



Children's  
Environmental  
Health  
Network



Alliance of Nurses for  
Healthy Environments



August 9, 2017

Scott Pruitt, Administrator  
U.S. Environmental Protection Agency  
1200 Pennsylvania Avenue, N.W.  
Washington, DC 20460

Re: Proposed Stay of Emissions Standards for New, Reconstructed, and Modified Sources in the Oil and Natural Gas Sector. Docket number# EPA-HQ-OAR-2010-0505-7736

Dear Administrator Pruitt:

On behalf of our nation's medical and public health groups, we urge you to retain and implement the current U.S. Environmental Protection Agency standards that limit harmful emissions of methane, volatile organic compounds and other pollutants from all new, reconstructed and modified production wells, processing plants, transmission pipelines, and storage units within the oil and natural gas industry. These standards will not only help to mitigate climate change and its associated health risks by curtailing emissions of methane – an especially potent greenhouse gas – from these sources, but will also limit emissions of toxic and carcinogenic air pollutants, benefiting public health in communities across the country. As public health groups and medical societies, we are keenly aware of the harmful health effects of these air pollutants, as well as the dangers that climate change poses to human health. We call on you to protect our patients and the public from these harms.

**EPA must retain and implement fully these strong standards to reduce methane and other emissions from the oil and gas industry that pose multiple threats to public health.**

The Clean Air Act requires that EPA adopt standards that protect public health from new sources of pollution and from hazardous air pollutants. The widespread and expanding oil and natural gas

production in the United States represents sources of such emissions that EPA must reduce under the law.

The rapid development of high volume, hydraulic fracturing (“fracking”) and horizontal drilling technologies to recover natural gas from shale formations has driven the expansion of new and modified sources, as it expanded the nation’s supply of natural gas resources. Emissions can occur during the extraction, production, processing, flaring, transportation, unloading and distribution of oil and natural gas. Those emissions can vent to the atmosphere (intentionally or unintentionally) and harm human health. EPA must require steps to prevent and reduce such emissions, and ensure compliance through added monitoring and inspections.

Once implemented, the current standards will not only help to mitigate climate change and its associated health risks by curtailing emissions of methane from new and modified sources, but also will limit emissions of toxic and carcinogenic air pollutants, protecting public health in communities across the country.

### **Oil and gas emissions pose direct risks to human health**

Any delay in implementing these standards poses a direct and on-going threat to human health, exposing more individuals and new communities to the risks from these emissions. As explained below, clear evidence documents harm directly from emissions of dangerous VOCs, and from ozone and fine particulate matter (PM<sub>2.5</sub>). These pollutants can cause or increase risk of cardiovascular, respiratory, and other acute and chronic systemic damage, and may increase risk of cancer.

Unless the standards are implemented, communities face higher risk of ozone and fine particulate matter levels in areas where oil and gas production occurs and downwind. Without these standards, these communities face increased exposure to hazardous air pollutants, including the risk of benzene and formaldehyde, both carcinogens, in the oil and gas production process and for transmission and storage. The discussion below summarizes the evidence that these pollutants pose serious threats to health and must be reduced with the strong implementation of these standards.

### ***Volatile organic compounds (VOCs)***

Communities nearby would face increased exposure to a broad group of carcinogens and other toxins from increased emissions of volatile organic compounds from the new, reconstructed and modified facilities. Volatile organic hazardous air pollutants are specific toxic gases that react easily with other gases and particles.

According to the EPA’s Regulatory Impact Assessment, six organic hazardous air pollutants dominate the mass from oil and natural gas wells and can most harm human health: benzene, toluene, carbonyl sulfide, ethylbenzene, mixed xylenes, and n-hexane. Other major hazardous air pollutants from wells include formaldehyde, ethylene glycol, methanol, and 2,2,4-trimethylpentane. One recent study of locations near oil and gas development sites around the U.S. found evidence of high levels of benzene and formaldehyde present at levels that exceed the Agency Toxic Substances and Disease Registry

(ATSDR) or EPA's Integrated Risk Information System (IRIS) standards for exposure (Macey et al., 2014). Current estimates likely also understate the emissions. A study looking "top-down" found that the monitored emissions in northeastern Colorado were seven times greater than the state's estimated emissions inventory (Pétron et al., 2013)

