal relationship between exposure and health

effects,"whatever that means. Rather, it presents a framework for inviting experts to opine about whether associations are causal without doing any formal or objective causal analysis needed to reach valid conclusions. It encourages selected experts to substitute their own subjective opinions or preconceptions for objective factual or scientific analyses of causation by asking them to base their opinions on considerations of selected "aspects" statistical associations (e.g., strength and consistency) that do not establish causation and that have no known or proven validity for informing speculations about causality (e.g., Morabia, 2013). The framework neither requires nor uses any formal or objective quantitative causal analyses, causal modeling, or causal hypothesis-testing to check whether the expert's subjective judgments are consistent with data or might be factually correct.

COMMENT: The cited report by Samet and Bodurow (2008) explicitly rejects EPA's claim here that consideration of aspects of statistical associations provide a sound basis for "establishing a general causal relationship between exposure and health effects." To the contrary, their report states that "Because a statistical association between exposure and disease does not prove causation, plausible alternative hypotheses must be eliminated by careful statistical adjustment and/or consideration of all relevant scientific knowledge. Epidemiologic studies that show an association after such adjustment, for example through multiple regression or instrumental variable estimation, and that are reasonably free of bias and further confounding, provide evidence but not proof of causation."[9] Nowhere does this report support EPA's claim that the types of evidence considered by EPA suffice to establish a causal relationship (general or otherwise) between exposure and health effects. Thus, EPA cites as an authority for establishing causation based on expert consideration of associations a source that explicitly states that epidemiologic studies showing associations do not prove causation.

> *"This framework... characterizes the process for integration and evaluation of evidence necessary to reach a conclusion about the existence of a causal relationship;"*

COMMENT: The framework does not "characteriz[e] the process for integration and evaluation of evidence necessary to reach a conclusion about the existence of a causal relationship." For example, it says nothing about how to evaluate evidence for or against propagation of changes in exposure through networks of causal mechanisms to produce changes in health outcomes, although consideration of such propagation of changes are necessary to reach valid conclusions about whether a causal relationship exists (Freedman, 2004).

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[9] www.nap.edu/openbook.php?record_id=11908&page=173

"This framework... identifies issues and approaches related to uncertainty;"

COMMENT: We agree that the cited report by Samet and Bodurow (2008) does an excellent job of identifying some key issues and approaches related to uncertainty. Specifically, this report states that:

"The uncertainty about the correct causal model involves uncertainty about whether exposure in fact causes disease at all, about the set of confounders that are associated with exposure and cause disease, about whether there is reverse causation, about what are the correct parametric forms of the relations of the exposure and confounders with outcome, and about whether there are other forms of bias affecting the evidence. One currently used method for making this uncertainty clear is to draw a set of causal graphs, each of which represents a particular causal hypothesis, and then consider evidence insofar as it favors one or more of these hypotheses and related graphs over the others. We explain this approach in more detail in Appendix J.

Uncertainty about the model is not just limited to the qualitative causal structure; however, it also involves uncertainty about the parametric form of the model specified, the variables included, whether or not measurement error is modeled, and so on. When mechanistic knowledge exists, this sort of uncertainty is mitigated. Nevertheless, model uncertainty is perhaps the most important level of uncertainty."[10]

However, EPA's risk assessment and uncertainty analysis do not incorporate or respond to these insights. They do not quantify or characterize model uncertainty about "about whether exposure in fact causes disease at all." They do not draw causal graph models or test causal hypotheses. They do not refute non-causal explanations for E-R and C-R statistical associations. In short, they cite a relatively sophisticated discussion of uncertainty and then do not follow the good advice and useful insights that it offers.

"This framework... provides a framework for classifying and characterizing the weight of evidence in support of a general causal relationship.

[10] www.nap.edu/openbook.php?record_id=11908&page=170

> *Approaches to assessing the separate and combined lines of evidence (e.g., epidemiologic, controlled human exposure, and animal toxicological studies) have been formulated by a number of regulatory and science agencies, including the IOM of the NAS (Samet and Bodurow, 2008), International Agency for Research on Cancer (IARC, 2006), U.S. EPA (2005), and Centers for Disease Control andPrevention (CDC, 2004). Causal inference criteria have also been described for ecological effects evidence (U.S. EPA, 1998; Fox, 1991). These formalized approaches offer guidance for assessing causality. The frameworks are similar in nature, although adapted to different purposes, and have proven effective in providing a uniform structure and language for causal determinations."*

COMMENT: The term "general causal relationship" is not carefully defined, as previously discussed.

COMMENT: Samet and Bodurow and the other references actually do not "provid[e] a framework for classifying and characterizing the weight of evidence in support of a general causal relationship." They provide a framework for classifying and characterizing opinions about some aspects of statistical associations that have no justification (other than long and widespread usage in epidemiology, though not in other fields) for being used to inform expert opinions and speculations about causation (Appendix A; Morabia, 2013).

As stated in the Samet and Bodurow report, "We begin by discussing the problem of integrating the evidence from multiple epidemiologic studies. We then describe a framework for combining epidemiologic and other evidence into a single *quantitative* judgment about the strength of causation. Next we discuss *qualitative* frameworks that have been used by expert committees for categorizing the overall strength of evidence for or against a causal claim. And lastly we propose a qualitative framework for causal reference to be used in the presumptive disability decision-making process."[11]

The quantitative judgment about strength of causation referred to is meta-analysis. This fails when the individual studies being integrated do not provide valid evidence about causation. The "*qualitative* frameworks that have been used by expert committees for categorizing the overall strength of evidence for or against a causal claim" do not identify the *fraction* of a statistical association that is causal (if any). Thus, however appropriate or inappropriate they might be "in the presumptive

[11] www.nap.edu/openbook.php?record_id=11908&page=175

disability decision-making process" that is the explicit focus of the Samet and Bodurow report, they are not appropriate for risk assessment of future health effects – the use that EPA makes of them.

Likewise, the proposed "qualitative framework for causal reference to be used in the presumptive disability decision-making process" may or may not be appropriate for this purpose, but it is certainly not justified for the purpose of predicting how future changes in ozone exposures will change health risks (if at all). EPA has used a *presumptive* framework intended for a different purpose (e.g. retrospective compensation awards), not a *predictive* framework for giving valid predictions to policy makers of the likely health consequences of future changes in exposure levels. The framework on which EPA has relied has not been validated or shown to be useful for the purpose to which they apply it, i.e., predictive risk modeling rather than presumptive, retrospective decision-making about disability awards.

APPENDIX A. Principles of Causal Analysis and Inference for Quantitative Risk Assessment

Some Limitations of Traditional Epidemiological Measures for Causal Inference

Uncertainty about Whether Associations are Causal

Epidemiology has a set of well-developed traditional methods and measures for quantifying associations between observed quantities, especially regression model coefficients and relative risk (RR) ratios (e.g., the ratio of disease rates for exposed and unexposed populations) and quantities derived from them. These include population attributable risks (PARs) and population attributable fractions (PAFs) for the fraction of disease or mortality cases attributable to a specific cause; global burden of disease estimates; etiologic fractions and probability-of-causation calculations; and estimated concentration-response slope factors for exposure-response relations (Rothman et al., 2012). The key idea of all these measures is to observe whether more-exposed people suffer adverse consequences at a higher rate than less-exposed people and, if so, to attribute the excess risks in the more-exposed group to a causal impact of exposure.

Conventional statistical methods for quantifying uncertainty about measures of association, such as confidence intervals and p-values for RR, PAF, or regression coefficients in logistic regression, Cox Proportional Hazards, or other parametric or semi-parametric regression models, are ubiquitously used to show how firmly the data can be used to reject the null hypothesis of independence (no association) between exposures and adverse health responses. In addition, model diagnostics (such as plots of residuals and tests of model assumptions) can reveal whether modeling assumptions appear to be satisfied; more commonly, though less informatively, goodness-of-fit measures are reported to build confidence that the models used do not give conspicuously poor descriptions of the data, at least as far as the goodness-of-fit test can determine.

The main limitation of these techniques is that they only address associations, rather than causation, and hence they cannot quantify the fraction or number of illnesses or mortalities per year that would be prevented by reducing or eliminating specific exposures. Unfortunately, as many methodologists have noted and warned against, PAF and probability of causation, as well as regression coefficients, are commonly misinterpreted as doing precisely this (e.g., Rothman et al., 2012). Large epidemiological initiatives, such as the World Health Organization's Global Burden

of Disease studies, make heavy use of association-based methods that are treated as if they were causal relations. This has become a very common mistake in contemporary epidemiological practice. It undermines the validity, credibility, and practical value of many (some have argued most) causal claims now being published using traditional epidemiological methods (Nuzzo, 2014; Sarewitz, 2012; Lehrer, 2012). To what extent associations correspond to stable causal laws that can be relied on to predict future consequences of policy actions is beyond the power of these traditional epidemiological measures to say; doing so requires different techniques (Rothman et al., 2012).

Example: Exposure-Response Relations Depend on Modeling Choices

A 2014 article in Science (Dominic et al., 2014) noted that "There is a growing consensus in economics, political science, statistics, and other fields that the associational or regression approach to inferring causal relations – on the basis of adjustment with observable confounders – is unreliable in many settings." To illustrate this point, the authors cite estimates of the effects of total suspended particulates (TSPs) on mortality rates of adults over 50, in which significantly positive associations (regression coefficients) are reported in some regression models that did not adjust for confounders such as age and sex, but significantly negative associations are reported in other regression models that did adjust for confounders by including them as explanatory variables.

The authors note that the sign, as well as the magnitude, of reported exposure concentration-response (C-R) relations depends on details of modeling choices about which variables to include as explanatory variables in the regression models. Thus, the quantitative results of risk assessments presented to policy makers as showing the expected reductions in mortality risk per unit decrease in pollution concentrations actually reflect specific modeling choices, rather than reliable causal relations that usefully predict how (or whether) reductions in exposure concentrations would reduce risks.

A distinction from econometrics between structural equations and reduced-form equations (Klein, 1974) is helpful in understanding how different epidemiologists can estimate exposure concentration-response regression coefficients with opposite signs from the same data. The following highly simplified hypothetical example illustrates the key idea. Suppose that cumulative exposure to a chemical increases in proportion to age, and that the risk of disease (the age-specific hazard rate, i.e., the probability of being first diagnosed with a disease or adverse medical condition at each age) also increases with age. Finally, suppose that the effect of exposure at any age is to decrease risk.

These causal relations are shown via the following two *structural equations*, which have the explicit causal interpretation that an increase in the variable on the right side causes an increase in the variable on the left side to make the equation hold (e.g., increasing age increases cumulative exposure and disease risk, but increasing exposure decreases risk at any age):

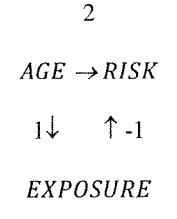
SEM Equations

$$EXPOSURE = AGE$$

$$RISK = 2 * AGE - EXPOSURE$$

These two structural equations together constitute a simple *structural equation model* (SEM) that can be diagrammed as in Figure 1.

Figure 1. SEM Causal Graph Model



In this diagram, each variable depends causally only on the variables that point into it, as revealed by the SEM equations. The weights on the arrows (the coefficients in the SEM equations) show how the average value of the variable at the arrow's head will change if the variable at its tail is increased by one unit. By contrast to such causal SEM models, what is called a *reduced-form model* is obtained by using the first SEM equation, EXPOSURE = AGE,to substitute EXPOSURE for AGE in the second SEM equation, RISK = 2*AGE – EXPOSURE, to obtain the following:

Reduced-form Equation

$$RISK = EXPOSURE$$

This reduced-form model is a valid *descriptive statistical* model: it reveals that in communities with higher exposure levels, risk should be expected to be greater. But it is not a valid *causal* model: a prediction that reducing exposure would cause a reduction in risk would be mistaken. The reduced-form equation is not a structural equation, so it cannot be used to predict correctly how changing the right side would cause the left side to change. The coefficient of EXPOSURE in the linear regression model relating exposure to risk is +1 in the reduced-form model, but is -1 in the SEM

model, showing how different investigators may reach opposite conclusions about the sign of "the" exposure-response coefficient based on whether or not they condition on age (or, equivalently, on whether they use structural or reduced-form regression equations).

In current epidemiological practice, the distinction between structural and reduced-form equations is often not clearly drawn. Regression coefficients of various signs and magnitudes, as well as various measures of association based on relative risk ratios, are all presented to policy makers as if they had valid causal interpretations and therefore important implications for risk management policy-making. In air pollution health effects epidemiology, for example, it is standard practice to present regression coefficients as expected reductions in elderly mortality rates (or expected increases in life span) per unit reduction in air pollution concentrations (EPA, 2011; Fann, 2012), thereby conflating associations between historical levels (e.g., pollutant levels and mortality rates both tend to be higher on cold winter days than during the rest of the year, and both have declined in recent decades) with a causal, predictive relation that implies that future reductions in pollution would cause further future reductions in elderly mortality rates. Since such association-based studies are often unreliable indicators of causality (Dominici et al., 2014) or simply irrelevant for determining causality (Rothman et al., 2012), policy makers who wish to use reliable causal relations to inform policy decisions by considering their likely consequences must seek elsewhere.

These limitations of association-based methods have been well discussed among methodological specialists for decades (Rothman et al., 2012). Key lessons, such as that the same data set can yield either a statistically significant positive exposure-response regression coefficient or a statistically significant negative exposure-response regression coefficient, depending on the detailed modeling choices made by the investigators, are becoming increasingly appreciated by practitioners (Dominici et al., 2014). They illustrate an important type of uncertainty that arises in epidemiology, but that is less familiar in many other applied statistical settings: *uncertainty about the interpretation of regression coefficients* (or other association-based measures such as RR, PAF, etc.) as indicating causal relations vs. confounded associations vs. some of each.

This type of uncertainty cannot be addressed by presenting conventional statistical uncertainty measures such as confidence intervals, p-values, regression diagnostics, sensitivity analyses, or goodness-of-fit statistics, since the uncertainty is not about how well a model fits data, or about the estimated parameters of the model. Rather, it is about the extent to which the model is descriptive of the past vs. predictive of

different futures caused by different choices. Although this is not an uncertainty to which conventional statistical tests apply, it is crucial for the practical purpose of making model-informed risk management decisions. Policy decisions successfully increase the probabilities of desired outcomes and decrease the frequencies of undesired ones only to the extent that they act causally on drivers of the outcomes, and not based on how well the models used describe past associations.

One way to try to bridge the gap between association and causation is to ask selected experts what they think about whether or to what extent associations might be causal. However, research on the performance of expert judgments has called into question the reliability of expert judgments, specifically including judgments about causation. Such judgments typically reflect qualitative "weight of evidence" (WoE) considerations about the strength, consistency (do multiple independent researchers find the claimed associations?), specificity, coherence (are associations of exposure with multiple health endpoints mutually consistent with each other and with the hypothesis of causality?) temporality (do hypothesized causes precede their hypothesized effects?), gradient (are larger exposures associated with larger risks?), and biological plausibility of statistical associations and the quality of the data sources and studies supporting them.

In practice, WoE-based judgments face challenges that may render them unreliable (e.g., Goodman et al., 2013; Rhomberg et al., 2013). One difficulty is that a strong confounder (such as age in Figure 1) with delayed effects can create strong, consistent, specific, coherent, temporal associations between exposure and risk of an adverse response, with a clear gradient associating larger risks with larger exposures, all without thereby providing any evidence that exposure actually causes increased risk. Showing that an association is strong, for example, does not address whether it is causal (although many WoE systems assume that the former supports the latter).

Similarly, showing that many different investigators find the same association does not shed any light on whether the association they have found is causal, or whether it results from biases and confounders that are common across studies. Conflating causal and associational concepts, such as evidence for the strength of an association and evidence for causality of the association, makes assessments of causality in epidemiology idiosyncratic and of uncertain trustworthiness (Morabia, 2013; Höfler, 2005) compared to methods used in other fields. Most experts in epidemiology have been trained to treat various aspects of association as evidence for causation, even though they are not, and this undermines the trustworthiness of expert judgments about causation based on WoE considerations (Morabia, 2013).

In addition, experts are sometimes asked to judge the *probability* that an association is causal (e.g., EPA, 2006). This makes little sense. It neglects the fact that an association may be partly causal and partly not (e.g., due to confounding or modeling biases or coincident historical trends). For example, if exposure does increase risk, but is also confounded by age, then asking for the probability that the regression coefficient relating exposure to risk is causal overlooks the realistic possibility that it reflects both a causal component and confounding, so that the probability that it is partly causal might be 1 and the probability that it is completely causal might be 0. (A more useful question to pose to experts might be what *fraction* of the association is causal.)

Common non-causal sources of statistical associations include model selection and multiple testing biases, model specification errors, unmodeled errors in explanatory variables in multivariate models, biases due to data selection and coding (e.g., dichotomizing or categorizing continuous variables such as age, which can lead to residual confounding), and coincident historical trends (which can induce statistically significant-appearing associations between statistically independent random walks – a phenomenon sometimes dubbed spurious regression) (Rothman et al., 2012; Cox et al., 2013).

Finally, qualitative subjective judgments and ratings used in many WoE systems are subject to well-documented psychological biases. These include confirmation bias (seeing what we expect to see and discounting or ignoring what challenges our preconceptions); motivated reasoning (finding what it benefits us to find and believing what it pays us to believe); and over-confidence (not sufficiently doubting, questioning, or testing our own beliefs, and hence not seeking potentially disconfirming information that might cause us to revise what we believe) (Kahneman, 2011; Sarewitz, 2012).

Despite these limitations, there is much of potential value in several WoE considerations (Rhomberg et al., 2013), especially consistency, specificity, and temporality of associations, if they can be freed from the context of qualitative subjective judgments and used as part of a more objective, quantitative, data-driven approach to inferring probable causation. This possibility is discussed in the following sections.

Some Limitations of Quantitative Risk Assessment (QRA) for Health Effects of Exposures

In the United States, regulatory risk assessments of the health effects attributed to exposures are often conducted according to the following six-step process, which corresponds closely to the process followed by EPA in its ozone risk assessment:

1. Establish that there is a statistically significant positive association between one or more measures of exposure (e.g., cumulative exposure) and one or more measures of risk (e.g., age-specific mortality risk), e.g., using meta-analyses of multiple individual studies that report such associations.

2. Estimate the quantitative magnitude of the association between exposure and risk, e.g., via a significant positive regression coefficient.

3. Judge whether the association is (probably) causal, based on expert evaluation of weight-of-evidence (WoE) considerations such as the strength, consistency, gradient, temporality, biological plausibility, etc. of the association.

4. Predict the reduction in risk for a proposed reduction in exposure, e.g., by applying the regression coefficient using the formula $\Delta Risk = K * \Delta Exposure$, where $\Delta Risk$ is the estimated reduction in risk caused by a reduction in exposure ($\Delta Exposure$), and K is the regression coefficient ("potency") linking the exposure and risk metrics.

5. Show that alternative models (within one or more classes of models) do not provide a significantly better fit to the data than the model (typically, a best-fitting model in some class of models) selected to project risk reductions caused by exposure reductions. Although many hypotheses about model form might be considered for purposes of sensitivity analysis, using a best-fitting model on which to base conclusions is standard practice.

6. Use uncertainty intervals (e.g., 95% confidence intervals) to quantify uncertainties about the likely reduction in risk caused by a proposed reduction in exposures. Part of responsible risk assessment and communication is to characterize uncertainties about the conclusions. A 95% confidence interval for risk reduction indicates a range, due to sampling variability, of risk reductions that might be expected (with 95% statistical confidence) to include the actual reduction in risk in response to a proposed reduction in exposures, if the selected model and underlying assumptions are all correct. Other sources of potential errors, such as errors in exposure estimates, uncertainty about model form,

possible confounders (e.g., smoking), possible selection bias in the data, etc. should also be discussed.

Despite their widespread acceptance, these six steps produce quantitative risk assessment (QRA) numbers that have no known or necessary relation to the risks actually caused by exposure, largely because they do not adequately model causation and uncertainties. Key challenges at each step are as follows.

- In Step 1, a statistically positive ER association can always be created by a combination of large sample size and incorrect model specifications, as well as by other possible explanations already mentioned such as coincident historical trends, data selection biases, model selection biases, and confounding. For example, fitting the line $Risk = K * Exposure$ to any data set consisting of positive values of *Exposure* and corresponding *Risk* estimates will always produce a positive estimate of the potency parameter *K*, even if *Exposure* has no effect on *Risk* (or has a negative effect). If the sample size is large enough, this positive association will always be statistically significantly greater than zero.

  Other, less obviously biased, modeling choices, specification errors, and selection biases can likewise generate statistically "significant" positive associations under the implicit assumption that the selected model describes the data approximately correctly, whether or not there is any true association in the data (e.g., discoverable using "model-free" non-parametric tests). As emphasized by Dominici et al. (2014), both significant positive and significant negative ER relations, depending on modeling choices. Therefore, unless model diagnostics (e.g., plots of residuals) are presented (Greenland, 1989; Maldonado and Greenland, 1993) that show that a model provides an appropriate description of the data to which it is applied, there is no way for readers of reported results to know whether a reported significant positive association based on regression modeling or other models has resulted from a real pattern in the data, or from fitting a mis-specified model to the data, or perhaps from some other reason such as residual confounding by a categorized continuous confounder. Yet, too often, QRAs and the key studies on which they are based present no model diagnostics, and instead offer only sensitivity analyses and goodness-of-fit measures that do not sharply test modeling assumptions and that lack the power to reveal important model specification errors.

- Step 2, quantification of regression of coefficients or other measures of association, is irrelevant for making causal predictions if the association in Step 1 is not causal. (See discussion of Figure 2.)

- Step 3, judging whether an association is causal, invites experts to substitute their own beliefs, opinions, or judgments for rigorous causal analysis. There is no reason to believe that the resulting opinions will necessarily or usually be useful guides to the truth. Experts (like other people) are notoriously poor at correctly judging causation (Kahneman, 2011). Moreover, the associations that they are asked to form causal judgments about typically do not contain the essential information needed to draw valid inferences about causation, so that there is no legitimate basis for offering judgments about whether they are causal. That experts are able and willing to offer opinions on many questions, including nonsensical ones (such as how old is the current king of France, or what is the probability that an association is causal, the first of which mistakenly assumes that there is a current king of France and the second of which mistakenly assumes that an association is either entirely causal or not), does not make their judgments useful or trustworthy.

  Although expert elicitation procedures today typically train experts on calibration and try to reduce over-confidence (Hora, 2007), they usually do not provide training on valid causal inference. As a result, experts often make confident causal judgments (e.g., Harvard School of Public Health, 2002) that are statistically naïve (e.g., ignoring comparisons to control groups) and that subsequently prove to be blatantly false (e.g., HEI, 2013). This holds not only for health effects of exposures, but also in other application domains, such as expert opinions about political, military, and world events.

  When expert judgments and predictions have been evaluated in hindsight, after the truth is learned, they turn out to be, on average, slightly worse than random guesses, with the more famous experts tending to be less accurate (but to have more interesting and plausible-sounding rationales for their predictions) (Kahneman, 2011, citing prior work by Tetlock). This puts a considerable burden of proof on risk assessors who use expert judgments in place of more objective, data-driven methods to show that expert judgments about causation are trustworthy.

- Step 4 is not valid: the slope of an exposure-response (ER) regression relation does *not* necessarily predict how (or whether) future responses would change if future exposure were changed, as discussed further for the example in Figure 2. Valid predictions about reductions in health risks caused by reductions in exposure require a different type of study design and a different type of analysis – *causal* study design and *causal* analysis – than the association-based approach in steps 1-6.

- Step 5, selection of a "best" model, understates model uncertainty. It leads to predictions and confidence intervals that do not account for the fact that even the "best" model (based on goodness-of-fit or other criteria) is almost certain to be wrong when there is a lot of model uncertainty. Model ensemble methods, such as Bayesian model averaging (BMA), consider the results from many (e.g., thousands or tens of thousands) of plausible models to avoid making model-based predictions overly dependent on the selection of one or a few models that are probably wrong. They typically lead to more accurate predictions, wider confidence intervals, and fewer false positives than the traditional approach of selecting a single "best" model (Hoeting et al., 1999). They avoid the fundamental error of treating one or a few finally selected models as if they were known to be correct, for purposes of calculating confidence intervals and significance levels.

- Step 6, presentation of uncertainty intervals around best estimates for the risk caused by exposure, or the risk that can be removed by reducing exposure, is misleading highly misleading in the usual case where the presented interval ignores model uncertainty and where no discrete probability (a positive fraction greater than zero) is presented for the discrete possibility that reducing exposure would not reduce risk because there is no causal relation between them.

  As just discussed, ignoring model uncertainty by selecting a single model biases conclusions toward false-positive findings (since confidence intervals that would include "no effect" if model uncertainty were accounted for are incorrectly narrowed) (e.g., Piegorsch, 2013; Swartz et al., 2001; Viallefont et al., 2001). Methods for overcoming this bias by including multiple plausible models in the calculation of results are now widely available (e.g., Piegorsch, 2013 and references therein) and should be used unless the data-generating process is understood well enough so that a single model that describes it well can be identified.

To illustrate the crucial difference between association-based inference and causal analysis and inference for exposure-response relations, imagine a population in which people with elevated risk of heart attacks tend to consume significantly more baby aspirin than people without elevated risks of heart attack. In that scenario, association-based risk assessment following steps 1-6 (with a mistaken assumption or belief that the association is causal) would lead to a confident statistical prediction that reducing the level of baby aspirin consumption would reduce heart attack risk. However, there is in fact no valid basis for such a conclusion: the association between *levels* of baby aspirin consumption and heart attack risk contains no relevant

information for predicting how *changes* in consumption would change heart attack risk.

As another example, consider the linear association between per-capita phone ownership and coronary heart disease (CHD) mortality risk shown in Figure 2.

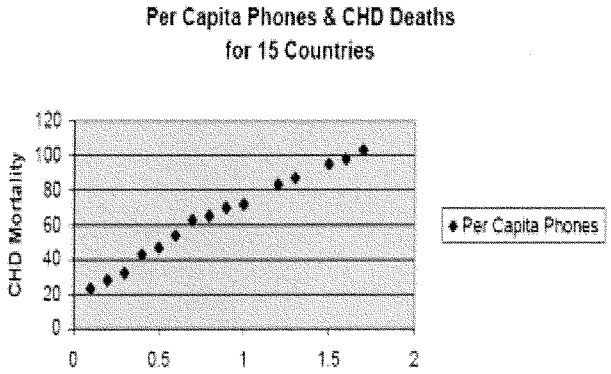


Figure 2. A strong, consistent, linear, no-threshold relation between exposure and mortality risk does not imply that reducing exposure would reduce risk.

Source: http://ocw.tufts.edu/Content/1/readings/193106

An association-based risk assessment might conclude on the basis of such evidence of a strong, linear, no threshold exposure-response (ER) relation that reducing exposure to phones would reduce CHD mortality risk. The slope of the line in Figure 2 would then give a quantitative estimate of the incremental reduction in mortality per unit reduction in per-capita phone ownership. But such causal interpretations and predictions are not valid and cannot be justified by associational data.

By contrast, statistical associations in historical data can be useful for predicting *observed* values of one variable from *observed* values of another. Indeed, predicting values (especially, past values) of one variable from past values of another is precisely what regression models are useful for. But most QRAs purport to answer a very different type of question, about future *changes* in health that would be caused by proposed future *changes* in exposure levels – not about historically *observed* levels of health based on historically *observed* levels of exposure. It is this type of causal inference which cannot legitimately be based on associations.

