Health Effects Of Unconventional Gas Extraction From Shale

A Presentation to Tompkins County Council of Governments 8/25/2011

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http://www.psehealthyenergy.org/

PSE

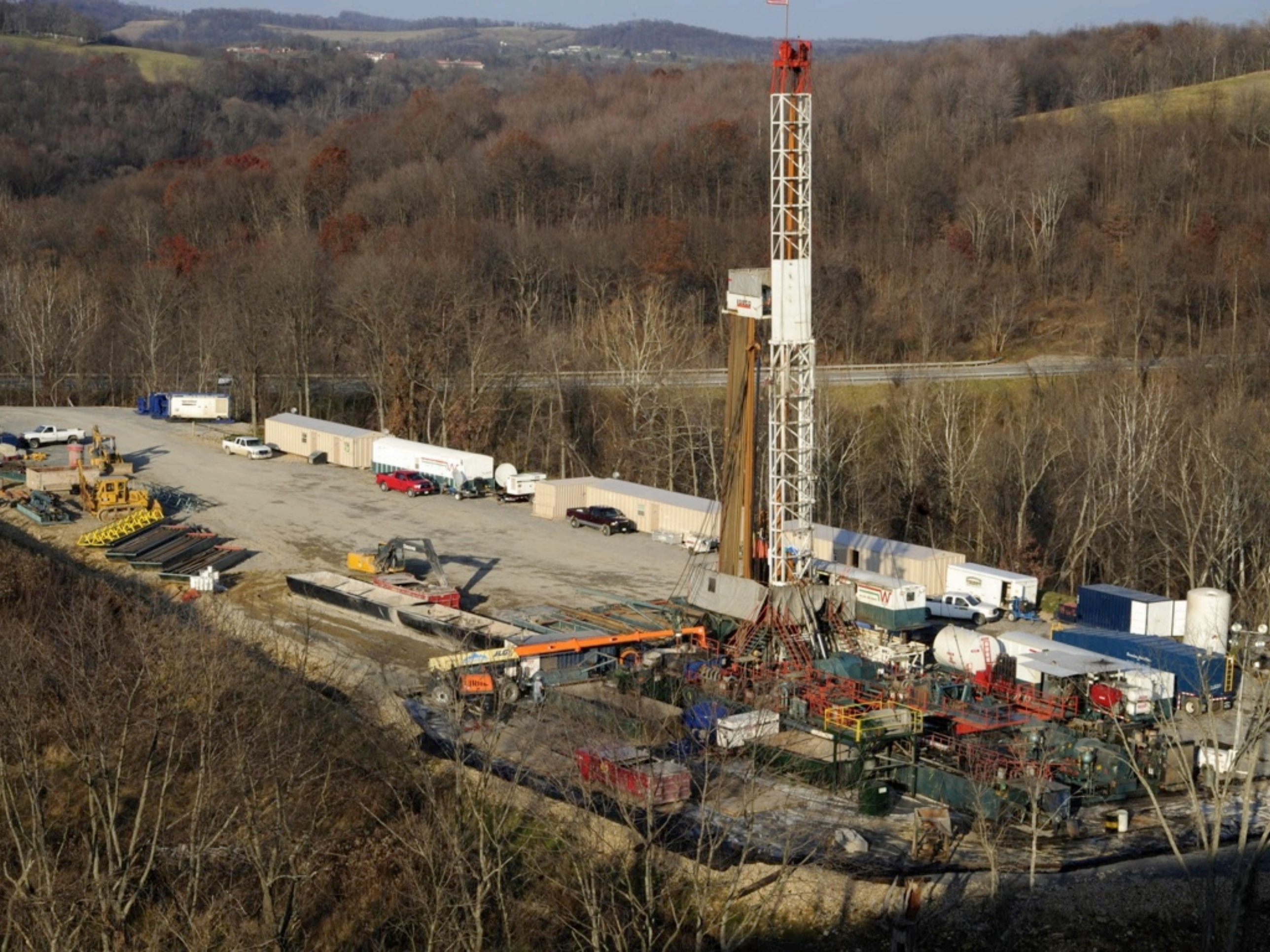
Physicians Scientists & Engineers for Healthy Energy

High-Volume, Slick-Water, Horizontal, Hydraulic Fracturing from Long Lateral Well Legs from Tight Shale Formations

"FRACKING"

35 year old teacher 6/3/2011

- July 2010
- Eyes swollen shut, rash torso, back
- Fatigue/disorientation
- Depression
- Vertigo/Dizziness