Many of these toxic air pollutants can cause cancer, but they can also irritate the eyes, skin, and respiratory tract, impair lung function, and affect vital organs. Benzene and formaldehyde are recognized as known human carcinogens, while ethylbenzene is considered a probable carcinogen (HHS, 2011). Long-term exposures to benzene can cause leukemia, a blood cancer, and other blood disorders such as anemia and depressed lymphocyte count in blood. Exposure to formaldehyde can also cause chronic bronchitis and nasal epithelial lesions. A recent review of the research found evidence that formaldehyde may increase the risk of asthma, particularly in the young (McGwin et al., 2010). Non-cancer effects associated with exposure to these organics range from irritation of the skin, eyes, nose, throat, and respiratory tract, and dizziness, nausea, and vomiting. These compounds can also cause difficulty in breathing, impaired lung function and respiratory symptoms, damage to the liver and kidneys, and stomach discomfort. They may also cause developmental disorders, adverse effects to the nervous system, impairment of memory and neurological function, and slow response to visual stimuli. These pollutants can also affect hearing, speech, vision, and motor coordination (ATSDR, 1999a, 1999b, 2000, 2007a, 2007b, 2010).

#### ***Volatile Organic Compounds as Precursors to Ozone (O<sub>3</sub>)***

As noted above, many VOCs are hazardous air pollutants. However, VOCs are also precursors to the formation of ground-level ozone when they react with nitrogen oxides (NO<sub>x</sub>) in the presence of sunlight. With unrestrained emissions of VOCs, the new oil and natural gas facilities will indirectly increase the amount of secondary ozone formed in the air, human exposure to ozone, and the incidence of ozone-related health effects. Cleaning up VOCs with these standards is critical to protecting human health.

Ozone is a colorless, odorless gas that reacts chemically ("oxidizes") with internal body tissues, such as those in the lung. Some have described the inflammation that ozone causes in the airways as similar to a "sunburn" on the lungs. It acts as a powerful respiratory irritant at the levels frequently found across the nation during the warmer months. EPA's most recent review of the research concluded that breathing ozone respiratory harm including increased risk of asthma attacks and increased susceptibility to respiratory infections, and need for medical treatment and for hospitalization for people with asthma or chronic obstructive pulmonary disease (COPD) and may lead to premature death. In addition, growing evidence suggests that ozone may worsen cardiovascular disease, may harm the central nervous system and have adverse reproductive and developmental effects (EPA 2013).

The expansion of oil and gas production has led to astonishing and unhealthy concentrations of ozone, including in unexpected areas. In Utah, spacious, rural Uintah County and Duchesne County have elevated levels of ozone that violate the 2008 national ambient air quality standard, and exceed the 2015 standard (EPA, 2015a). The emissions from the oil and gas extraction industry are the biggest contributor to these unhealthy air levels (Helmig et al., 2014). In Colorado, a study of the oil and gas

extraction in the North Front Range area found not only a significant source of precursor VOC emissions for the ozone in the Denver metro area, but that the emissions had increased likely due to the expanded wells, despite Colorado's strengthening of emissions standards (Thompson et al., 2014).

### ***Fine Particulate Matter (PM<sub>2.5</sub>)***

Increases in some VOCs, specifically organic carbon aerosols, would provide an additional risk, absent the implementation of the oil and natural gas wells standards: an increase in secondary fine particulate matter. PM<sub>2.5</sub> is made up of microscopic particles, including aerosols, which can bypass the body's natural defenses and lodge deep within the lungs (EPA, 2009). The evidence shows that long-term exposure to PM<sub>2.5</sub> causes premature death, respiratory and cardiovascular harm and suggests that long-term exposure to PM<sub>2.5</sub> causes reproductive and developmental effects (EPA, 2009). Most recently, PM<sub>2.5</sub> has been found to cause lung cancer (Hamra et al., 2014).

### ***Methane (CH<sub>4</sub>)***

Methane poses a serious health risk by itself, as well as a greenhouse gas. Methane is a VOC, and is an odorless gas that can burn or explode at concentrations of 5 percent to 15 percent by volume of air (ATSDR, 2001). Methane also poses a risk from an occupational safety and health standpoint for workers at natural gas wells exposed to explosions or uncontrolled fires during the hydraulic fracturing process (NIOSH, 2015). As a VOC, methane is also a precursor to ozone, particularly in remote areas (EPA, 2013).