The statistical relation in Figure 2 could be used correctly to predict the *level* of CHD mortality risk in a population based on the *level* of phone ownership per capita. (A possible mechanism for the association might be that both are associated with a third factor or variable, such as stress levels or dietary factors, although no such explanation need be known to make an empirical association useful for predicting the level of one variable from the level of another, correlated variable.) This is a perfectly good use of statistical inference, but it implies nothing about how changing one variable would change the other.

The key point illustrated by such examples is not simply the truism that association is not causation. Rather, the key point is that the information contained in associations between historical levels of exposure and levels of adverse response is not what is needed to draw valid causal conclusions about how future changes in exposures will change future levels of risk. An implication is that expert judgments about causation based on such associations are not well founded: the associations do not carry the information needed to draw sound inferences about causation, and so neither do expert opinions or interpretations derived from them. What is required instead is information on how changes in inputs (such as exposures) propagate through causal pathways to produce changes in outputs (such as mortality rates). Without such information on propagation of changes, statistical associations are powerless to give valid causal predictions, including predicting whether reducing exposures will reduce risks, and, if so, by how much (Freedman, 2004).

A second implication is that a positive, increasing ER relation such as that in Figure 2 gives no insight into what the causal relation between exposure and response (if there is one) might look like. The causal ER relation could have a threshold, or be J-shaped (flat or negative slope at very low exposures, positive slope at higher exposures), or have a flat or even a negative slope throughout, and yet these characteristics would be obscured by the positive statistical association, which does not isolate the causal component (if any) of the empirical ER association.

This crucial methodological point—that statistical associations do not in general convey information useful for making valid causal predictions—has been well understood for over a decade by statisticians and epidemiologists specializing in technical methods for causal analysis (e.g., Greenland and Brumback, 2002; Freedman, 2004). This understanding strengthens warnings that associations do not *prove* causation (e.g., Samet and Bodurow, 2008) by showing that they need not be *informative* about causation. It is only slowly percolating through the larger epidemiological and risk analysis communities, however. Peer-reviewed published papers and authoritative reports, including those relied on in many regulatory QRAs,

still make the fundamental mistake of reinterpreting empirical exposure-response (ER) associations between historical levels of exposure and response *as if* they were causal relations useful for predicting how changes in exposures would change responses. This confusion is unnecessary: appropriate technical methods for causal analysis and modeling are now well developed, and can be applied to the same kinds of cross-sectional and longitudinal data collected for association-based studies. Table 1 summarizes some of the most useful study designs and methods for valid causal analysis and modeling of causal exposure-response relations.

Particularly harmful is that many authoritative sources propagate the delusion, peculiar to epidemiology (Morabia, 2013), that somehow associations alone can suffice to establish causation, if only they are qualified with enough laudatory adjectives (the association is strong, consistent, plausible, etc.) This is a mistake. For example, Samet and Bodurow (2008) present a table that begins as follows:

TABLE 8-2 IOM Categorization from the Executive Summary of *Gulf War and Health, Volume 1: Depleted Uranium, Pyridostigmine Bromide, Sarin, Vaccines*

Sufficient Evidence of a Causal Relationship	Evidence is sufficient to conclude that a causal relationship exists between the exposure to a specific agent and a health outcome in humans. The evidence fulfills the criteria for sufficient evidence of an association (below) and satisfies several of the criteria used to assess causality: strength of association, dose-response relationship, consistency of association, temporal relationship, specificity of association, and biological plausibility.
Sufficient Evidence of an Association	Evidence is sufficient to conclude that there is a positive association. That is, a positive association has been observed between an exposure to a specific agent and a health outcome in human studies in which chance, bias, and confounding could be ruled out with reasonable confidence.

Source: www.nap.edu/openbook.php?record_id=11908&page=186

It should be clear that the characterization of "Sufficient evidence of a causal relationship" offered here is wrong: as suggested by counter-examples such as Figure 2 (and recognizing that "biological plausibility" is often in the eye of the beholder, with more associations perhaps seeming plausible to those who know least), it is easy for statistical associations to satisfy all of these conditions, and yet not be causal.

Table 1. Some formal methods for modeling and testing causal hypotheses

Method and References	**Basic Idea**	**Appropriate study design**
Conditional independence tests (Freedman, 2004, Friedman and Goldszmidt, 1998)	Is hypothesized effect (e.g., lung cancer) statistically independent of hypothesized cause (e.g., exposure to crystalline silica), given values of other variables (e.g., education and income)? If so, this undermines causal interpretation.	Cross-sectional data Can also be applied to multi-period data (e.g., in dynamic Bayesian networks)
Panel data analysis (Angrist and Pischke, 2009, Stebbings, 1976)	Are changes in exposures followed by changes in the effects that they are hypothesized to help cause? If not, this undermines causal interpretation; if so, this strengthens causal interpretation. Example: Are changes in crystalline silica exposure levels in different quarries followed (but not preceded) by corresponding changes in respiratory mortality rates?	Panel data study: Collect a sequence of observations on same subjects or units over time
Granger causality test (Eichler and Didelez, 2010)	Does the history of the hypothesized cause improve ability to predict the future of the hypothesized effect? If so, this strengthens causal interpretation; otherwise, it undermines causal interpretation. Example: Can lung cancer mortality rates in different occupational groups be predicted better from time series histories of crystalline silica levels and mortality rates than from the time series history of mortality rates alone?	Time series data on hypothesized causes and effects
Quasi-experimental design and analysis (Campbell and Stanley, 1966)	Can control groups and other comparisons refute alternative (non-causal) explanations for observed associations between hypothesized causes and effects? For example, can coincident trends and regression to the mean be refuted as possible explanations? If so, this strengthens causal interpretation.	Longitudinal observational data on subjects exposed and not exposed to interventions that change the hypothesized cause(s) of effects.
Intervention analysis, change point analysis (Helfenstein, 1991; Gilmour et al., 2006)	Does the best-fitting model of the observed data change significantly at or following the time of an intervention? If so, this strengthens causal interpretation.	Time series observations on hypothesized effects, and knowledge of

	Do the quantitative changes in hypothesized causes predict and explain the subsequently observed quantitative changes in hypothesized effects? If so, this strengthens causal interpretation. Example: Did lung disease mortality rates fall significantly faster or sooner in workplaces that reduced exposures more or earlier than in workplaces that did not?	timing of intervention(s) Quantitative time series data for hypothesized causes and effects
Counterfactual and potential outcome models (Robins et al. 2000; Moore et al., 2012)	Do exposed individuals have significantly different response probabilities than they would have had if they had not been exposed? Example: Do workers have lower mortality risk after historical exposure reductions than they would have had otherwise?	Cross-sectional and/or longitudinal data, with selection biases and feedback among variables allowed
Causal network models of change propagation (Hack et al., 2010, Dash and Druzdzel, 2008)	Do changes in exposures (or other causes) create a cascade of changes through a network of causal mechanisms (represented by equations), resulting in changes in the effect variables?	Observations of variables in a dynamic system out of equilibrium
Negative controls (for exposures or for effects) (Lipsitch et al., 2010)	Do exposures predict health effects better than they predict effects that cannot be caused by exposures (e.g., reductions in traumatic injuries)?	Observational studies

Although they are not adequate for valid causal inference or QRA, statistical and epidemiological methods based on associations (e.g., relative risks, odds ratios, logistic regression of Cox proportional hazards coefficients, etc.) are far from useless. Although they usually cannot deliver valid causal predictions about the effects on responses caused by changes in exposures—the main requirement for sound risk assessment and risk management—they can, when carefully implemented, support valid inferences about the expected past historical values (or conditional distributions) of some quantities, such as mortality rates, given the measured values of other historical quantities, such as exposure levels. The technology for drawing statistical inferences about the likely values of some variables, given the values of others (e.g., based on maximum-likelihood, best-fit, or conditional probability distributions or expected values), is now extremely well developed and sophisticated, but it should not be confused with the quite different technology of causal analysis and modeling needed for purposes of valid QRA (e.g., Table 1).

Association-Based QRAs commonly produce false-positive results.

In practice, QRAs based on some or all of steps 1-6, routinely produce a large excess of false-positive errors, both in published results and in confident public assertions about the health benefits expected from various interventions. That is, they predict beneficial effects from interventions that turn out to reflect motivated reasoning, confirmation bias and other biases by investigators, and that do not hold in reality (e.g., Lehrer, 2012, Sarewitz, 2012, Ottenbacher, 1998; Imberger et al., 2011). Scientists with subject matter expertise in health effects epidemiology for specific chemicals are not necessarily or usually also experts in causal analysis and valid causal interpretation of data, and their causal conclusions are often mistaken, with a pronounced bias toward declaring and publishing findings of "significant" effects where none actually exists (false positives).

This has led some commentators to worry that "science is failing us," due largely to widely publicized but false beliefs about causation (Lehrer, 2012); and that, in recent times, "Most published research findings are wrong" (Ioannadis, 2005), with the most sensational and publicized claims being most likely to be wrong. These important policy-relevant limitations of association-based risk assessments and epidemiological studies have been increasingly well recognized by specialists in recent decades (e.g., Ottenbacher, 1998), but have only recently started to attract much attention in the mainstream press (e.g., Lehrer, 2012; *The Economist*, October, 2013). To overcome them, it is probably crucial to pivot from reliance on expert judgments about causation to greater reliance on more objective methods, such as those in Table 1.

Association-Based QRA does not answer critical questions for risk management.

The numbers produced by the regulatory risk assessment framework using steps 1-6 also fail to address key questions that should be answered in informing any responsible risk management decision or regulatory action. Among them are the following.

- *What fraction of the association-based ER relations is causal?* As already discussed, ER associations are unlikely to be entirely causal, since some fraction of association probably results from coincident historical trends (e.g., both pollution levels and disease rates have declined in recent decades, apart from any causal relation between them), confounding (e.g., both pollution levels and elderly mortality rates may be elevated on extremely hot summer days and extremely cold winter days, apart from any causal relation between them), and

biases (e.g., excess false positives in published results, as just discussed). It is therefore important to quantify how large is the causal fraction, and how sure we can be about the answer. Steps 1-6 leave this unaddressed, usually asking experts instead (in Step 4) to opine about whether associations are causal.

- What is the probability that the health benefits caused by a proposed reduction in exposures will be less than the lowest estimated values? Focusing on "best-fit" models (often within a few parametric classes, none of which necessarily describes the true but unknown ER relation) does not answer the key question of how wrong the predictions are likely to be. Might the true benefits be less than 10% as large as the smallest estimated ones? How likely is this? How likely is it that the true benefits are zero, or less than 1% as large as those estimated?

  There is no way to answer such decision-relevant questions based solely on modeling assumptions and choices having uncertain validity, along with confidence intervals calculated using those assumptions. (By contrast, a well-executed QRA using the methods in Table 1 would provide estimates or bounds for the posterior probability of different effects sizes caused by a proposed reduction in exposure.) Too many studies are silent about the probability that their best predictions are mistaken, and about the potential size of the mistakes. Yet, such information is crucial for rational risk management (e.g., working within the expected utility model of rational choice among alternative actions with uncertain consequences).

- What is the probability that reducing exposures below the current permissible exposure level will not yield any incremental human health benefits?

- Is the totality of available evidence more consistent with the null hypothesis that future reductions in exposures will not reduce risk, or with the alternative hypothesis that they will? This is similar to the previous question, but focuses on comparing the evidence for each of the two disjoint hypotheses, rather than on assessing their probabilities. (Technically, this question might be addressed via a likelihood ratio calculation rather than via a Bayesian posterior probability calculation.)

  QRAs often focus primarily on building a case for the alternative hypothesis, and on (mis)using associational data to develop estimates of the change in health risk that would be caused by a further reduction in exposures if the association between them were entirely causal and were correctly described by the QRA's assumed models. Too often, they neglect to evaluate whether the same data are

equally or more consistent with the null hypothesis that further reductions in exposure will have no effect on human health, and that ER associations are due entirely to non-causal explanations such as data selection biases, modelling choices, coincidental but not causal historical trends in exposure and health effects, and so forth.

In summary, steps 1-6 do not answer the questions that a sound QRA should address: what are the probable consequences of alternative actions, such as making or not making a proposed reduction in exposure levels? Moreover, the numbers that they produce are based on historical associations that usually have no known predictive value and no basis for being interpreted as causal. Reinterpreting them as if they were derived from sound causal analysis and modeling is unwarranted. Using them to project reductions in future morbidity and mortality rates that would be caused by proposed reductions in exposure levels is not justified in the absence of sound causal analysis and modeling.

Thus, even if steps 1-6 are executed flawlessly, the resulting numbers do not support valid causal interpretations and predictions. As indicated in Table 1, many methods are available that address the challenges of quantifying causal relations and uncertainties about them without invoking expert judgments about the causal significance of associations. These are examined next.

Valid Methods for Establishing Probable Causation

Over the past century, the following main ideas have been developed, largely outside epidemiology, to determine whether available knowledge and data warrant an inference that exposure probably causes adverse health effects.

Causes precede their effects

If significant changes in exposures always precede and help to explain and predict subsequent significant changes in health effects, this is consistent with the hypothesis that the former cause the latter. To formally test whether this is the case, *change-point analysis* (CPA) algorithms estimate the times of changes in effects time series (e.g., http://surveillance.r-forge.r-project.org/; James and Matteson, 2014). These times can then be compared to the times at which exposures changed (e.g., due to passage of a regulation, opening or closing of a pollution source, etc.) to determine whether changes in exposures are followed by changes in effects.

Similarly, *intervention analysis* algorithms (also called interrupted time series analysis algorithms) test whether effects time series change following changes in exposures that occur at known times. Finally, *Granger causality tests* provide formal

quantitative tests of the hypothesis that the future of the health effects time series can be predicted better using the exposure time series than it can be predicted without using the exposure time series. If this is not the case, then the exposure-response histories provide no evidence that exposure is a (Granger) cause of the effects time series, no matter how strong, consistent, etc. the association between their levels over time may be.

Causes are informative about their effects

If exposure is a cause of increased disease risk, then measures of exposure and response (i.e., disease risk) should provide mutual information about each other that allows either to be predicted from the other (i.e., the conditional probability distribution for either one varies with the value of the other). Moreover, it should not be the case that the mutual information between exposure and response can be eliminated by conditioning on the values of other variables, such as confounders, if exposure is a cause of the response. This is the basis for using formal statistical *conditional independence tests* as tests of causal hypotheses: An effect should never be conditionally independent of its direct causes, given the values of other variables.

Changes in causes produce changes in effects via causal mechanisms

Perhaps the most useful and compelling valid evidence of causation (with the possible exception of well-conducted randomized control trials) consists of showing that changes in exposures propagate through a network of validated law-like equations or mechanisms to produce predictable changes in effects (e.g., health responses). For example, showing that measured changes in ambient levels of pollution produce consistent corresponding changes in lung inflammation markers, recruitment rates of alveolar macrophages and activated neutrophils to the inflamed lung, levels of enzymes released by these cell populations that degrade the alveolar wall, and resulting rates of lung tissue loss and scarring and onset of inflammation-mediated diseases, would provide compelling evidence of a causal relation between changes in exposures and changes in disease rates.

Structural equation models (SEMs) in which changes in right-hand side variables cause adjustments of left-hand side variables to restore equality provide one way of describing mechanisms for situations where the precise time course of the adjustment process is not of interest. Differential equation models, in which changes in flow rates lead to changes in the equilibrium levels of variables for different compartments provide another, complementary way to describe mechanisms when the time course of adjustment is of interest. Figure 3 presents a high-level view of the structure of a simulation model for cardiovascular disease (CVD) outcomes; these

provide still a third way to describe and model the propagation of changes through causal networks.

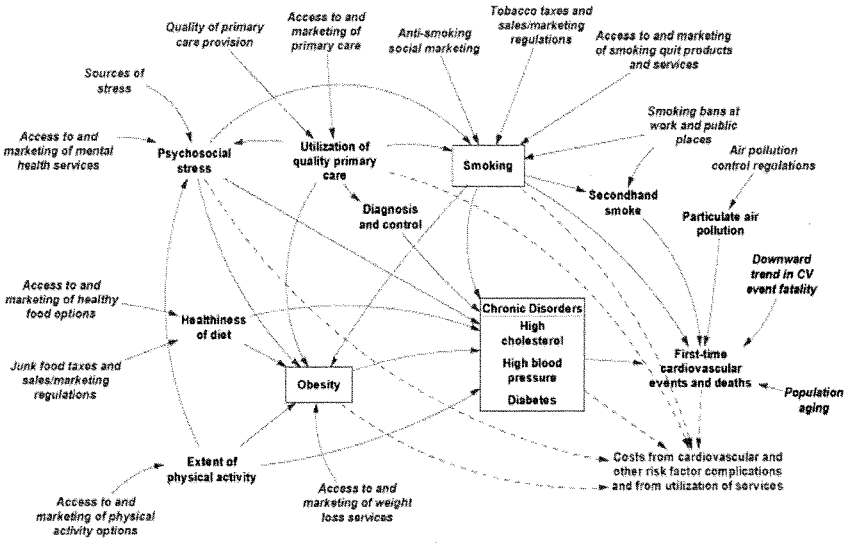


Figure 3. Simulation model for cardiovascular disease (CVD) outcomes. This diagram depicts major health conditions related to CVD and their causes. Boxes identify risk factor prevalence rates modeled as dynamic stocks. The population flows associated with these stocks — including people entering the adult population, entering the next age category, immigration, risk factor incidence, recovery, cardiovascular event survival, and death — are not shown.

Key: Blue solid arrows: causal linkages affecting risk factors and cardiovascular events and deaths.
Brown dashed arrows: influences on costs.
Purple italics: factors amenable to direct intervention.
Black italics (population aging, cardiovascular event fatality): other specified trends.
Black nonitalics: all other variables, affected by italicized variables and by each other

Source: Homer J, Milstein B, Wile K, Trogdon J, Huang P, Labarthe D, et al. Simulating and evaluating local interventions to improve cardiovascular health. Prev Chronic Dis 2010;7(1):A18. http://www.cdc.gov/pcd/issues/2010/jan/08_0231.htm. Accessed 3-11-15

For most of the past century, methods such as *path analysis* (based on SEMs) have been used to explicate causal networks of mechanisms and to provide formal tests for

hypothesized causal structures. These methods exploit the fact that, if all effects of variables on each other can be well approximated by linear regression models, then correlations between variables should be strongest when the variables are closer to each other along a causal chain than when they are more remote.

Moreover, the effect of a change in an ancestor variable on the value of a remote descendent (several nodes away along one or more causal paths) should be decomposable into the effects of the change in the ancestor variable on any intermediate variables and the effects of those changes, in turn, on the remote descendent variable. Such consistency and coherence constraints can be expressed as systems of SEM equations that can be solved to estimate the path coefficients relating changes in parent variables to changes in their children.

Summing these changes over all paths leading from exposure to response variables allows the total effect (via all paths) of a change in exposure on changes in expected responses to be estimated. Path analysis and other SEM models are particularly valuable for detecting and quantifying the effects of unmeasured ("latent") confounders based on the patterns of correlations that they induce among observed variables. Standard statistics packages and procedures, such as PROC CALIS in SAS, have made this technology available to modelers for the past four decades.

More recently, *causal graph models* (including Bayesian networks) have been developed, in which mechanisms need not be described by linear models, but may be described by nonlinear and probabilistic relations (e.g., the conditional probability distributions for the value of a node (i.e., variable) in a causal graph, given the values of the variables that point into it). These models greatly extend the flexibility and power of causal hypothesis testing and causal predictive modeling.[12]

These advances are particularly useful for characterizing uncertain causal relations. As noted by Samet and Bodurow (2008), "The uncertainty about the correct causal model involves uncertainty about whether exposure in fact causes disease at all, about the set of confounders that are associated with exposure and cause disease, about whether there is reverse causation, about what are the correct parametric forms of the relations of the exposure and confounders with outcome, and about whether there are other forms of bias affecting the evidence. One currently used method for making this uncertainty clear is to draw a set of causal graphs, each of which represents a particular causal hypothesis, and then consider evidence insofar as it favors one or more of these hypotheses and related graphs over the others."

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[12] www.stat.cmu.edu/~cshalizi/uADA/12/lectures/ch25.pdf

Valid causal relations cannot be explained away by non-causal explanations

An older, but still useful, approach to causal inference from observational data developed largely in the 1960s and 1970s consists of showing that there is an association between exposure and response that cannot plausibly be explained by confounding, biases (including model and data selection biases and specification errors), or coincidence (e.g., from historical trends in exposure and response that move together but that do not reflect causation).

Quasi-experiment design and analysis approaches developed in social statistics (Campbell and Stanley, 1966) systematically enumerate potential alternative explanations for observed associations (e.g., coincident historical trends, regression to the mean) and provide statistical tests for refuting them, if indeed they can be refuted. A substantial tradition of *refutationist approaches* in epidemiology follows the same general idea, of providing evidence for causation by using data to explicitly test, and if possible refute, other explanations for E-R associations (Maclure, 1991).

As stated by Samet and Bodurow (2008), "Because a statistical association between exposure and disease does not prove causation, plausible alternative hypotheses must be eliminated by careful statistical adjustment and/or consideration of all relevant scientific knowledge. Epidemiologic studies that show an association after such adjustment, for example through multiple regression or instrumental variable estimation, and that are reasonably free of bias and further confounding, provide evidence but not proof of causation."[13]

As we have seen, these authors are overly optimistic in asserting that associations that are reasonably free of bias and confounding therefore provide evidence of causation (since, for example, the strong, statistically "significant" associations in regression models that often occur between levels of statistically independent random walks ("spurious regression") do not arise from confounding or bias, and since "In general, regression models for non-stationary variables give spurious results" due to coincident historical trends created by random processes that are not well described by regression models.[14] Nonetheless, the recommendation that "plausible alternative hypotheses must be eliminated by careful statistical adjustment and/or consideration of all relevant scientific knowledge" well expresses the refutationist point of view.

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[13] www.nap.edu/openbook.php?record_id=11908&page=173

[14] www.econ.ku.dk/metrics/econometrics2_05_ii/slides/10_cointegration_2pp.pdf

Valid causal mechanisms are law-like: consistent and homogeneous

A proposed causal relation that turns out to be very heterogeneous, sometimes showing large significant positive effects and other times no effects or significant negative effects for exchangeable individuals under the same conditions, does not correspond to a law-like causal relation, and cannot be relied on to make valid causal predictions (e.g., by using mean values averaged over many heterogeneous studies). A true causal relation can be thought of as a stable relation (e.g., the conditional probability table (CPT) for a node in a Bayesian network or causal graph model) that gives the same conditional probabilities of output values whenever the input values are the same. Unexplained heterogeneity, in which the CPT appears to differ significantly when study designs are repeated by different investigators, signals that a causal mechanism has not yet been discovered, and that models and the knowledge they represent need to be further refined to discover and express predictively useful causal relations that reflect genuine causal mechanisms instead of random associations.

These methods for drawing valid causal conclusions suggest the following checklist for judging the adequacy of a quantitative health risk assessment (QRA) that claims to have identified a useful predictive causal relation between exposure concentrations and risk of adverse health effects (responses), i.e., causal exposure-response (E-R) or concentration-response (C-R) relations.

1. Does the QRA show that changes in exposures precede – and do not follow or coincide with – the changes in health effects that they are said to cause? Are results of change-point analyses, intervention analyses, and Granger causality tests presented, along with supporting data? (If effects turn out to precede their presumed causes, then unmeasured confounders or residual confounding by confounders that have been statistically "controlled for" may be at work.)

2. Does the QRA demonstrate that health effects cannot be made conditionally independent of exposure by conditioning on other variables (especially, potential confounders)? Does it present the details, data, and results of conditional independence tests showing that health effects and exposures share mutual information that cannot be explained away by any combination of confounders?

3. *Does the QRA present and test explicit causal graph models,* showing the results of formal statistical tests of the causal hypotheses implied by the structure of the model (i.e., which variables point into which others, as in

Figures 1 or 3)? Does it identify which alternative causal graph models are most consistent with available data (e.g., using the Occam's Window method of Madigan and Raftery, 1994)?[15] Most importantly, does it present clear evidence that changes in exposure propagate through the causal graph, causing successive measurable changes in the intermediate variables along hypothesized causal paths?

Such coherence, consistency, and biological plausibility demonstrated in explicit causal graph models showing how hypothesized causal mechanismsdovetail with each other to transduce changes in exposures to changes in health risks can provide compelling objective evidence of a causal relation between them, thus accomplishing what older and more problematic WoE frameworks have long sought to provide(Rhomberg et al., 2015).

4. Have non-causal explanations for statistical relations among observed variables (including exposures, health effects, and any intermediate variables, modifying factors, and confounders) been identified and refuted using well-conducted and reported statistical tests? Especially, have model diagnostics (e.g., plots of residuals and discussions of any patterns) and formal tests of modeling assumptions been presented that convincingly show that the models used appropriately describe the data to which the QRA applies them, and that claimed associations are not caused by model selection biases or specification errors, failures to model errors in exposure estimates and other explanatory variables, omitted confounders or other latent variables, uncorrected multiple testing bias, or coincident historical trends (e.g., spurious regression, if the exposure and health effects time series in longitudinal studies are not stationary)?

5. Have any causal mechanisms postulated in the QRA modeling been demonstrated to exhibit stable, uniform, law-like behavior, so that there is no substantial unexplained heterogeneity in estimated input-output (e.g., E-R or C-R) relations?

If the answers to these five questions are all yes, then the QRA has met the burden of proof of showing that the available data are consistent with a causal relation, and that other (non-causal) explanations are not plausible. The QRA can then proceed to quantify the changes in (probability distributions of) outputs, such as future health effects, that would be caused by changes in controllable inputs (e.g., exposure

[15] www.stat.cmu.edu/~fienberg/Statistics36-756/MadiganRaftery-JASA-1994.pdf

levels). The effort needed to establish valid evidence of a causal relation between historical levels of inputs and outputs by being able to answer yes to questions 1-5 pays off at this stage. Causal graph models (e.g., Bayesian networks), simulation models based on composition of validated causal mechanisms, and path diagrams and SEM models can all be used to predict quantitative changes in outputs caused by changes in inputs, e.g., changes in future health risks caused by changes in future exposure levels, given any scenario for the future values of other inputs (e.g., those with only outward-pointing arrows in Figure 3).

If the answer to any of the preceding five questions is no, then it is premature to make causal predictions based on the w done so far. Either the additional work needed to make the answers yes should be done, or results should be stated as contingent on the as-yet unproved assumption that this can eventually be done.

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USDA Agricultural Air Quality Task Force
Comments on the Proposed Ozone Secondary Standard

(Officially Approved December 4, 2014)

Executive Summary

There should be a separate, biologically-relevant secondary ozone standard (not coupled with the primary ozone standard) that takes into account the full body of research related to ozone exposure impacts on plant growth. The W126 form of the secondary ozone standard proposed in EPA's final Policy Assessment bears no biological relevance to plant growth and, as such, should not be the basis for the secondary ozone standard. Furthermore, when establishing the level of a new ozone standard, EPA should quantify uncertainties in estimates of policy-relevant background (PRB) concentrations and the potential impacts of inaccurately estimating the PRB on potential non-attainment areas and the cost of implementation[1] for both a proposed primary and secondary standard.

Background

Ozone is not a pollutant emitted into the air. It is the product of chemical reactions among nitrogen oxides (NO_x) and volatile organic compounds (VOCs) and is predominantly formed in the summer when ambient temperatures are the hottest.

Under Section 109 of the Clean Air Act (CAA), EPA is required to issue national ambient air quality standards (NAAQS) for six air pollutants, one of which is ozone, and is required to review these standards every five years to ensure an adequate margin of safety. For each NAAQS, EPA is tasked to issue both primary and secondary standards. Protection of public health is the focus of the primary standard while protection of public welfare is the focus of the secondary standard.