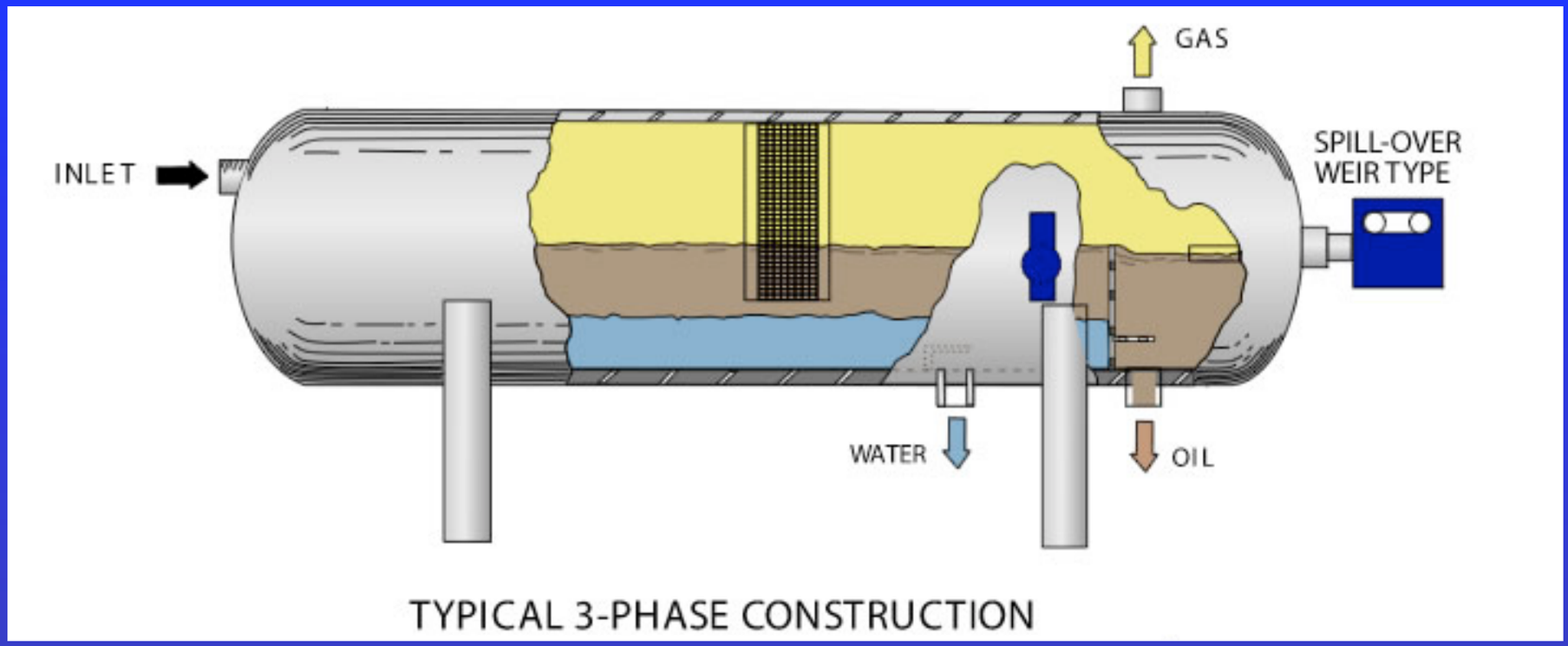


- Feb 2011
- “Flu” - fever/vomiting/chills/muscle pain
- 2 months - 10 lbs weight loss
- ED - Vomiting, hypotension
- Tender right upper quadrant abdomen

- Treated with IV fluid resuscitation
- Lab results - elevated liver function tests
- “Toxic hepatitis”

Spill 1/24/11 11:30 pm

- PA Department of Environmental Protection Oil and Gas management program
- 50 barrels production fluid
- Failure of Gas Production Unit
- Vacuum truck/Super sucker truck
- Violation of Clean Streams Law, The Solid Waste Management Act and PA 25 Code 78.57 for discharging brine into the ground or into waters of Commonwealth



TYPICAL 3-PHASE CONSTRUCTION

- Quit position 5/7/2011
- Advised to move away - going to Vermont
- 7/18/2011 Improving
- Residual: muscle pain, vertigo, continued fatigue, vertigo waking her at night, muscle pain

Many questions raised

- July 2011 Symptoms: allergies vs toxic exposure
- Feb 2011 Could spill travel 1/2 mile ?
- What was the toxin (s)?
- What is the utility of individual case reports?
- Who should provide care?
- How should cases be reported?
- How should providers be trained?
- Who should pay?
- Where should people go?

Air Pollution

- BTEX, along with other VOCs
  - ✦ Stationary and truck diesel engines, flaring, venting, produced water storage, dehydration of natural gas; carcinogens
- Dust—ubiquitous problem, especially in summer
  - ✦ Dirt moving, vehicle traffic; hay fever, allergies; reduced visibility
- Methane - venting, flaring, leaking
  - ✦ Carries BTEX, other hazardous components of raw gas
- Carbon monoxide—engine exhausts, flaring; toxic

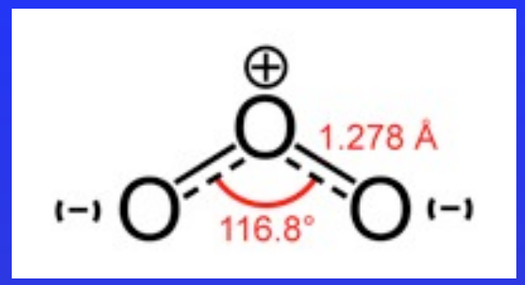
Air pollution (contd)_

- Hydrogen sulfide
  - Pyrite formations (Marcellus)
  - May come up with gas, acidic flow-back water
- Nitrogen oxides (NOx)
  - Fossil fuels, Diesel engines, flaring operations
  - Reddish haze
  - Respiratory problems, heart conditions and lung damage

Air pollution (contd)