The EPA has identified the oil and gas industry as the "single largest contributor to United States anthropogenic methane emissions" (EPA, 2011). The growing problem of methane in the atmosphere indicates that existing oil and gas infrastructure currently produce higher methane emissions than have been estimated (Brandt et al., 2014). One recent report estimated that nearly 90 percent of projected emissions from oil and gas development in 2018 will come from existing infrastructure (ICF, 2014).

### **Climate change poses serious threats to human health**

The changing climate threatens the health of Americans alive now and in future generations. Growing evidence over the past few years has demonstrated the multiple, profound risks that imperil the lives and health of millions from climate change. Consequently, the nation has a short window to act to reduce those threats.

Last year, the U.S. Global Change Research Program published its assessment in *The Impacts of Climate Change on Human Health in the United States* (USGCRP, 2016). Scores of scientists, physicians and analysts reviewing the data and research concluded, "Every American is vulnerable to the health impacts associated with climate change."

"Current and future climate impacts expose more people in more places to public health threats. Already in the United States, we have observed climate-related increases in our exposure to elevated temperatures; more frequent, severe, or longer-lasting extreme events; degraded air quality; diseases transmitted through food, water, and disease vectors (such as ticks and mosquitoes); and stresses to our mental health and well-being. Almost all of these threats are expected to worsen with continued climate change. Some of these health threats

will occur over longer time periods, or at unprecedented times of the year; some people will be exposed to threats not previously experienced in their locations.” (USGCRP, 2016).

This review echoed reports previously produced by several of our organizations: the American Academy of Pediatrics technical report in 2015 on “Global Climate Change and Children’s Health”(Andoot et al., 2015); Trust for America’s Health, *Health Problems Heat Up: Climate Change and the Public’s Health*, in October 2009 (TfAH, 2009); the Asthma and Allergy Foundation of America’s *Extreme Allergies and Global Warming*, issued with the National Wildlife Foundation in 2010 (NWF and AAFA, 2010); the American Public Health Association’s *Climate Change: Mastering the Public Health Role*, in April 2011 (APHA, 2011) and *Public Health Opportunities to Address the Health Effects of Climate Change*, in November 2015 (APHA, 2015); and the American Thoracic Society’s workshop on Climate Change and Human Health published in 2012 (Pinkerton et al., 2012). All these reviews arrived at similar conclusions, summarized below.

In 2014, the Intergovernmental Panel on Climate Change issued its most recent policy assessment of current observations and analyses about the changing climate. The IPCC found:

“Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks.” (IPCC 2014)

This report makes clear the essential need to adopt and maintain the strongest possible measures to reduce methane and other greenhouse gases that endanger the long-term health of all people.

**Ground-level ozone is likely to be worse in some locations.** Higher temperatures increase the likelihood that the precursor gases will react to form ground-level ozone, making it harder to protect people from this most widespread air pollutant. Ozone causes asthma attacks and respiratory distress, and may increase cardiovascular harm, risk of harm to the central nervous system and the risk of low birth weight in newborns as well as premature death (EPA, 2013).

**Wildfires and drought conditions give rise to smoke and dust storms spreading miles from their source.** Recent years have showcased the risks from wildfire smoke from blazes in the West. In September 2014, California had reported nearly 5,000 wildfires in 2014—1,000 *more than usual*—before fire season had even begun, as the *Los Angeles Times* noted (Rocha, 2014). This year has seen similar events from wildfires. As the *Washington Post* noted, during the week of July 8<sup>th</sup>, more than 700 fires in Alaska and Canada were blowing smoke that created unhealthy air pollution in Minneapolis and Colorado (Fritz, 2015).

Drought-driven dust storms also produce high levels of particulate matter. The impact of dust storms in recent years, such as one in Oklahoma in 2012 that shut down Interstate 35, demonstrate their power to threaten health in multiple ways (Juozapavicius, 2012).

Even short-term exposure to such levels of particulate matter threaten human health. As EPA concluded in the 2009 review of the research, short-term increases in particle pollution cause premature death and cardiovascular harm including increased numbers of heart attacks, especially among the elderly and in people with heart conditions increased and likely cause respiratory harm, including increased severity of asthma attacks in children (EPA, 2009b).

