

Health Implications of Natural Gas Leaks: A Role for Public Health Practitioners

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Overview

- What is natural gas?
- What do we know about the health effects of natural gas infrastructure?
- What do we need to know about the health effect of natural gas infrastructure?
 - Comprehensive health impact assessments
- Wellesley: a case study in natural gas leaks

Sources

- Physicians for Social Responsibility report, February 2017
- Concerned Health Professionals of New York compendium of scientific, medical and media findings, November 2016
- Union of Concerned Scientists
- Pubmed

Expansion of Natural Gas Industry

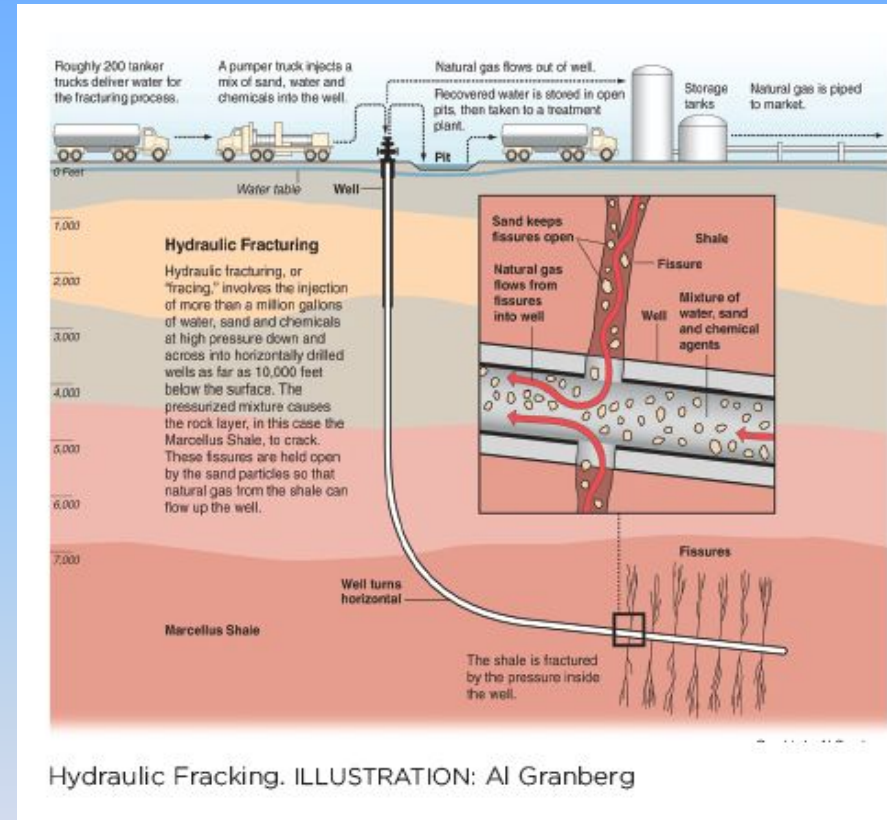
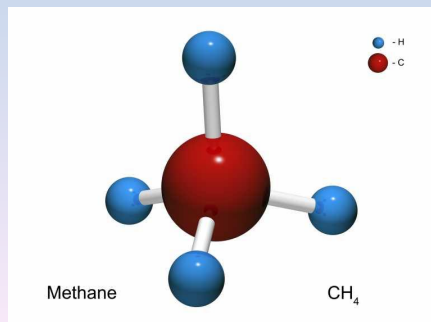
- Natural gas boom in past 15 years
 - Over 15 million Americans now in close proximity to this heavy industry



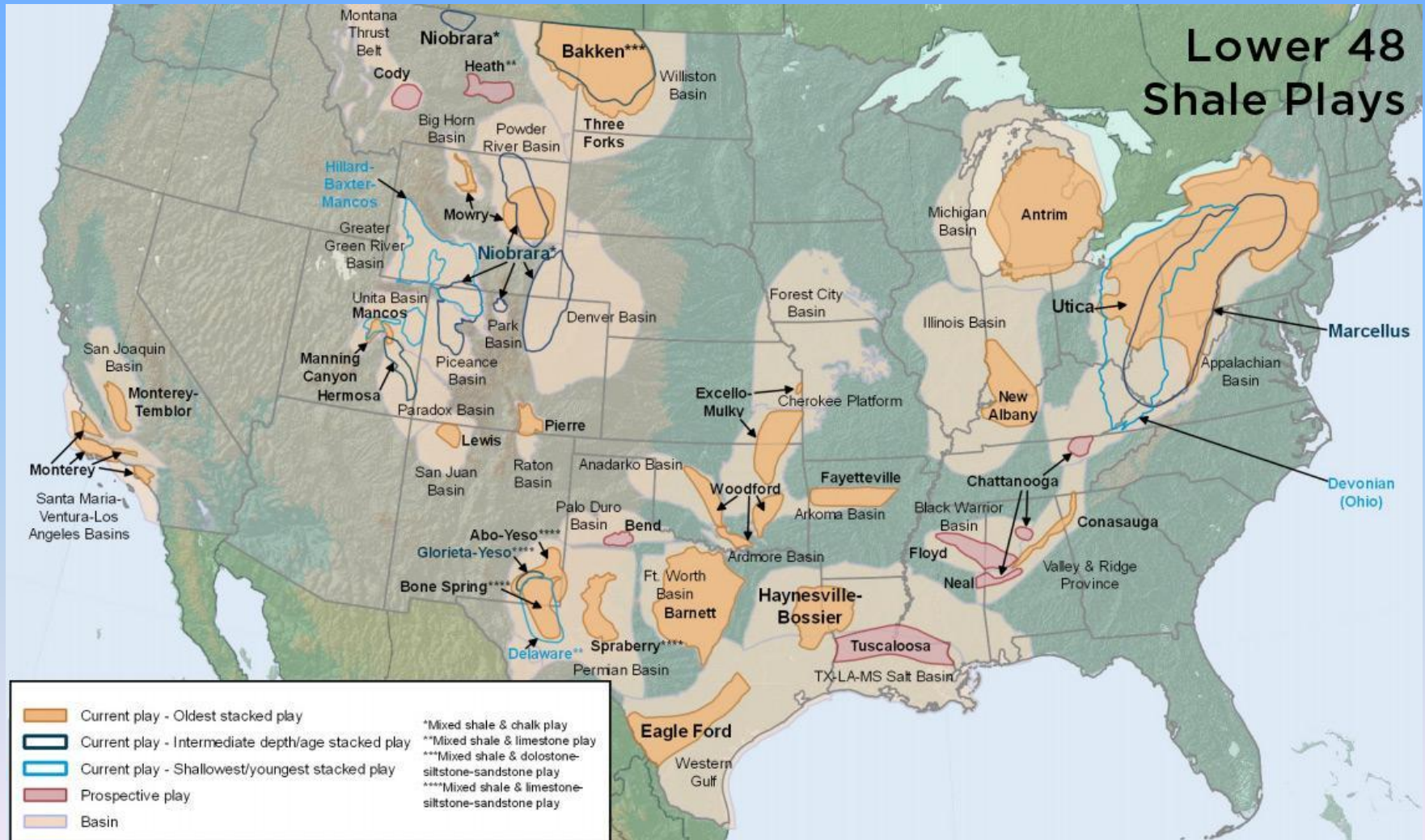
Living close to fracking operations increases the risk of premature birth and congenital heart defects.

What is Natural Gas?

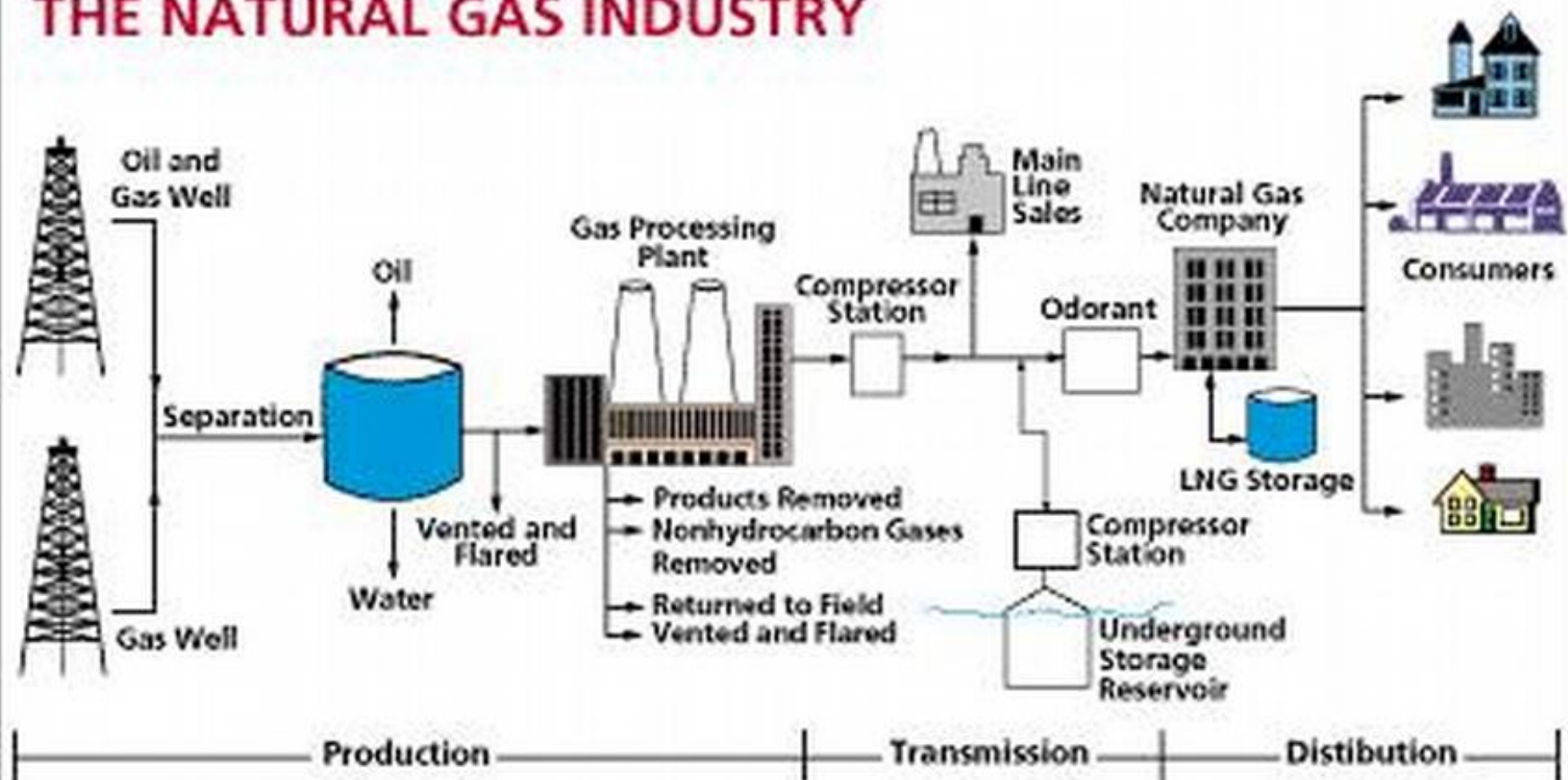
- Extracted from complex geologic formations by hydraulic fracturing (fracking)
- Methane (CH_4) + other substances