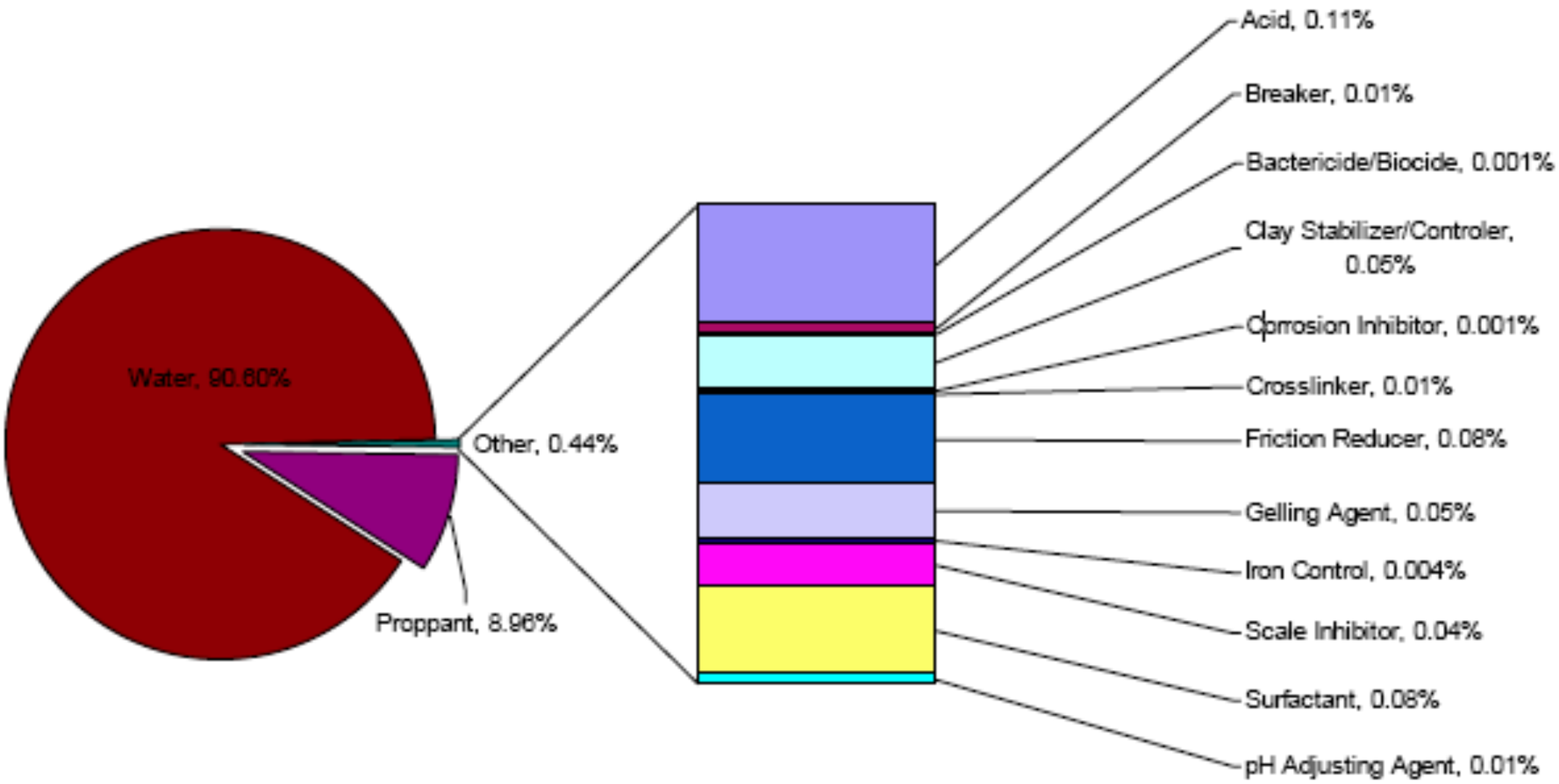
- Particulate matter
  - Fossil fuels; diesel engines, flaring
  - May cause respiratory problems, cancer
- Sulfur dioxide
  - Burning of sulfur containing fuels are burned, diesel engines and flaring
  - An EPA criteria air pollutant
  - Acid rain

Ozone



- Volatile Organic Compounds (VOC)
- Nitrogen Oxides (NOx)
- Photochemical reaction
- Photochemical smog

Slick-Water



NYS DEC dSGEIS 2009

Flow-back/produced waters

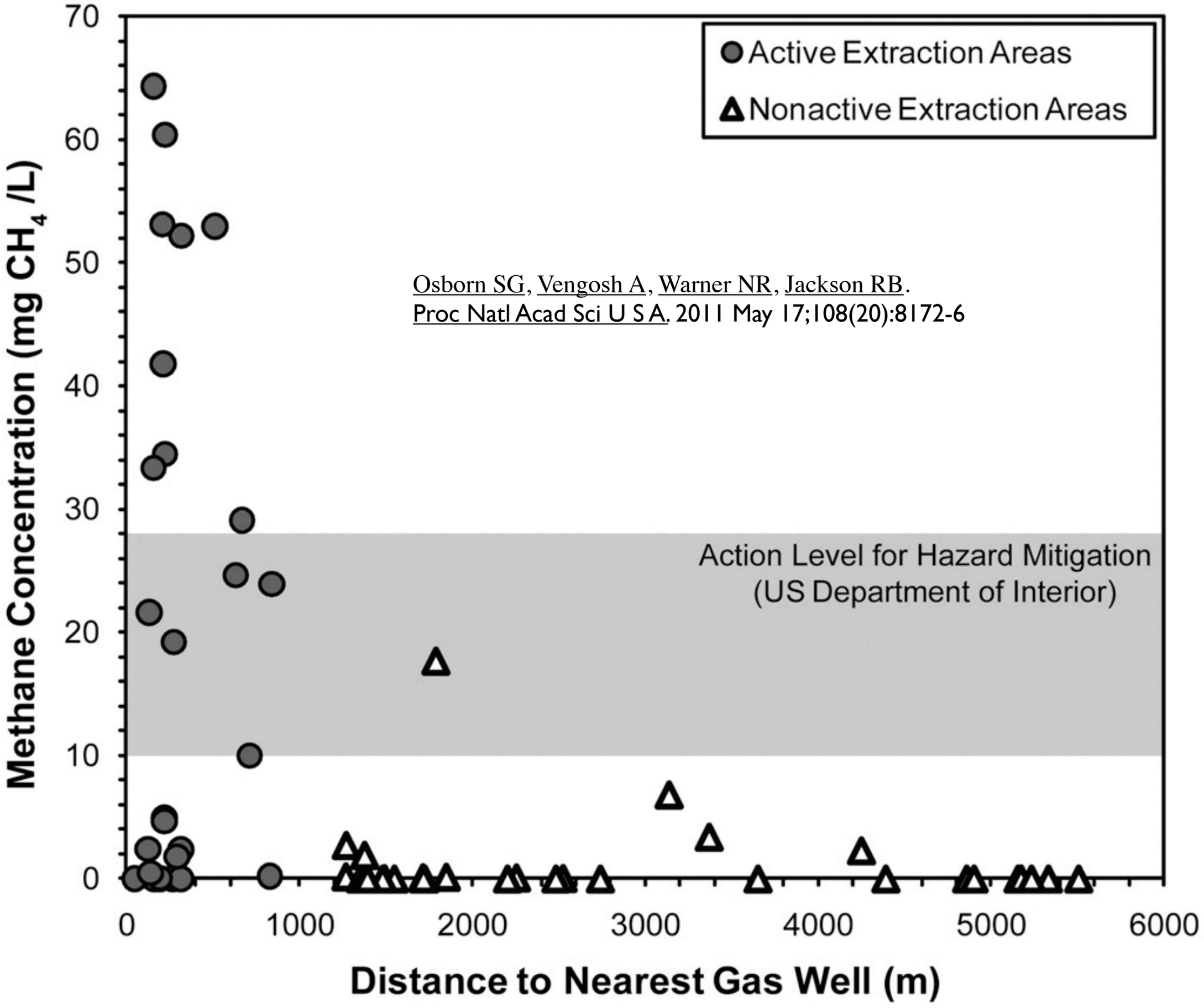
- Brines - Saline - chlorides, sulfates
- Metals - calcium, magnesium
- Heavy metals
  - arsenic, barium (dissolved), cadmium, chromium, cobalt, lead, molybdenum, nickel, selenium, silver, strontium, thallium