These examples show that these changes erect new hurdles to our ability to protect human health from air pollution. As EPA noted in its 2009 report on the impacts of global climate change on ground-level ozone, modeling for future pollution levels shows the complexity of the problem, with one compelling outcome: climate change had “the potential to make U.S. air quality management more difficult” (EPA, 2009a).

**Extreme weather threatens health.** Many cities across the U.S., such as Chicago and Milwaukee have experienced increased death rates from episodic heat waves in recent years. Hotter temperatures can increase the risk of heat stroke and heat exhaustion and can increase the risk of hospitalization for cardiovascular and respiratory diseases (Luber et al., 2014; Li et al., 2012).

Increased risk of dangerous hurricanes threatens not only damage and death directly from the high winds and water, but from the disruption in communities that suffer the hurricanes. As Hurricanes Katrina and Sandy showed, the disruption can last for years. Hospitals, clinics, medical care and public health services may be blocked from serving their patients and communities as resources are diverted to emergency response or too damaged to provide those services. Patients find themselves in emergency shelters or relocated to new homes far away from their previous medical caregivers.

According to the most recent assessments, the nation has experienced increased heavy rainfall and flooding since 1991 (Walsh et al., 2014). Flooding causes premature deaths, often through drowning, but the aftermath of flooding expands the burden. Water damage leaves behind lingering risks including dampness and mold, chemicals and sewage spread through flood waters, and contaminated debris in flooded homes, schools, hospitals and other community facilities. (Luber et al., 2014; APHA, 2011).

**Allergens and risk of vector-borne diseases will increase.** Warmer weather leads to shifting growing seasons that change flowering time and pollen development and can expand the habitat for allergen-rich plant species. Higher concentrations and longer growing seasons increase the exposure to allergens that trigger asthma and other respiratory and allergic responses. (NWF and APHA, 2010; Ziska et al., 2012; Luber et al., 2014). In the U.S., spread of diseases such as Lyme, West Nile Virus, and Rocky Mountain spotted fever, is linked to complex differences in weather, hosts and human behavior that can be profoundly affected by changes in climate (Luber et al., 2014).

**Food and water supplies face uncertain challenges.** The ongoing drought in the West, particularly in California, exemplifies the risks to supplying adequate water and food to the nation (USDA, 2014). As the water levels continue to drop, farmers confront more challenges growing food to supply the rest of the nation and the world. Certain communities, such as Alaska Natives, may suffer shortages of fresh water and food they have historically hunted or fished (Chapin et al, 2014).

**Stress will complicate response and mental health issues.** Mental health problems increase after disasters, such as seen after Hurricane Katrina. Moreover, even people with no history of mental health problems, including children, will risk increased stress from responding to and accommodating these severe changes. Among the expected impacts from these stresses are: post-traumatic stress disorder; depression and anxiety; increases in violence; and strains due to relocation (Luber et al., 2014; Clayton et al., 2014).

To help reduce climate change, the nation must reduce methane emissions, which have the second most powerful global warming potential according to the International Panel on Climate Change. The IPCC calculates that methane has a more than 30-times greater impact per pound emitted than carbon dioxide over 20 years and a more than 80-times greater over 100 years (IPCC, 2013).

Living nearer to oil and gas development may expose residents to greater risk. For example, a 2012 study found that people who lived within one-half mile of those developments in Garfield County, Colorado, faced increased risk from cancer, largely due to elevated benzene exposure (McKenzie et al., 2012). A Pennsylvania study found evidence of higher rates of hospital use for cardiovascular and neurological conditions associated with increased oil and gas extraction (Jemielita et al., 2015). Recent reviews of the research examining the health effects associated with proximity to oil and gas extraction and development have warned about the potential for harm from the emissions, the growth in the development and the increased proximity to more people (Werner et al., 2014; Shonkoff et al., 2014; and Adgate et al., 2014).

### **Millions of Americans suffer greater vulnerability to these threats**

Many people face greater risk or exposure. Children court special risks because their bodies are growing and because they are so active (Shear et al., 2007; AAP, 2004). Older adults are more likely to die during high heat events (Zannobetti et al., 2012). People with chronic respiratory diseases like asthma and chronic obstructive pulmonary disease, people with cardiovascular diseases and people with diabetes also risk greater harm from increased pollution (EPA, 2009; EPA 2013).