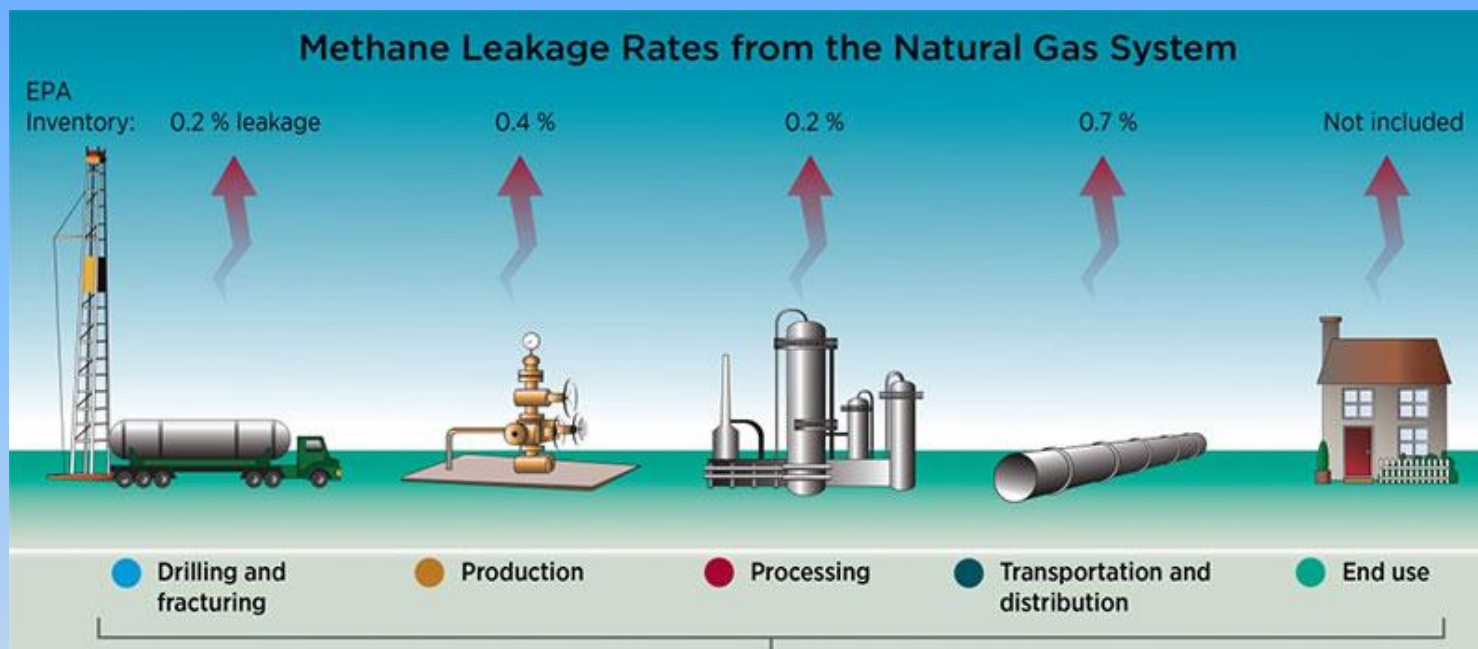
Natural Gas Shale Formations in US



THE NATURAL GAS INDUSTRY



Methane is a Potent Greenhouse Gas



Atmospheric methane isotopic record favors fossil sources flat in 1980s and 1990s with recent increase

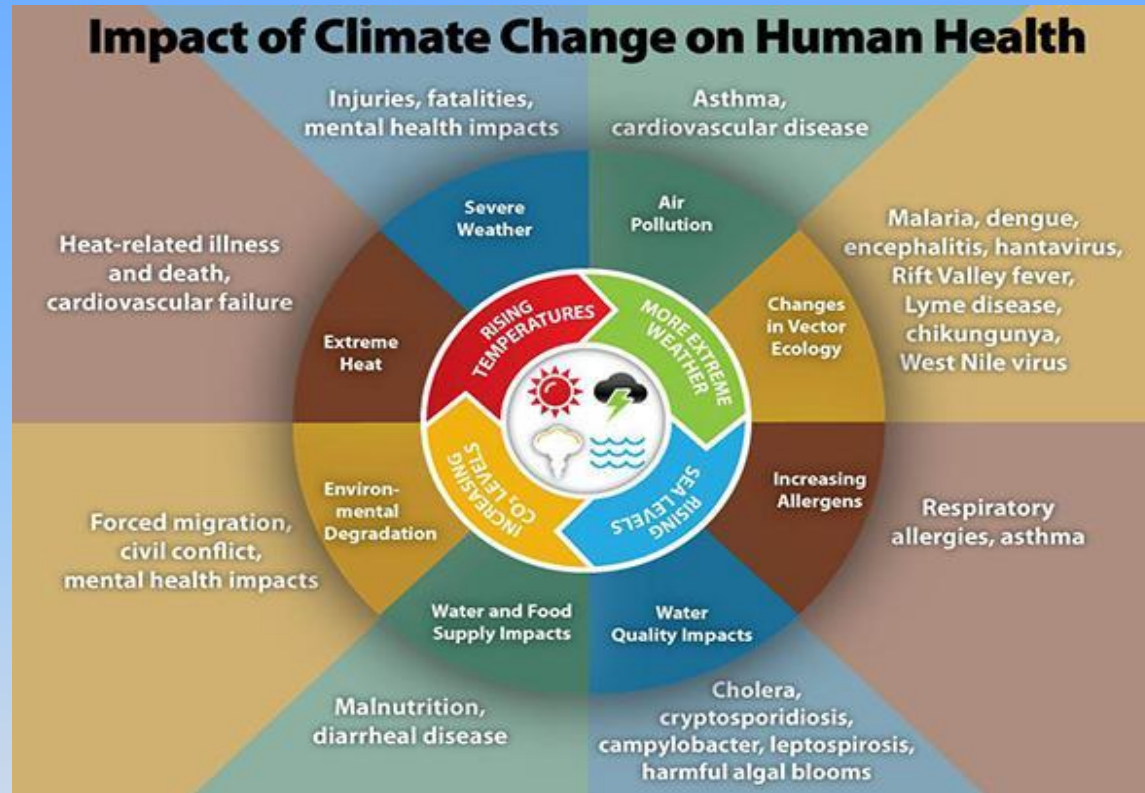
Andrew L. Rice^{a,1,2}, Christopher L. Butenhoff^{a,1}, Doaa G. Teama^a, Florian H. Röger^a, M. Aslam K. Khalil^a, and Reinhold A. Rasmussen^b

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Edited by Mark H. Thieme, University of California, San Diego, La Jolla, CA, and approved July 26, 2016 (received for review November 19, 2015)



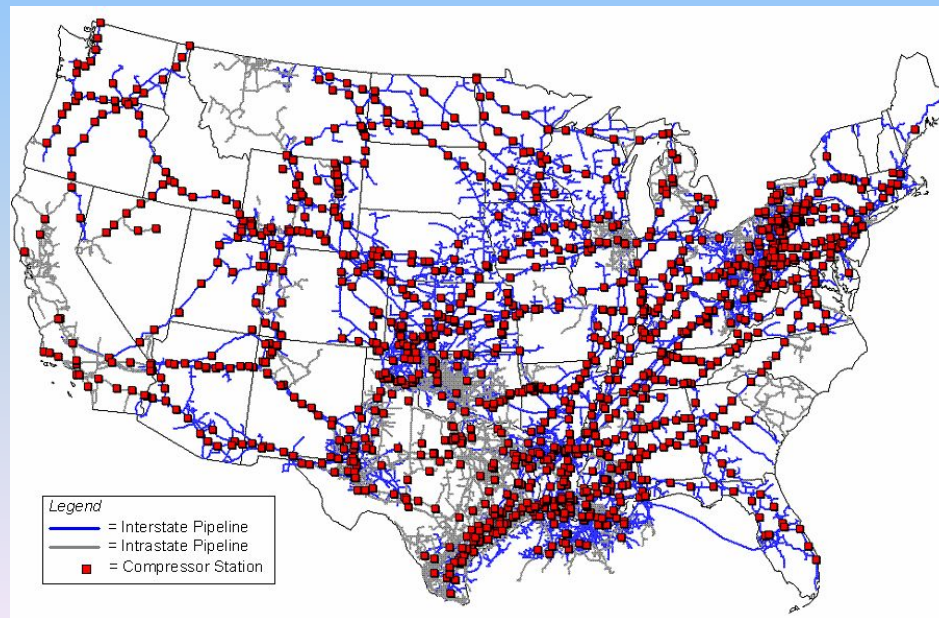
Climate Change Impacts Human Health



In 2015, the Lancet Commission on Health and Climate Change warned that the health effects of climate change threaten to reverse the hard-won public health gains of the last century.