Naturally Occurring Radioactive Material

- Marcellus formation rich in radioactive isotopes
- Identified in drilling logs by a spike in gamma rays
- Uranium, radium-226, radium-228, radon "daughters"
- The level of radioactivity in flow-back water is many times higher than allowable for discharge to the environment

FLIR HI ON AUTO HIST WH

5/31/11 12.01.02PM



Osborn SG, Vengosh A, Warner NR, Jackson RB.
Proc Natl Acad Sci U S A. 2011 May 17;108(20):8172-6

Summary, references, and supporting technical report available at:
http://www.eeb.cornell.edu/howarth/Howarth_EnergyandEnvironment.html

Climatic Change
DOI 10.1007/s10584-011-0061-5

LETTER

Methane and the greenhouse-gas footprint of natural gas from shale formations

A letter

Robert W. Howarth · Renee Santoro · Anthony Ingraffea

Received: 12 November 2010 / Accepted: 13 March 2011

Abstract We evaluate the greenhouse gas footprint of natural gas obtained by high-volume hydraulic fracturing from shale formations, focusing on methane emissions. Natural gas is composed largely of methane, and 3.6% to 7.9% of the methane from shale-gas production escapes to the atmosphere in venting and leaks over the lifetime of a well. These methane emissions are at least 30% more than and perhaps more than twice as great as those from conventional gas. The higher emissions from shale gas occur at the time wells are hydraulically fractured—as methane escapes from flow-back return fluids—and during drill out following the fracturing. Methane is a powerful greenhouse gas, with a global warming potential that is far greater than that of carbon dioxide, particularly over the time horizon of the first few decades following emission. Methane contributes substantially to the greenhouse gas footprint of shale gas on shorter time scales, dominating it on a 20-year time horizon. The footprint for shale gas is greater than that for conventional gas or oil when viewed on any time horizon, but particularly so over 20 years. Compared to coal, the footprint of shale gas is at least 20% greater and perhaps more than twice as great on the 20-year horizon and is comparable when compared over 100 years.

Keywords Methane · Greenhouse gases · Global warming · Natural gas · Shale gas · Unconventional gas · Fugitive emissions · Lifecycle analysis · LCA · Bridge fuel · Transitional fuel · Global warming potential · GWP

Electronic supplementary material The online version of this article (doi:10.1007/s10584-011-0061-5) contains supplementary material, which is available to authorized users.

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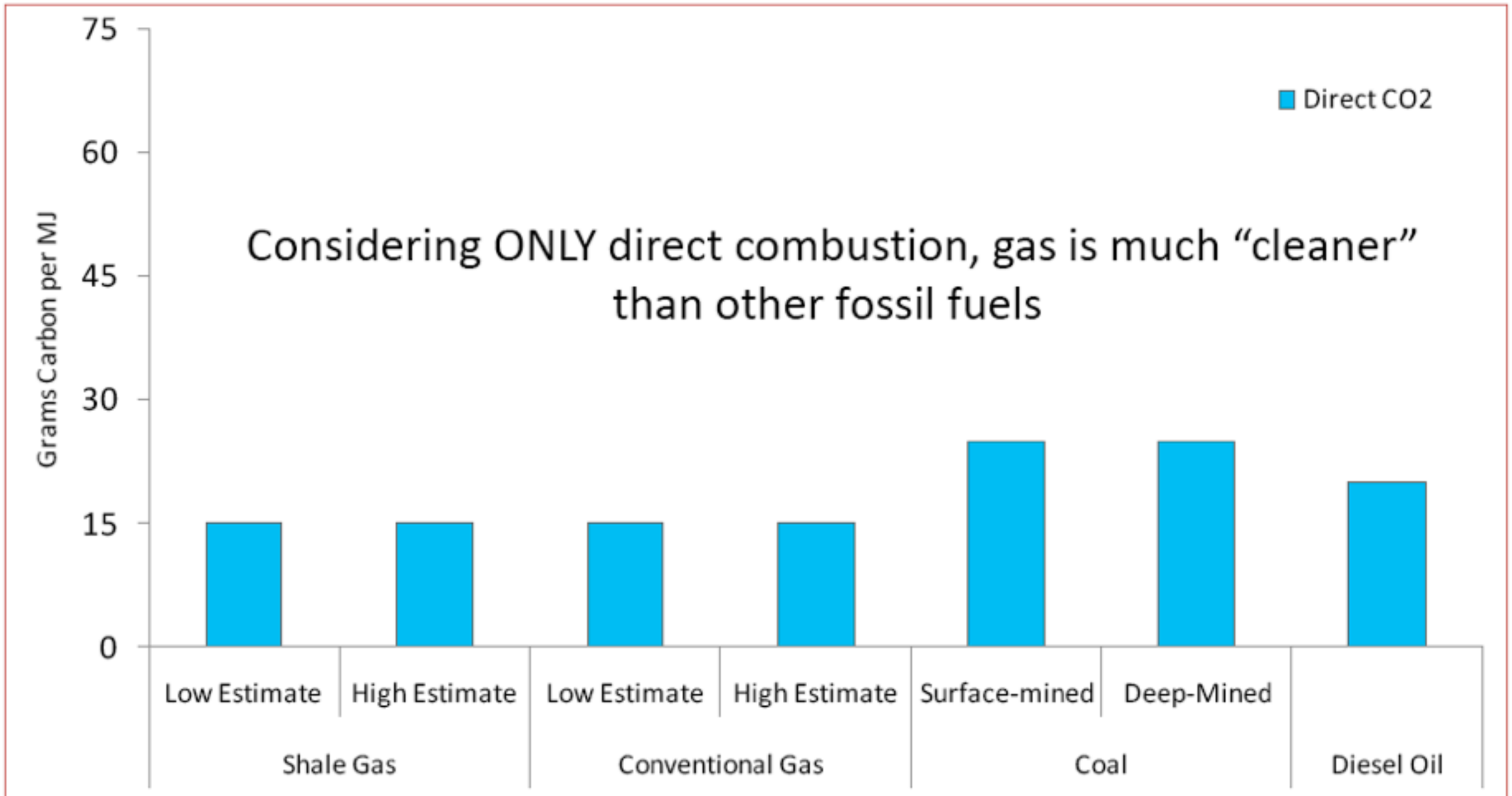
Published online: 12 April 2011