The secondary standard is intended to protect ecosystems and sensitive plants. Currently, the secondary ozone standard is equal to the primary ozone standard, based on short-term (8-hour) average concentration measurements. However, plant growth and foliage damage are more sensitive to long-term ozone exposure rather than short-term episodic events. Scientists have shown that a cumulative index of exposure is better correlated with plant growth effects than the 8-hour average concentration used to measure human health effects. However, an appropriate cumulative index must consider not only ambient concentrations of ozone but ozone uptake by the plant through stomatal conductance.

Since the 1997 ozone NAAQS review, EPA Staff have considered implementing a secondary ozone standard having a cumulative form such as the W126 index. The W126 index form of the secondary standard is determined by multiplying a sigmoidal weighting value (W_i) at a specific

[1] It is recognized that the Administrator cannot consider costs in his or her decisions regarding establishment or revisions of NAAQS, but an accurate assessment of the costs associated with implementation of a standard provides important information to legislators and the public regarding the true costs associated with new air quality standards.

one-hour average concentration (C_i, ppm) by the one-hour average concentration and then summing over all concentrations. The sigmoidal weighting function takes the form:

$$W_i = \frac{1}{1 + M \times e^{-(A \times C_i)}} \quad (1)$$

where "M" and "A" are empirical constants of 4403 and 126 ppm^{-1}, respectively. The indicator is then calculated as:

$$\text{W126 Index} = \sum (W_i \times C_i) \quad (2)$$

EPA Staff decided it is appropriate to cumulate daily exposures for the 12-hour period from 8:00am to 8:00pm during the three-month period with the greatest index values (USEPA, 2014).

History of W126 in the EPA Regulatory Agenda

In June 2007, the EPA Administrator recommended the W126 exposure index as the form for a secondary standard to protect vegetation from ozone exposure (USEPA, 2007). However, in March 2008, the Administrator decided not to adopt the W126 exposure index based on advice from the White House (Washington Post, April 8, 2008; Page D02), the EPA Administrator made the secondary (i.e., vegetation) ozone standard the same as the primary (human health) 8-hour average standard (0.075 ppm)" (A.S.L. & Associates, 2010).

In 2010, EPA again proposed to establish a distinct, cumulative, seasonal secondary ozone standard having the form of the W126 index within the range of 7-15 ppm-hours (USEPA, 2010). In August 2010, EPA delayed its announcement of a final decision on the ozone NAAQS and has continued to do so until the present (A.S.L. & Associates, 2010). In 2013, the D.C. Circuit Court remanded the secondary standard to EPA, ruling that, in setting the secondary standard equal to the primary standard, EPA had failed to identify a level of air quality requisite to protect public welfare and, therefore, EPA's selection of a secondary standard equivalent to the primary standard was inherently arbitrary.

Scientific Support for the Secondary Ozone Standard

Ozone effects on plants are initiated in leaves when the gas enters through the stomates and disrupts cellular processes, resulting in suppression of growth and yield of many crops. Non-stomatal ozone deposition may be large, but its phytotoxic effects are likely small, although effects on epicuticular wax and subsequent interactions between leaves and the atmosphere are unknown.

Ozone impairs growth primarily by inhibiting net photosynthesis and perhaps translocation processes, which limit availability of photosynthate needed for biomass production. Ozone results in lower carbon fixation due to inhibition of ribulose bisphosphate carboxylase (Rubisco) activity in the chloroplasts of leaves with the result that:

- Allocation of carbon and energy resources to detoxification and repair processes in ozone-stressed plants likely detracts from growth as well.
- With less carbon available, plants produce fewer branches, leaves, roots, flowers and fruit.
- Ozone exposure also accelerates plant senescence, reduces leaf longevity, decreases water use efficiency, and inhibits pollen tube growth (Raymond Knighton, 2006).

EPA Staff have proposed using the W126 index and accumulating daily exposures for the 12-hour period from 8:00am to 8:00pm during the three-month period with the greatest index values. However, this approach is decoupled from known plant physiological responses in which plant stomata will close during the hottest parts of the day to minimize moisture loss, effectively limiting gaseous exchange between plants and the atmosphere. During the peak ozone season, plants will often experience exposure during off-peak concentration hours. In experiments on permanent grasslands, Grünhage and Jäger (1994) found that, "atmospheric conditions that facilitate the daily occurrences of peak (highest) O_3 concentrations in general do not coincide with the conditions that promote plant uptake." In fact, Krupa et al. (1998) reported that "...daily peak (highest) hourly O_3 values not as important as moderate to higher concentrations in eliciting negative crop biomass responses." Later, Krupa et al. (1995) reported that cumulative frequencies of occurrences of hourly ozone concentrations in the range of 50-87 ppb were the best predictors of negative crop biomass responses rather than the statistically forced W126 index. As can be seen in Pinto et al. (2007), highest rates of ozone conductance often coincide with the lowest O_3 concentrations, particularly in rural locations where a protective secondary standard would be most desirable for protecting ozone-sensitive species. As pointed out by Manning (2004), "Ground proofing [of ozone uptake metrics] must be done to verify and validate plant injury predictions. If this is not done, then the standards have no biological significance and are only exercises in air quality assessment."

Based on three years of physiological measurements on ponderosa pine, Panek (2004) documented that stomatal conductance of ozone was strongly correlated with leaf water potential ($R^2 = 0.82$) which closely followed the dynamics of stomatal conductance. Peak ozone update occurred in early summer and did not correspond to periods of peak ozone concentration. Panek (2004) therefore concluded that cumulative metrics based on ozone concentrations, including the W126 index, were <u>not</u> appropriate for plants in the studied region.

The USDA has funded or conducted specific studies and results that should be corroborated into the consideration of a secondary ozone standard. Below are just a few.

- The Aspen FACE (Free-Air Carbon Dioxide Enrichment) Experiment – A multi-disciplinary study to assess effects of increasing tropospheric ozone and carbon dioxide levels on the structure and function of northern forest ecosystems: results suggest that:
    - Moderate levels of O_3 will offset elevated CO_2 responses projected for the year 2100;
    - Carbon sequestration under elevated CO_2 is being overestimated by modelers who do not consider O_3 in areas with periodic episodic O_3;
    - Elevated CO_2 delays normal autumn leaf senescence, predisposing some aspen genotypes to winter dieback;
    - Aspen and birch insects and disease may increase under elevated CO_2 and O_3. (Free-Air Carbon Dioxide Enrichment (FACE), 2014)

- SoyFACE (Soybean Free Air Concentration Enrichment) – An innovative facility for growing crops completely in open-air conditions within an agricultural field. The facility allows researchers to evaluate the influence of natural variability of meteorological factors such as drought and temperature in conjunction with imposed atmospheric composition (elevated CO_2 and O_3) on naturally occurring soybean diseases across several growing seasons. An increase in the daytime ozone concentration from 60 ppb to 72 ppb led to a 15% decrease in yield from 2002 to 2003. (University of Illinois/USDA ARS, 2014).

  SoyFACE is mentioned in EPA's most recent Policy Assessment, but it is the only new study included related to ozone effects on crop production since the previous review. In fact, EPA relies heavily on the 1980's crop yield study in its assessment. Given that different species (and even cultivars within a species) vary tremendously in their sensitivity to ozone, transference of effects from soybeans to other crops is inappropriate. Instead, additional research is needed to elucidate the effects of ozone on other crop species and cultivars.

- Through collaborative research between Minnesota and Alberta scientists, a natural field exposure study in Alberta was conducted that included ambient air quality and meteorological data. Those two elements accounted for two thirds of the variability in alfalfa yield; air quality influenced half of the accounted variation, with O_3 accounting for 25%. (Raymond Knighton, 2006).

- Research at Auburn University to understand the combined effects of elevated O_3 and N deposition on productivity and nutritive quality of grazing lands will assist policymakers and resource managers concerned with forage-based production systems.

- Adaptation of agricultural and commercial forest species to air pollution and climate change can take advantage of modern breeding and genetics approaches but requires an understanding of the mechanisms controlling plant response as a step toward identifying genes of interest and developing screening protocols. Research on the physiological and molecular basis of O_3 tolerance is being conducted on multiple species by the Northeast Coordinating Committee 1013 (NECC-1013) members (Raymond Knighton, 2006).

- Ozone-sensitive and -tolerant snap beans developed by USDA-ARS in Raleigh, NC, were used in ozone gardens at Harvard University, the St. Louis Science Center and two other locations in St. Louis, and the Goddard Science Center, Greenbelt, MD. The snap beans were also grown by a University of Illinois, Urbana-Champaign graduate students' urban agriculture project in Chicago and are being tested as an ozone bio-indicator system at a number of locations in Europe and Asia by the ICP-Vegetation program (United States Department of Agriculture, 2010).

In the 2014 Policy Assessment, EPA Staff assert that the W126 is the "more biologically relevant cumulative, seasonal form" of a long-term exposure index, but the W126 index was compared only to the threshold metrics such as the SUM06 metric, ignoring other possible metrics such as 1-hour maximum concentrations, AOT40, N100, flux methods, or even the EPA primary

standard with modified averaging time and co-factors. In fact, based on a five-year study at the Aspen FACE facility using aspen and birch trees, a plant growth model of mean basal area was well predicted (adjusted R^2 from 61.5 to 94.6%; $p < 0.0005$) by the 4th highest daily maximum 8-hour O_3 concentration along with six other meteorological and agronomic predictors (i.e., wind speed, precipitation, growing-degree days, relative humidity, soil moisture, and solar radiation) (Percy et al., 2009). Reducing the regression to a more usable form, mean basal area can be predicted using 4th highest daily maximum 8-hour concentration (the primary standard form), wind speed and growing degree days (adjusted R^2 from 68 to 89%; $p < 0.0005$), and the regression model makes biological sense, unlike the W126 index, which is purely a statistical regression with no basis in plant physiology (Percy et al., 2007).

Unlike the W126 index, a standard based on the 4th highest daily maximum 8-hour average ozone concentration has a high degree of statistical significance and goodness of fit while also having greater biological association with the economically and ecologically relevant endpoint of plant growth. Furthermore, unlike the W126 index, for which there has been no empirical response evidenced demonstrating a biological association outside of chambered studies[2], a standard incorporating daily maximum 8-hour average concentrations, wind speed, and growing degree days has been shown to have significant biological association with two species (and five genotypes) of trees over five years, under free-air conditions characterized by large inter-annual climate variation, stand dynamics, and pest activity (Percy et al., 2007, 2009).

RECOMMENDATION: The AAQTF Air Quality Standards Committee recommends that the USDA Staff work with EPA Staff to identify a secondary ozone standard form that is more biologically-relevant than the W126 index and to consider the full suite of agricultural ozone effects research that may affect the level of a proposed standard.

Setting Levels for the Primary and Secondary Standards

Once the forms of the primary and secondary ozone standards have been determined, EPA must establish levels for each of these standards. In the Policy Assessment, EPA proposes a W126 value in the range of 7–15 ppm-hours for a new secondary ozone standard. Standard levels should consider not only the health and welfare effects of ambient concentrations but also the portion of measured concentrations originating from background conditions, international transport and stratospheric ozone (i.e., "policy-relevant background" or "PRB").

There is confusion among EPA staff and CASAC as to the relevance of the policy level background and how it is to be used in the independent scientific process in the setting of new standards. On December 3, 2009, CASAC member, Dr. Michelle Bell, Associate Professor, School of Forestry and Environmental Studies, Yale University, New Haven, CT, offered the following to then Administrator Jackson about establishing policy relevant background (PRB) levels:

[2] Grunhage and Jager (1994) found that dose-response relationships established using chamber experiments overestimate negative impacts of ozone exposure relative to open-air experiments that better mimic ambient conditions.

> *"Establishing the policy relevant background (PRB) level [see page 39] is by no means trivial, and the draft Review Plan acknowledges some of these limitations. The Plan notes that greater emphasis will be placed on understanding the contribution of different components that contribute to PRB [see page 40]. However, given the complexities of establishing a PRB and the wide range of approaches available, it would be helpful to have more information on how the PRB will be determined and how sensitivity analyses might be conducted."*

During the May 19-20, 2011 Clean Air Scientific Advisory Committee (CASAC) meeting, EPA stated that by its using GEOS-Chem Model, background ozone is in the range of 15-35 ppb. A number of researchers contend that frequent occurrences of ozone greater than or equal to 50 ppb occur at both high- and low-elevation monitoring sites across the United States due to transport from the stratosphere to the lower troposphere, thereby increasing the background levels of ozone. These ozone concentrations appear to be related to stratospheric transport occurring during the springtime and sometimes in the summertime. Also missing in EPA's equation is the impact of the long-range transport of Eurasian biomass burning and wildfires in the US and the ability to affect background ozone concentrations. (A.S.L. & Associates, 2010)

If the actual background level of ozone is higher than EPA estimates with the GEOS-Chem model (or another tool used to establish PRB), results may overestimate human health and vegetation risks and present inaccurate information to the public and policymakers. The range of background concentrations is used in the EPA's risk assessment for both humans and vegetation and provides the baseline for assessing the amount of emission reductions required to attain a specific ozone level within the standard.

RECOMMENDATION: The AAQTF Air Quality Standards Committee recommends that the USDA Secretary requests EPA to quantify uncertainties in PRB estimates and the potential impacts of inaccurately estimating the PRB on potential non-attainment areas and the cost of implementation for both a proposed primary and secondary standard.

Conclusions

In August 2014, the EPA released its policy assessment for review of the ozone NAAQS in which it recommended an independent secondary standard for ozone having the form of the W126 index in order to protect sensitive ecosystems from damage caused by high levels of ozone exposure. The W126 form of the secondary ozone standard proposed in EPA's final Policy Assessment bears no biological relevance to plant exposure as ozone uptake is highly dependent on stomatal activity. As such, the W126 index should not be the basis for the secondary ozone standard.

Furthermore, when establishing the level of a new ozone standard, EPA should quantify uncertainties in estimates of policy-relevant background (PRB) concentrations and the potential impacts of inaccurately estimating the PRB on potential non-attainment areas and the cost of implementation for both a proposed primary and secondary standard.

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AAQTF Update
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Wildland Fire Air Quality Response Program

- National Effort
  - Cadre of Air Resource Advisors (THSP-ARA)
  - National Monitor Cache/Display (AirNow Smoke Page)
  - PNW AirFire Team incident smoke model runs (1km+)
  - Two Classes held – Trainee Program- another Spring 2015
  - Range of Skills in 24 ARA, 12 trainees
  - FS, BLM, FWS, NPS, NRCS, AD-Contractor, EPA???, States: GA, NC,
  - Dispatches: 2011- handful, 2012-13, 2013-25, 2014-39
  - Typical Assignment is 2-weeks
  - 2014-Low impacts (ozone too) due to frequent wind shifts
  - 2014-King Fire-Iron Man cancelled by wildfire smoke
  - Canada and other country interest (shadow in 2015)

WFAQR Program-Challenges

- Thresholds for warnings and evacuation
  - Federal/state/districts can have different thresholds
  - No defined evacuation threshold (level, duration, extant)
- PM2.5 Limited Monitoring (small #, device type, placement)
  - Other pollutants: monitors, models, display
  - Other pollutants: combined exposure/thresholds
- Program awareness issues and acceptance (ARAs)
- Display of monitored data
  - National, state, tribal, local district, Blogs, Chinese hourly site
  - Thresholds and duration (1-hr, 3-hr, 24-hr, NowCast)
- Smoke Alerts
  - Shelter in place and Air Quality Shelters – citeria,
  - N95 masks – Role and information for medical providers
  - Kids and schools…

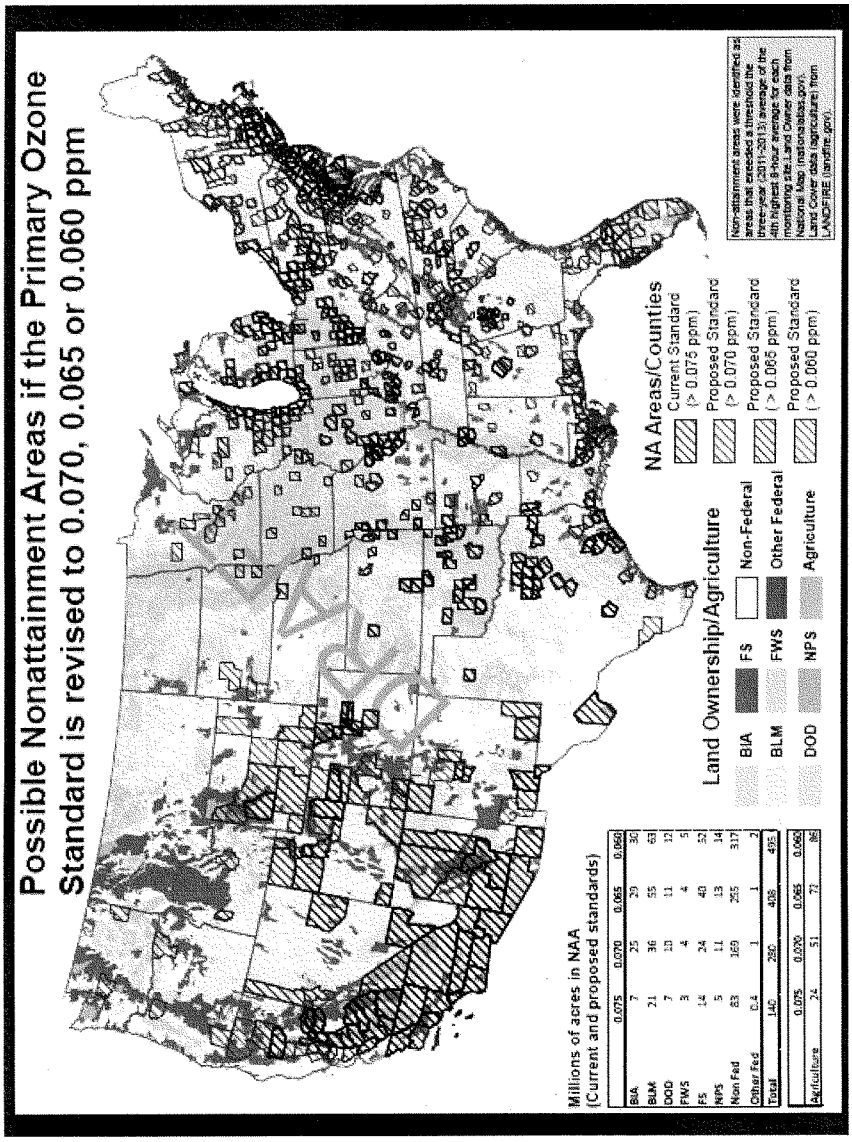
2014 National Ambient Air Quality Standards for Ozone – EPA Proposal 12/1/14

- EPA is proposing to update both the primary ozone standard, to protect public health, and the secondary standard, to protect the public welfare.
- Both proposals are 8-hour standards set within a range of 65 to 70 parts per billion (ppb).
- EPA is seeking comment (90-day open period) on levels for the health standard as low as 60 ppb and on retaining the existing standard.

- The agency will issue a final decision by Oct. 1, 2015.
- Monitoring season extended in many locations in the US into spring and fall months. Year-round some locations.
- Changes proposed to the Air Quality Index – proportionally changed to reflect the new standard.

AQI Category	Index Values	Current Breakpoints (2008 AQI) (ppb, 8-hour average)	Proposed Breakpoints (ppb, 8-hour average) *Note: parentheses indicate a range*
Good	0 - 50	0-59	0 to (49-54)
Moderate	51 - 100	60-75	(50-55) to (65-70)
Unhealthy for Sensitive Groups	101 – 150	76-95	(66-71) to 85
Unhealthy	151 – 200	96-115	86-105
Very Unhealthy	201 – 300	116-374	106-200
Hazardous	301 –500	375 to the Significant Harm Level*	201 to the Significant Harm Level*

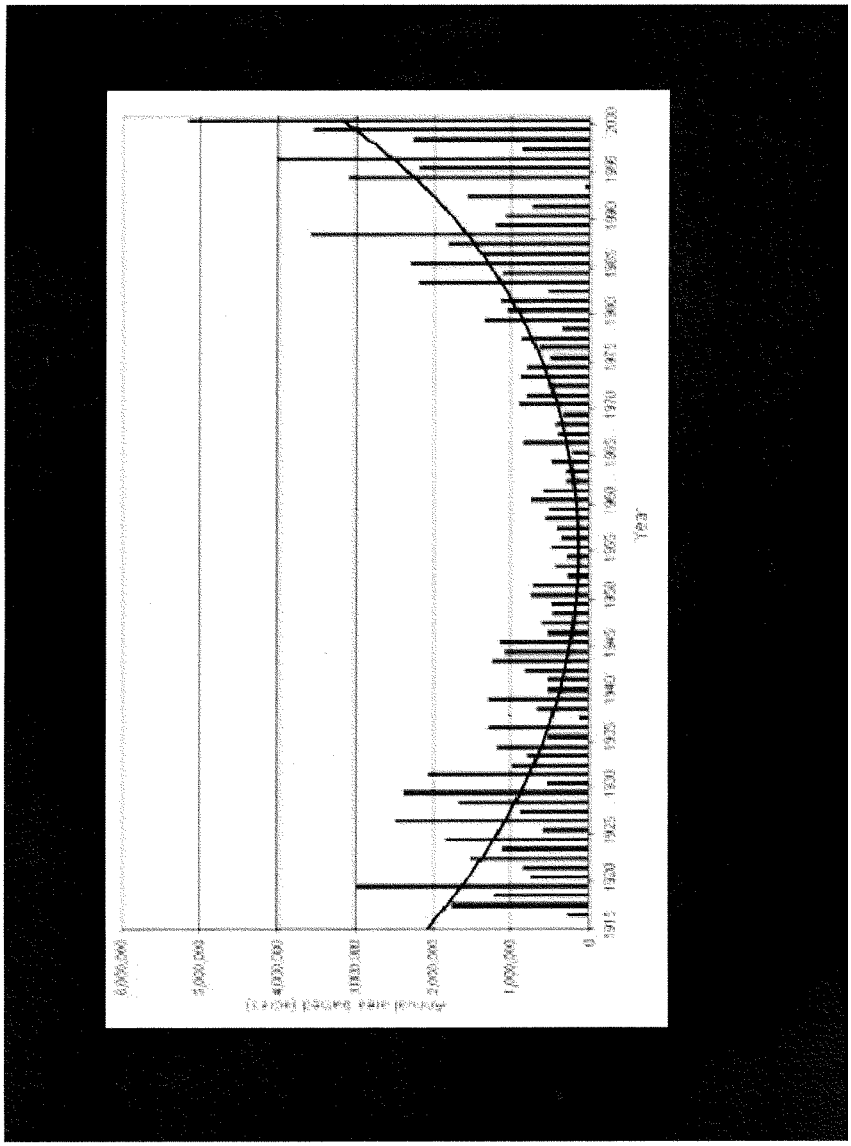
**The Significant Harm Level for ozone is 600 ppb, two-hour average*

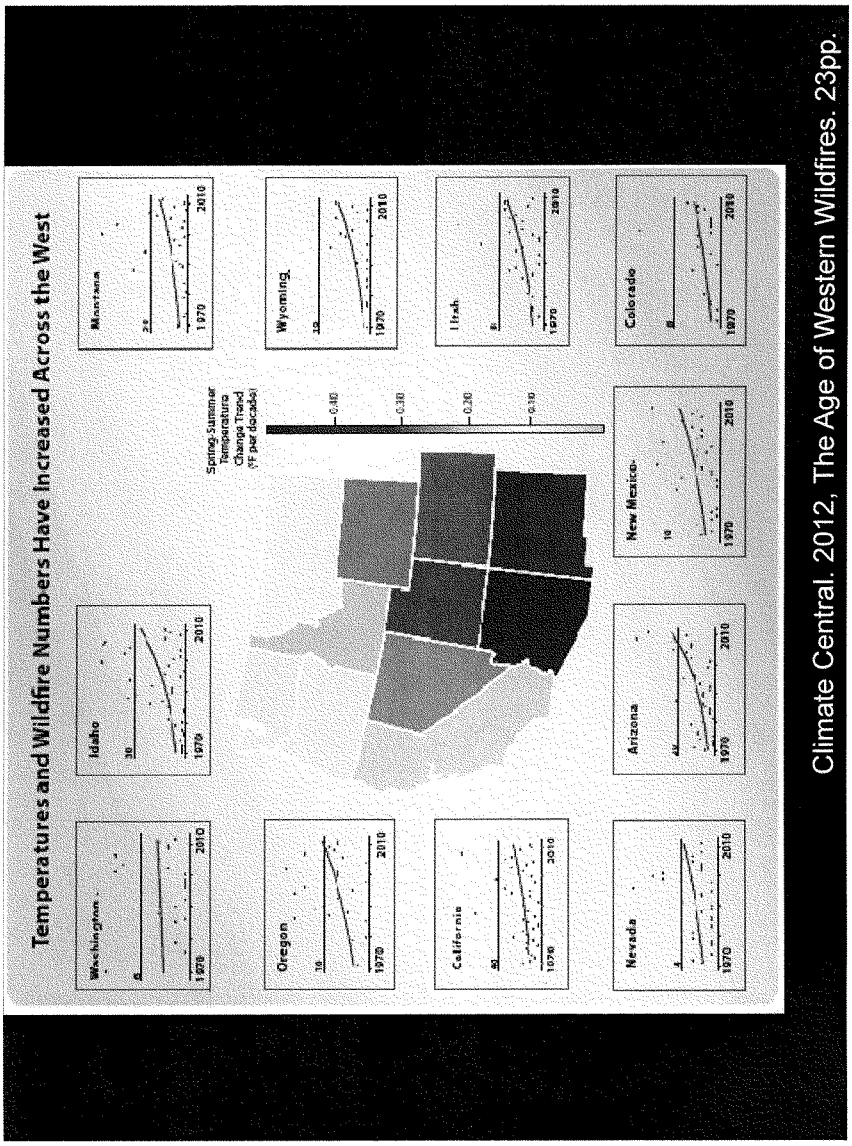

Possible Nonattainment Areas if the Primary Ozone Standard is revised to 0.070, 0.065 or 0.060 ppm
NA Areas/Counties
Current Standard (> 0.075 ppm)
Proposed Standard (> 0.070 ppm)
Proposed Standard (> 0.065 ppm)
Proposed Standard (> 0.060 ppm)
Land Ownership/Agriculture
BIA
FS
Non-Federal
BLM
FWS
Other Federal
DOD
NPS
Agriculture
Millions of acres in NAA (Current and proposed standards)
0.075 0.070 0.065 0.060
BIA 7 25 29 36
BLM 21 36 55 63
DOD 7 10 11 12
FWS 3 4 4 5
FS 14 24 48 52
NPS 5 11 13 14
Non Fed 83 169 255 317
Other Fed 0.4 1 1 2
Total 140 280 408 495
0.075 0.070 0.065 0.060
Agriculture 24 51 72 86

NA Areas/Counties
Current Standard
(> 0.075 ppm)
Proposed Standard
(> 0.070 ppm)
Proposed Standard
(> 0.065 ppm)
Proposed Standard
(> 0.060 ppm)

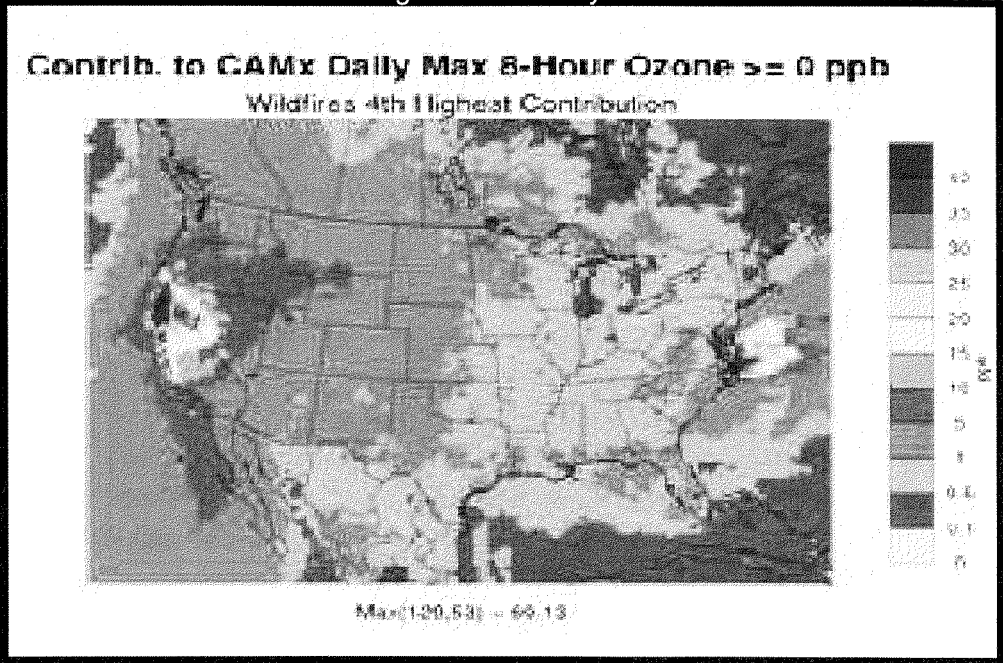
The Fine Print of the Ozone NAAQS and Fire

- Regulatory Impact Assessment (RIA) conducted
  - At 70 ppb, 2011-2013 358 counties nonattainment**
  - At 65 ppb, 2011-2013 558 counties nonattainment**
  - At 70 ppb, 2025 9 counties nonattainment**
  - At 65 ppb, 2025 68 counties nonattainment**
- **Excluding California
- RIA projection did **not** address effects of:
  - Temperature increases due to climate change – high temp records being set in Spring and fall
  - Increased monitoring duration into spring and fall
  - Wildfire effect on high ozone and background ozone
  - Increase of wildfires, natural background & International sources
  - Dependence on Exceptional Events Rule for wildfires and other "natural" sources (stratospheric ozone or international)
- Wildfire, role of fire & Rx fire discussed

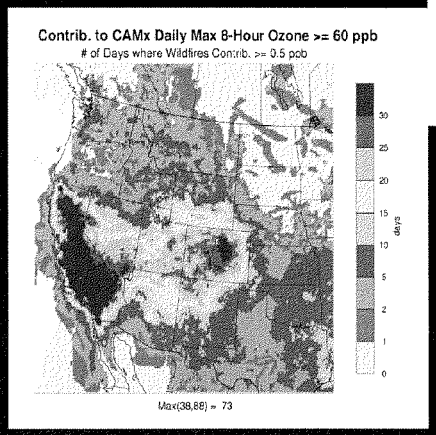


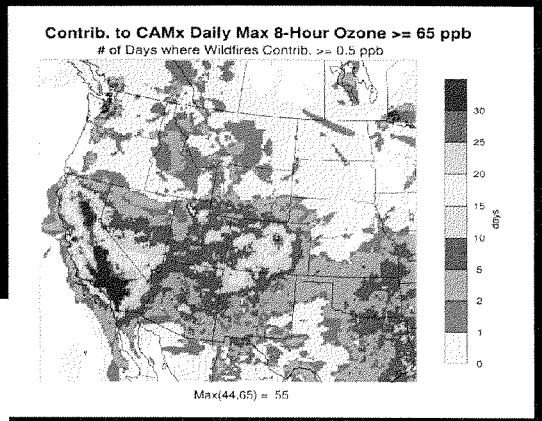

Temperatures and Wildfire Numbers Have Increased Across the West
Washington
Idaho
Montana
Oregon
Wyoming
Utah
California
New Mexico
Colorado
Nevada
Arizona
1970
2010
Spring-Summer Temperature Change Trend (°F per decade)
0.40
0.30
0.20
0.10
Climate Central. 2012, The Age of Western Wildfires. 23pp.