Where do (local) health effects occur?

- Near fracking sites (production)
- Processing, transport, and delivery through compressor stations and distribution pipelines



Barriers to Understanding Health Effects of Natural Gas Infrastructure

- Political will
 - The list of chemicals used in fracking fluids is considered proprietary and is not always made public
 - Funding
- Availability of relevant data
- Sample size
- Latency period



Health Effects of Natural Gas

- More than 900 peer-reviewed scientific publications on environmental, health and societal effects
 - >80% since January 2013
- Many of the chemicals associated with fracking cause cancer, are toxic, or are endocrine-disruptive
- Increasing number of studies linking health outcomes to residential proximity to natural gas infrastructure
 - Air quality, water quality, physical hazards

Air Quality Basics

- Clean Air Act requires EPA to set national ambient air quality standards for six common “criteria air pollutants”
 - Ozone, particulate matter, CO, NO, SO₂, lead
 - Smog, acid rain, respiratory irritants, neurotoxins

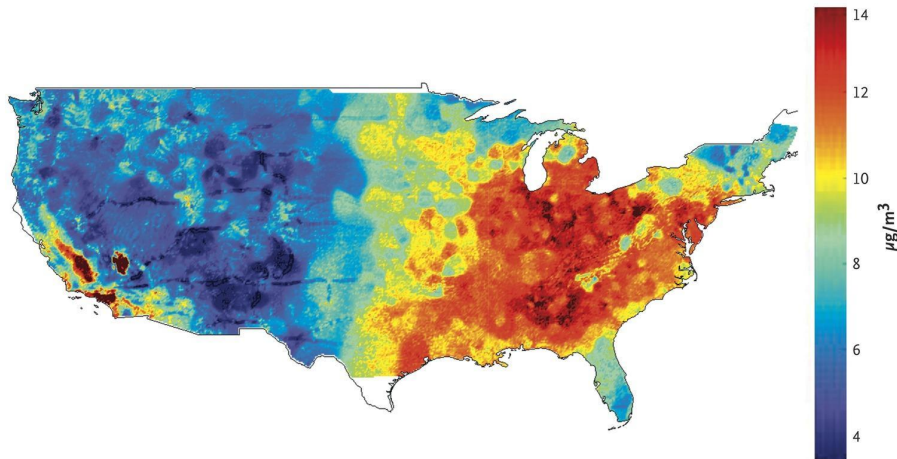
Particulate Matter

- Particulate matter
 - Decreased lung function
 - Aggravated asthma symptoms
 - Heart attacks
 - High blood pressure
 - Children are especially vulnerable