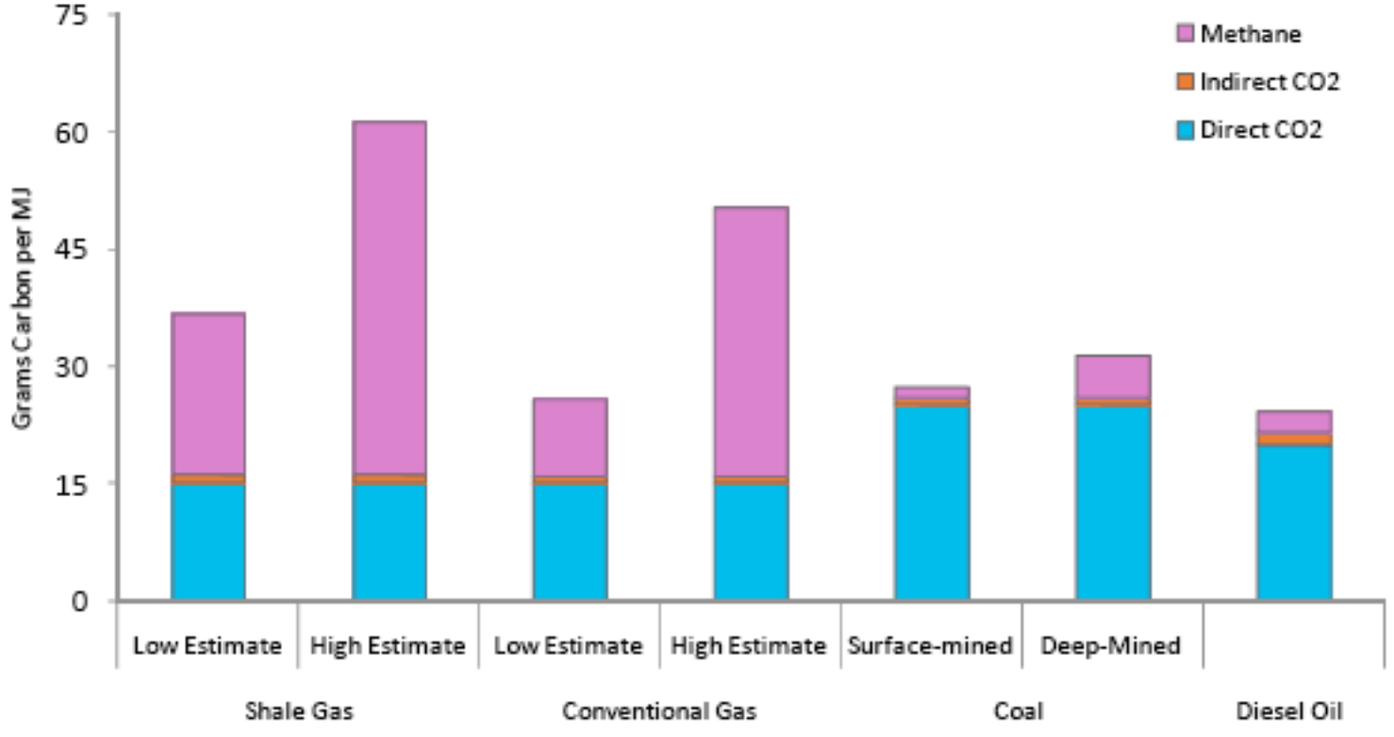
Direct CO_2 Emissions During Combustion of Fossil Fuels