A growing body of research indicates that oil and gas development is associated with adverse health impacts, including premature birth, congenital heart defects, neural tube defects, and low birth weight for infants born to mothers living near natural gas development (Casey et al., 2015; McKenzie et al., 2014; Stacey et al., 2015).

Poorer people and some racial and ethnic groups are among those who often confront 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 (O'Neill et al., 2003; Brender et al. 2011).

Poorer people, people of color, older people and disabled people will have a harder time responding to the threats, especially if electricity is lost or relocation or evacuation is required (Luber et al., 2014; APHA, 2011). Hurricane Katrina demonstrated that many people in these groups had difficulty

evacuating and relocating after a major weather event. Native American tribal communities may face threats to food supplies and difficulty relocating due to tribal land locations (Luber et al., 2014).

People most at risk of harm from breathing these air pollutants from the oil and natural gas industry include: infants, children and teenagers; older adults; pregnant women; people with asthma and other lung diseases; people with cardiovascular disease; diabetics; people with low incomes; and healthy adults who work or exercise outdoors, including employees of the oil and gas industry. Many live and work in communities near these oil and gas facilities, which are often located near lower income or minority communities.

### **Conclusion**

This extensive evidence proves why EPA must implement these standards for new, modified, and reconstructed oil and gas facilities: essentially, to protect our children, our communities and the public. The United States must significantly reduce methane and volatile organic compounds from all oil and gas facilities. Reducing methane, a powerful greenhouse gas, is essential to reduce the burden of climate change. However, the benefits go far outside the impact on the climate, particularly in the reduction of other toxic and carcinogenic emissions with the same effort. Lifesaving benefits to public health can begin immediately.

The cleanup of air pollution from oil and natural gas wells is necessary for the protection of public health, appropriate for the EPA to undertake, and of growing importance. We oppose the stay and, instead, call upon EPA to retain and rapidly implement these standards.

Sincerely,

**Alliance of Nurses for Healthy Environments**

**American Lung Association**

**American Public Health Association**

**American Thoracic Society**

**Asthma and Allergy Network**

**Center for Climate Change and Health**

**Children's Environmental Health Network**

**Healthcare Without Harm**

**National Environmental Health Association**

**Physicians for Social Responsibility**

**Trust for America's Health**

## References Cited

Adgate J.L., B.D. Goldstein, and L.M. McKenzie. 2014. Potential Public Health Hazards, Exposures and Health Effects from Unconventional Natural Gas Development. *Environ Sci Technol* 48:8307–8320.

American Academy of Pediatrics, Council on Environmental Health (AAP). 2015. Global Climate Change and Children's Health. *Pediatrics* 136: 6. DOI: 10.1542/peds.2015-3232.

American Academy of Pediatrics, Committee on Environmental Health, Ambient Air Pollution. 2004. Health Hazards to Children. *Pediatrics* 114: 1699-1707. Statement was reaffirmed in 2010.

American Public Health Association (APHA). 2011. *Climate Change: Mastering the Public Health Role*. Available: [https://www.apha.org/~media/files/pdf/factsheets/climate\\_change\\_guidebook.ashx](https://www.apha.org/~media/files/pdf/factsheets/climate_change_guidebook.ashx).

American Public Health Association (APHA). 2015. *Public Health Opportunities to Address the Health Effects of Climate Change*. Policy Number 20157. Available: <https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2015/12/03/15/34/public-health-opportunities-to-address-the-health-effects-of-climate-change>

Agency for Toxic Substances and Disease Registry (ATSDR). 1999a. Toxicological profile for Formaldehyde. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Available: <http://www.atsdr.cdc.gov/toxprofiles/tp111-c2.pdf> [Accessed: 17 October 2011].

Agency for Toxic Substances and Disease Registry (ATSDR). 1999b. Toxicological profile for *n*-Hexane. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Available: <http://www.atsdr.cdc.gov/toxprofiles/tp113-c2.pdf> [Accessed: 17 October 2011].

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological profile for Toluene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Available: <http://www.atsdr.cdc.gov/ToxProfiles/tp56-c2.pdf> [Accessed: 17 October 2011].