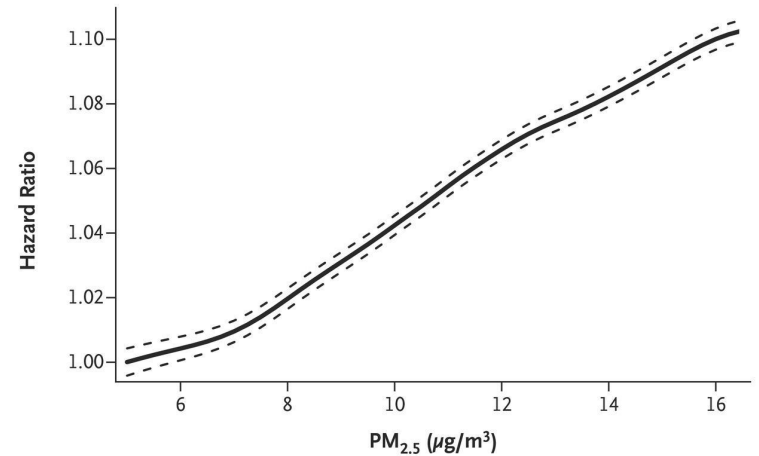


Particulate Matter

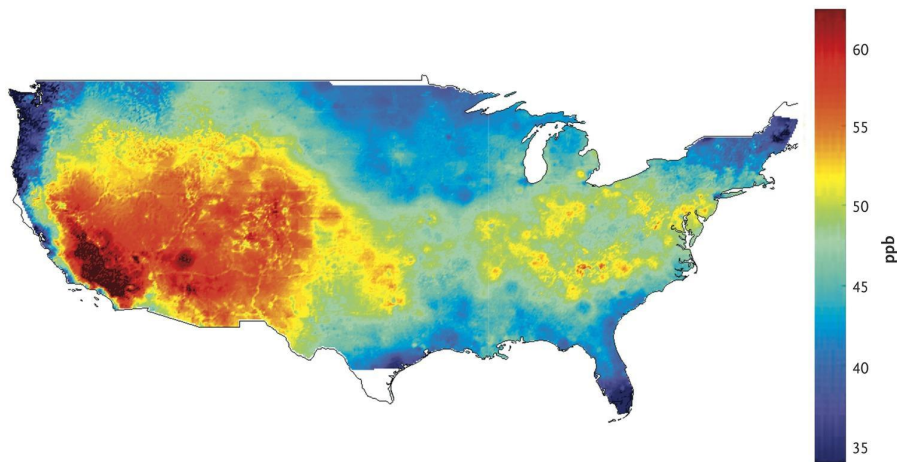
A Average Concentrations of PM_{2.5}



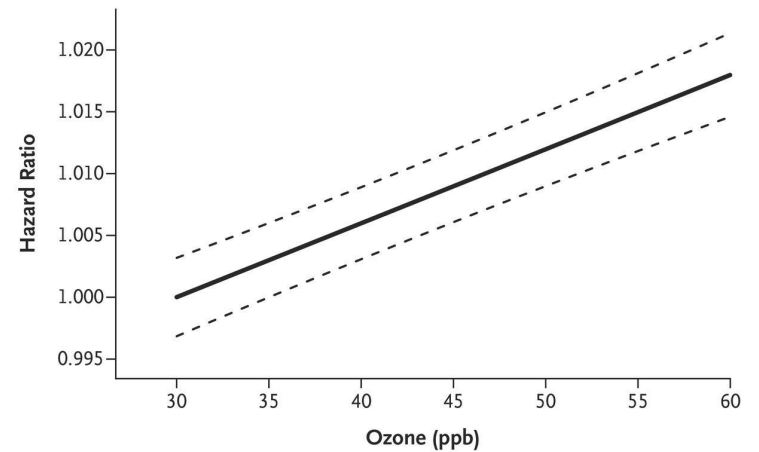
A Exposure to PM_{2.5}



B Average Warm-Season Concentrations of Ozone

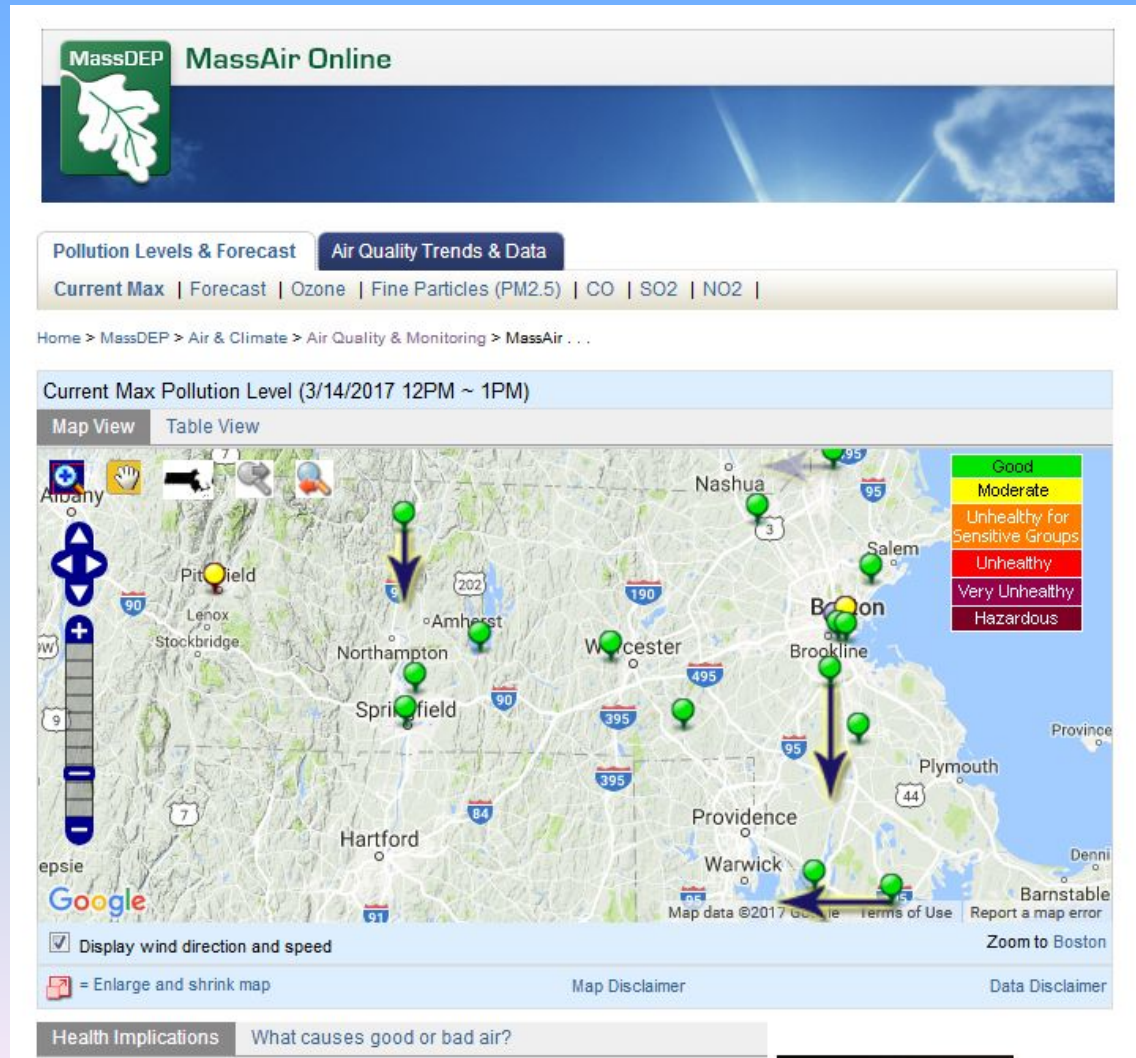


B Exposure to Ozone



Air Quality Monitoring

Concentrations of criteria air pollutants are measured at more than 4000 monitoring stations owned and operated mainly by state environmental agencies.

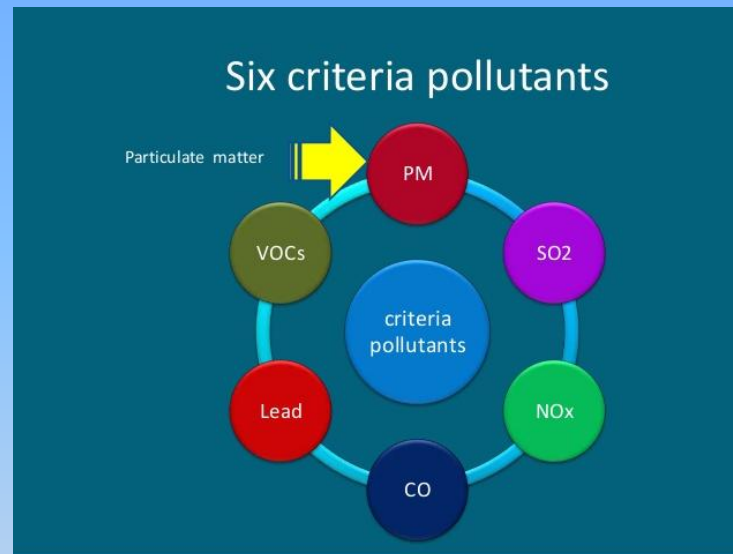


Air Quality Basics

- Hazardous air pollutants (HAP)
 - National Air Toxics Assessment (12/2015)
 - Model based on 2011 emissions data
- No data on endocrine-disruptors or radioactive substances



Natural Gas is Associated with Criteria Air Pollutants



Viscous Black Powder



Dry Black Powder



Wet Black Powder

Natural Gas is Associated with Hazardous Air Pollutants

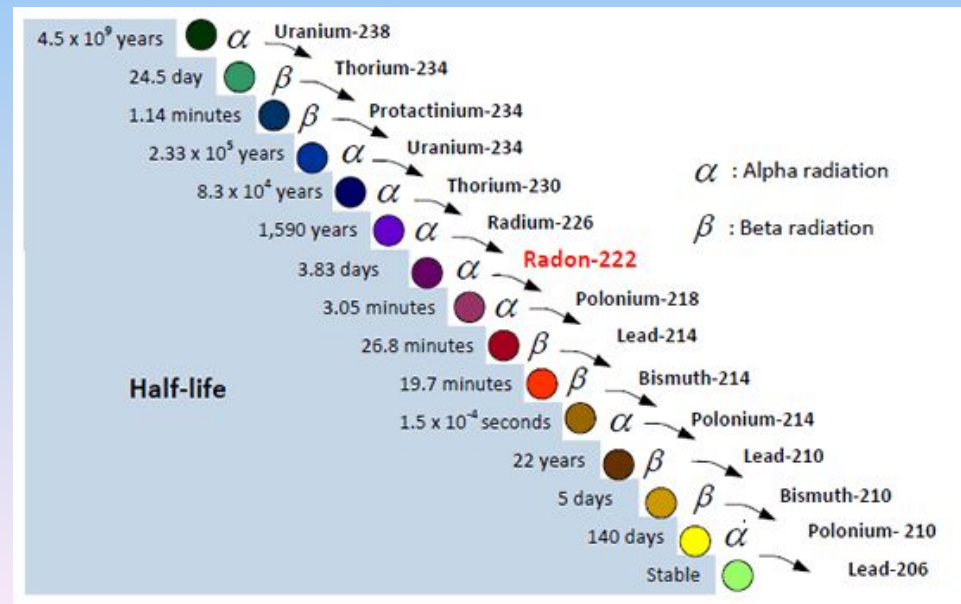
- Volatile organic compounds (benzene, toluene, ethylbenzene and xylene)
 - Affect the nervous system, cause cancer and can cause birth defects
 - No safe level



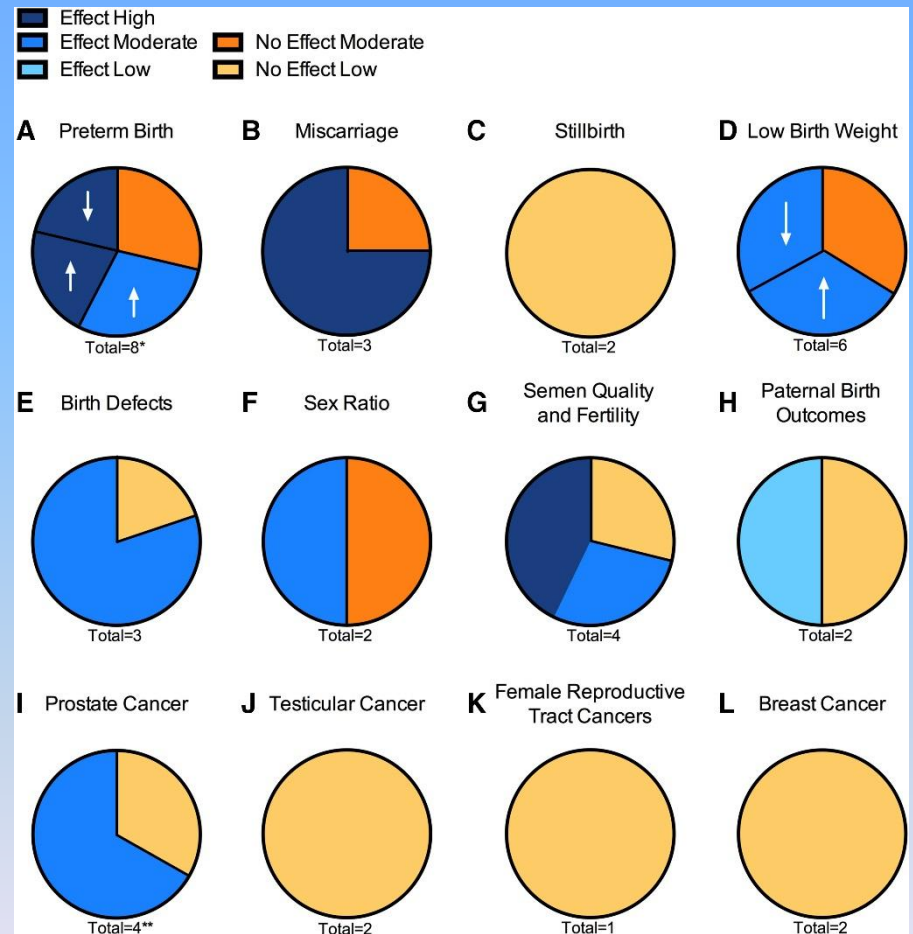
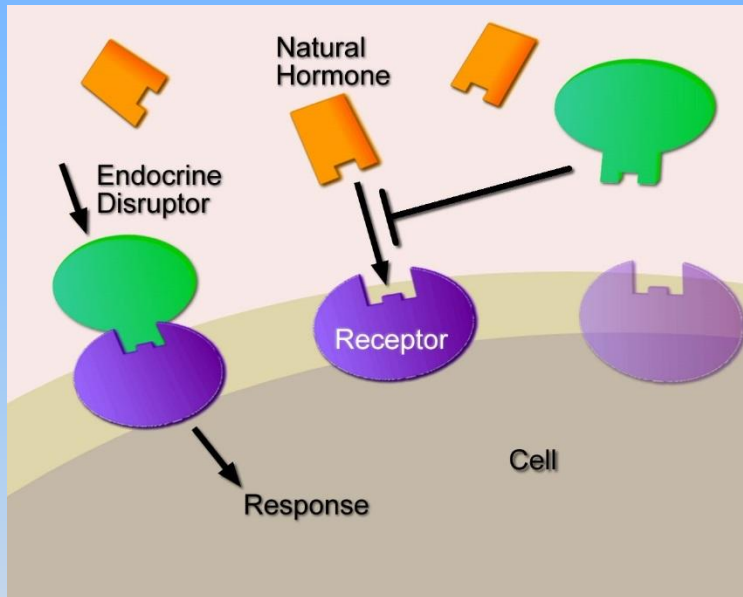
AIR CONTAMINANTS ASSOCIATED WITH HYDRAULIC FRACTURING	
BENZENE	Known carcinogen. May cause anemia; can lessen white blood cell count, weakening the immune system. ⁵⁸ Prolonged exposure may result in leukemia, reproductive and developmental disorders, and other cancers. ⁵⁹ There is no known safe level for air exposure. ⁶⁰
TOLUENE	Long-term exposure may affect the nervous system and cause miscarriages and birth defects. ⁶¹
ETHYL-BENZENE	Long-term exposure may result in blood disorders. ⁶²
XYLENES	Short-term exposure to high levels may cause irritation of the nose and throat, nausea, vomiting, and neurological effects. Long-term exposure at high levels may affect the nervous system. ⁶³