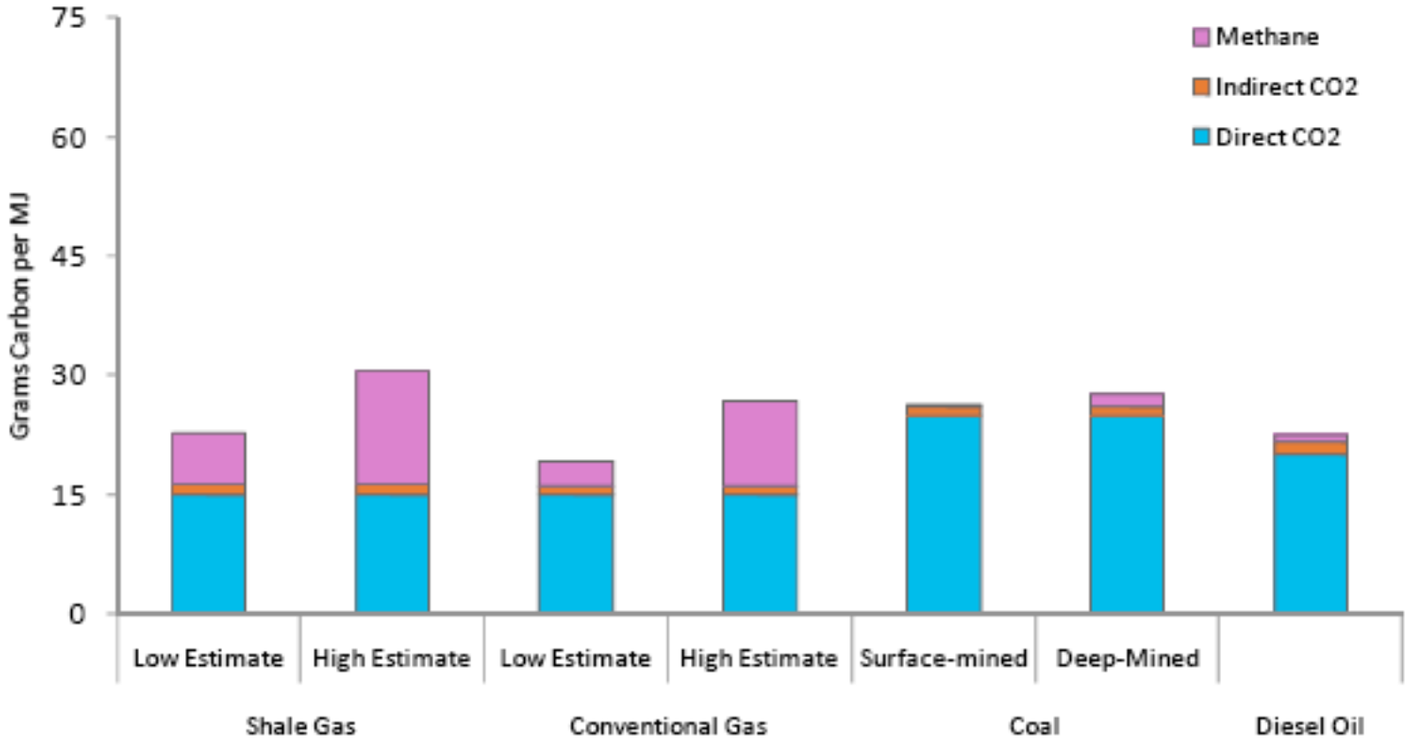
Howarth *et al. Climatic Change Letters* (2011)

	Conventional gas	Shale gas
Emissions during well completion	0.01%	1.9%
Routine venting and equipment leaks at well site	0.3 to 1.9%	0.3 to 1.9%
Emissions during liquid unloading	0 to 0.26%	0 to 0.26%
Emissions during gas processing	0 to 0.19%	0 to 0.19%
Emissions during transport, storage, and distribution	1.4 to 3.6%	1.4 to 3.6%
Total emissions	1.7 to 6.0%	3.6 to 7.9%

A. 20-year time horizon

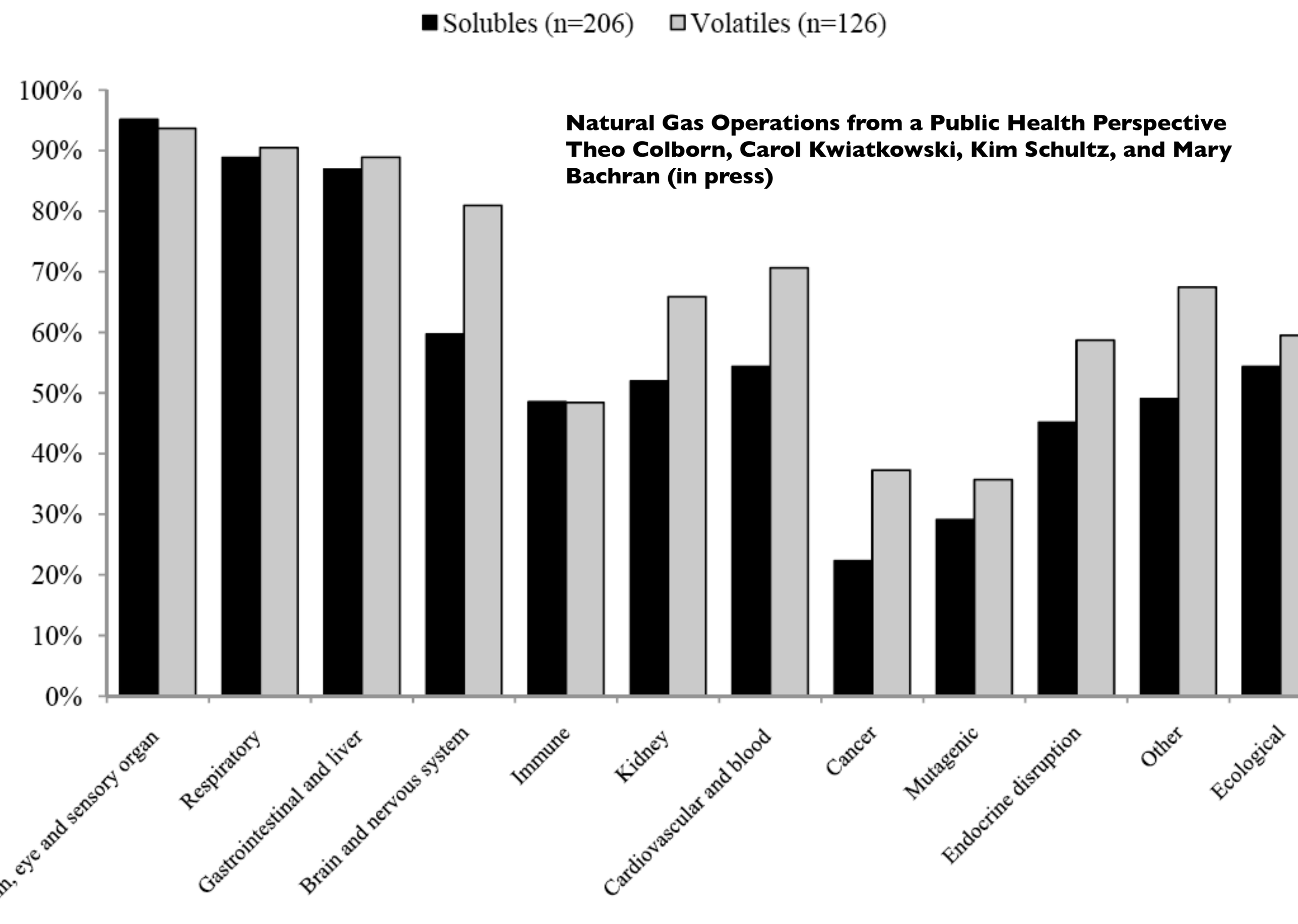


B. 100-year time horizon



Mechanisms of disease

- Toxic
- Teratogenic
- Infectious
- Accidents
- Psychological
- Mutagenic/oncological
- Endocrine disruption