Agency for Toxic Substances and Disease Registry (ATSDR). 2001. Landfill Gas Primer – An Overview for Environmental Health Professionals: Chapter 3 – Landfill Gas Safety and Health Issues. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Available: <http://www.atsdr.cdc.gov/HAC/landfill/html/ch3.html> [Accessed: 17 October 2011].

Agency for Toxic Substances and Disease Registry (ATSDR). 2007a. Toxicological profile for Benzene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Available: <http://www.atsdr.cdc.gov/ToxProfiles/tp3-c3.pdf> [Accessed: 17 October 2011].

Agency for Toxic Substances and Disease Registry (ATSDR). 2007b. Toxicological profile for Xylenes. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Available: <http://www.atsdr.cdc.gov/ToxProfiles/tp71-c3.pdf> [Accessed: 17 October 2011].

Agency for Toxic Substances and Disease Registry (ATSDR). 2010. Toxicological profile for Ethylbenzene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Available: <http://www.atsdr.cdc.gov/ToxProfiles/tp110-c3.pdf> [Accessed: 17 October 2011].

Brender J.D., J.A. Maantay, and J. Chakraborty. 2011. Residential Proximity to Environmental Hazards and Adverse Health Outcomes. *Am J Public Health* 101(Suppl 1): S37–S52. doi: 10.2105/AJPH.2011.300183.

Brandt A.E., G.A. Heath, E.A. Kort, F. O’Sullivan, G. Pétron, S.M. Jordaan, et al. 2014. Methane Leaks from North American Natural Gas System. *Science* 343: 733-735.

Casey J.A., D.A. Savitz, S.G. Rasmussen, E.L. Ogburn, J. Pollak, D.G. Mercer, et al. 2015. Unconventional Natural Gas Development and Birth Outcomes in Pennsylvania, USA. *Epidemiology* 1; doi:10.1097/EDE.0000000000000387.

Chapin F.S., III, S.F. Trainor, P. Cochran, H. Huntington, C. Markon, M. McCammon, A.D. McGuire, and M. Serreze, 2014: Ch. 22: Alaska. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J.M. Melillo, Terese (T.C.) Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Program, 514-536. doi:10.7930/J00Z7150.

Clayton S., C.M. Manning, and C. Hodge. 2014. Beyond Storms and Droughts: The Psychological Impacts of Climate Change. Washington, DC: American Psychological Association and ecoAmerica.

Fritz A. 2015. Smoke from Hundreds of North American Wildfires is Taking a Toll on U.S. Air Quality. *Washington Post*, July 8, 2015. Available: <https://www.washingtonpost.com/news/capital-weather-gang/wp/2015/07/08/smoke-from-hundreds-of-north-american-wildfires-is-taking-a-toll-on-u-s-air-quality/>.

Hamra G.B., N. Guha, A. Cohen, F. Laden, O. Raaschou-Nielsen, J.M. Samet, et al. 2014. Outdoor Particulate Matter Exposure and Lung Cancer: A Systematic Review and Meta-Analysis. *Environmental Health Perspective* 122: 906-911.

Hays J., S.B.C. Shonkoff. 2015. Toward an Understanding of the Environmental and Public Health Impacts of Shale Gas Development: An Analysis of the Peer Reviewed Scientific Literature, 2009-2015. *PSE Healthy Energy*, 16 June 2015. Available: <http://www.psehealthyenergy.org/data/Database Analysis 2015.6 .16 .pdf>.

Helmig D, C.R. Thompson, J. Evans, P. Boylan, J. Hueber, and J-H. Park. 2014. Highly Elevated Atmospheric Levels of Volatile Organic Compounds in the Uintah Basin, Utah. *Environ. Sci. Technol.* 48:4707–4715.

ICF International (ICF). 2014. Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries. Available: [https://www.edf.org/sites/default/files/methane\\_cost\\_curve\\_report.pdf](https://www.edf.org/sites/default/files/methane_cost_curve_report.pdf).

Intergovernmental Panel on Climate Change (IPCC). 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp. Accessed: <http://www.ipcc.ch/report/ar5/wg1/>

Intergovernmental Panel on Climate Change (IPCC). 2014. *Climate Change 2014 Synthesis Report*. November 1, 2014. Accessed: [http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR\\_AR5\\_SPM.pdf](http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_SPM.pdf).