Wildfire contribution to the 4th highest ozone days across the United States for 2008.



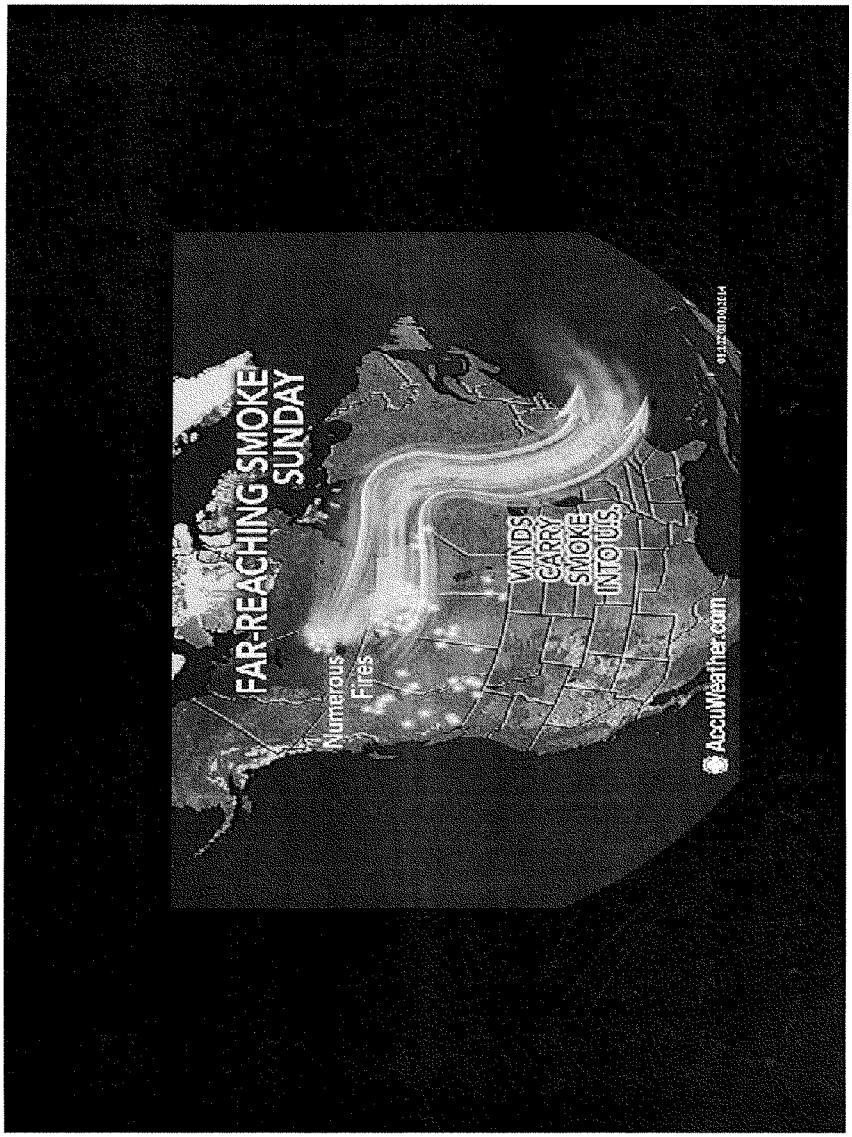
Moore, Charles T. et al., Deterministic and Empirical Assessment of Smoke's Contribution to Ozone (DEASCO3) Final Report, 2014. https://wraptools.org/pdf/11-1-6-6_final_report_DEASCO3_project.pdf





Contribution of ozone from wildfire 2008 to maximum ozone values.

West-Wide Jump-Start Air Quality Modeling Study, Final Report (**PDF** 15MB), September 30, 2013". http://www.wrapair2.org/WestJumpAQMS.aspx

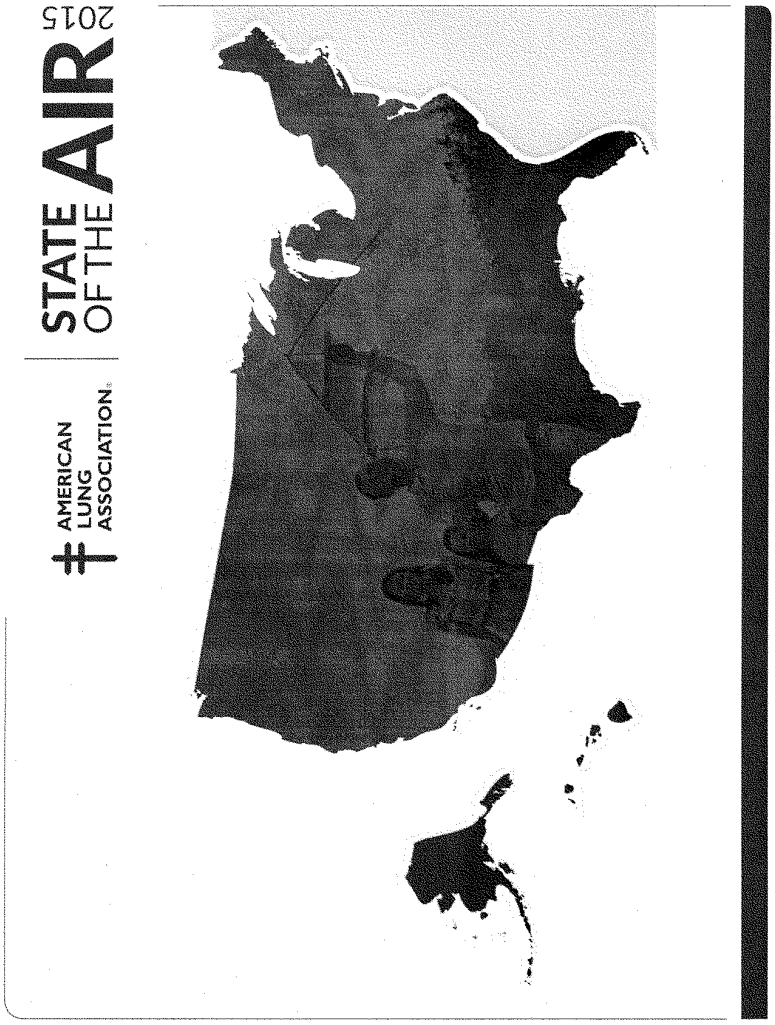

FAR-REACHING SMOKE SUNDAY
Numerous Fires
WINDS CARRY SMOKE INTO U.S.
AccuWeather.com

The Fine Print of the Ozone NAAQS and Fire

- Wildfire is considered a natural background source
- Wildfire impacts to be removed through use of the Exceptional Events Rule as a "natural event" (under revision and no current guidance)
- EPA cited example for wildfire ozone impact relied on regression modeling, back trajectories, and satellite imagery. This is a challenging and expensive process (ask SJAPCD).
- Based on EPA posted information, only one example of EER for ozone from wildfire approved by EPA and three from prescribed fire (KS and SC) since 2007.

- EPA seeking comment on Background, how to consider its effects and approaches…

DOCUMENTS SUBMITTED BY SUBCOMMITTEE RANKING MINORITY MEMBER SUZANNE BONAMICI



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The American Lung Association assumes sole responsibility for the content of the *American Lung Association State of the Air 2015*.

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State of the Air 2015 shows that more than

four out of ten people

had unhealthy air quality in their communities.

The *State of the Air 2015* shows that progress in improving the nation's air quality was mixed. Many cities experienced strong improvement and many others suffered worse episodes of unhealthy air. While most of the nation has much cleaner air quality than even a decade ago, a few cities even reported their worst episodes. Nearly 138.5 million people—almost 44 percent of the nation—live where pollution levels are too often dangerous to breathe. Fortunately, that represents fewer people exposed than in our previous report. Despite that risk, some seek to weaken the Clean Air Act, the public health law that has driven the cuts in pollution since 1970, and to undermine the ability of the nation to fight for healthy air.

The *State of the Air 2015* report looks at levels of ozone and particle pollution found in official monitoring sites across the United States in 2011, 2012, and 2013. The report uses the most current quality-assured nationwide data available for these analyses.

The report examines particle pollution ($PM_{2.5}$) in two different ways: averaged year-round (annual average) and over short-term levels (24-hour). For both ozone and short-term particle pollution, the analysis uses a weighted average number of days that recognizes places with higher levels of pollution. For the year-round particle pollution rankings, the report uses averages calculated and reported by the U.S. Environmental Protection Agency (EPA). For comparison, the *State of the Air 2014* report covered data from 2010, 2011, and 2012.

Overall Trends

Thanks to stronger standards for pollutants and for the sources of pollution, the United States has seen **continued reduction in ozone and particle pollution** as well as other pollutants for decades. Figure 1 from the EPA shows that since 1970, the air has gotten cleaner while the population, the economy,

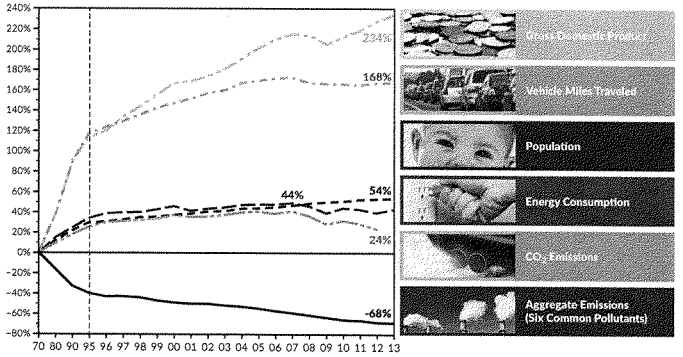

Figure 1 Air emissions have dropped steadily since 1970 thanks to the Clean Air Act. Even as the economy continues to recover from the recession, emissions that contribute to the most widespread pollutants continue to drop. (Source: U.S. EPA, Air Quality Trends, 2015.)

energy use and miles driven increased greatly. Even as the economy continues to recover after the recession, overall air emissions that create the six most widespread pollutants continue to drop.

Overall, **the best progress came in the continued reduction of year-round particle pollution in the eastern half of the nation,** thanks to cleaner diesel fleets and cleaner fuels used in power plants. Continued progress cleaning up pollution makes a difference, but a changing climate is making it harder to protect human health. **Many cities had a record number of days with high short-term particle pollution**, particularly in the West, where continuing drought and heat may have increased the dust, grass fires and wildfires, while burning wood as a heat source appears to contribute to the problem in many smaller cities. The impact of climate change is particularly apparent in the West where the heat and drought create situations ripe for episodes of high particle days. High use of wood-burning stoves contributes to the dangerous particle levels in the winter in places like Fairbanks, Alaska and Logan, Utah.

Unfortunately, particle pollution data from all of Illinois, most of Tennessee and many counties in Georgia were missing because of problems with data processing in laboratories and other data issues. This means that no one knows if the levels of particle pollution were unhealthy in many cities that have been among the most polluted cities in last year's report, including Chicago, St. Louis, and Atlanta.

Many cities continued a decade of progress reducing ozone, but many others had more unhealthy air days. Particularly in California, thirteen of the 25 most ozone-polluted cities had fewer high ozone days on average in 2011-2013 compared to 2010-2012. Unfortunately, twelve cities recorded more days of unhealthy air, while one city had no change from the previous report. Rising temperatures create conditions favorable to forming ozone. Thanks to the Clean Air Act, even these places have much better air quality compared to fifteen years ago in the earliest reports. Communities will need more help to reduce ozone pollution in the warmer temperatures expected from the changing climate.

Los Angeles remains as the metropolitan area with the worst ozone pollution, as it has for all but one of the 16 reports, although Los Angeles reported its lowest average year-round particles and fewest high ozone days in the report's history.

Year-round Particle Pollution

The best progress came in the continued reduction of year-round particle pollution in 2011-2013, especially in the eastern U.S. Of the 25 metro areas with the worst year-round levels of particle pollution, fourteen reduced their annual levels compared to 2010-2013—and **13 cities recorded their cleanest years yet**, some continuing to reduce levels for the second report in a row. Eleven of the cities with the highest year-round particle levels now get a passing grade; that is, they meet the official health-based standard for year-round particle pollution.

Fresno-Madera (CA) improved, but remained the most polluted metropolitan area for year-round particle pollution, as it was in the 2014 report. Some of the biggest improvements have been in the East and South—and Los Angeles, which had its lowest ever annual average level of particle pollution since our report began. Five other cities also had their lowest year-round particle pollution, but still had levels above the national air quality standard: Pittsburgh, Cleveland, Philadelphia, New York City, and Louisville (KY). Six other cities had their lowest year-round particle pollution, but met the national air quality standard, a marker that they benefited decisively from the measures put in place to reduce this dangerous air pollutant. Those cities include: Lancaster (PA), Birmingham (AL), Indianapolis (IN), Houston, Macon (GA), Little Rock (AR), and Wheeling (WV). Two other cities improved and also met the national air quality standard: El Paso-Las Cruces (TX-NM), and Shreveport (LA).

Many of the seven cities with more annual particle pollution compared to the 2014 report are in the West, especially in the central valley of California. Six of those metro areas still fail the national air quality standard: Bakersfield (CA), Modesto-Merced (CA), El Centro (CA), San Jose-San Francisco, Cincinnati and Harrisburg-York (PA). Only Erie (PA) recorded higher annual particle levels and still met the national air quality standards. Johnstown (PA) had the same level as in the 2014 report, failing the standard, while new monitoring data added Altoona (PA) to the list, but at a level that

passes the national test.

Data are missing for 4 cities that were in the 2014 most polluted cities list. Data are unavailable for St. Louis, Atlanta, Chicago and Columbus (GA) so it is impossible to know whether the air quality there improved or worsened. Problems with data processing in Illinois, most of Tennessee and part of Georgia prevented people in those states from having information on their particle pollution levels for this period.

Continued cleanup of power plants and the continued turnover of the diesel fleet have likely driven these reductions. These steps continue because of the Clean Air Act and U.S. Environmental Protection Agency steps to enforce it.

Short-term Particle Pollution

Episodes of high levels of particles increased as a problem during the years covered by this report compared to last year's report. Western states were especially hard hit, with drought and wildfires contributing to the existing problem. Many cities suffered more days as short-term particle pollution worsened, especially in the West. Five cities had their worst records since our report began.

Six cities set a record for their highest weighted average number of unhealthy particle pollution days ever, while 15 other cities had additional high-particle days on average in 2011-2013 compared to 2010-2012. Cities that recorded their largest number of days with high particle pollution on average were Visalia (CA), San Francisco, Fairbanks (AK), Phoenix, Yakima (WA) and Reno (NV). San Francisco is included because of the addition last year of San Joaquin County to the San Jose-San Francisco–Oakland Consolidated Statistical Area. The other cities with higher weighted average number of days in this report include Fresno-Madera (CA), which retained its ranking as the most polluted for short-term particle pollution in the nation; Modesto-Merced (CA); Los Angeles; Salt Lake City; Logan (UT- ID); Sacramento (CA); New York City; Seattle; Harrisburg-York (PA), Eugene (OR); Lancaster (PA); Philadelphia; Boise City (ID); and Medford-Grants Pass (OR).

Four cities reduced their average number of days with unhealthy particle levels. One city—Pittsburgh—had its fewest unhealthy days on average ever in our report history. The other three cities that reduced their pollution were: Missoula (MT); El Paso-Las Cruces (TX-NM); and Indianapolis.

Increased heat and continuing drought in the West likely contributed to the worsening problem, although they are not the only sources. High particle days frequently result from use of wood-burning stoves for heat, dust storms, wildfires and weather patterns that trap in emissions from power plants, trucks, buses, trains, ships and industrial sources.

Data are missing on one city that was listed among the most polluted in the 2014 report. Data are unavailable for Chicago so it is impossible to know whether the air quality there improved or worsened. Problems with data processing in Illinois, most of Tennessee and part of Georgia prevented people in those states from having information on their particle pollution levels for this period.

Ozone Pollution

Many cities suffered fewer ozone days (by weighted average) than in the 2014 report, but almost as many of the most polluted cities suffered more days. Steps to reduce ozone continue to pay off in many ozone-burdened metropolitan areas, as exemplified in Los Angeles, still ranked as the most ozone-polluted city in the nation. Los Angeles experienced its best three-year period since this report began, dropping more than one-third of its average number of unhealthy air days since the late 1990s. Four other metropolitan areas reported their fewest high ozone days on average in the 2015 report: Visalia (CA); Bakersfield (CA); Sacramento (CA); and Washington, DC- Baltimore.

Thirteen of the 25 most ozone-polluted cities had fewer high ozone days on average in 2011-2013 compared with 2010-2012. In addition to the five cities noted above, eight other cities improved: Houston, St. Louis, Chicago, Pittsburgh, Cincinnati, Sheboygan (W), Kansas City, and Memphis.

Twelve cities fared worse, suffering slightly more high ozone days on average, while one remained the same. Cities that

recorded more high ozone days or days with higher ozone included: Fresno (CA); Dallas-Fort Worth; Modesto-Merced (CA); Las Vegas; Phoenix; New York City; Tulsa (OK); Denver; El Centro (CA); Fort Collins (CO); Grand Rapids (MI); and South Bend (IN). Oklahoma City (OK) recorded the same weighted average for ozone as in the 2014 report.

Changes in ozone likely came from multiple factors, including weather. Ozone forms best in warmer, sunny weather with still winds. The warm, drier summer in 2012 contributed to higher ozone readings and more frequent high ozone days, while the wetter weather in 2013 in the east contributed to a drop in these days. Real success despite extended hot, dry days in California came from concentrated efforts to reduce emissions that contribute to ozone.

The improvements documented in the past sixteen years of this report show the benefit of steps taken to reduce ozone. Even the more polluted cities had significantly fewer unhealthy ozone days than they had a decade ago.

Cleanest Cities

Six cities ranked on all three lists of the cleanest cities in 2011-2013. That means they had no days in the unhealthy level for ozone or short-term particle pollution and were on the list of the cleanest cities for year-round particle pollution. Listed alphabetically, the six cities are:

- Bismarck, ND
- Cape Coral-Fort Myers-Naples, FL
- Elmira-Corning, NY
- Fargo-Wahpeton, ND-MN
- Rapid City-Spearfish, SD
- Salinas, CA

Eleven other cities ranked as the cleanest for both year-round and short-term particle pollution, listed alphabetically:

- Bangor, ME
- Farmington, NM
- Flagstaff, AZ
- Homosassa Springs, FL
- Kahului-Wailuku-Lahaina, HI
- Lakeland-Winter Haven, FL
- North Port-Sarasota, FL
- Palm Bay-Melbourne-Titusville, FL
- Prescott, AZ
- Sierra Vista-Douglas, AZ
- Tampa-St. Petersburg-Clearwater, Fl

Two other cities were on both the cleanest cities lists for ozone and for year-round particle pollution, listed alphabetically:

- Burlington-South Burlington, VT
- Urban Honolulu, HI

Thirteen other cities made both the cleanest cities lists for ozone and for short-term particle pollution, listed alphabetically:

- Brownsville-Harlingen-Raymondville, TX
- Des Moines-Ames-West Des Moines, IA
- Dothan-Enterprise-Ozark, AL
- Eau Claire-Menomonie, WI
- Gadsden, AL
- Harrisonburg-Staunton-Waynesboro, VA
- La Crosse-Onalaska, WI-MN
- Lincoln-Beatrice, NE
- McAllen-Edinburg, TX
- Monroe-Ruston-Bastrop, LA
- Montgomery, AL
- Rochester-Austin, MN
- Sioux Falls, SD

People At Risk

Looking at the nation as a whole, the American Lung Association State of the Air 2015 finds—

- **More than 4 in 10 people (nearly 44 %) in the United States live in counties that have unhealthful levels of either ozone or particle pollution.**

  Nearly 138.5 million Americans live in 287 counties where they are exposed to unhealthful levels of air pollution in the form of either ozone or short-term or year-round levels of particles.

  - This is a decrease of more than 9.1 million people compared to 2010-2012, when 47% lived where there were unhealthy levels, as we covered in the 2014 report. However, it is still a larger percentage of the population than in the 2009-2011 period covered by the 2013 report.

- **More than 4 in 10 people in the United States (40.7%) live in areas with unhealthful levels of ozone.**

  Counties that were graded F for ozone levels have a combined population of more than 128.7 million. These people live in the 254 counties where the monitored air quality places them at risk for premature death, aggravated asthma, difficulty breathing, cardiovascular harm and lower birth weight. The actual number who breathe unhealthy levels of ozone is likely

More than 17.7 million people in the U.S. live in counties where the outdoor air failed all three tests.

much larger, since this number does not include people who live in adjacent counties in metropolitan areas where no monitors exist.

- **More than 13 percent of people in the United States live in an area with too many days with unhealthful levels of particle pollution.**

  Close to 41.7 million Americans live in 55 counties that experienced too many days with unhealthy spikes in particle pollution, a decrease from the last report. This number may undercount the total because of lack of data from Illinois, Tennessee and Georgia. Short-term spikes in particle pollution can last from hours to several days and can increase the risk of heart attacks, strokes and emergency room visits for asthma and cardiovascular disease, and most importantly, can increase the risk of early death.

- **Nearly 24 million people (7.6%) in the United States live in counties with unhealthful year-round levels of particle pollution.**

  These people live in the 24 counties where chronic levels are regularly a threat to their health. This number may undercount the total because of lack of data from Illinois, Tennessee and Georgia. Even when levels are fairly low, exposure to particles over time can increase risk of hospitalization for asthma, damage to the lungs and, significantly, increase the risk of premature death.

- **Nearly 17.8 million people (5.6%) in the United States live in 12 counties with unhealthful levels of all three: ozone and short-term and year-round particle pollution.**

  This is 10 million fewer people than were exposed to all three problems in the 2014 report when nearly 9% were exposed. However, data are missing on particle pollution in all or parts of 3 states.

With the risks from airborne pollution so great, the American Lung Association seeks to inform people who may be in danger. Many people are at greater risk because of their age or because they have asthma or other chronic lung disease, cardiovascular disease or diabetes. The following list identifies the numbers of people in each at-risk group. The numbers living in counties that fail all three tests may be undercounted because of the missing data on particle pollution in Illinois, Tennessee and Georgia.

- **Older and Younger**—More than 17.6 million adults age 65 and over and close to 33.4 million children under 18 years old live in counties that received an F for at least one pollutant. Close to 2.2 million seniors and close to 4.4 million children live in counties failing all three tests.
- **People with Asthma**—Close to 3.1 million children and close to 9.5 million adults with asthma live in counties of the United States that received an F for at least one pollutant. Close to 393,000 children and close to 1.2 million adults with asthma live in counties failing all three tests.
- **Chronic Obstructive Pulmonary Disease (COPD)**—More than 6.3 million people with COPD live in counties that received an F for at least one pollutant. More than 632,000 people with COPD live in counties failing all three tests.
- **Cardiovascular Disease**—More than 8.6 million people with cardiovascular diseases live in counties that received an F for at least one pollutant; close to 909,000 people live in counties failing all three tests.
- **Diabetes**—More than 3.5 million people with diabetes live in counties that received an F for either short-term or year round particle pollution; close to 2.2 million live in counties failing both tests. Having diabetes increases the risk of harm from particle pollution.
- **Poverty**—Nearly 21.4 million people with incomes meeting the federal poverty definition live in counties that received an F for at least one pollutant. More than 3.4 million people in poverty live in counties failing all three tests. Evidence shows that people who have low incomes may face higher risk from air pollution.

What Needs To Be Done

Our nation has made significant progress, but clearly more must be done to reduce the burden of air pollution and improve the health of millions of Americans. Cleaning up air pollution requires strong and coordinated effort on the part of our federal and state leaders.