Radioactive Substances

- Some shale formations (particularly Marcellus) contain large amounts of naturally occurring radon and other radioactive elements
- Radon is the leading cause of lung cancer in non-smokers
- Radon decays



Endocrine Disruptors



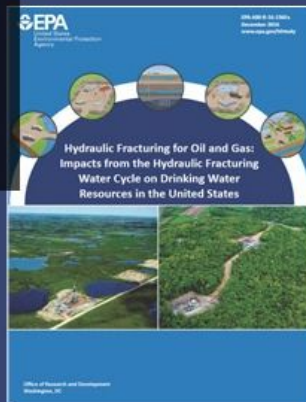
Balise, V. D., Meng, C-X., Cornelius-Green, J. N., Kassotis, C. D., Kennedy, R., & Nagel, S. C. (2016). Systematic review of the association between oil and natural gas extraction processes and human reproduction. *Fertility and Sterility*, 106(4).

Water Contamination

- EPA report (Feb 2017) confirmed that drilling and hydraulic fracturing activities can impact drinking water
- 8.6 million Americans are served by a drinking water source that is located within a mile of a fracking well

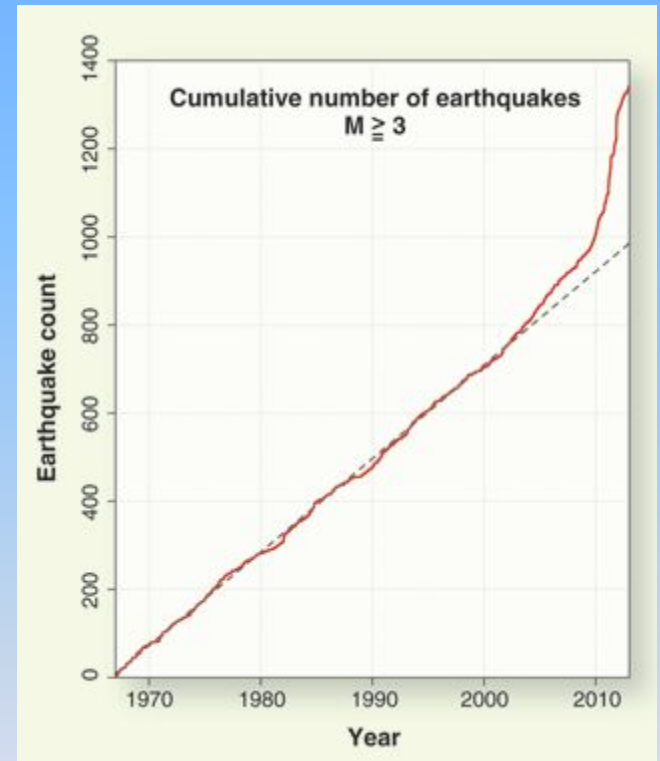
Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States

[Read the final assessment.](#)

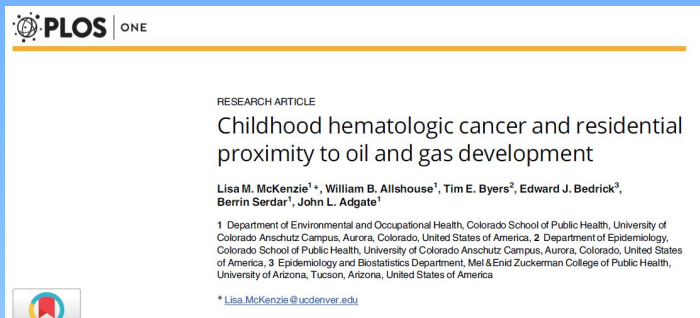


Earthquakes

- Several of the largest earthquakes in the U.S. midcontinent in 2011 and 2012 may have been triggered by nearby disposal wells.
- The largest of these was a magnitude 5.6 event in central Oklahoma that destroyed 14 homes and injured two people.



Health Effects Near Hydraulic Fracturing Sites



Association Between Unconventional Natural Gas Development in the Marcellus Shale and Asthma Exacerbations

Sara G. Rasmussen, MHS¹; Elizabeth L. Ogburn, PhD²; Meredith McCormack, MD³; et al

» Author Affiliations

JAMA Intern Med. 2016;176(9):1334-1343. doi:10.1001/jamainternmed.2016.2436

al List > Environ Health Perspect > v.122(4); 2014 Apr > PMC3984231



Environ Health Perspect. 2014 Apr; 122(4): 412–417.

Published online 2014 Jan 28. doi: [10.1289/ehp.1306722](https://doi.org/10.1289/ehp.1306722)

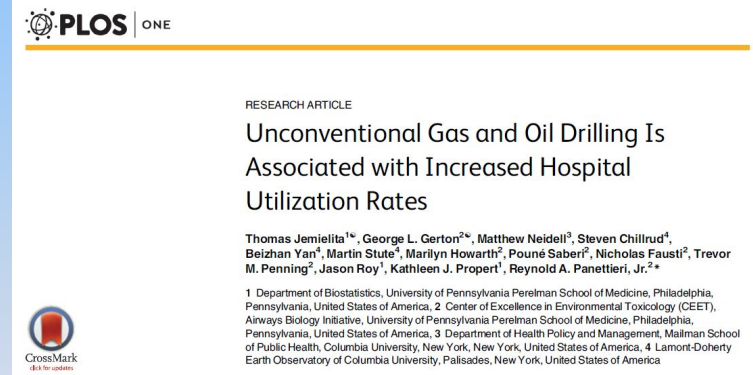
Research

PMCID: PMC3984231

Birth Outcomes and Maternal Residential Proximity to Natural Gas Development in Rural Colorado

[Lisa M. McKenzie](#)^{✉1}, [Ruixin Guo](#)², [Roxana Z. Witter](#)¹, [David A. Savitz](#)³, [Lee S. Newman](#)¹ and [John L. Adgate](#)¹

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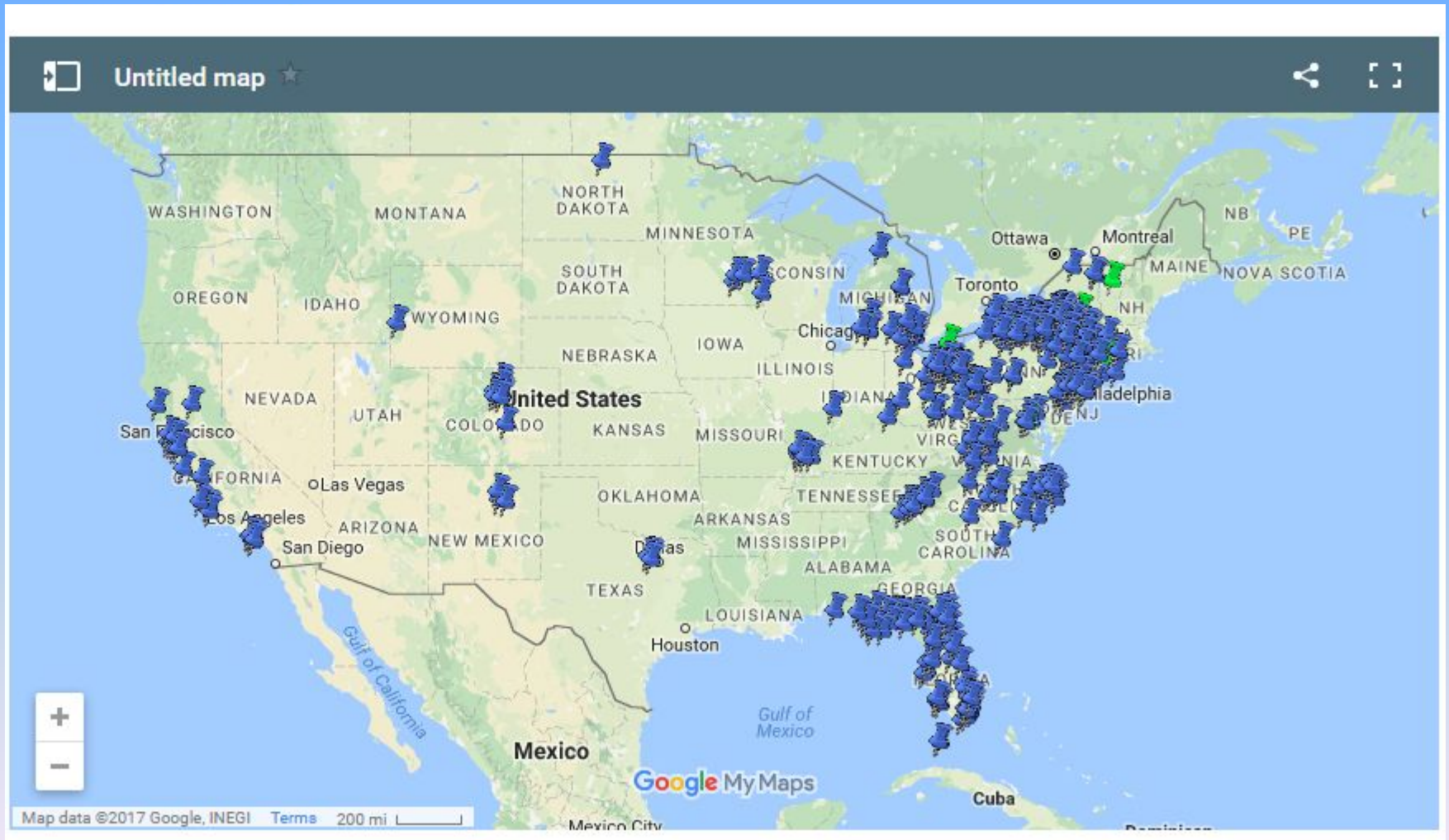
Epidemiology. 2016 Mar;27(2):163–72. doi: 10.1097/EDE.0000000000000387.