Jemielita T, Gerton GL, Neidell M, Chillrud S, Yan B, Stute M, et al. 2015. Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates. *PLoS ONE* 10:e0131093; doi:10.1371/journal.pone.0131093.

Juozapavicius J. 2012. Oklahoma Dust Storm Shuts Down Portion Of Interstate 35. Associated Press, October 18, 2012. Available: [http://www.huffingtonpost.com/2012/10/18/oklahoma-dust-storm-n\\_1982501.html](http://www.huffingtonpost.com/2012/10/18/oklahoma-dust-storm-n_1982501.html).

Li B., S. Sain, L.O. Mearns, et al. 2012. The Impact of Extreme Heat on Morbidity in Milwaukee, Wisconsin. *Climate Change*; 110: 959-976.

Luber G., K. Knowlton, J. Balbus, H. Frumkin, M. Hayden, J. Hess, et al. 2014. Ch. 9: Human Health. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J.M. Melillo, Terese (T.C.) Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Program, 220-256. doi:10.7930/JOPN93H5.

Macey G.P., R. Breech, M. Chernaik, C. Cox, D. Larson, D. Thomas, et al. 2014. Air Concentrations of Volatile Compounds near Oil and Gas Production: A Community-Based Exploratory Study. *Environmental Health* 13:82.

McKenzie L.M., R. Guo, R.Z. Witter, D.A. Savitz, L.S. Newman, J.L. Adgate. 2014. Birth Outcomes and Maternal Residential Proximity to Natural Gas Development in Rural Colorado. *Environmental Health Perspectives* 122; doi:10.1289/ehp.1306722.

Melillo J.M., Terese (T.C.) Richmond, and G.W. Yohe, Eds. 2014. *Climate Change Impacts in the United States. The Third National Climate Assessment*. U.S. Global Change Research Program. Available: [www.nca2014.globalchange.gov](http://www.nca2014.globalchange.gov).

McGwin G, J. Lienert, and J.L. Kennedy. 2010. Formaldehyde Exposure and Asthma in Children: A Systematic Review. *Environ Health Perspect* 118(3): 313-317.

National Institute for Occupational Safety and Health (NIOSH). 2015. International Chemical Safety Cards: Methane. Atlanta, GA: Centers for Disease Control and Prevention (CDC). Available: <http://www.cdc.gov/niosh/ipcsneng/neng0291.html> [Accessed: 14 November 2015].

National Wildlife Federation and Asthma and Allergy Foundation of America (NWF and AAFA). *Extreme Allergies and Global Warming*. National Wildlife Foundation, 2010. Accessed: [http://www.nwf.org/pdf/Reports/NWF\\_AllergiesFinal.pdf](http://www.nwf.org/pdf/Reports/NWF_AllergiesFinal.pdf).

O'Neill M.S., M. Jerrett, I. Kawachi, J.I. Levy, A.J. Cohen, et al. 2003. Health, Wealth, and Air Pollution: Advancing Theory and Methods. *Environ Health Perspect* 111: 1861-1870.

Pétron G, Karion A, Sweeney C, Miller BR, Montzka SA, Frost G, et al. 2014. A New Look at Methane and Non-Methane Hydrocarbon Emissions from Oil and Natural Gas Operations in the Colorado Denver-Julesburg Basin. *J Geophys Res Atmos*. 2013JD021272.

Pinkerton K.E., W.N. Rom, M. Akpınar-Elci, J.R. Balmes, H. Bayram, O. Brandli, et al. 2012. An Official American Thoracic Society Workshop Report: Climate Change and Human Health. *Proceedings of the American Thoracic Society* 9: 3-8, doi:10.1513/pats.201201-015ST. Available: <http://www.atsjournals.org/doi/pdf/10.1513/pats.201201-015ST>.

Rocha V. 2014. 1,000 More California Wildfires Than Usual in 2014, and Fire Season Just Started. *Los Angeles Times*, September 23, 2014. Available: <http://www.latimes.com/local/lanow/la-me-ln-california-1000-wildfires-20140923-story.html>.

Shea K.M., and the Committee on Environmental Health. 2007. Global Climate Change and Children's Health. *Pediatrics* 120: e1359.