President Barack Obama, EPA Administrator Gina McCarthy, Members of Congress, Governors and state leaders all have a key role to play. These leaders have a choice to make: either support steps to improve the air we breathe so that it does not cause or worsen lung disease, or allow pressure from polluting industries to weaken healthy air protections. The American Lung Association urges our nation's leaders to stand up for public health and take these important steps for to improve the air we all breathe:

Protect the Clean Air Act

The continued improvement shown in the State of the Air report is possible because of the Clean Air Act, the nation's strong public health law put in place by an overwhelming bipartisan majority in Congress more than 40 years ago. The Clean Air Act requires that the EPA and each state take steps to clean up the air and protect public health by reducing pollution. Unfortunately, some in Congress continue to seek weakening changes to the Clean Air Act that would dismantle progress made in the last 40 years and make it harder to achieve future reductions. To achieve the promise of the Clean Air Act, Congress must keep the law strong, fully implemented and enforced.

Reduce Carbon Pollution from Power Plants by Adopting a Strong Final Clean Power Plan

In 2014, EPA proposed the Clean Power Plan as a way to reduce carbon pollution from power plants by 2030, working with states. Now President Obama and EPA need to finish the job and issue strong final standards for carbon pollution from new and existing plants as soon as possible. Power plants are the largest stationary source of greenhouse gases in the United States. Energy production accounts for 86 percent of total 2009 greenhouse gas emissions, and the electric sector represents 39 percent of all energy-related carbon dioxide (CO_2) emissions. Scientists tell us that carbon pollution contributes to a warming climate, enhancing conditions for ozone formation, and making it harder to reduce this lethal pollutant. Taking steps to reduce carbon pollution from electricity generation will also reduce ozone and particle pollution. EPA's own analysis shows that these co-benefits can prevent up to 6,600 premature deaths and up to 150,000 asthma attacks in children in 2030.

Revise the Ozone Air Quality Standard to Reflect the Science and Protect Health

National air quality standards set the official limits that drive the cleanup of air pollution around the nation. The Clean Air Act requires that the EPA set national air quality standards for ozone based on the need to protect public health, "with an adequate margin of safety." The Clean Air Act also requires that the EPA review the standards every five years to make sure that the standards are based on the most current science.

Today, the research shows that the current standard is woefully inadequate to protect public health, and a much stronger standard is needed. Multiple reviews by the independent scientists who advise the EPA have confirmed that the current standard fails to provide the protection required under the law. The good news is that the EPA proposed to strengthen the health-based standard in November 2014, with the EPA Administrator recommending a standard between 65 and 70 parts per billion (ppb) from the current standard of 75 ppb. EPA is also seeking input on an even more protective standard of 60ppb. The American Lung Association and the leading medical and public health organizations strongly support the most protective standard under consideration, 60 ppb. A standard set at the most protective level (60ppb) would prevent 7,900 premature deaths and 1.8 million asthma attacks in children, and 1.9 million school days missed in 2025, for all counties in the U.S. expected to meet the standard that year. That estimate does not include California, which is not expected to meet that standard until after 2025. Under a court order, the EPA must adopt a standard by October 1, 2015. The Lung Association will continue to urge the EPA to set the most protective standard.

Set Strong Limits on Air Pollution that Blows Across State Lines

Air pollution, including ozone and particle pollution, can be transported by the wind hundreds of miles away from its source, placing a significant health burden on communities and states that have no ability to limit pollution from neighboring states. The EPA, working with the states, must move rapidly to reduce transported ozone and particle pollution to protect downwind communities, who otherwise have limited ability to intervene or protect themselves. The American Lung Association urges EPA to strengthen

the limits on transported ozone and particle pollution to help downwind states protect their citizens from pollution blown hundreds of miles across the nation.

Clean Up Harmful Emissions from Dirty Diesel Vehicles and Heavy Equipment

Rules the EPA put in effect over the past several years mean that new diesel vehicles and equipment must be much cleaner. Still, the vast majority of diesel trucks, buses, and heavy equipment (such as bulldozers) will likely be in use for thousands more miles, spewing dangerous diesel exhaust into communities and neighborhoods. The good news is that affordable technology exists to cut emissions by 90 percent. Congress needs to fund the EPA's diesel cleanup ("retrofit") program. Congress should also require that clean diesel equipment be used in federally-funded construction programs.

Improve the Air Pollution Monitoring

The grades in this report come from information from the nationwide air pollution monitoring network. That network forms the infrastructure for air pollution. States and local governments use monitors to accurately measure the amount of air pollution in the community.

Less than one-third of all counties have ozone or particle pollution monitors, seriously limiting the ability to adequately detect and track the levels of harmful air pollution. Unfortunately, funds for existing air pollution monitors have been cut across the nation. More monitoring is needed near roadways to measure the highest levels of exposures from air pollution related to traffic. These resources may be cut further unless Congress and the White House resolve to protect the health of the nation from air pollution.

What You Can Do

You can do a great deal to help reduce air pollution outdoors by speaking up and stepping up. Here's how.

1. Speak up for Healthy Air Protections

Tell the White House we need strong standards for carbon pollution from all power plants and truly protective standards for ozone.

Send a message to Congress. Urge them to support cleaner, healthier air and oppose measures to block or delay the cleanup of air pollution. They should support and protect the Clean Air Act.

Share your story. Do you or any member of your family have a personal reason to want healthier, cleaner air? Go to www.Fightingforair.org to let us know how healthy air affects you. Your story helps us remind decision-makers what is at stake when it comes to clean air.

Get involved. Participate in your community's review of its air pollution plans and support state and local efforts to clean up air pollution. To find your local air pollution control agency, go to www.4cleanair.org.

2. Step up to curb pollution at home

Drive less. Combine trips, walk, bike, carpool or vanpool, and use buses, subways or other alternatives to driving. Vehicle emissions are a major source of air pollution. Support community plans that provide ways to get around that don't require a car, such as more sidewalks, bike trails and transit systems.

Use less electricity. Turn out the lights and use energy-efficient appliances. Generating electricity is one of the biggest sources of pollution, particularly in the eastern United States.

Don't burn wood or trash. Burning firewood and trash are among the largest sources of particles in many parts of the country. If you must use a fireplace or stove for heat, convert your woodstoves to natural gas, which has far fewer polluting emissions. Compost and recycle as much as possible and dispose of other waste properly; don't burn it. Support efforts in your community to ban outdoor burning of construction and yard wastes. Avoid the use of outdoor hydronic heaters, also called outdoor wood boilers, which are frequently much more polluting than woodstoves.

Make sure your local school system requires clean school buses, which includes replacing or retrofitting old school buses with filters and other equipment to reduce emissions. Make sure your local schools don't idle their buses, a step that can immediately reduce emissions.

People at Risk from Short-term Particle Pollution (24-Hour $PM_{2.5}$)

	Chronic Diseases						Age Groups			
In Counties where the Grades were:	Adult Asthma	Pediatric Asthma	COPD	CV Disease	Diabetes	Poverty	Under 18	65 and Over	Total Population	Number of Counties
Grade A	5,873,452	1,781,786	4,227,802	5,732,397	6,460,720	12,957,361	19,217,471	11,536,072	83,272,298	301
Grade B	2,615,351	792,005	1,846,023	2,493,590	2,787,986	5,829,437	8,783,638	5,059,225	38,026,959	110
Grade C	1,560,518	415,733	956,618	1,329,569	1,582,604	3,152,549	4,595,488	2,962,552	21,280,654	47
Grade D	842,001	259,211	570,964	763,122	917,382	1,931,586	2,966,989	1,607,707	12,332,260	22
Grade F	2,840,983	922,566	1,691,463	2,353,536	3,056,176	7,051,483	10,305,570	5,245,485	41,695,213	55
National Population in Counties with $PM_{2.5}$ Monitors	15,402,677	4,743,496	10,519,625	14,447,891	16,830,963	34,643,917	52,041,420	29,869,710	222,852,103	645

People at Risk from Year-Round Particle Pollution (Annual $PM_{2.5}$)

	Chronic Diseases						Age Groups			
In Counties where the Grades were:	Adult Asthma	Pediatric Asthma	COPD	CV Disease	Diabetes	Poverty	Under 18	65 and Over	Total Population	Number of Counties
Pass	11,283,728	3,369,299	7,761,955	10,581,911	12,180,145	24,522,130	36,995,221	21,769,489	160,320,502	461
Fail	1,612,794	534,994	950,153	1,320,642	1,789,777	4,456,874	5,905,934	2,993,874	23,972,657	24
National Population in Counties with $PM_{2.5}$ Monitors	15,310,374	4,713,855	10,414,136	14,330,603	16,728,976	34,436,558	51,751,007	29,691,344	221,584,918	637

People at Risk from Ozone

	Chronic Diseases					Age Groups			
In Counties where the Grades were:	Adult Asthma	Pediatric Asthma	COPD	CV Disease	Poverty	Under 18	65 and Over	Total Population	Number of Counties
Grade A	1,623,346	458,994	1,120,203	1,579,454	3,612,375	5,203,594	3,557,443	23,231,242	159
Grade B	1,998,401	534,599	1,458,651	2,052,142	4,088,464	6,156,919	4,374,436	28,290,500	120
Grade C	1,881,476	571,988	1,340,394	1,821,888	3,852,691	6,375,726	3,753,224	27,168,081	136
Grade D	1,656,017	479,459	1,175,434	1,616,503	3,455,764	5,303,158	3,227,038	23,553,321	98
Grade F	8,782,289	2,881,245	5,919,569	8,049,199	20,062,207	30,952,896	16,389,559	128,725,230	254
National Population in Counties with Ozone Monitors	16,255,094	5,020,263	11,240,312	15,444,254	35,729,354	55,043,053	32,008,251	235,696,206	815

Note: *The State of the Air 2015* covers the period 2011-2013. The Appendix provides a full discussion of the methodology.

People at Risk In 25 U.S. Cities Most Polluted by Short-term Particle Pollution (24-hour $PM_{2.5}$)

2015 Rank[1]	Metropolitan Statistical Areas	Total Population[2]	Under 18[3]	65 and Over[3]	Pediatric Asthma[4,6]	Adult Asthma[5,6]	COPD[7]	CV Disease[8]	Diabetes[9]	Poverty[10]
1	Fresno-Madera, CA	1,107,661	320,969	122,769	28,434	68,326	35,215	50,742	76,410	302,747
2	Bakersfield, CA	864,124	256,286	83,355	22,704	52,702	26,422	37,419	57,022	189,029
3	Visalia-Porterville-Hanford, CA	605,103	186,336	59,173	16,507	36,242	18,179	25,830	39,162	161,927
4	Modesto-Merced, CA	788,719	225,161	88,537	19,947	49,080	25,498	36,795	55,529	176,917
5	Los Angeles-Long Beach, CA	18,351,929	4,449,763	2,197,260	394,199	1,212,912	633,626	915,447	1,383,294	3,173,150
6	San Jose-San Francisco-Oakland, CA	8,469,854	1,870,604	1,119,507	165,714	578,767	310,320	453,045	682,920	1,014,067
7	Salt Lake City-Provo-Orem, UT	2,389,225	743,554	213,920	45,611	148,651	64,220	99,124	113,349	284,263
8	Logan, UT-ID	129,763	40,841	11,495	2,622	7,895	3,295	5,091	5,762	17,613
9	Fairbanks, AK	100,436	24,790	7,558	2,180	7,074	3,810	4,402	4,592	8,497
10	Pittsburgh-New Castle-Weirton, PA-OH-WV	2,659,937	517,286	481,225	52,576	203,830	159,280	223,889	225,070	336,867
11	Missoula, MT	111,807	21,728	14,635	1,788	7,779	5,266	6,624	5,989	18,908
12	Phoenix-Mesa-Scottsdale, AZ	4,398,762	1,113,693	604,442	121,465	291,167	228,913	301,692	338,791	756,661
13	Yakima, WA	247,044	74,058	30,799	5,090	17,137	9,562	13,435	14,416	51,184
14	Sacramento-Roseville, CA	2,482,660	593,746	341,775	52,599	165,924	90,455	133,253	199,725	402,463
15	New York-Newark, NY-NJ-CT-PA	23,484,225	5,208,397	3,308,078	470,293	1,741,306	1,049,821	1,565,768	1,777,519	3,265,046
15	Reno-Carson City-Fernley, NV	590,428	131,134	92,788	10,308	34,894	32,226	43,075	46,707	85,454
17	El Paso-Las Cruces, TX-NM	1,044,496	294,994	119,945	26,262	57,674	40,385	55,829	78,609	241,447
18	Seattle-Tacoma, WA	4,459,677	987,530	573,920	67,874	345,126	192,013	264,420	287,959	558,610
19	Harrisburg-York-Lebanon, PA	1,233,708	271,818	197,882	27,743	92,102	68,709	95,169	97,083	131,307
20	Eugene, OR	356,212	68,159	59,766	5,706	32,743	18,846	26,051	26,422	73,471
20	Lancaster, PA	529,600	128,486	85,085	13,114	38,335	28,477	39,703	40,138	54,181
22	Philadelphia-Reading-Camden, PA-NJ-DE-MD	7,146,706	1,611,257	1,034,071	155,846	530,288	359,527	497,353	531,268	953,193
23	Boise City-Mountain Home-Ontario, ID-OR	729,547	195,533	92,525	17,160	46,196	23,556	38,048	43,564	116,913
23	Indianapolis-Carmel-Muncie, IN	2,336,237	581,643	294,556	46,408	180,762	136,419	162,411	185,079	349,835
25	Medford-Grants Pass, OR	291,851	60,714	60,814	5,083	25,843	16,430	23,905	23,756	54,430

Notes:

1. Cities are ranked using the highest weighted average for any county within that Combined or Metropolitan Statistical Area.
2. **Total Population** represents the at-risk populations for all counties within the respective Combined or Metropolitan Statistical Area.
3. Those **under 18** and **65 and over** are vulnerable to $PM_{2.5}$ and are, therefore, included. They should not be used as population denominators for disease estimates.
4. **Pediatric asthma** estimates are for those under 18 years of age and represent the **estimated** number of people who had asthma in 2013 based on state rates (BRFSS) applied to population estimates (U.S. Census).
5. **Adult asthma** estimates are for those 18 years and older and represent the **estimated** number of people who had asthma in 2013 based on state rates (BRFSS) applied to population estimates (U.S. Census).
6. Adding across rows does not produce valid estimates, e.g., summing pediatric and adult asthma.
7. **COPD** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
8. **CV disease** is cardiovascular disease and estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
9. **Diabetes** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
10. **Poverty** estimates come from the U.S. Census Bureau and are for all ages.

People at Risk In 25 U.S. Cities Most Polluted by Year-Round Particle Pollution (Annual $PM_{2.5}$)

2015 Rank[1]	Metropolitan Statistical Areas	Total Population[2]	Under 18[3]	65 and Over[3]	Pediatric Asthma[4,6]	Adult Asthma[5,6]	COPD[7]	CV Disease[8]	Diabetes[9]	Poverty[10]
1	Fresno-Madera, CA	1,107,661	320,969	122,769	28,434	68,326	35,215	50,742	76,410	302,747
2	Bakersfield, CA	864,124	256,286	83,355	22,704	52,702	26,422	37,419	57,022	189,029
3	Visalia-Porterville-Hanford, CA	605,103	186,336	59,173	16,507	36,242	18,179	25,830	39,162	161,927
4	Modesto-Merced, CA	788,719	225,161	88,537	19,947	49,080	25,498	36,795	55,529	176,917
5	Los Angeles-Long Beach, CA	18,351,929	4,449,763	2,197,260	394,199	1,212,912	633,626	915,447	1,383,294	3,173,150
6	El Centro, CA	176,584	50,940	20,339	4,513	10,926	5,688	8,239	12,374	38,067
7	San Jose-San Francisco-Oakland, CA	8,469,854	1,870,604	1,119,507	165,714	578,767	310,320	453,045	682,920	1,014,067
8	Cincinnati-Wilmington-Maysville, OH-KY-IN	2,196,629	533,524	292,504	52,177	161,635	144,112	168,306	166,969	309,586
9	Pittsburgh-New Castle-Weirton, PA-OH-WV	2,659,937	517,286	481,225	52,576	203,830	159,280	223,889	225,070	336,867
10	Cleveland-Akron-Canton, OH	3,501,538	772,540	570,198	75,140	264,324	232,292	288,367	291,142	536,298
11	Philadelphia-Reading-Camden, PA-NJ-DE-MD	7,146,706	1,611,257	1,034,071	155,846	530,288	359,527	497,353	531,268	953,193
12	Harrisburg-York-Lebanon, PA	1,233,708	271,818	197,882	27,743	92,102	68,709	95,169	97,083	131,307
12	Johnstown-Somerset, PA	217,019	41,189	42,975	4,204	16,628	13,282	19,100	19,064	30,560
14	New York-Newark, NY-NJ-CT-PA	23,484,225	5,208,397	3,308,078	470,293	1,741,306	1,049,821	1,565,768	1,777,519	3,265,046
15	Louisville/Jefferson County—Elizabethtown—Madison, KY-IN	1,490,724	349,525	205,747	34,072	110,025	117,040	131,892	121,025	211,086
16	Lancaster, PA	529,600	128,486	85,085	13,114	38,335	28,477	39,703	40,138	54,181
17	Altoona, PA	126,314	25,974	23,918	2,651	9,508	7,457	10,666	10,652	19,894
17	Birmingham-Hoover-Talladega, AL	1,313,105	305,712	189,321	36,432	85,980	104,029	125,962	138,180	218,927
17	Indianapolis-Carmel-Muncie, IN	2,336,237	581,643	294,556	46,408	180,762	136,419	162,411	185,079	349,835
20	Houston-The Woodlands, TX	6,508,323	1,760,785	631,535	159,533	344,949	250,334	343,680	498,871	1,050,548
20	Macon-Warner Robins, GA	417,473	103,022	55,398	11,089	26,250	21,100	27,171	35,246	86,505
22	Little Rock-North Little Rock, AR	898,683	215,724	122,384	18,967	56,224	59,676	77,035	75,464	142,834
23	El Paso-Las Cruces, TX-NM	1,044,496	294,994	119,945	26,262	57,674	40,385	55,829	78,609	241,447
23	Erie-Meadville, PA	367,670	80,160	58,675	8,182	27,546	20,343	28,126	28,655	59,912
23	Shreveport-Bossier City, LA	446,471	109,612	63,421	8,616	26,048	25,350	38,720	39,654	87,957
23	Wheeling, WV-OH	145,757	28,128	27,425	2,584	10,958	11,583	15,334	14,519	22,679

Notes:

1. Cities are ranked using the highest Design Value for any county within that Combined or Metropolitan Statistical Area.
2. **Total Population** represents the at-risk populations for all counties within the respective Combined or Metropolitan Statistical Area.
3. Those **under 18** and **65 and over** are vulnerable to $PM_{2.5}$ and are, therefore, included. They should not be used as population denominators for disease estimates.
4. **Pediatric asthma** estimates are for those under 18 years of age and represent the **estimated** number of people who had asthma in 2013 based on state rates (BRFSS) applied to population estimates (U.S. Census).
5. **Adult asthma** estimates are for those 18 years and older and represent the **estimated** number of people who had asthma in 2013 based on state rates (BRFSS) applied to population estimates (U.S. Census).
6. Adding across rows does not produce valid estimates, e.g., summing pediatric and adult asthma.
7. **COPD** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
8. **CV disease** is cardiovascular disease and estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
9. **Diabetes** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
10. **Poverty** estimates come from the U.S. Census Bureau and are for all ages.

People at Risk In 25 Most Ozone-Polluted Cities

2015 Rank[1]	Metropolitan Statistical Areas	Total Population[2]	Under 18[3]	65 and Over[3]	Pediatric Asthma[4,6]	Adult Asthma[5,6]	COPD[7]	CV Disease[8]	Poverty[9]
1	Los Angeles-Long Beach, CA	18,351,929	4,449,763	2,197,260	394,199	1,212,912	633,626	915,447	3,173,150
2	Visalia-Porterville-Hanford, CA	605,103	186,336	59,173	16,507	36,242	18,179	25,830	161,927
3	Bakersfield, CA	864,124	256,286	83,355	22,704	52,702	26,422	37,419	189,029
4	Fresno-Madera, CA	1,107,661	320,969	122,769	28,434	68,326	35,215	50,742	302,747
5	Sacramento-Roseville, CA	2,482,660	593,746	341,775	52,599	165,924	90,455	133,253	402,463
6	Houston-The Woodlands, TX	6,508,323	1,760,785	631,535	159,533	344,949	250,334	343,680	1,050,548
7	Dallas-Fort Worth, TX-OK	7,206,144	1,935,629	745,554	175,579	384,060	282,399	392,934	1,069,998
8	Modesto-Merced, CA	788,719	225,161	88,537	19,947	49,080	25,498	36,795	176,917
9	Las Vegas-Henderson, NV-AZ	2,273,195	536,416	324,174	43,350	134,010	116,515	154,614	375,479
10	Phoenix-Mesa-Scottsdale, AZ	4,398,762	1,113,693	604,442	121,465	291,167	228,913	301,692	756,661
11	New York-Newark, NY-NJ-CT-PA	23,484,225	5,208,397	3,308,078	470,293	1,741,306	1,049,821	1,565,768	3,265,046
12	Tulsa-Muskogee-Bartlesville, OK	1,131,458	282,545	160,838	31,199	76,507	66,702	87,508	169,693
13	Denver-Aurora, CO	3,277,309	784,677	370,191	68,992	218,369	109,846	142,143	397,651
14	El Centro, CA	176,584	50,940	20,339	4,513	10,926	5,688	8,239	38,067
15	Oklahoma City-Shawnee, OK	1,390,835	346,127	175,414	38,220	93,837	78,343	100,459	205,084
16	Fort Collins, CO	315,988	65,099	42,528	5,724	21,966	11,353	15,046	42,547
16	St. Louis-St. Charles-Farmington, MO-IL	2,905,893	666,421	421,158	53,945	225,143	156,154	221,691	379,992
18	Grand Rapids-Wyoming-Muskegon, MI	1,407,323	347,323	185,874	38,021	122,354	89,486	104,530	203,843
19	Chicago-Naperville, IL-IN-WI	9,912,730	2,380,781	1,245,287	218,620	589,842	386,984	620,405	1,403,734
20	Sheboygan, WI	114,922	26,382	18,161	2,049	9,145	5,237	7,646	12,249
21	Pittsburgh-New Castle-Weirton, PA-OH-WV	2,659,937	517,286	481,225	52,576	203,830	159,280	223,889	336,867
22	Washington-Baltimore-Arlington, DC-MD-VA-WV-PA	9,443,180	2,176,749	1,149,549	222,089	685,067	418,692	570,448	883,118
23	Cincinnati-Wilmington-Maysville, OH-KY-IN	2,196,629	533,524	292,504	52,177	161,635	144,112	168,306	309,586
24	Kansas City-Overland Park-Kansas City, MO-KS	2,393,623	587,534	310,151	49,264	182,028	123,128	167,116	308,003
25	Memphis-Forrest City, TN-MS-AR	1,369,006	351,480	160,432	31,860	74,363	91,085	117,293	272,926
25	South Bend-Elkhart-Mishawaka, IN-MI	721,543	178,949	107,828	15,661	57,641	45,224	55,249	122,532

Notes:

1. Cities are ranked using the highest weighted average for any county within that Combined or Metropolitan Statistical Area.
2. **Total Population** represents the at-risk populations for all counties within the respective Combined or Metropolitan Statistical Area.
3. Those **under 18** and **65 and over** are vulnerable to $PM_{2.5}$ and are, therefore, included. They should not be used as population denominators for disease estimates.
4. **Pediatric asthma** estimates are for those under 18 years of age and represent the **estimated** number of people who had asthma in 2013 based on state rates (BRFSS) applied to population estimates (U.S. Census).
5. **Adult asthma** estimates are for those 18 years and older and represent the **estimated** number of people who had asthma in 2013 based on state rates (BRFSS) applied to population estimates (U.S. Census).
6. Adding across rows does not produce valid estimates, e.g., summing pediatric and adult asthma.
7. **COPD** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
8. **CV disease** is cardiovascular disease and estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
9. **Poverty** estimates come from the U.S. Census Bureau and are for all ages.

People at Risk in 25 Counties Most Polluted by Short-term Particle Pollution (24-hour $PM_{2.5}$)

2015 Rank[1]	County	ST	Total Population[2]	At-Risk Groups							High $PM_{2.5}$ Days in Unhealthy Ranges, 2011–2013	
				Under 18[3]	65 and Over[3]	Pediatric Asthma[4,6]	Adult Asthma[5,6]	COPD[7]	CV Disease[8]	Diabetes[9]	Poverty[10]	Weighted Avg.[11]	Grade[12]
1	Fresno	CA	955,272	278,110	103,705	24,637	58,765	30,120	43,282	65,253	268,773	47.0	F
2	Kern	CA	864,124	256,286	83,355	22,704	52,702	26,422	37,419	57,022	189,029	43.2	F
3	Kings	CA	150,960	41,854	13,265	3,708	9,403	4,549	6,334	9,707	28,877	40.8	F
4	Stanislaus	CA	525,491	145,255	61,652	12,868	33,197	17,455	25,308	38,162	113,074	38.0	F
5	Riverside	CA	2,292,507	615,555	294,281	54,531	146,427	78,238	114,669	171,404	392,513	33.5	F
6	Lemhi	ID	7,712	1,375	2,037	121	554	376	652	697	1,373	31.2	F
7	Madera	CA	152,389	42,859	19,064	3,797	9,561	5,096	7,460	11,157	33,974	28.8	F
8	Los Angeles	CA	10,017,068	2,322,711	1,187,071	205,766	670,227	347,183	499,827	755,975	1,872,964	26.2	F
9	Ravalli	MT	40,823	8,450	8,950	695	2,778	2,339	3,330	2,860	8,008	23.7	F
10	San Joaquin	CA	704,379	198,720	80,542	17,604	44,161	23,160	33,502	50,634	137,451	21.3	F
11	Salt Lake	UT	1,079,721	308,137	101,015	18,902	69,914	30,586	47,220	54,135	134,970	20.7	F
12	Cache	UT	116,909	36,460	9,753	2,237	7,169	2,905	4,439	5,033	16,042	19.3	F
13	Merced	CA	263,228	79,906	26,885	7,079	15,883	8,043	11,487	17,367	63,843	18.2	F
14	Franklin	ID	12,854	4,381	1,742	385	726	390	652	729	1,571	17.7	F
15	Utah	UT	551,891	193,132	38,512	11,847	31,871	12,467	18,561	21,205	74,189	16.2	F
16	Fairbanks North Star Borough	AK	100,436	24,790	7,558	2,180	7,074	3,810	4,402	4,592	8,497	15.5	F
17	Shoshone	ID	12,690	2,510	2,652	221	882	544	922	1,017	2,431	13.8	F
18	Weber	UT	238,519	69,901	25,995	4,288	15,323	6,998	11,195	12,669	31,343	12.8	F
19	Tulare	CA	454,143	144,482	45,908	12,799	26,839	13,630	19,496	29,455	133,050	11.2	F
20	Allegheny	PA	1,231,527	235,864	210,970	24,074	95,161	70,847	98,751	99,933	161,788	10.0	F
21	Inyo	CA	18,467	3,888	3,782	344	1,307	807	1,254	1,834	2,839	9.8	F
22	Lake	OR	7,820	1,407	1,774	118	712	470	690	691	1,543	9.3	F
23	Silver Bow	MT	34,523	7,154	5,856	589	2,359	1,781	2,394	2,112	6,709	9.0	F
24	Missoula	MT	111,807	21,728	14,635	1,788	7,779	5,266	6,624	5,989	18,908	8.2	F
25	Maricopa	AZ	4,009,412	1,016,299	538,073	110,843	265,248	207,731	272,789	306,866	696,086	7.7	F

Notes:

1. Counties are ranked by weighted average. See note 11 below.
2. **Total Population** represents the at-risk populations in counties with $PM_{2.5}$ monitors.
3. Those **under 18** and **65 and over** are vulnerable to $PM_{2.5}$ and are, therefore, included. They should not be used as population denominators for disease estimates.
4. **Pediatric asthma** estimates are for those under 18 years of age and represent the **estimated** number of people who had asthma in 2013 based on state rates (BRFSS) applied to population estimates (U.S. Census).
5. **Adult asthma** estimates are for those 18 years and older and represent the **estimated** number of people who had asthma in 2013 based on state rates (BRFSS) applied to population estimates (U.S. Census).
6. Adding across rows does not produce valid estimates, e.g., summing pediatric and adult asthma.
7. **COPD** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
8. **CV disease** is cardiovascular disease and estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
9. **Diabetes** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
10. **Poverty** estimates come from the U.S. Census Bureau and are for all ages.
11. The **Weighted Average** was derived by counting the number of days in each unhealthful range (orange, red, purple, maroon) in each year (2011-2013), multiplying the total in each range by the assigned standard weights (i.e., 1 for orange, 1.5 for red, 2.0 for purple, 2.5 for maroon), and calculating the average.
12. **Grade** is assigned by weighted average as follows: A=0.0, B=0.3-0.9, C=1.0-2.0, D=2.1-3.2, F=3.3+.