Solubles (n=206)
Volatiles (n=126)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Natural Gas Operations from a Public Health Perspective
Theo Colborn, Carol Kwiatkowski, Kim Schultz, and Mary Bachran (in press)
n, eye and sensory organ
Respiratory
Gastrointestinal and liver
Brain and nervous system
Immune
Kidney
Cardiovascular and blood
Cancer
Mutagenic
Endocrine disruption
Other
Ecological

Toxicology

- Route of exposure
- Acute/chronic
- “Dose makes the poison” Paracelsus
- Susceptibility
- Mixtures

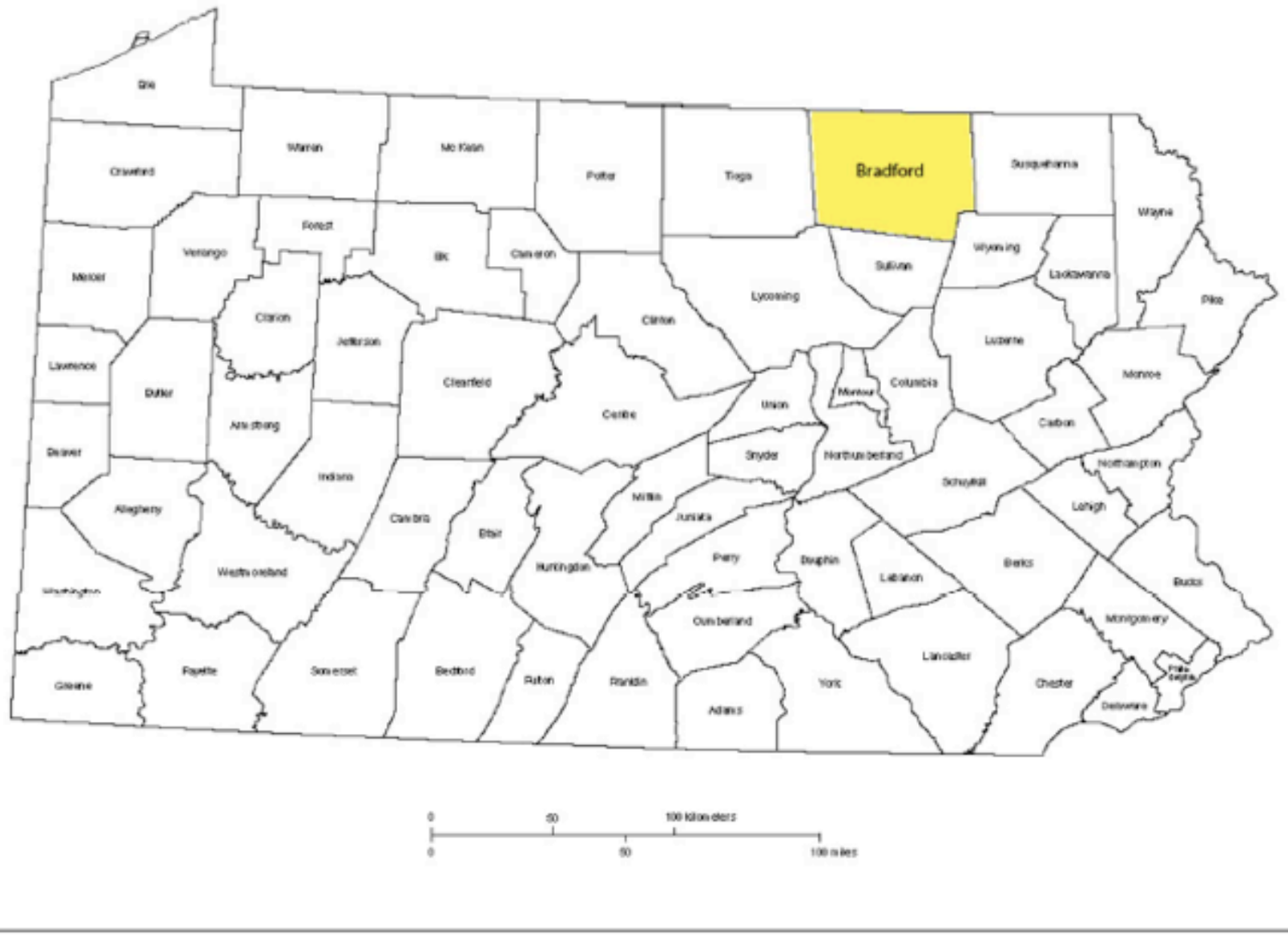
GUTHRIE℠

Local Experiences Related to the Marcellus Shale Industry

May 10, 2011

Staci Covey, RN, MS, NE-BC
President, Troy Community Hospital
VP, Post Acute Care

PENNSYLVANIA



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BRADFORD COUNTY PENNSYLVANIA