Shonkoff S.B.C., J. Hays, and M.L. Finkel. 2014. Environmental Health Dimensions of Shale and Tight Gas Development. *Environmental Health Perspectives* 122(8): 787-795. Available: <http://ehp.niehs.nih.gov/1307866/>.

Stacy S.L., L.L. Brink, J.C. Larkin, Y. Sadovsky, B.D. Goldstein, B.R. Pitt, et al. 2015. Perinatal Outcomes and Unconventional Natural Gas Operations in Southwest Pennsylvania. *PLoS ONE* 10:e0126425; doi:10.1371/journal.pone.0126425.

Thompson C.R., J. Hueber, D. Helmig. 2014. Influence of oil and gas emissions on ambient atmospheric non-methane hydrocarbons in residential areas of Northeastern Colorado. *Elementa: Science of the Anthropocene* 2:000035. doi: 10.12952/journal.elementa.000035.

Trust for America's Health (TfAH). 2009. *Health Problems Heat Up: Climate Change and the Public's Health*. Available: <http://healthyamericans.org/reports/environment/TFAHClimateChangeWeb.pdf>.

U.S. Environmental Protection Agency (EPA). 2009a. Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impact on Ground-level Ozone. April 2009. EPA/600/R-07/094F.

U.S. Environmental Protection Agency (EPA). 2009b. Integrated Science Assessment for Particulate Matter (Final Report). EPA-600-R-08-139F. Available: <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=216546>.

U.S. Environmental Protection Agency (EPA). 2011. 2011 U.S. Greenhouse Gas Inventory Report Executive Summary. 76 Fed. Reg. 52,792. Available: <http://epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Executive-Summary.pdf>.

U.S. Environmental Protection Agency (EPA). 2013. Integrated Science Assessment for Ozone and Related Photochemical Oxidants. EPA 600/R-10/076F. Available: <http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492#Download>.

U.S. Environmental Protection Agency (EPA). 2015a. County-Level Design Values for the 2015 Ozone Standards based on Monitored Air Quality Data from 2012-2014. Available: <http://www3.epa.gov/ozonepollution/pdfs/20151001datatable20122014.pdf>.

U.S. Environmental Protection Agency (EPA). 2015b. Regulatory Impact Analysis of the Proposed Emissions Standards for New and Modified Sources in the Oil and Natural Gas Sector. EPA-452/R-15-002. Available: [http://www3.epa.gov/airquality/oilandgas/pdfs/og\\_prop\\_ria\\_081815.pdf](http://www3.epa.gov/airquality/oilandgas/pdfs/og_prop_ria_081815.pdf).

U.S. Department of Agriculture Economic Research Service. California Drought 2014: Farm and Food Impacts. September 12, 2014. Available: <http://ers.usda.gov/topics/in-the-news/california-drought-2014-farm-and-food-impacts.aspx>

U.S. Department of Health and Human Services (HHS). National Toxicology Program. 2011. *Report on Carcinogens, Twelfth Edition*. Research Triangle Park, NC: U.S. Department of Health and Human Services.

U.S. Global Change Research Program (USGCRP). 2016. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. U.S. Global Change Research Program, Washington, DC. <http://dx.doi.org/10.7930/JOR49NQX>

Walsh J., D. Wuebbles, K. Hayhoe, J. Kossin, K. Kunkel, G. Stephens, P. Thorne, R. Vose, M. Wehner, J. Willis, D. Anderson, S. Doney, R. Feely, P. Hennon, V. Kharin, T. Knutson, F. Landerer, T. Lenton, J. Kennedy, and R. Somerville, 2014: Ch. 2: Our Changing Climate. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J.M. Melillo, Terese (T.C.) Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Program, 19-67. doi:10.7930/J0KW5CXT.

Werner A.K., S. Vink, K. Watt, P. Jagals. 2015. Environmental Health Impacts of Unconventional Natural Gas Development: A Review of the Current Strength of Evidence. *Science of The Total Environment* 505:1127–1141.

Zanobetti A, et al. 2012. Summer Temperature Variability and Long-Term Survival among Elderly People with Chronic Disease. *Proceedings of the National Academy of Sciences* 109: 6608-6613.

Ziska L.H., and P.J. Beggs. 2012. Anthropogenic Climate Change and Allergen Exposure: The Role of Plant Biology. *J Allergy Clin Immunol* 129(1):27-32.