People at Risk In 25 Counties Most Polluted by Year-Round Particle Pollution (Annual $PM_{2.5}$)

2015 Rank[1]	County	ST	Total Population[2]	At-Risk Groups								$PM_{2.5}$ Annual, 2011–2013	
				Under 18[3]	65 and Over[3]	Pediatric Asthma[4,6]	Adult Asthma[5,6]	COPD[7]	CV Disease[8]	Diabetes[9]	Poverty[10]	Design Value[11]	Pass/ Grade[12]
1	Madera	CA	152,389	42,859	19,064	3,797	9,561	5,096	7,460	11,157	33,974	18.1	Fail
2	Kern	CA	864,124	256,286	83,355	22,704	52,702	26,422	37,419	57,022	189,029	17.3	Fail
3	Kings	CA	150,960	41,854	13,265	3,708	9,403	4,549	6,334	9,707	28,877	17.0	Fail
4	Tulare	CA	454,143	144,482	45,908	12,799	26,839	13,630	19,496	29,455	133,050	16.6	Fail
5	Fresno	CA	955,272	278,110	103,705	24,637	58,765	30,120	43,282	65,253	268,773	16.4	Fail
6	Stanislaus	CA	525,491	145,255	61,652	12,868	33,197	17,455	25,308	38,162	113,074	15.7	Fail
7	Riverside	CA	2,292,507	615,555	294,281	54,531	146,427	78,238	114,669	171,404	392,513	15.1	Fail
8	Imperial	CA	176,584	50,940	20,339	4,513	10,926	5,688	8,239	12,374	38,067	14.3	Fail
9	San Joaquin	CA	704,379	198,720	80,542	17,604	44,161	23,160	33,502	50,634	137,451	13.8	Fail
10	Butler	OH	371,272	90,516	47,573	8,804	27,488	22,452	26,395	27,170	47,855	13.6	Fail
11	Allegheny	PA	1,231,527	235,864	210,970	24,074	95,161	70,847	98,751	99,933	161,788	13.4	Fail
12	Merced	CA	263,228	79,906	26,885	7,079	15,883	8,043	11,487	17,367	63,843	13.3	Fail
13	Los Angeles	CA	10,017,068	2,322,711	1,187,071	205,766	670,227	347,183	499,827	755,975	1,872,964	13.0	Fail
14	Plumas	CA	18,859	3,263	4,525	289	1,413	916	1,445	2,104	2,917	12.8	Fail
14	Shoshone	ID	12,690	2,510	2,652	221	882	544	922	1,017	2,431	12.8	Fail
16	San Bernardino	CA	2,088,371	578,417	208,565	51,241	131,342	66,473	94,315	144,112	392,242	12.6	Fail
17	Cuyahoga	OH	1,263,154	274,640	204,413	26,713	95,840	83,463	103,263	104,358	237,268	12.5	Fail
18	Delaware	PA	561,973	127,010	83,515	12,963	41,833	30,268	41,306	42,428	58,964	12.4	Fail
19	Hamilton	OH	804,520	187,530	111,965	18,240	60,236	50,042	59,823	61,195	146,764	12.3	Fail
19	Cambria	PA	140,499	26,993	27,742	2,755	10,734	8,555	12,302	12,269	21,465	12.3	Fail
19	Lebanon	PA	135,486	30,953	24,472	3,159	9,919	7,709	10,984	10,988	14,738	12.3	Fail
22	Northampton	PA	299,791	62,361	50,896	6,365	22,672	17,132	23,940	24,274	29,237	12.2	Fail
23	Stark	OH	375,432	83,018	64,778	8,075	28,238	25,229	31,786	31,920	56,543	12.1	Fail
23	Clark	IN	112,938	26,181	15,741	2,089	8,942	6,941	8,386	9,499	13,047	12.1	Fail
25	Lancaster	PA	529,600	128,486	85,085	13,114	38,335	28,477	39,703	40,138	54,181	12.0	Pass
25	Lemhi	ID	7,712	1,375	2,037	121	554	376	652	697	1,373	12.0	Pass

Notes:

1. Counties are ranked by Design Value. See note 11 below.
2. **Total Population** represents the at-risk populations in counties with $PM_{2.5}$ monitors.
3. Those **under 18** and **65 and over** are vulnerable to $PM_{2.5}$ and are, therefore, included. They should not be used as population denominators for disease estimates.
4. **Pediatric asthma** estimates are for those under 18 years of age and represent the **estimated** number of people who had asthma in 2013 based on state rates (BRFSS) applied to population estimates (U.S. Census).
5. **Adult asthma** estimates are for those 18 years and older and represent the **estimated** number of people who had asthma in 2013 based on state rates (BRFSS) applied to population estimates (U.S. Census).
6. Adding across rows does not produce valid estimates, e.g., summing pediatric and adult asthma.
7. **COPD** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
8. **CV disease** is cardiovascular disease and estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
9. **Diabetes** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
10. **Poverty** estimates come from the U.S. Census Bureau and are for all ages.
11. The **Design Value** is the calculated concentration of a pollutant based on the form of the Annual $PM_{2.5}$ National Ambient Air Quality Standard, and is used by EPA to determine whether the air quality in a county meets the current (2012) standard. (U.S. EPA).
12. **Grades** are based on EPA's determination of meeting or failure to meet the NAAQS for annual $PM_{2.5}$ levels during 2011-2013. Counties meeting the NAAQS received grades of Pass; counties not meeting the NAAQS received grades of Fail.

People at Risk in 25 Most Ozone-Polluted Counties

2014 Rank[1]	County	ST	Total Population[2]	At-Risk Groups							High Ozone Days in Unhealthy Ranges, 2011–2013	
				Under 18[3]	65 and Over[3]	Pediatric Asthma[4,6]	Adult Asthma[5,6]	COPD[7]	CV Disease[8]	Poverty[9]	Weighted Avg.[10]	Grade[11]
1	San Bernardino	CA	2,088,371	578,417	208,565	51,241	131,342	66,473	94,315	392,242	117.7	F
2	Riverside	CA	2,292,507	615,555	294,281	54,531	146,427	78,238	114,669	392,513	97.0	F
3	Tulare	CA	454,143	144,482	45,908	12,799	26,839	13,630	19,496	133,050	82.7	F
4	Los Angeles	CA	10,017,068	2,322,711	1,187,071	205,766	670,227	347,183	499,827	1,872,964	76.7	F
5	Kern	CA	864,124	256,286	83,355	22,704	52,702	26,422	37,419	189,029	69.7	F
6	Fresno	CA	955,272	278,110	103,705	24,637	58,765	30,120	43,282	268,773	68.0	F
7	Uintah	UT	35,555	11,918	3,248	731	2,140	943	1,472	3,817	35.2	F
8	Madera	CA	152,389	42,859	19,064	3,797	9,561	5,096	7,460	33,974	31.8	F
9	Sacramento	CA	1,462,131	360,895	181,076	31,971	96,329	51,022	74,142	272,592	30.7	F
10	Harris	TX	4,336,853	1,187,625	388,443	107,603	228,402	162,296	218,480	788,276	24.7	F
11	Kings	CA	150,960	41,854	13,265	3,708	9,403	4,549	6,334	28,877	23.5	F
12	Tarrant	TX	1,911,541	522,683	189,414	47,357	100,974	73,732	101,859	286,019	22.8	F
13	Stanislaus	CA	525,491	145,255	61,652	12,868	33,197	17,455	25,308	113,074	22.3	F
14	Denton	TX	728,799	193,127	60,255	17,498	38,783	27,427	36,309	64,055	21.7	F
15	Duchesne	UT	20,308	6,956	2,187	427	1,211	557	905	2,091	20.5	F
16	Clark	NV	2,027,868	489,627	260,156	38,488	116,641	100,210	130,734	325,684	20.3	F
17	Maricopa	AZ	4,009,412	1,016,299	538,073	110,843	265,248	207,731	272,789	696,086	19.7	F
18	El Dorado	CA	181,737	38,761	31,203	3,434	12,858	7,672	11,621	20,575	19.5	F
19	Fairfield	CT	939,904	224,358	133,684	22,052	70,241	41,397	57,941	88,010	18.8	F
20	Tulsa	OK	622,409	158,584	79,490	17,511	41,724	35,246	45,356	95,783	18.3	F
21	Jefferson	CO	551,798	117,185	78,326	10,303	37,656	21,088	28,059	49,495	17.0	F
22	Dallas	TX	2,480,331	671,624	234,557	60,851	131,322	94,013	127,961	477,557	16.8	F
23	Imperial	CA	176,584	50,940	20,339	4,513	10,926	5,688	8,239	38,067	16.2	F
24	Oklahoma	OK	755,245	192,521	93,326	21,258	50,525	41,992	53,722	129,256	15.7	F
25	Collin	TX	854,778	235,649	79,420	21,351	44,958	32,871	44,949	67,525	15.3	F

Notes:

1. Counties are ranked by weighted average. See note 10 below.
2. Total Population represents the at-risk populations in counties with $PM_{2.5}$ monitors.
3. Those **under 18** and **65 and over** are vulnerable to $PM_{2.5}$ and are, therefore, included. They should not be used as population denominators for disease estimates.
4. **Pediatric asthma** estimates are for those under 18 years of age and represent the **estimated** number of people who had asthma in 2013 based on state rates (BRFSS) applied to population estimates (U.S. Census).
5. **Adult asthma** estimates are for those 18 years and older and represent the **estimated** number of people who had asthma in 2013 based on state rates (BRFSS) applied to population estimates (U.S. Census).
6. Adding across rows does not produce valid estimates, e.g., summing pediatric and adult asthma.
7. **COPD** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
8. **CV disease** is cardiovascular disease and estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
9. **Poverty** estimates come from the U.S. Census Bureau and are for all ages.
10. The **Weighted Average** was derived by counting the number of days in each unhealthful range (orange, red, purple) in each year (2011-2013), multiplying the total in each range by the assigned standard weights (i.e., 1 for orange, 1.5 for red, 2.0 for purple), and calculating the average.
11. Grade is assigned by weighted average as follows: A=0.0, B=0.3-0.9, C=1.0-2.0, D=2.1-3.2, F=3.3+.

Cleanest U.S. Cities for Short-term Particle Pollution (24-hour $PM_{2.5}$)[1]

Metropolitan Statistical Area	Population
Alexandria, LA	154,753
Asheville-Brevard, NC	470,560
Austin-Round Rock, TX	1,883,051
Bangor, ME	153,364
Beckley, WV	124,432
Bismarck, ND	123,751
Bloomington-Bedford, IN	208,933
Bowling Green-Glasgow, KY	216,546
Brownsville-Harlingen-Raymondville, TX	439,197
Buffalo-Cheektowaga, NY	1,213,007
Cape Coral-Fort Myers-Naples, FL	1,000,757
Charleston-Huntington-Ashland, WV-OH-KY	702,984
Charlotte-Concord, NC-SC	2,493,040
Charlottesville, VA	224,055
Chattanooga-Cleveland-Dalton, TN-GA-AL	940,299
Cincinnati-Wilmington-Maysville, OH-KY-IN	2,196,629
Colorado Springs, CO	678,319
Columbus-Marion-Zanesville, OH	2,370,839
Dayton-Springfield-Sidney, OH	1,079,679
Des Moines-Ames-West Des Moines, IA	755,200
Dothan-Enterprise-Ozark, AL	248,513
Eau Claire-Menomonie, WI	208,692
Elmira-Corning, NY	187,156
Fargo-Wahpeton, ND-MN	246,386
Farmington, NM	126,503
Fayetteville-Lumberton-Laurinburg, NC	548,059
Fayetteville-Springdale-Rogers, AR-MO	491,966
Flagstaff, AZ	136,539
Florence, SC	206,261
Florence-Muscle Shoals, AL	147,317
Fort Collins, CO	315,988
Fort Smith, AR-OK	279,974
Gadsden, AL	103,931
Goldsboro, NC	124,583
Grand Island, NE	83,989
Greenville-Washington, NC	221,727
Gulfport-Biloxi-Pascagoula, MS	382,516
Harrisonburg-Staunton-Waynesboro, VA	248,661
Hickory-Lenoir, NC	408,533
Homosassa Springs, FL	139,271
Hot Springs-Malvern, AR	130,673
Houma-Thibodaux, LA	209,890
Houston-The Woodlands, TX	6,508,323
Huntsville-Decatur-Albertville, AL	683,871
Kahului-Wailuku-Lahaina, HI	160,292
Kalamazoo-Battle Creek-Portage, MI	528,156
La Crosse-Onalaska, WI-MN	135,512
Lafayette-Opelousas-Morgan City, LA	616,113
Lake Charles, LA	202,040
Lakeland-Winter Haven, FL	623,009
Lansing-East Lansing-Owosso, MI	536,221
Lexington-Fayette-Richmond-Frankfort, KY	708,677
Lima-Van Wert-Celina, OH	220,461
Lincoln-Beatrice, NE	335,989
Lynchburg, VA	256,455
Macon-Warner Robins, GA	417,473
McAllen-Edinburg, TX	877,959
Mobile-Daphne-Fairhope, AL	609,619
Monroe-Ruston-Bastrop, LA	253,035
Montgomery, AL	373,510
Morgantown-Fairmont, WV	193,001
New Orleans-Metairie-Hammond, LA-MS	1,467,880
North Port-Sarasota, FL	931,788
Oklahoma City-Shawnee, OK	1,390,835
Owensboro, KY	116,401
Palm Bay-Melbourne-Titusville, FL	550,823
Parkersburg-Marietta-Vienna, WV-OH	153,780
Pensacola-Ferry Pass-Brent, FL	466,913
Pittsfield, MA	129,585
Portland-Lewiston-South Portland, ME	627,504
Prescott, AZ	215,133
Pueblo-Cañon City, CO	207,902
Rapid City-Spearfish, SD	166,341
Richmond, VA	1,245,764
Roanoke, VA	311,835
Rochester-Austin, MN	251,180
Rochester-Batavia-Seneca Falls, NY	1,178,141
Rocky Mount-Wilson-Roanoke Rapids, NC	306,626
Saginaw-Midland-Bay City, MI	387,293
Salinas, CA	428,826
Salisbury, MD-DE	385,438
San Antonio-New Braunfels, TX	2,277,550
Santa Maria-Santa Barbara, CA	435,697
Sierra Vista-Douglas, AZ	129,473
Sioux Falls, SD	243,513
Springfield-Branson, MO	533,616
Springfield-Greenfield Town, MA	698,136
St. George, UT	147,800
Syracuse-Auburn, NY	741,411
Tallahassee-Bainbridge, FL-GA	400,614
Tampa-St. Petersburg-Clearwater, FL	2,870,569
Texarkana, TX-AR	149,619
Toledo-Port Clinton, OH	649,298
Tulsa-Muskogee-Bartlesville, OK	1,131,458
Waterloo-Cedar Falls, IA	169,484
Wheeling, WV-OH	145,757
Wichita-Arkansas City-Winfield, KS	673,598

Note:

1. Monitors in these cities reported no days when $PM_{2.5}$ levels reached the unhealthful range using the Air Quality Index based on the 2006 NAAQS.

Top 25 Cleanest U.S. Cities for Year-Round Particle Pollution (Annual $PM_{2.5}$)[1]

Rank[2]	Design Value[3]	Metropolitan Statistical Area	Population
1	4.2	Prescott, AZ	215,133
2	4.7	Farmington, NM	126,503
3	4.8	Casper, WY	80,973
3	4.8	Cheyenne, WY	95,809
5	5.3	Flagstaff, AZ	136,539
6	6.1	Duluth, MN-WI	279,887
6	6.1	Kahului-Wailuku-Lahaina, HI	160,292
6	6.1	Palm Bay-Melbourne-Titusville, FL	550,823
6	6.1	Salinas, CA	428,826
10	6.2	Anchorage, AK	396,142
10	6.2	Bismarck, ND	123,751
10	6.2	Rapid City-Spearfish, SD	166,341
13	6.5	Cape Coral-Fort Myers-Naples, FL	1,000,757
13	6.5	Elmira-Corning, NY	187,156
15	6.6	North Port-Sarasota, FL	931,788
16	6.7	Albuquerque-Santa Fe-Las Vegas, NM	1,163,966
16	6.7	Sierra Vista-Douglas, AZ	129,473
18	6.9	Burlington-South Burlington, VT	214,796
19	7.0	Fargo-Wahpeton, ND-MN	246,386
19	7.0	Homosassa Springs, FL	139,271
19	7.0	Lakeland-Winter Haven, FL	623,009
19	7.0	Orlando-Deltona-Daytona Beach, FL	2,975,658
23	7.1	Bangor, ME	153,364
23	7.1	Miami-Fort Lauderdale-Port St. Lucie, FL	6,447,610
23	7.1	Tampa-St. Petersburg-Clearwater, FL	2,870,569
23	7.1	Urban Honolulu, HI	983,429

Notes:

1. This list represents cities with the lowest levels of annual $PM_{2.5}$ air pollution.
2. Cities are ranked by using the highest design value for any county within that metropolitan area.
3. The **Design Value** is the calculated concentration of a pollutant based on the form of the Annual $PM_{2.5}$ National Ambient Air Quality Standard, and is used by EPA to determine whether the air quality in a county meets the current (2012) standard, (U.S. EPA).

Cleanest U.S. Cities for Ozone Air Pollution[1]

Metropolitan Statistical Area	Population
Bellingham, WA	206,353
Bend-Redmond-Prineville, OR	186,769
Bismarck, ND	123,751
Blacksburg-Christiansburg-Radford, VA	180,351
Brownsville-Harlingen-Raymondville, TX	439,197
Brunswick, GA	113,807
Burlington-South Burlington, VT	214,796
Cape Coral-Fort Myers-Naples, FL	1,000,757
Charleston-North Charleston, SC	712,220
Cheyenne, WY	95,809
Crestview-Fort Walton Beach-Destin, FL	253,618
Des Moines-Ames-West Des Moines, IA	755,200
Dothan-Enterprise-Ozark, AL	248,513
Eau Claire-Menomonie, WI	208,692
Elmira-Corning, NY	187,156
Eugene, OR	356,212
Fairbanks, AK	100,436
Fargo-Wahpeton, ND-MN	246,386
Gadsden, AL	103,931
Gainesville-Lake City, FL	337,925
Harrisonburg-Staunton-Waynesboro, VA	248,661
Idaho Falls-Rexburg-Blackfoot, ID	232,740
Ithaca-Cortland, NY	152,593
La Crosse-Onalaska, WI-MN	135,512
Lincoln-Beatrice, NE	335,989
Logan, UT-ID	129,763
McAllen-Edinburg, TX	877,959
Medford-Grants Pass, OR	291,851
Missoula, MT	111,807
Monroe-Ruston-Bastrop, LA	253,035
Montgomery, AL	373,510
New Bern-Morehead City, NC	196,091
Panama City, FL	190,816
Rapid City-Spearfish, SD	166,341
Rochester-Austin, MN	251,180
Rockford-Freeport-Rochelle, IL	443,748
Rome-Summerville, GA	120,959
Salinas, CA	428,826
Savannah-Hinesville-Statesboro, GA	518,020
Sebring, FL	97,616
Sioux City-Vermillion, IA-SD-NE	182,649
Sioux Falls, SD	243,513
Spokane-Spokane Valley-Coeur d'Alene, WA-ID	679,989
Steamboat Springs-Craig, CO	36,616
Tallahassee-Bainbridge, FL-GA	400,614
Tuscaloosa, AL	235,628
Urban Honolulu, HI	983,429
Utica-Rome, NY	297,766
Waterloo-Cedar Falls, IA	169,484
Wausau-Stevens Point-Wisconsin Rapids, WI	308,439
Williamsport-Lock Haven, PA	156,708

Note:

1. This list represents cities with no monitored ozone air pollution in unhealthful ranges using the Air Quality Index based on 2008 NAAQS.

Cleanest Counties for Short-term Particle Pollution (24-hour $PM_{2.5}$)[1]

County	State	MSAs and Respective CSA[2]
Anchorage Municipality	AK	Anchorage, AK
Kenai Peninsula Borough	AK	
Baldwin	AL	Mobile-Daphne-Fairhope, AL
Clay	AL	
Colbert	AL	Florence-Muscle Shoals, AL
DeKalb	AL	
Etowah	AL	Gadsden, AL
Houston	AL	Dothan-Enterprise-Ozark, AL
Madison	AL	Huntsville-Decatur-Albertville, AL
Mobile	AL	Mobile-Daphne-Fairhope, AL
Montgomery	AL	Montgomery, AL
Morgan	AL	Huntsville-Decatur-Albertville, AL
Russell	AL	Columbus-Auburn-Opelika, GA-AL
Shelby	AL	Birmingham-Hoover-Talladega, AL
Talladega	AL	Birmingham-Hoover-Talladega, AL
Arkansas	AR	
Ashley	AR	
Garland	AR	Hot Springs-Malvern, AR
Jackson	AR	
Polk	AR	
Union	AR	
Washington	AR	Fayetteville-Springdale-Rogers, AR-MO
Cochise	AZ	Sierra Vista-Douglas, AZ
Coconino	AZ	Flagstaff, AZ
Mohave	AZ	Las Vegas-Henderson, NV-AZ
Pima	AZ	Tucson-Nogales, AZ
Yavapai	AZ	Prescott, AZ
Humboldt	CA	
Lake	CA	
Mendocino	CA	
Monterey	CA	Salinas, CA
San Benito	CA	San Jose-San Francisco-Oakland, CA
Santa Barbara	CA	Santa Maria-Santa Barbara, CA
Shasta	CA	Redding-Red Bluff, CA
Sonoma	CA	San Jose-San Francisco-Oakland, CA
Arapahoe	CO	Denver-Aurora, CO
Douglas	CO	Denver-Aurora, CO
El Paso	CO	Colorado Springs, CO
La Plata	CO	
Larimer	CO	Fort Collins, CO
Montezuma	CO	
Pueblo	CO	Pueblo-Cañon City, CO
Litchfield	CT	New York-Newark, NY-NJ-CT-PA
New London	CT	Hartford-West Hartford, CT
Kent	DE	Philadelphia-Reading-Camden, PA-NJ-DE-MD
Sussex	DE	Salisbury, MD-DE
Brevard	FL	Palm Bay-Melbourne-Titusville, FL
Citrus	FL	Homosassa Springs, FL
Escambia	FL	Pensacola-Ferry Pass-Brent, FL
Hillsborough	FL	Tampa-St. Petersburg-Clearwater, FL
Lee	FL	Cape Coral-Fort Myers-Naples, FL
Leon	FL	Tallahassee-Bainbridge, FL-GA
Orange	FL	Orlando-Deltona-Daytona Beach, FL
Pinellas	FL	Tampa-St. Petersburg-Clearwater, FL
Polk	FL	Lakeland-Winter Haven, FL
Sarasota	FL	North Port-Sarasota, FL
Seminole	FL	Orlando-Deltona-Daytona Beach, FL
Bibb	GA	Macon-Warner Robins, GA
Clarke	GA	Atlanta—Athens-Clarke County—Sandy Springs, GA
Clayton	GA	Atlanta—Athens-Clarke County—Sandy Springs, GA
DeKalb	GA	Atlanta—Athens-Clarke County—Sandy Springs, GA
Hall	GA	Atlanta—Athens-Clarke County—Sandy Springs, GA
Houston	GA	Macon-Warner Robins, GA
Walker	GA	Chattanooga-Cleveland-Dalton, TN-GA-AL
Kauai	HI	
Maui	HI	Kahului-Wailuku-Lahaina, HI
Black Hawk	IA	Waterloo-Cedar Falls, IA
Delaware	IA	
Johnson	IA	Cedar Rapids-Iowa City, IA
Lee	IA	
Montgomery	IA	
Polk	IA	Des Moines-Ames-West Des Moines, IA

Notes:
1. Monitors in these counties reported no days when $PM_{2.5}$ levels reached the unhealthful range using the Air Quality Index based on the 2006 NAAQS.

2. MSA and CSA are terms used by the U.S. Office of Management and Budget for statistical purposes. MSA stands for Metropolitan Statistical Area. CSA stands for Combined Statistical Area, which may include multiples and individual counties.

Cleanest Counties for Short-term Particle Pollution (24-hour $PM_{2.5}$)[1] (cont.)