Unconventional Natural Gas Development and Birth Outcomes in Pennsylvania, USA.

[Casey JA](#)¹, [Savitz DA](#), [Rasmussen SG](#), [Ogburn EL](#), [Pollak J](#), [Mercer DG](#), [Schwartz BS](#).

➕ Author information

Many Communities Have Banned Hydraulic Fracturing for Natural Gas



Source: Food and Water Watch

Health Effects during Processing, Transport and Delivery

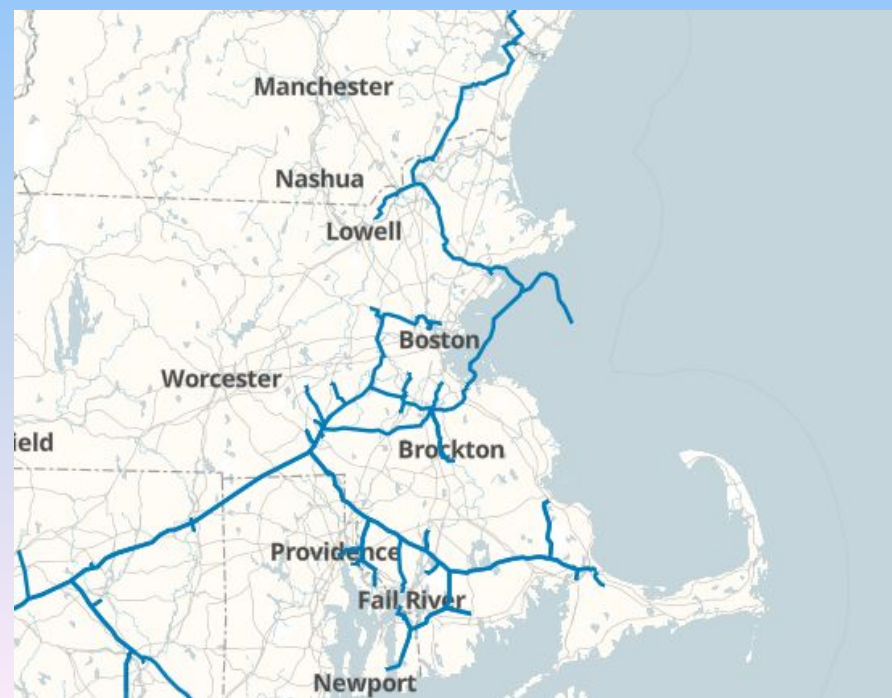
Growing body of evidence documents leaks of methane, toxic volatile organic chemicals and particulate matter throughout this infrastructure



Algonquin Pipeline Gas Contains Benzene

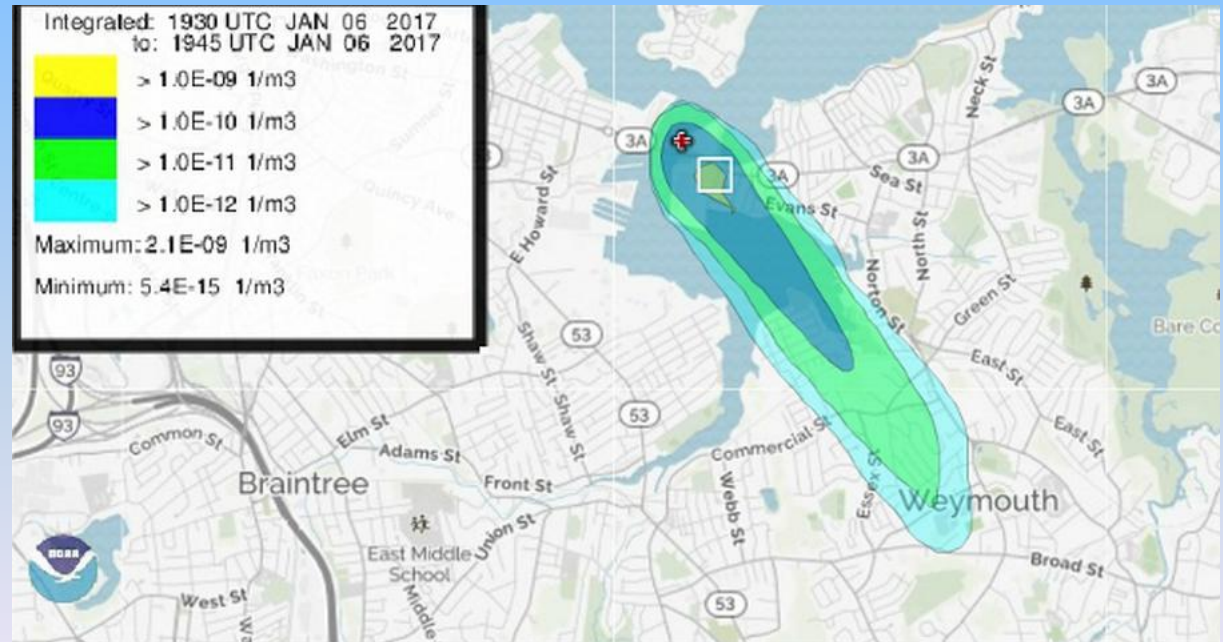
Category	Station C		
Source	WEYM-GR-ST		
	Avg. Hourly	Max. Annual	Max. Hourly
Gas Release	1,747 scfh	15,300,000 scf/yr	975,000 scfh
	81 lb/hr	708,097 lb/yr	46,959 lb/hr
HAP (Total)	0.0472 lb/hr	0.2067 tpy	69.6676 lb/hr
Benzene	0.0076 lb/hr	0.0334 tpy	11.2516 lb/hr

Spectra Energy Partners, ibid. Table G-1C. (PDF pg 752).



Compressor Stations: Blowdowns and Leaks

- “Blowdown” – complete venting of the gases in a pipeline or compressor to control pressure
- Weymouth metering & regulating station leak



Source: Dr. Curtis Nordgaard, NOAA

Compressor Stations: Blowdowns and Leaks

- People living near compressor stations have reported symptoms ranging from skin rashes to GI, respiratory, neurological and psychological problems.
- Air samples near compressor stations have shown elevated concentrations of many of the dangerous substances associated with gas from hydraulic fracturing.

Underground Gas Storage Leaks

- 400 underground storage facilities in U.S.
- Aliso Canyon, California
 - 4 month leak from 5th largest facility
 - Uncontrollable array of chemical exposures to large suburban population
 - Headaches, nosebleeds, eye irritation, asthma
 - Health study being initiated



Explosions



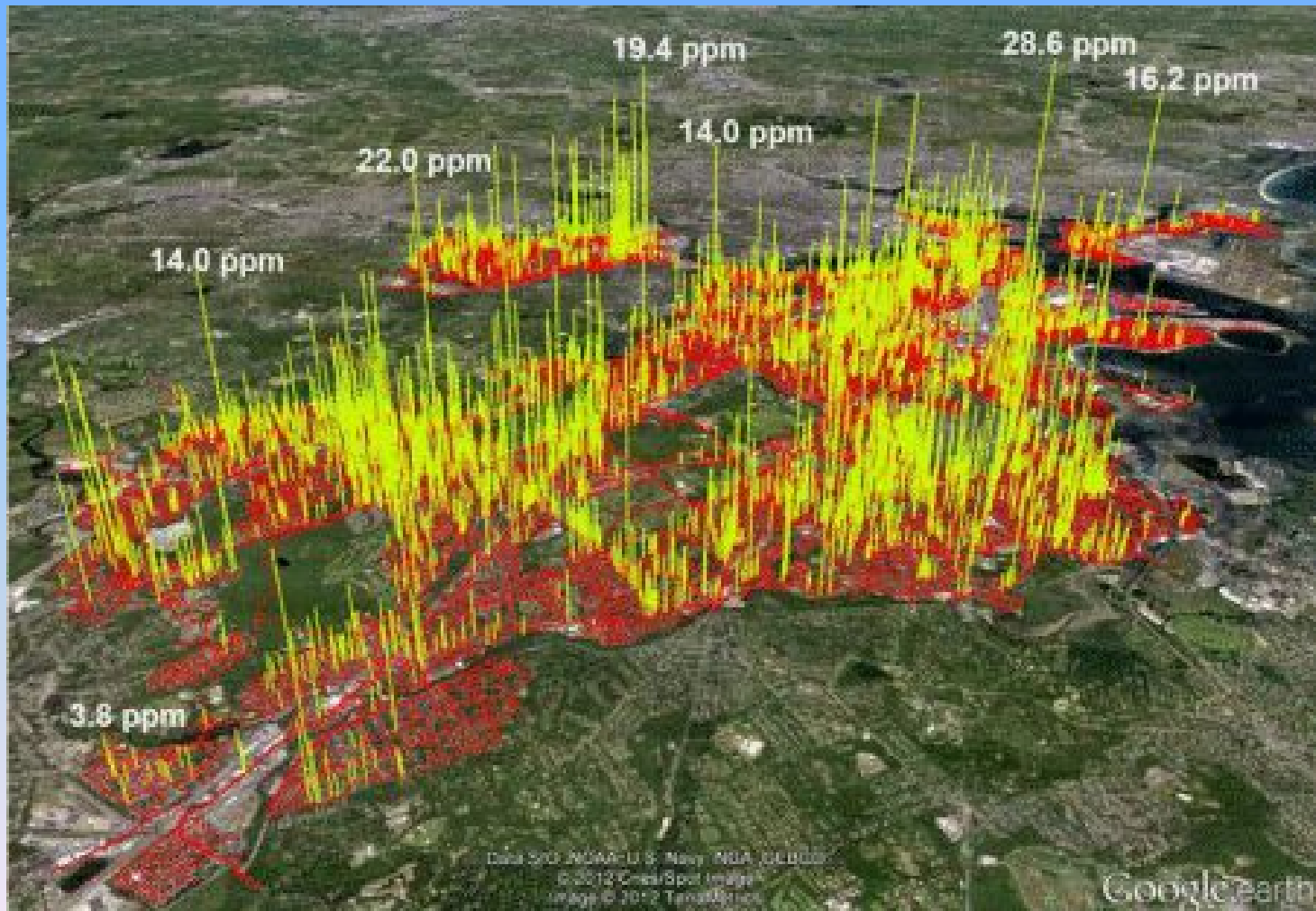
Warren, Michigan May 2011

Pipeline and Hazardous Materials Safety Administration recorded 858 serious incidents (involving fatality or injury requiring hospitalization) from 1996-2016.