County	State	MSAs and Respective CSA[2]
Pottawattamie	IA	Omaha-Council Bluffs-Fremont, NE-IA
Van Buren	IA	
Delaware	IN	Indianapolis-Carmel-Muncie, IN
Henry	IN	Indianapolis-Carmel-Muncie, IN
LaPorte	IN	Chicago-Naperville, IL-IN-WI
Monroe	IN	Bloomington-Bedford, IN
Spencer	IN	
Johnson	KS	Kansas City-Overland Park-Kansas City, MO-KS
Linn	KS	Kansas City-Overland Park-Kansas City, MO-KS
Sedgwick	KS	Wichita-Arkansas City-Winfield, KS
Sumner	KS	Wichita-Arkansas City-Winfield, KS
Wyandotte	KS	Kansas City-Overland Park-Kansas City, MO-KS
Bell	KY	
Boyd	KY	Charleston-Huntington-Ashland, WV-OH-KY
Campbell	KY	Cincinnati-Wilmington-Maysville, OH-KY-IN
Carter	KY	
Christian	KY	Clarksville, TN-KY
Daviess	KY	Owensboro, KY
Fayette	KY	Lexington-Fayette--Richmond--Frankfort, KY
Hardin KY-IN	KY	Louisville/Jefferson County--Elizabethtown--Madison,
Henderson	KY	Evansville, IN-KY
Madison	KY	Lexington-Fayette--Richmond--Frankfort, KY
McCracken	KY	Paducah-Mayfield, KY-IL
Warren	KY	Bowling Green-Glasgow, KY
Calcasieu Parish	LA	Lake Charles, LA
Iberville Parish	LA	Baton Rouge, LA
Jefferson Parish	LA	New Orleans-Metairie-Hammond, LA-MS
Lafayette Parish	LA	Lafayette-Opelousas-Morgan City, LA
Ouachita Parish	LA	Monroe-Ruston-Bastrop, LA
Rapides Parish	LA	Alexandria, LA
St. Bernard Parish	LA	New Orleans-Metairie-Hammond, LA-MS
Tangipahoa Parish	LA	New Orleans-Metairie-Hammond, LA-MS
Terrebonne Parish	LA	Houma-Thibodaux, LA
Berkshire	MA	Pittsfield, MA
Bristol	MA	Boston-Worcester-Providence, MA-RI-NH-CT
Essex	MA	Boston-Worcester-Providence, MA-RI-NH-CT
Hampden	MA	Springfield-Greenfield Town, MA
Plymouth	MA	Boston-Worcester-Providence, MA-RI-NH-CT
Worcester	MA	Boston-Worcester-Providence, MA-RI-NH-CT
Anne Arundel	MD	Washington-Baltimore-Arlington, DC-MD-VA-WV-PA
Baltimore	MD	Washington-Baltimore-Arlington, DC-MD-VA-WV-PA
Garrett	MD	
Harford	MD	Washington-Baltimore-Arlington, DC-MD-VA-WV-PA
Montgomery	MD	Washington-Baltimore-Arlington, DC-MD-VA-WV-PA
Androscoggin	ME	Portland-Lewiston-South Portland, ME
Aroostook	ME	
Cumberland	ME	Portland-Lewiston-South Portland, ME
Hancock	ME	
Kennebec	ME	
Oxford	ME	
Penobscot	ME	Bangor, ME
Allegan	MI	Grand Rapids-Wyoming-Muskegon, MI
Bay	MI	Saginaw-Midland-Bay City, MI
Berrien	MI	South Bend-Elkhart-Mishawaka, IN-MI
Chippewa	MI	
Genesee	MI	Detroit-Warren-Ann Arbor, MI
Ingham	MI	Lansing-East Lansing-Owosso, MI
Kalamazoo	MI	Kalamazoo-Battle Creek-Portage, MI
Kent	MI	Grand Rapids-Wyoming-Muskegon, MI
Lenawee	MI	Detroit-Warren-Ann Arbor, MI
Macomb	MI	Detroit-Warren-Ann Arbor, MI
Missaukee	MI	
Monroe	MI	Detroit-Warren-Ann Arbor, MI
Oakland	MI	Detroit-Warren-Ann Arbor, MI
Ottawa	MI	Grand Rapids-Wyoming-Muskegon, MI
St. Clair	MI	Detroit-Warren-Ann Arbor, MI

Notes:

1. Monitors in these counties reported no days when $PM_{2.5}$ levels reached the unhealthful range using the Air Quality Index based on the 2006 NAAQS.
2. MSA and CSA are terms used by the U.S. Office of Management and Budget for statistical purposes. MSA stands for Metropolitan Statistical Area. CSA stands for Combined Statistical Area, which may include multiples and individual counties.

Cleanest Counties for Short-term Particle Pollution (24-hour $PM_{2.5}$)[1] (cont.)

County	State	MSAs and Respective CSA[2]
Washtenaw	MI	Detroit-Warren-Ann Arbor, MI
Dakota	MN	Minneapolis-St. Paul, MN-WI
Lyon	MN	
Olmsted	MN	Rochester-Austin, MN
Scott	MN	Minneapolis-St. Paul, MN-WI
Buchanan	MO	Kansas City-Overland Park-Kansas City, MO-KS
Cass	MO	Kansas City-Overland Park-Kansas City, MO-KS
Cedar	MO	
Clay	MO	Kansas City-Overland Park-Kansas City, MO-KS
Greene	MO	Springfield-Branson, MO
Jefferson	MO	St. Louis-St. Charles-Farmington, MO-IL
DeSoto	MS	Memphis-Forrest City, TN-MS-AR
Grenada	MS	
Hancock	MS	Gulfport-Biloxi-Pascagoula, MS
Harrison	MS	Gulfport-Biloxi-Pascagoula, MS
Jackson	MS	Gulfport-Biloxi-Pascagoula, MS
Powder River	MT	
Richland	MT	
Buncombe	NC	Asheville-Brevard, NC
Caswell	NC	
Catawba	NC	Hickory-Lenoir, NC
Chatham	NC	Raleigh-Durham-Chapel Hill, NC
Cumberland	NC	Fayetteville-Lumberton-Laurinburg, NC
Davidson	NC	Greensboro—Winston-Salem—High Point, NC
Durham	NC	Raleigh-Durham-Chapel Hill, NC
Edgecombe	NC	Rocky Mount-Wilson-Roanoke Rapids, NC
Forsyth	NC	Greensboro—Winston-Salem—High Point, NC
Gaston	NC	Charlotte-Concord, NC-SC
Guilford	NC	Greensboro—Winston-Salem—High Point, NC
Haywood	NC	Asheville-Brevard, NC
Jackson	NC	
Martin	NC	
McDowell	NC	Hickory-Lenoir, NC
Mecklenburg	NC	Charlotte-Concord, NC-SC
Mitchell	NC	
Montgomery	NC	
Pitt	NC	Greenville-Washington, NC
Robeson	NC	Fayetteville-Lumberton-Laurinburg, NC
Rowan	NC	Charlotte-Concord, NC-SC
Swain	NC	
Wayne	NC	Goldsboro, NC
Billings	ND	
Burke	ND	
Burleigh	ND	Bismarck, ND
Cass	ND	Fargo-Wahpeton, ND-MN
Dunn	ND	
McKenzie	ND	
Mercer	ND	
Oliver	ND	Bismarck, ND
Hall	NE	Grand Island, NE
Lancaster	NE	Lincoln-Beatrice, NE
Scotts Bluff	NE	
Belknap	NH	Boston-Worcester-Providence, MA-RI-NH-CT
Grafton	NH	
Hillsborough	NH	Boston-Worcester-Providence, MA-RI-NH-CT
Merrimack	NH	Boston-Worcester-Providence, MA-RI-NH-CT
Rockingham	NH	Boston-Worcester-Providence, MA-RI-NH-CT
Atlantic	NJ	Philadelphia-Reading-Camden, PA-NJ-DE-MD
Bergen	NJ	New York-Newark, NY-NJ-CT-PA
Essex	NJ	New York-Newark, NY-NJ-CT-PA
Gloucester	NJ	Philadelphia-Reading-Camden, PA-NJ-DE-MD
Mercer	NJ	New York-Newark, NY-NJ-CT-PA
Middlesex	NJ	New York-Newark, NY-NJ-CT-PA
Morris	NJ	New York-Newark, NY-NJ-CT-PA
Ocean	NJ	New York-Newark, NY-NJ-CT-PA
Passaic	NJ	New York-Newark, NY-NJ-CT-PA
San Juan	NM	Farmington, NM
Bronx	NY	New York-Newark, NY-NJ-CT-PA
Chautauqua	NY	
Erie	NY	Buffalo-Cheektowaga, NY

Notes:

1. Monitors in these counties reported no days when $PM_{2.5}$ levels reached the unhealthful range using the Air Quality Index based on the 2006 NAAQS.
2. MSA and CSA are terms used by the U.S. Office of Management and Budget for statistical purposes. MSA stands for Metropolitan Statistical Area. CSA stands for Combined Statistical Area, which may include multiples and individual counties.

Cleanest Counties for Short-term Particle Pollution (24-hour $PM_{2.5}$)[1] (cont.)

County	State	MSAs and Respective CSA[2]
Essex	NY	
Kings	NY	New York-Newark, NY-NJ-CT-PA
Monroe	NY	Rochester-Batavia-Seneca Falls, NY
New York	NY	New York-Newark, NY-NJ-CT-PA
Niagara	NY	Buffalo-Cheektowaga, NY
Onondaga	NY	Syracuse-Auburn, NY
Orange	NY	New York-Newark, NY-NJ-CT-PA
Queens	NY	New York-Newark, NY-NJ-CT-PA
Richmond	NY	New York-Newark, NY-NJ-CT-PA
Steuben	NY	Elmira-Corning, NY
Suffolk	NY	New York-Newark, NY-NJ-CT-PA
Allen	OH	Lima-Van Wert-Celina, OH
Athens	OH	
Butler	OH	Cincinnati-Wilmington-Maysville, OH-KY-IN
Clark	OH	Dayton-Springfield-Sidney, OH
Franklin	OH	Columbus-Marion-Zanesville, OH
Greene	OH	Dayton-Springfield-Sidney, OH
Hamilton	OH	Cincinnati-Wilmington-Maysville, OH-KY-IN
Lake	OH	Cleveland-Akron-Canton, OH
Lawrence	OH	Charleston-Huntington-Ashland, WV-OH-KY
Lorain	OH	Cleveland-Akron-Canton, OH
Lucas	OH	Toledo-Port Clinton, OH
Medina	OH	Cleveland-Akron-Canton, OH
Montgomery	OH	Dayton-Springfield-Sidney, OH
Portage	OH	Cleveland-Akron-Canton, OH
Preble	OH	
Scioto	OH	Charleston-Huntington-Ashland, WV-OH-KY
Summit	OH	Cleveland-Akron-Canton, OH
Trumbull	OH	Youngstown-Warren, OH-PA
Adair	OK	
Oklahoma	OK	Oklahoma City-Shawnee, OK
Sequoyah	OK	Fort Smith, AR-OK
Tulsa	OK	Tulsa-Muskogee-Bartlesville, OK
Monroe	PA	New York-Newark, NY-NJ-CT-PA
Kent	RI	Boston-Worcester-Providence, MA-RI-NH-CT
Chesterfield	SC	
Florence	SC	Florence, SC
Richland	SC	Columbia-Orangeburg-Newberry, SC
Spartanburg	SC	Greenville-Spartanburg-Anderson, SC
Brookings	SD	
Brown	SD	
Codington	SD	
Custer	SD	Rapid City-Spearfish, SD
Jackson	SD	
Minnehaha	SD	Sioux Falls, SD
Pennington	SD	Rapid City-Spearfish, SD
Hamilton	TN	Chattanooga-Cleveland-Dalton, TN-GA-AL
Bexar	TX	San Antonio-New Braunfels, TX
Bowie	TX	Texarkana, TX-AR
Cameron	TX	Brownsville-Harlingen-Raymondville, TX
Ellis	TX	Dallas-Fort Worth, TX-OK
Harris	TX	Houston-The Woodlands, TX
Hidalgo	TX	McAllen-Edinburg, TX
Travis	TX	Austin-Round Rock, TX
Washington	UT	St. George, UT
Albemarle	VA	Charlottesville, VA
Arlington	VA	Washington-Baltimore-Arlington, DC-MD-VA-WV-PA
Bristol City	VA	Johnson City-Kingsport-Bristol, TN-VA
Charles City	VA	Richmond, VA
Chesterfield	VA	Richmond, VA
Henrico	VA	Richmond, VA
Loudoun	VA	Washington-Baltimore-Arlington, DC-MD-VA-WV-PA
Lynchburg City	VA	Lynchburg, VA
Page	VA	
Roanoke City	VA	Roanoke, VA
Rockingham	VA	Harrisonburg-Staunton-Waynesboro, VA
Salem City	VA	Roanoke, VA
Virginia Beach City	VA	Virginia Beach-Norfolk, VA-NC
Bennington	VT	
Ashland	WI	

Notes:

1. Monitors in these counties reported no days when $PM_{2.5}$ levels reached the unhealthful range using the Air Quality Index based on the 2006 NAAQS.
2. MSA and CSA are terms used by the U.S. Office of Management and Budget for statistical purposes. MSA stands for Metropolitan Statistical Area. CSA stands for Combined Statistical Area, which may include multiples and individual counties.

Cleanest Counties for Short-term Particle Pollution (24-hour $PM_{2.5}$)[1] (cont.)

County	State	MSAs and Respective CSA[2]
Eau Claire	WI	Eau Claire-Menomonie, WI
Forest	WI	
Grant	WI	
Kenosha	WI	Chicago-Naperville, IL-IN-WI
La Crosse	WI	La Crosse-Onalaska, WI-MN
Ozaukee	WI	Milwaukee-Racine-Waukesha, WI
Sauk	WI	Madison-Janesville-Beloit, WI
Taylor	WI	
Vilas	WI	
Waukesha	WI	Milwaukee-Racine-Waukesha, WI
Cabell	WV	Charleston-Huntington-Ashland, WV-OH-KY
Hancock	WV	Pittsburgh-New Castle-Weirton, PA-OH-WV
Harrison	WV	
Kanawha	WV	Charleston-Huntington-Ashland, WV-OH-KY
Marion	WV	Morgantown-Fairmont, WV
Marshall	WV	Wheeling, WV-OH
Monongalia	WV	Morgantown-Fairmont, WV
Ohio	WV	Wheeling, WV-OH
Raleigh	WV	Beckley, WV
Wood	WV	Parkersburg-Marietta-Vienna, WV-OH
Albany	WY	
Park	WY	
Sheridan	WY	

Notes:

1. Monitors in these counties reported no days when $PM_{2.5}$ levels reached the unhealthful range using the Air Quality Index based on the 2006 NAAQS.
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Top 25 Cleanest Counties for Year-Round Particle Pollution (Annual $PM_{2.5}$)[1]

2014 Rank[2]	County	ST	Design Value[3]
1	Lake	CA	3.8
2	Custer	SD	3.9
3	Yavapai	AZ	4.2
3	Jackson	SD	4.3
3	Essex	NY	4.3
5	Billings	ND	4.4
7	Park	WY	4.6
8	Hancock	ME	4.7
8	San Juan	NM	4.7
10	Laramie	WY	4.8
10	Natrona	WY	4.8
12	Albany	WY	4.9
12	Santa Fe	NM	4.9
14	Ashland	WI	5.1
14	Forest	WI	5.1
16	Coconino	AZ	5.3
16	Teton	WY	5.3
18	Vilas	WI	5.4
19	San Benito	CA	5.5
19	Litchfield	CT	5.5
21	Anchorage Municipality	AK	5.6
22	Sweetwater	WY	5.7
22	Palm Beach	FL	5.7
24	Pima	AZ	5.8
25	Mercer	ND	5.9
25	Missaukee	MI	5.9

Notes:

1. This list represents counties with the lowest levels of monitored long term $PM_{2.5}$ air pollution.
2. Counties are ranked by Design Value.
3. The Design Value is the calculated concentration of a pollutant based on the form of the Annual $PM_{2.5}$ National Ambient Air Quality Standard, and is used by EPA to determine whether the air quality in a county meets the current (2012) standard. (U.S. EPA).

Cleanest Counties for Ozone Air Pollution[1]

County	State	Metropolitan Statistical Area
Fairbanks North Star Borough	AK	Fairbanks, AK
Yukon-Koyukuk Census Area	AK	
DeKalb	AL	
Elmore	AL	Montgomery, AL
Etowah	AL	Gadsden, AL
Houston	AL	Dothan-Enterprise-Ozark, AL
Montgomery	AL	Montgomery, AL
Tuscaloosa	AL	Tuscaloosa, AL
Colusa	CA	
Glenn	CA	
Humboldt	CA	
Marin	CA	San Jose-San Francisco-Oakland, CA
Mendocino	CA	
Monterey	CA	Salinas, CA
San Francisco	CA	San Jose-San Francisco-Oakland, CA
San Mateo	CA	San Jose-San Francisco-Oakland, CA
Santa Cruz	CA	San Jose-San Francisco-Oakland, CA
Siskiyou	CA	
Sonoma	CA	San Jose-San Francisco-Oakland, CA
Jackson	CO	
Moffat	CO	Steamboat Springs-Craig, CO
Alachua	FL	Gainesville-Lake City, FL
Baker	FL	Jacksonville-St. Marys-Palatka, FL-GA
Bay	FL	Panama City, FL
Collier	FL	Cape Coral-Fort Myers-Naples, FL
Columbia	FL	Gainesville-Lake City, FL
Flagler	FL	Orlando-Deltona-Daytona Beach, FL
Highlands	FL	Sebring, FL
Holmes	FL	
Indian River	FL	Miami-Fort Lauderdale-Port St. Lucie, FL
Lee	FL	Cape Coral-Fort Myers-Naples, FL
Leon	FL	Tallahassee-Bainbridge, FL-GA
Liberty	FL	
Okaloosa	FL	Crestview-Fort Walton Beach-Destin, FL
Osceola	FL	Orlando-Deltona-Daytona Beach, FL
Pasco	FL	Tampa-St. Petersburg-Clearwater, FL
Volusia	FL	Orlando-Deltona-Daytona Beach, FL
Wakulla	FL	Tallahassee-Bainbridge, FL-GA
Chatham	GA	Savannah-Hinesville-Statesboro, GA
Chattooga	GA	Rome-Summerville, GA
Coweta	GA	Atlanta—Athens-Clarke County—Sandy Springs, GA
Dawson	GA	Atlanta—Athens-Clarke County—Sandy Springs, GA
Glynn	GA	Brunswick, GA
Muscogee	GA	Columbus-Auburn-Opelika, GA-AL
Sumter	GA	
Honolulu	HI	Urban Honolulu, HI
Bremer	IA	Waterloo-Cedar Falls, IA
Montgomery	IA	
Polk	IA	Des Moines-Ames-West Des Moines, IA
Story	IA	Des Moines-Ames-West Des Moines, IA
Warren	IA	Des Moines-Ames-West Des Moines, IA
Butte	ID	Idaho Falls-Rexburg-Blackfoot, ID
Rock Island	IL	Davenport-Moline, IA-IL
Winnebago	IL	Rockford-Freeport-Rochelle, IL
Hancock	IN	Indianapolis-Carmel-Muncie, IN
Orleans Parish	LA	New Orleans-Metairie-Hammond, LA-MS
Ouachita Parish	LA	Monroe-Ruston-Bastrop, LA
Androscoggin	ME	Portland-Lewiston-South Portland, ME
Aroostook	ME	
Kennebec	ME	
Oxford	ME	
Sagadahoc	ME	Portland-Lewiston-South Portland, ME
Becker	MN	
Crow Wing	MN	
Goodhue	MN	Minneapolis-St. Paul, MN-WI
Lake	MN	
Lyon	MN	
Mille Lacs	MN	Minneapolis-St. Paul, MN-WI
Olmsted	MN	Rochester-Austin, MN
St. Louis	MN	Duluth, MN-WI
Stearns	MN	Minneapolis-St. Paul, MN-WI
Wright	MN	Minneapolis-St. Paul, MN-WI
Lauderdale	MS	
Yalobusha	MS	
Flathead	MT	
Lewis and Clark	MT	
Missoula	MT	Missoula, MT
Powder River	MT	
Richland	MT	

Note:
1. This list represents counties with no monitored ozone air pollution in unhealthful ranges using the Air Quality Index based on 2008 NAAQS.

Cleanest Counties for Ozone Air Pollution[1] (cont.)

County	State	Metropolitan Statistical Area
Rosebud	MT	
Carteret	NC	New Bern-Morehead City, NC
Macon	NC	
Swain	NC	
Billings	ND	
Burke	ND	
Burleigh	ND	Bismarck, ND
Cass	ND	Fargo-Wahpeton, ND-MN
Dunn	ND	
McKenzie	ND	
Mercer	ND	
Oliver	ND	Bismarck, ND
Lancaster	NE	Lincoln-Beatrice, NE
Belknap	NH	Boston-Worcester-Providence, MA-RI-NH-CT
Cheshire	NH	
Grafton	NH	
Merrimack	NH	Boston-Worcester-Providence, MA-RI-NH-CT
Lea	NM	
Luna	NM	
Sandoval	NM	Albuquerque-Santa Fe-Las Vegas, NM
Santa Fe	NM	Albuquerque-Santa Fe-Las Vegas, NM
Carson City	NV	Reno-Carson City-Fernley, NV
Churchill	NV	
Franklin	NY	
Herkimer	NY	Utica-Rome, NY
Saratoga	NY	Albany-Schenectady, NY
Steuben	NY	Elmira-Corning, NY
Tompkins	NY	Ithaca-Cortland, NY
Noble	OH	
Clackamas	OR	Portland-Vancouver-Salem, OR-WA
Columbia	OR	Portland-Vancouver-Salem, OR-WA
Deschutes	OR	Bend-Redmond-Prineville, OR
Jackson	OR	Medford-Grants Pass, OR
Lane	OR	Eugene, OR
Marion	OR	Portland-Vancouver-Salem, OR-WA
Umatilla	OR	
Washington	OR	Portland-Vancouver-Salem, OR-WA
Franklin	PA	Washington-Baltimore-Arlington, DC-MD-VA-WV-PA
Lycoming	PA	Williamsport-Lock Haven, PA
Monroe	PA	New York-Newark, NY-NJ-CT-PA
Aiken	SC	Augusta-Richmond County, GA-SC
Berkeley	SC	Charleston-North Charleston, SC
Charleston	SC	Charleston-North Charleston, SC
Colleton	SC	
Edgefield	SC	Augusta-Richmond County, GA-SC
Oconee	SC	Greenville-Spartanburg-Anderson, SC
Brookings	SD	
Custer	SD	Rapid City-Spearfish, SD
Jackson	SD	
Meade	SD	Rapid City-Spearfish, SD
Minnehaha	SD	Sioux Falls, SD
Union	SD	Sioux City-Vermillion, IA-SD-NE
Cameron	TX	Brownsville-Harlingen-Raymondville, TX
Hidalgo	TX	McAllen-Edinburg, TX
Cache	UT	Logan, UT-ID
Garfield	UT	
Fauquier	VA	Washington-Baltimore-Arlington, DC-MD-VA-WV-PA
Giles	VA	Blacksburg-Christiansburg-Radford, VA
Page	VA	
Rockbridge	VA	
Rockingham	VA	Harrisonburg-Staunton-Waynesboro, VA
Chittenden	VT	Burlington-South Burlington, VT
Clallam	WA	
Clark	WA	Portland-Vancouver-Salem, OR-WA
Pierce	WA	Seattle-Tacoma, WA
Skagit	WA	Seattle-Tacoma, WA
Spokane	WA	Spokane-Spokane Valley-Coeur d'Alene, WA-ID
Whatcom	WA	Bellingham, WA
Ashland	WI	
Eau Claire	WI	Eau Claire-Menomonie, WI
La Crosse	WI	La Crosse-Onalaska, WI-MN
Marathon	WI	Wausau-Stevens Point-Wisconsin Rapids, WI
Taylor	WI	
Vilas	WI	
Big Horn	WY	
Carbon	WY	
Laramie	WY	Cheyenne, WY
Sweetwater	WY	
Teton	WY	
Uinta	WY	

Note:
1. This list represents counties with no monitored ozone air pollution in unhealthful ranges using the Air Quality Index based on 2008 NAAQS.

Two types of air pollution dominate in the U.S.: ozone and particle pollution.[1] These two pollutants threaten the health and the lives of millions of Americans. Thanks to the Clean Air Act, the U.S. has far less of both pollutants now than in the past. Still, more than 138.5 million people live in counties where monitors show unhealthy levels of one or both—meaning the air a family breathes could shorten life or cause lung cancer.

So what are ozone and particle pollution?

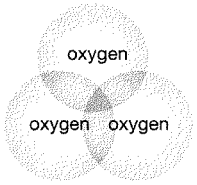
Ozone Pollution

It may be hard to imagine that pollution could be invisible, but ozone is. The most widespread pollutant in the U.S. is also one of the most dangerous.

Scientists have studied the effects of ozone on health for decades. Hundreds of research studies have confirmed that ozone harms people at levels currently found in the United States. In the last few years, we've learned that it can also be deadly.

What Is Ozone?

Ozone (O_3) is a gas molecule composed of three oxygen atoms. Often called "smog," ozone is harmful to breathe. Ozone aggressively attacks lung tissue by reacting chemically with it.



The ozone layer found high in the upper atmosphere (the stratosphere) shields us from much of the sun's ultraviolet radiation. However, ozone air pollution at ground level where we can breathe it (in the troposphere) causes serious health problems.

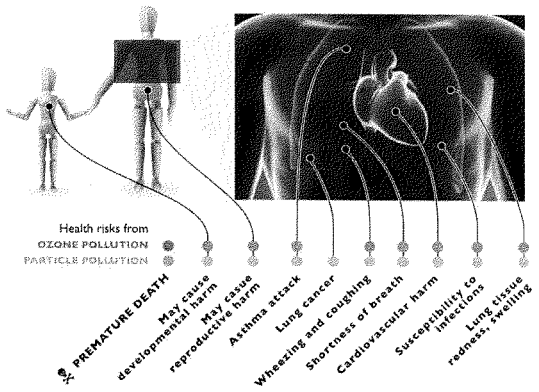
Where Does Ozone Come From?

Ozone develops in the atmosphere from gases that come out of tailpipes, smokestacks and many other sources. When these gases come in contact with sunlight, they react and form ozone smog.

The essential raw ingredients for ozone come from nitrogen oxides (NO_x), hydrocarbons, also called volatile organic compounds (VOCs) and carbon monoxide (CO). They are produced primarily when fossil fuels like gasoline, oil or coal are burned or when some chemicals, like solvents, evaporate. NO_x is emitted from power plants, motor vehicles and other sources of high-heat combustion. VOCs are emitted from motor vehicles, chemical plants, refineries, factories, gas stations, paint and other sources. CO is also primarily emitted from motor vehicles.[2]

If the ingredients are present under the right conditions, they

Air pollution remains a major danger to the health of children and adults.



react to form ozone. And because the reaction takes place in the atmosphere, the ozone often shows up downwind of the sources of the original gases. In addition, winds can carry ozone far from where it began.

You may have wondered why "ozone action day" warnings are sometimes followed by recommendations to avoid activities such as mowing your lawn or driving your car. Lawn mower exhaust and gasoline vapors are VOCs that could turn into ozone in the heat and sun.

Who is at risk from breathing ozone?

Anyone who spends time outdoors where ozone pollution levels are high may be at risk. Five groups of people are especially vulnerable to the effects of breathing ozone:

- children and teens[3];
- anyone 65 and older[4];
- people who work or exercise outdoors[5];
- people with existing lung diseases, such as asthma and chronic obstructive pulmonary disease (also known as COPD, which includes emphysema and chronic bronchitis)[6]; and
- people with cardiovascular disease.[7]

In addition, some evidence suggests that other groups—including women, people who suffer from obesity and people with low incomes—may also face higher risk from ozone.[8] More research is needed to confirm these findings.

The impact on your health can depend on many factors, however. For example, the risks would be greater if ozone levels are higher, if you are breathing faster because you're working outdoors or if you spend more time outdoors.

Lifeguards in Galveston, Texas, provided evidence of the impact of even short-term exposure to ozone on healthy, active adults in a study published in 2008. Testing the breathing capacity of these outdoor workers several times a day, researchers found that many lifeguards had greater obstruction in their airways when ozone levels were high. Because of this research, Galveston became the first city in the nation to install an air quality warning flag system on the beach.[9]

How Ozone Pollution Harms Your Health

Premature death. Breathing ozone can shorten your life. Strong evidence exists of the deadly impact of ozone in large studies conducted in cities across the U.S., in Europe and in Asia. Researchers repeatedly found that the risk of premature death increased with higher levels of ozone.[10] Newer research has confirmed that ozone increased the risk of premature death even when other pollutants also exist.[11]

Even low levels of ozone may be deadly. A large study of 48 U.S. cities looked at the association between ozone and all-cause mortality during the summer months. Ozone concentrations by city in the summer months ranged from 16 percent to 80 percent lower than the U.S. Environmental Protection Agency (EPA) currently considers safe. Researchers found that ozone at those lower levels was associated with deaths from cardiovascular disease, strokes, and respiratory causes.[12]

Immediate breathing problems. Many areas in the United States produce enough ozone during the summer months to cause health problems that can be felt right away. Immediate problems—in addition to increased risk of premature death—include:

- shortness of breath, wheezing and coughing;
- asthma attacks;
- increased risk of respiratory infections;
- increased susceptibility to pulmonary inflammation; and
- increased need for people with lung diseases, like asthma or chronic obstructive pulmonary disease (COPD), to receive medical treatment and to go to the hospital.[13]

Cardiovascular effects. Inhaling ozone may affect the heart as well as the lungs. A 2006 study linked exposures to high ozone levels for as little as one hour to a particular type of cardiac arrhythmia that itself increases the risk of premature death and stroke.[14] A French study found that exposure to elevated ozone levels for one to two days increased the risk of heart attacks for middle-aged

adults without heart disease.[15] Several studies around the world have found increased risk of hospital admissions or emergency department visits for cardiovascular disease.[16]

Long-term exposure risks. New studies warn of serious effects from breathing ozone over longer periods. With more long-term data, scientists are finding that long-term exposure—that is, for periods longer than eight hours, including days, months or years—may increase the risk of early death.