Milford, Texas November 2013

Distribution Pipeline Leaks



State of the Our Air



**STATE
OF THE AIR 2017**

5 of 14 Massachusetts counties received a D or F grade.

Mass Spectrometry of Natural Gas from Laboratory Reveals VOCs

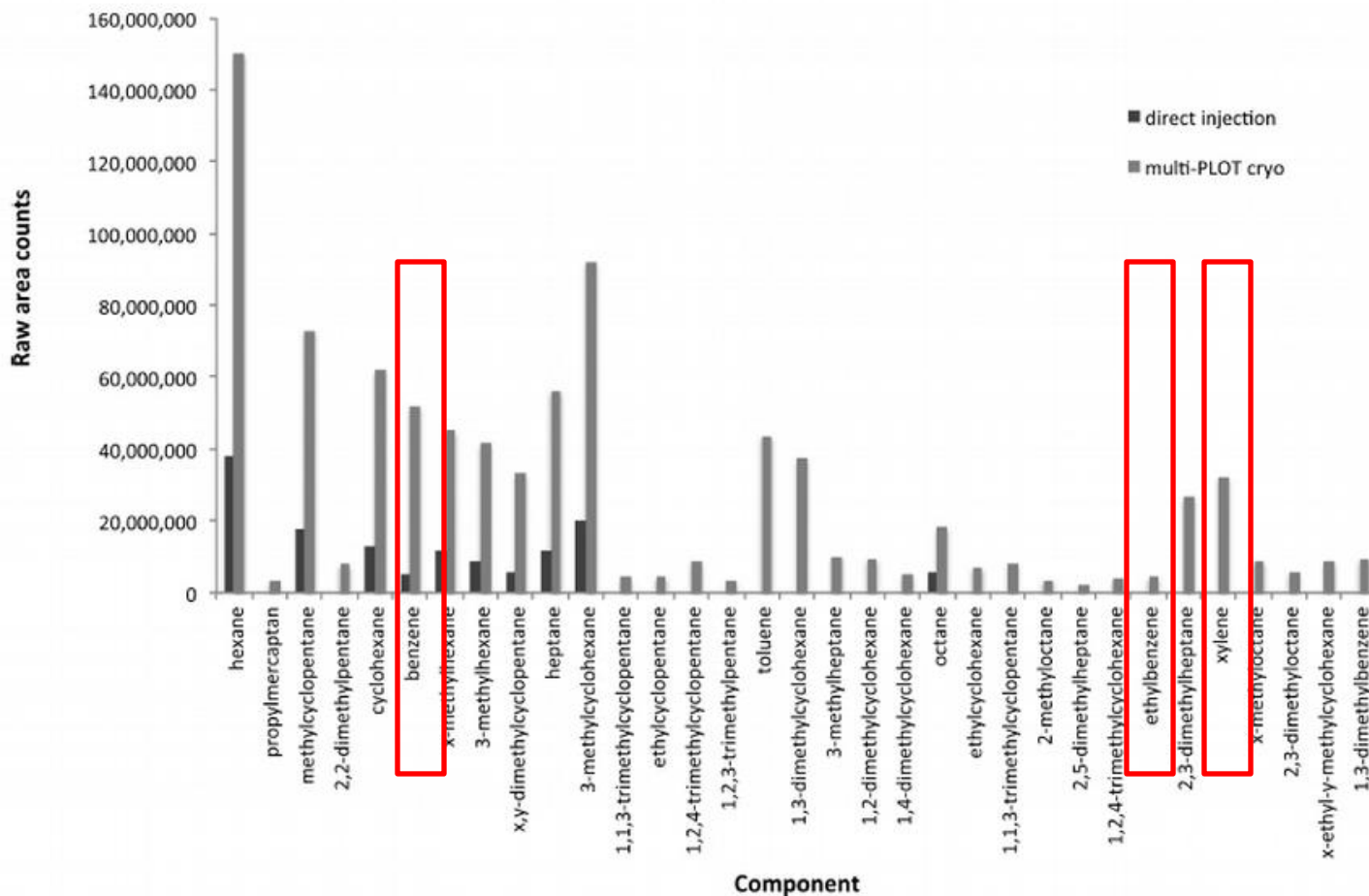


Figure 5. Comparison of GC-MS raw area counts for the C₆+ fraction of natural gas as determined by direct injection and the multi-PLOT-cryo method.

Pediatric Asthma and Natural Gas

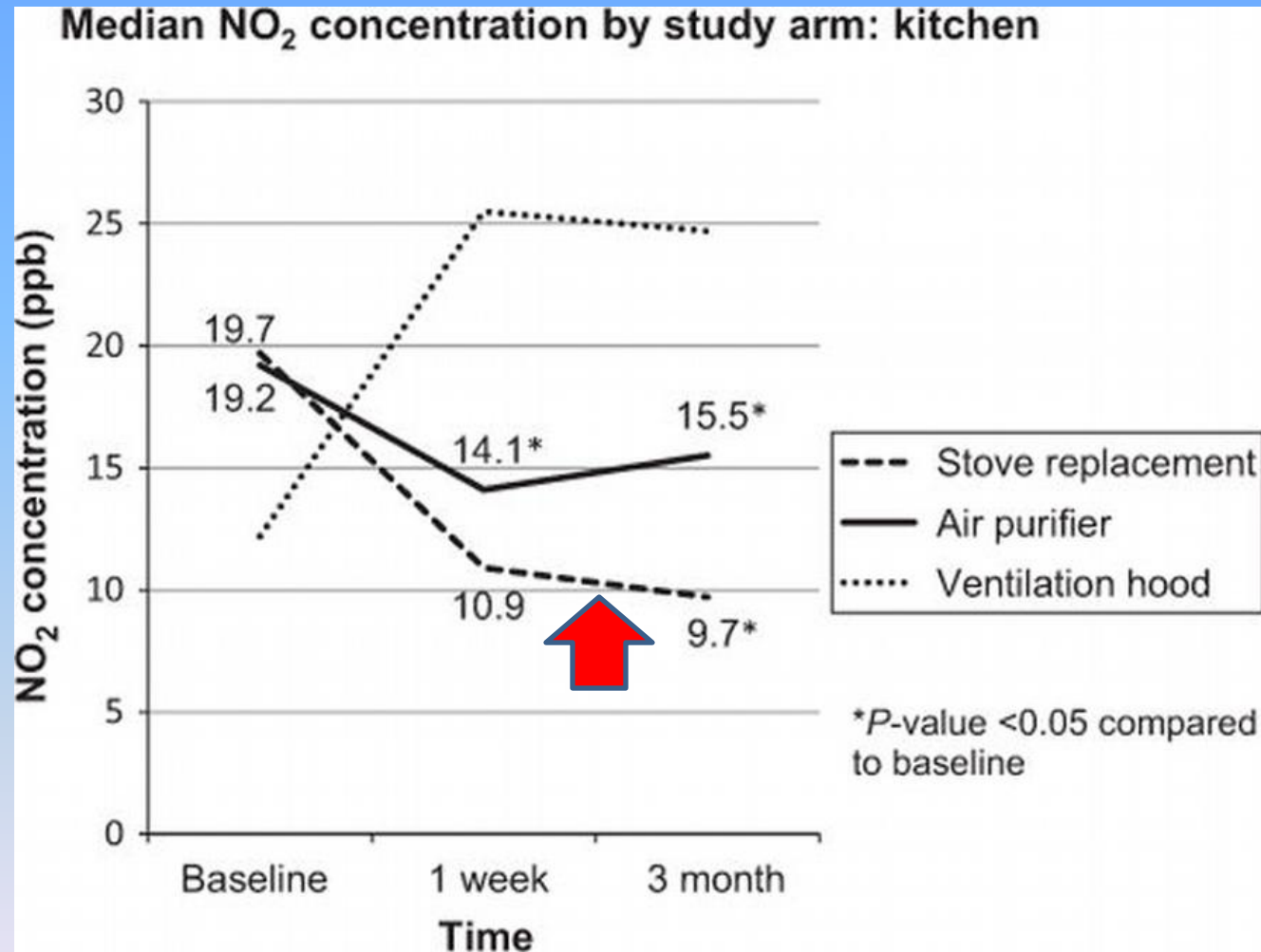
U.S. children under age 6 who live in homes where gas stoves are used for cooking or heating have an increased risk of asthma, wheeze and reduced lung function.

Ventilation of gas stove	No. cases	OR (95% CI)
No	269	1 Ref.
Yes	224	0.64 (0.43, 0.97)*

*P-value <0.05.

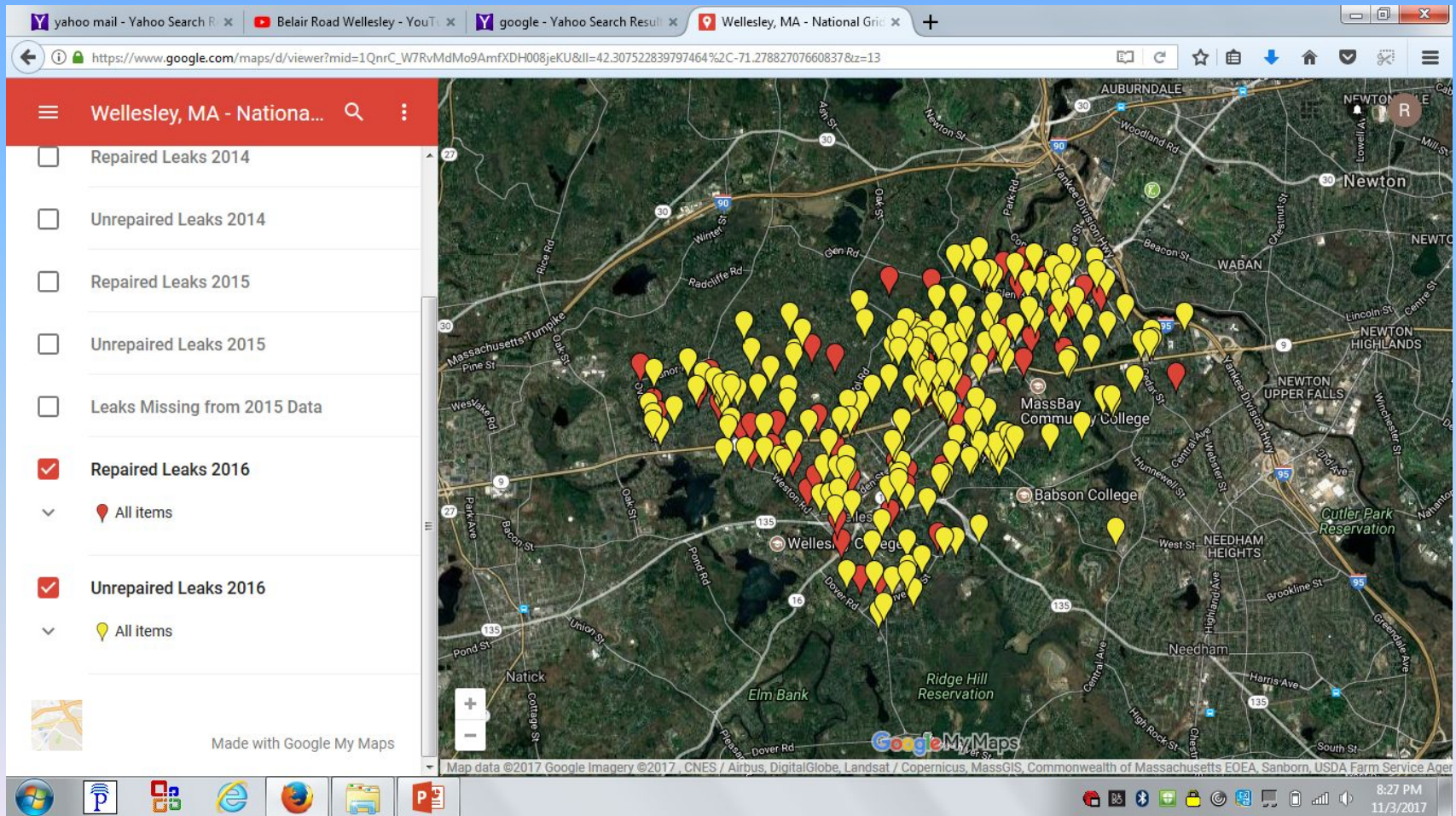
Kile ML, et al. A cross-sectional study of the association between ventilation of gas stoves and chronic respiratory illness in U.S. children enrolled in NHANESIII. Environ Health. 2014 Sep 2;13:71

Pediatric Asthma and Natural Gas



Paulin, L. M. et al. "Home Interventions Are Effective at Decreasing Indoor Nitrogen Dioxide Concentrations." *Indoor air* 24.4 (2014): 416–424.

Natural Gas Leaks in Wellesley



Tagging Gas Leaks

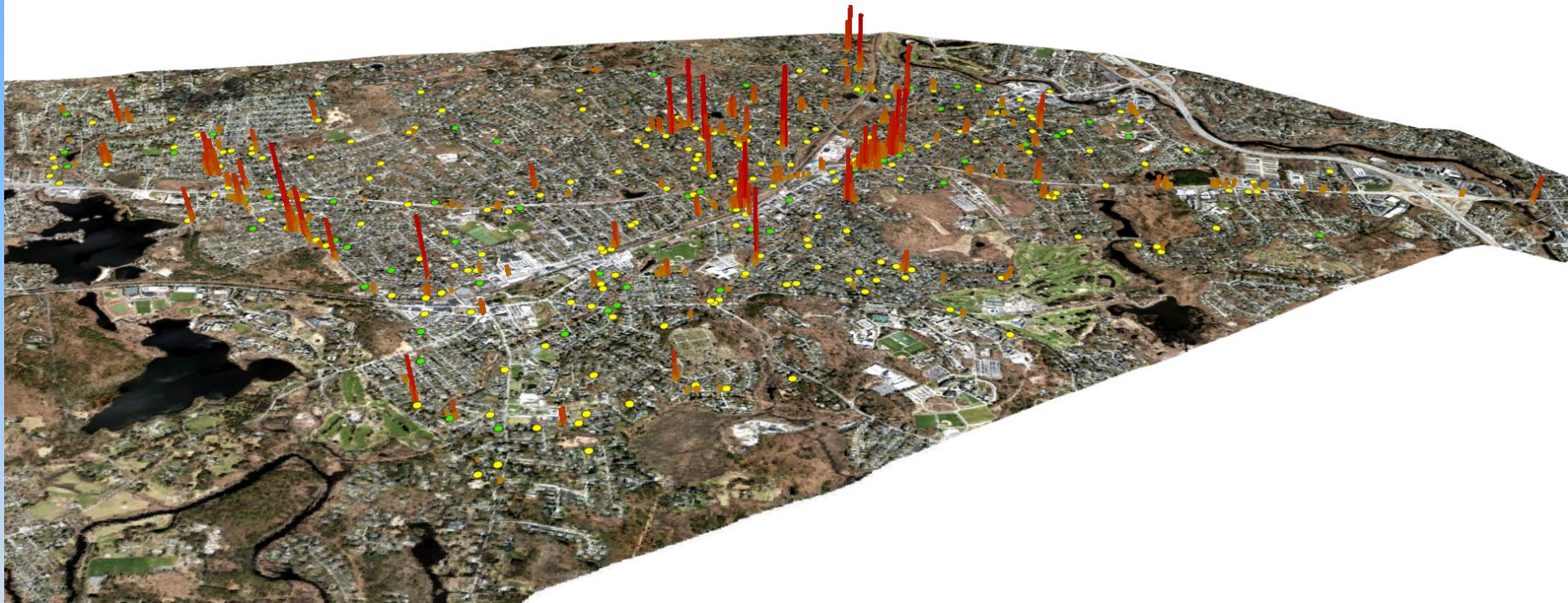


Community Forum



Board of Selectmen, Natural Resources Commission, State Representative Alice Peisch

Natural Gas Leaks in Wellesley



More than 200 leaks, including in commercial center and near schools

Natural Gas Leaks in Wellesley



2016 Tree Budget

- Tree Planting and Watering - \$57,000
- Tree Maintenance - \$48,000
- Tree Removal - \$124,000



Natural Gas Leaks in Wellesley: Advocacy & Partners

- Natural Resources Commission
- Board of Selectman
- Board of Health
 - Inclusion in Town's "Public Health Plan"
- Gas Leaks Allies

Gas Leaks in Wellesley:

Community Questions and Concerns

- Whose health are we concerned about?
- What's in the leaking gas?
- Do proximity to or intensity of leak matter?
- How do local meteorological conditions affect the distribution of leaked gas?
- Are there vulnerable populations?
 - Children, pregnant women, elderly, those with chronic medical conditions

Comprehensive Health Impact Assessments

- Massachusetts Medical Society, the American Medical Association, and the Massachusetts Nurses' Association
- H. 3391: an act relative to the Energy Facilities Siting Board
- 50 Massachusetts Boards of Health



Comprehensive Health Impact Assessments

The execution of a well-designed, expansive study does not mean simply reviewing the published literature that already exists and zeroing out uncertainties as “no effect” defaults. It means aggressively seeking out an array of data sources and bringing a multi-disciplinary approach to their analysis.

- *Concerned Health Professionals of New York*



Recommendations

(Physicians for Social Responsibility)

- While we still continue to use natural gas, we must reduce its negative consequences as quickly and effectively as possible and reject practices that allow methane and pollutants to enter the environment.
- We must step up the pace of our transition to renewable energy and energy efficiency.

Save the Date!

**Natural Gas Infrastructure and Health
BU Photonics Center
January 30, 2018**

Sponsored by: MAHB, Boston University School of Public Health, Massachusetts Health Professionals for Clean Energy, Greater Boston Physicians for Social Responsibility, Health Care Without Harm

“It is impossible to have healthy populations on a sick planet.”