- Examining the records from a long-term national database, researchers found a higher risk of death from respiratory diseases associated with increases in ozone.[17]
- New York researchers looking at hospital records for children's asthma found that the risk of admission to hospitals for asthma increased with chronic exposure to ozone. Younger children and children from low income families were more likely than other children to need hospital admissions even during the same time periods.[18]
- California researchers analyzing data from their long-term Southern California Children's Health Study found that some children with certain genes were more likely to develop asthma as adolescents in response to the variations in ozone levels in their communities.[19]
- Studies link lower birth weight and decreased lung function in newborns to ozone levels in their community.[20] This research provides increasing evidence that ozone may harm newborns.

Breathing other pollutants in the air may make your lungs more responsive to ozone—and breathing ozone may increase your body's response to other pollutants. For example, research warns that breathing sulfur dioxide and nitrogen oxide—two pollutants common in the eastern U.S.—can make the lungs react more strongly than to just breathing ozone alone. Breathing ozone may also increase the response to allergens in people with allergies. A large study published in 2009 found that children were more likely to suffer from hay fever and respiratory allergies when ozone and $PM_{2.5}$ levels were high.[21]

EPA finds ozone causes harm. The EPA released their most recent review of the current research on ozone pollution in February 2013.[22] The EPA had engaged a panel of expert scientists, the Clean Air Scientific Advisory Committee, to help them assess the evidence; in particular, they examined research published between 2006 and 2012. The EPA concluded that ozone pollution posed multiple, serious threats to health. Their findings are highlighted in the box below.

EPA Concludes Ozone Pollution Poses Serious Health Threats

- Causes respiratory harm (e.g. worsened asthma, worsened COPD, inflammation)
- Likely to cause early death (both short-term and long-term exposure)
- Likely to cause cardiovascular harm (e.g. heart attacks, strokes, heart disease, congestive heart failure)
- May cause harm to the central nervous system
- May cause reproductive and developmental harm

—U.S. Environmental Protection Agency, *Integrated Science Assessment for Ozone and Related Photochemical Oxidants*, 2013. EPA/600/R-10/076F.

Particle Pollution

Ever look at dirty truck exhaust?

The dirty, smoky part of that stream of exhaust is made of particle pollution. Overwhelming evidence shows that particle pollution—like that coming from that exhaust smoke—can kill. Particle pollution can increase the risk of heart disease, lung cancer and asthma attacks and can interfere with the growth and work of the lungs.

What Is Particle Pollution?

Particle pollution refers to a mix of very tiny solid and liquid particles that are in the air we breathe. But nothing about particle pollution is simple. And it is so dangerous it can shorten your life.

Size matters. Particles themselves are different sizes. Some are one-tenth the diameter of a strand of hair. Many are even tinier; some are so small they can only be seen with an electron microscope. Because of their size, you can't see the individual particles. You can only see the haze that forms when millions of particles blur the spread of sunlight.

The differences in size make a big difference in how they affect us. Our natural defenses help us to cough or sneeze larger particles out of our bodies. But those defenses don't keep out smaller particles, those that are smaller than 10 microns (or micrometers) in diameter, or about one-seventh the diameter of a single human hair. These particles get trapped in the lungs, while the smallest are so minute that they can pass through the lungs into the bloodstream, just like the essential oxygen molecules we need to survive.

Researchers categorize particles according to size, grouping them as coarse, fine and ultrafine. Coarse particles fall between 2.5 microns and 10 microns in diameter and are called $PM_{10-2.5}$. Fine particles are 2.5 microns in diameter or smaller and are called $PM_{2.5}$. Ultrafine particles are smaller than 0.1 micron in diameter[23] and are small enough to pass through the lung tissue into the blood stream, circulating like the oxygen molecules themselves. No matter what the size, particles can harm your health.

"A mixture of mixtures." Because particles are formed in so many different ways, they can be composed of many different compounds. Although we often think of particles as solids, not all are. Some are completely liquid; some are solids suspended in liquids. As the EPA puts it, particles are really "a mixture of mixtures."[24]

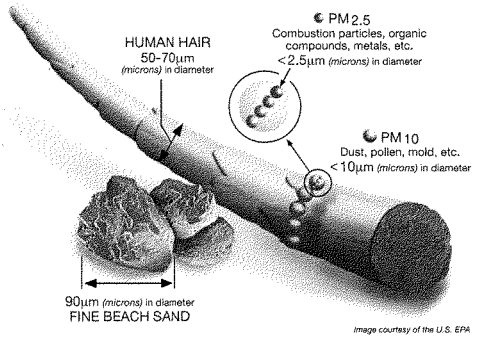


Image courtesy of the U.S. EPA

The mixtures differ between the eastern and western United States and in different times of the year. For example, the Midwest, Southeast and Northeast states have more sulfate particles than the West on average, largely due to the high levels of sulfur dioxide emitted by large, coal-fired power plants. By contrast, nitrate particles from motor vehicle exhaust form a larger proportion of the unhealthful mix in the winter in the Northeast, Southern California, the Northwest, and North Central U.S.[25]

Who Is at Risk?

Anyone who lives where particle pollution levels are high is at risk. Some people face higher risk, however. People at the greatest risk from particle pollution exposure include:

- Infants, children and teens[26];
- People over 65 years of age[27];
- People with lung disease such as asthma and chronic obstructive pulmonary disease (COPD), which includes chronic bronchitis and emphysema;
- People with heart disease[28] or diabetes[29];
- People with low incomes[30]; and
- People who work or are active outdoors.[31]

Diabetics face increased risk at least in part because of their higher risk for cardiovascular disease.[32] A 2010 study examined prevalence of diagnosed diabetes in relation to fine particle pollution in 2004-2005. The evidence suggested that air pollution is a risk factor for diabetes.[33]

What Can Particles Do to Your Health?

Particle pollution can be very dangerous to breathe. Breathing particle pollution may trigger illness, hospitalization and premature death, risks that are showing up in new studies that validate earlier research.

Thanks to steps taken to reduce particle pollution, good news is growing from researchers who study the drop in year-round levels of particle pollution.

- Looking at air quality in 545 counties in the U.S. between 2000 and 2007, researchers found that people had approximately four months added to their life expectancy on average due to cleaner air. Women and people who lived in urban and densely populated counties benefited the most.[34]
- Another long-term study of six U.S. cities tracked from 1974 to 2009 added more evidence of the benefits. Their findings suggest that cleaning up particle pollution had almost immediate health benefits. They estimated that the U.S. could prevent approximately 34,000 premature deaths a year if the nation could lower annual levels of particle pollution by 1 $\mu g/m^3$.[35]

These studies add to the growing research that cleaning up air pollution improves life and health.[36] Other researchers estimated that reductions in air pollution can be expected to produce rapid improvements in public health, with fewer deaths occurring within the first two years after reductions.[37]

Researchers are exploring possible differences in health effects of the three sizes of particles and particles from different sources, such as diesel particles from trucks and buses or sulfates from coal-fired power plants. So far, the evidence remains clear that particles of all sizes from all sources can be dangerous.[38]

Short-Term Exposure Can Be Deadly

First and foremost, short-term exposure to particle pollution can kill. Peaks or spikes in particle pollution can last for hours to days. Deaths can occur on the very day that particle levels are high, or within one to two months afterward. Particle pollution does not just make people die a few days earlier than they might otherwise—these are deaths that would not have occurred if the air were cleaner.[39]

Particle pollution also diminishes lung function, causes greater use of asthma medications and increased rates of school absenteeism, emergency room visits and hospital admissions. Other adverse effects can be coughing, wheezing, cardiac arrhythmias and heart attacks. According to the findings from some of the latest studies, short-term increases in particle pollution have been linked to:

- death from respiratory and cardiovascular causes, including strokes[40,41,42,43];
- increased mortality in infants and young children[44];
- increased numbers of heart attacks, especially among the elderly and in people with heart conditions[45];
- inflammation of lung tissue in young, healthy adults[46];
- increased hospitalization for cardiovascular disease, including strokes and congestive heart failure[47,48,49];
- increased emergency room visits for patients suffering from acute respiratory ailments[50];
- increased hospitalization for asthma among children[51,52,53]; and
- increased severity of asthma attacks in children.[54]

Again, the impact of even short-term exposure to particle pollution on healthy adults showed up in the Galveston lifeguard study. In addition to the harmful effects of ozone pollution, lifeguards had reduced lung volume at the end of the day when fine particle levels were high.[55]

Year-Round Exposure

Breathing high levels of particle pollution day in and day out also can be deadly, as landmark studies in the 1990s conclusively showed[56] and as other studies confirmed.[57] Chronic exposure to particle pollution can shorten life by one to three years.[58]

In late 2013, the International Agency for Research on Cancer, part of the World Health Organization, concluded that particle pollution could cause lung cancer. The IARC reviewed the most recent research and reported that the risk of lung cancer increases as the particle levels rise.[59]

Year-round exposure to particle pollution has also been linked to:

- increased hospitalization for asthma attacks for children living near roads with heavy truck or trailer traffic[60,61];
- slowed lung function growth in children and teenagers[62,63];
- significant damage to the small airways of the lungs[64];
- increased risk of death from cardiovascular disease[65]; and
- increased risk of lower birth weight and infant mortality.[66]

Research into the health risks of 65,000 women over age 50 found that those who lived in areas with higher levels of particle pollution faced a much greater risk of dying from heart disease than had been previously estimated. Even women who lived

within the same city faced differing risks depending on the annual levels of pollution in their neighborhood.[67]

The EPA completed their most recent review of the current research on particle pollution in December 2009.[68] The EPA had engaged a panel of expert scientists, the Clean Air Scientific Advisory Committee, to help them assess the evidence. The EPA concluded that particle pollution caused multiple, serious threats to health. Their findings are highlighted in the box below.

EPA Concludes Fine Particle Pollution Poses Serious Health Threats

- Causes early death (both short-term and long-term exposure)
- Causes cardiovascular harm (e.g. heart attacks, strokes, heart disease, congestive heart failure)
- Likely to cause respiratory harm (e.g. worsened asthma, worsened COPD, inflammation)
- May cause cancer
- May cause reproductive and developmental harm

–U.S. Environmental Protection Agency, Integrated Science Assessment for Particulate Matter, December 2009. EPA 600/R-08/139F.

Where Does Particle Pollution Come From?

Particle pollution is produced through two separate processes—mechanical and chemical.

Mechanical processes break down bigger bits into smaller bits with the material remaining essentially the same, only becoming smaller. Mechanical processes primarily create coarse particles.[69] Dust storms, construction and demolition, mining operations, and agriculture are among the activities that produce coarse particles. Tire, brake pad and road wear can also create coarse particles. Bacteria, pollen, mold, and plant and animal debris are also included as coarse particles.[70]

By contrast, chemical processes in the atmosphere create most of the tiniest fine and ultrafine particles. Combustion sources burn fuels and emit gases. These gases can vaporize and then condense to become a particle of the same chemical compound. Or, they can react with other gases or particles in the atmosphere to form a particle of a different chemical compound. Particles formed by this latter process come from the reaction of elemental carbon (soot), heavy metals, sulfur dioxide (SO_2), nitrogen oxides (NO_x) and volatile organic compounds with water and other compounds in the atmosphere.[71] Burning fossil fuels in factories, power plants, steel mills, smelters, diesel- and gasoline-powered motor vehicles (cars and trucks) and equipment generate a large part of the raw materials for fine particles. So does burning wood in residential fireplaces and wood stoves or burning agricultural fields or forests.

Focusing on Children's Health

Children face special risks from air pollution because their lungs are growing and because they are so active.

Just like the arms and legs, the largest portion of a child's lungs will grow long after he or she is born. Eighty percent of their tiny air sacs develop after birth. Those sacs, called the alveoli, are where the life-sustaining transfer of oxygen to the blood takes place. The lungs and their alveoli aren't fully grown until children become adults.[72] In addition, the body's defenses that help adults fight off infections are still developing in young bodies.[73] Children have more respiratory infections than adults, which also seems to increase their susceptibility to air pollution.[74]

Furthermore, children don't behave like adults, and their behavior also affects their vulnerability. They are outside for longer periods and are usually more active when outdoors. Consequently, they inhale more polluted outdoor air than adults typically do.[75]

Air Pollution Increases Risk of Underdeveloped Lungs

The Southern California Children's Health study looked at the long-term effects of particle pollution on teenagers. Tracking 1,759 children who were between ages 10 and 18 from 1993 to 2001, researchers found that those who grew up in more polluted areas face the increased risk of having underdeveloped lungs, which may never recover to their full capacity. The average drop in lung function was 20 percent below what was expected for the child's age, similar to the impact of growing up in a home with parents who smoked.[76]

Community health studies are pointing to less obvious, but serious effects from year-round exposure to ozone, especially for children. Scientists followed 500 Yale University students and

determined that living just four years in a region with high levels of ozone and related co-pollutants was associated with diminished lung function and frequent reports of respiratory symptoms.[77] A much larger study of 3,300 school children in Southern California found reduced lung function in girls with asthma and boys who spent more time outdoors in areas with high levels of ozone.[78]

Cleaning Up Pollution Can Reduce Risk to Children

There is also real-world evidence that reducing air pollution can help protect children.

A just-published follow-up to that Southern California Children's Health study showed that reducing pollution could improve children's health. This time they tracked a different group of 863 children living in the same area, but growing up between 2007 and 2011, when the air in Southern California was much cleaner. They compared these children to those who had been part of their earlier studies when the air was dirtier. Children growing up in the cleaner air had much greater lung function, a benefit that may help them throughout their lives. As the researchers noted, their study suggested that "all children have the potential to benefit from improvements in air quality." [79]

In Switzerland, particle pollution dropped during a period in the 1990s. Researchers there tracked 9,000 children over a nine-year period, following their respiratory symptoms. After taking other factors such as family characteristics and indoor air pollution into account, the researchers noted that during the years with less pollution, the children had fewer episodes of chronic cough, bronchitis, common cold, and conjunctivitis symptoms.[80]

Disparities in the Impact of Air Pollution

The burden of air pollution is not evenly shared. Poorer people and some racial and ethnic groups are among those who often face higher exposure to pollutants and who may experience greater responses to such pollution. Many studies have explored the differences in harm from air pollution to racial or ethnic groups and people who are in a low socioeconomic position, have less education, or live nearer to major sources,[81] including a workshop the American Lung Association held in 2001 that focused on urban air pollution and health inequities.[82]

Many studies have looked at differences in the impact on premature death. Results have varied widely, particularly for effects between racial groups. Some studies have found no differences among races,[83] while others found greater responsiveness for Whites and Hispanics, but not African Americans,[84] or for African Americans but not other races or ethnic groups.[85] Other researchers have found greater risk for African Americans from air toxics, including those pollutants that also come from traffic sources.[86]

Socioeconomic position has been more consistently associated with greater harm from air pollution. Recent studies show evidence of that link. Low socioeconomic status consistently increased the risk of premature death from fine particle pollution among 13.2 million Medicare recipients studied in the largest examination of particle pollution mortality nationwide.[87] In the 2008 study that found greater risk for premature death for African Americans, researchers also found greater risk for people living in areas with higher unemployment or higher use of public transportation.[88] A 2008 study of Washington, DC found that while poor air quality and worsened asthma went hand-in-hand in areas where Medicaid enrollment was high, the areas with the highest Medicaid enrollment did not always have the strongest association of high air pollution and asthma attacks.[89] However, two other recent studies in France have found no association with lower income and asthma attacks.[90]

Scientists have speculated that there are three broad reasons why disparities may exist. First, groups may face greater exposure to pollution because of factors ranging from racism to class bias to housing market dynamics and land costs. For example, pollution sources may be located near disadvantaged communities, increasing exposure to harmful pollutants. Second, low social position may make some groups more susceptible to health threats because of factors related to their disadvantage. Lack of access to health care, grocery stores and good jobs, poorer job opportunities, dirtier workplaces or higher traffic exposure are among the factors that could handicap groups and increase the risk of harm. Finally, existing health conditions, behaviors, or traits may predispose some groups to greater risk. For example, diabetics are

among the groups most at risk from air pollutants, and the elderly, African Americans, Mexican Americans and people living near a central city have higher incidence of diabetes.[91]

Communities of color also may be more likely to live in counties with higher levels of pollution. Non-Hispanic Blacks and Hispanics were more likely to live in counties that had worse problems with particle pollution, researchers found in a 2011 analysis. Non-Hispanic Blacks were also more likely to live in counties with worse ozone pollution. Income groups, by contrast, differed little in these exposures. However, since few rural counties have monitors, the primarily older, non-Hispanic white residents of those counties lack information about the air quality in their communities.[92]

Unemployed people, those with low income or low education and non-Hispanic Blacks were found to be more likely to live in areas with higher exposures to particle pollution in a 2012 study. However, the different racial/ethnic and income groups were breathing often very different kinds of particles; the different composition and structure of these particles may have different health impacts.[93]

Highways May Be Especially Dangerous for Breathing

Being in heavy traffic, or living near a road, may be even more dangerous than being in other places in a community. Growing evidence shows that the vehicle emissions coming directly from those highways may be higher than in the community as a whole, increasing the risk of harm to people who live or work near busy roads.

The number of people living "next to a busy road" may include 30 to 45 percent of the urban population in North America, according to the most recent review of the evidence. In January 2010, the Health Effects Institute published a major review of the evidence by a panel of expert scientists. The panel looked at over 700 studies from around the world, examining the health effects. They concluded that traffic pollution causes asthma attacks in children, and may cause a wide range of other effects including: the onset of childhood asthma, impaired lung function, premature death and death from cardiovascular diseases, and cardiovascular morbidity. The area most affected, they concluded, was roughly 0.2 mile to 0.3 mile (300 to 500 meters) from the highway.[94]

Children and teenagers are among the most vulnerable—though not the only ones at risk. A Danish study found that long-term exposure to traffic air pollution may increase the risk of developing chronic obstructive pulmonary disease (COPD). They found that those most at risk were people who already had asthma or diabetes.[95] Studies have found increased risk of premature death from living near a major highway or an urban road.[96] Another study found an increase in risk of heart attacks from being in traffic, whether driving or taking public transportation.[97] Urban women in a Boston study experienced decreased lung function associated with traffic-related pollution.[98]

How to Protect Yourself from Ozone and Particle Pollution

To minimize your exposure to ozone and particle pollution:

- Pay attention to forecasts for high air pollution days to know when to take precautions;
- Avoid exercising near high-traffic areas;
- Avoid exercising outdoors when pollution levels are high, or substitute an activity that requires less exertion;
- Do not let anyone smoke indoors and support measures to make all places smokefree; and
- Reduce the use of fireplaces and wood-burning stoves.

Bottom line: Help yourself and everyone else breathe easier. Support national, state and local efforts to clean up sources of pollution. Your life and the life of someone you love may depend on it.

1. Ozone and particle pollution are the most widespread, but they aren't the only serious air pollutants. Others include carbon monoxide, lead, nitrogen dioxide, and sulfur dioxide, as well as scores of toxins such as mercury, arsenic, benzene, formaldehyde, and acid gases. However, the monitoring networks are not as widespread nationwide for the other pollutants.
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National Farmers Union
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March 12, 2015

Docket ID No. EP-HQ-OAR-2008-0699
A-and-R-Docket@epa.gov
Environmental Protection Agency
EPA Docket Center (EPA/DC)
Mailcode 28221T
1200 Pennsylvania Ave. NW
Washington, DC 20460

Attention Docket ID No. OAR-2008-0699: National Ambient Air Quality Standards for Ozone

Dear Administrator McCarthy:

National Farmers Union (NFU) welcomes the opportunity to submit comments to the Environmental Protection Agency (EPA) on its proposed rule regarding revisions to national ambient air quality standards for ozone. NFU is the second-largest general farm organization in the United States. Since 1902, NFU has served as an advocate for the economic and social well-being and quality of life of family farmers and their communities by supporting the sustainable production of food, fiber, feed and fuel. NFU is a federation of independent state and regional organizations, with organized divisions in 33 states and nearly 200,000 members nationwide.

NFU appreciates EPA's efforts to increase protection of human health and welfare by revising the primary and secondary national ambient air quality standards (NAAQS) for ozone. NFU policy, enacted annually by delegates to the organization's national convention, states, "Our policy encourages a well-balanced, sensible environmental policy that protects the public and the environment without unduly burdening family farmers through excessive regulation or economic hardship."[1] NFU finds the purpose of EPA's revisions in agreement with our environmental policy goals.

In addition to NFU's general support of well-balanced and sensible environmental policy, EPA's proposed revisions may protect the interests of family farmers in two more specific ways. According to EPA's Integrated Science Assessment (ISA) for Ozone and Related Photochemical Oxidants, lowering ambient ozone is likely to help mitigate climate change and protect crop yields. NFU supports changes to

[1] Nat'l Farmers Union, 2014 Policy of the National Farmers Union 61 (2014) available at http://nfu.org/images/03%2011%2014%20FINAL%202014%20POLICY%20CLEAN%20COPY.pdf.

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NAAQS for ozone that achieve these goals, noting that increased use of ethanol in Reformulated Gasoline (RFG) will help states to achieve these goals.

NFU's support for EPA's proposed rule does include a very important caveat. NFU insists that any changes to the NAAQS regulating ozone allow for necessary prescribed burns pursuant to cultivating crops and livestock. The NAAQS revisions can achieve their goals without interference with this practice.

I. Climate Change

NFU's policy states, "NFU is concerned about the effects of climate change and believes further research and analysis is necessary to determine its actual and potential impacts."[2] Family farmers and ranchers across the U.S. are already feeling the impact of increasing weather volatility, one among many of the hazards to agriculture attendant to climate change. A recent U.S. Department of Agriculture (USDA) report said, "Some evidence exists that the United States is already experiencing an increased incidence of extreme weather events. A compilation of the economic impact of extreme weather events with an economic impact in excess of $1 billion shows an increase in this extent of economic damage over the last 30 years."[3] Extreme weather events limit workable field days, exacerbate productivity and environmental issues related to soil erosion, and harm the economy by increasing crop insurance claims. Other climate-related challenges agriculture may face include changes to water access and pollination services, increased heat stress for crops and livestock, and more pressure from invasive species, pests and weeds.

In addition to the direct impact climate change will bring upon agriculture, family farmers are concerned with the likely consequences of climate change for the country and world at large. Increased frequency of extreme heat will have a negative impact on human health and drive increases in energy cost as people attempt to cope with air conditioning. The expected loss of land to rising sea levels will be extremely disruptive to coastal property owners and the entire economy.

There is evidence that exposure to ozone reduces forests' ability to store carbon from the atmosphere. The preamble to the proposed rule states:

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[2] *Id.* at 66.

[3] Walthall, C.L., J. Hatfield, P. Backlund, L. Lengnick, E. Marshall, M. Walsh, S. Adkins, M. Aillery, E.A. Ainsworth, C. Ammann, C.J. Anderson, I. Bartomeus, L.H. Baumgard, F. Booker, B. Bradley, D.M. Blumenthal, J. Bunce, K. Burkey, S.M. Dabney, J.A. Delgado, J. Dukes, A. Funk, K. Garrett, M. Glenn, D.A. Grantz, D. Goodrich, S. Hu, R.C. Izaurralde, R.A.C. Jones, S-H. Kim, A.D.B. Leaky, K. Lewers, T.L. Mader, A. McClung, J. Morgan, D.J. Muth, M. Nearing, D.M. Oosterhuis, D. Ort, C. Parmesan, W.T. Pettigrew, W. Polley, R. Rader, C. Rice, M. Rivington, E. Rosskopf, W.A. Salas, L.E. Sollenberger, R. Srygley, C. Stöckle, E.S. Takle, D. Timlin, J.W. White, R. Winfree, L. Wright-Morton, L.H. Ziska. 2012. *Climate Change and Agriculture in the United States: Effects and Adaptation*. USDA Technical Bulletin 1935. Washington, DC. At 111.

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> Ozone effects on tree growth affects the climate regulation service provided by ecosystems by reducing carbon sequestration and storage...exposure affects photosynthesis and CO2 uptake by trees, forests sequester less carbon and thus more carbon stays in the atmosphere.[4]

Even though the preamble to the proposed rule acknowledges that the severity of ozone exposure's impact on vegetation's ability to sequester carbon was influenced by a number of interacting biological and environmental variables,[5] NFU argues that EPA should move forward with the proposed revisions because the threat climate change poses to family agriculture requires decisive action and because the other benefits to be gained through the revisions are also compelling.

II. Crop Yields

EPA's ISA found "a causal relationship exists between exposure to ozone in ambient air and visible foliar injury effects on vegetation, reduced vegetation growth, reduced productivity in terrestrial ecosystems, reduced yield and quality of agricultural crops and alteration of below-ground biogeochemical cycles."[6] Such findings are of obvious concern to family farmers. Risks to size or quality of yield directly affect family farmers' incomes and their ability to continue producing food, fiber, fuel and feed.

Even if farmers are able to circumvent this disadvantage with intensive management, ozone exposure is one more variable and challenge they will have to account for, further complicating their decision-making process. NFU supports EPA's proposed revisions to the NAAQS for ozone because of its potential benefit for crop yields.

III. Biofuels

NFU's policy is extremely supportive of biofuels because of their environmental benefits and the much-needed reinvestment the growing biofuels industry brings to rural America.[7] Increased use of Reformulated Gasoline (RFG) is a readily-accessible way for communities to comply with EPA's revised NAAQS for ozone. Biofuels are the best oxygenate to use in RFG because they do not carry the same environmental hazards as other oxygenates. The relative ease with which more RFG could be utilized presents a strong argument in favor of this proposed rule because, if more RFG is used, compliance will not be as difficult and costly as some of the proposed rule's critics fear. NFU supports the proposed rule because the environmental benefits the proposed rule embodies can be achieved through increased investment in biofuels, an industry that has numerous environmental benefits and supports family agriculture.

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[4] "National Ambient Air Quality Standards for Ozone; Proposed Rule," 79 Fed. Reg. 75325, (proposed December 17, 2014)(amending 40 CFR Parts 50-53, 58).
[5] Id. at 75315
[6] *Id.*
[7] Nat'l Farmers Union, 2014 Policy of the National Farmers Union 77.

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IV. Prescribed Burns

NFU policy notes,

> Controlled field burning is a viable farming practice.
> We support:
> 1) The right to safe burning when necessary; and
> 2) Ongoing research to discover economically viable alternatives to burning.[8]

Prescribed burns are a necessary process for farmers and only an intermittent source of ozone emissions compared to stationary sources. Any adjustment of the NAAQS regulating ozone emissions must allow for prescribed burns pursuant to agriculture.

Continued promotion of voluntary conservation practices, including best practices to reduce emissions from burns and alternatives to burning, are likely to result in lowered ozone emissions. Family farmers are good stewards of the environment and accustomed to voluntarily participating in practices with ecological benefits when they are accompanied with sufficient education.

V. Conclusion

NFU appreciates EPA's work, the environmental benefits and the positive impacts this proposed rule may carry for family agriculture. As long as the proposed rule does not interfere with necessary prescribed burns, NFU supports the rule as proposed. NFU stands ready to offer any support and assistance EPA may find helpful on this or related matters. Thank you for your consideration of these comments.

Sincerely,

Roger Johnson
President

[8] *Id.* at 64