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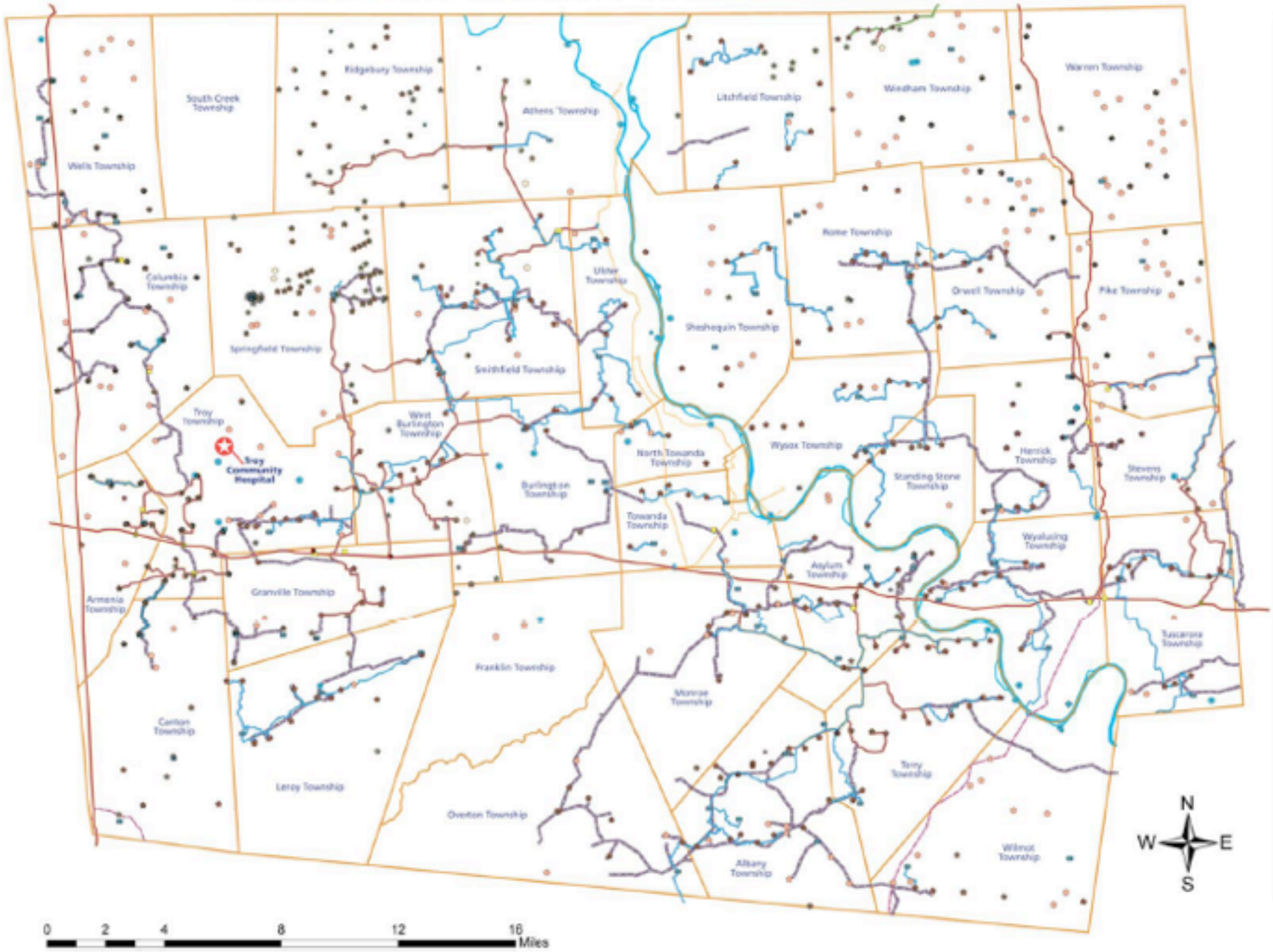

Legend

DEP Wells April 2011

ORGANIZATIONS

- ANDERMAN ASSOC INC
- BELDEN & BLAKE CORP
- BTI ENERGY INC
- CHESAPEAKE APPALACHIA LLC
- CHIEF OIL & GAS LLC
- COLUMBIA NATURAL RES INC
- CONSOL GAS CO
- CTL NEW YORK OIL & GAS CO LLC
- EAST RESOURCES INC
- ENERVEST OPR LLC
- EOG RESOURCES INC
- FAIRMAN DRILLING CO
- FENIX & SCISSON INC
- GODDWIN IND INC
- MARK RESOURCES CORP
- PENNZOIL PROD CO
- PURE OIL CO
- QUAKER STATE CORP
- RANGE RESOURCES APPALACHIA LLC
- SHAW CBIE
- SHELL OIL CO
- SOUTHWESTERN ENERGY PROD CO
- SWEPI LP
- TALISMAN ENERGY USA INC
- UNKNOWN OPR
- VAUCO LLC
- WEAVER OIL & GAS CORP

Bradford County Natural Gas Database

FEATURE TYPE

- HORIZONTAL GAS WELL
- VERTICAL GAS WELL
- COMMUNICATION TOWER
- COMPRESSOR STATION
- METER STATION
- SUBSTATION
- TAP LOCATION
- DEHYDRATOR
- GROUNDWATER WITHDRAWAL
- WATER PUMP STATION
- SURFACE WATER WITHDRAWAL
- WATER IMPOUNDMENT
- WATER TRANSFER PAD
- WATER TREATMENT FACILITY
- WATER WITHDRAWAL
- Water Lines

Gas Lines

LINE_TYPE

- GATHERING - PROPOSED
- GATHERING - BUILT
- SERVICE - BUILT
- STORAGE - BUILT
- TRANSPORT - PROPOSED
- TRANSPORT - BUILT
- RegionalBoundaryDonutHole

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"What have we seen"

- An increase in outpatient volume
- Pre-hire, accident follow up, sobriety
- Increase in industry-related injuries
- Increased traffic and MVAs
- Worker illness and injury

“Other issues”

- Increased STDs
- Increased drug use
- Potential for multiple casualties
- Training for EMS and ED
- Industry training: “isn’t necessarily reality”

Recommendations

- Establish a task force which will work with local municipalities and key personnel to establish programs designed to address issues discussed
- Increased DOH available services related to STD's and substance abuse
- **While discussing an industry tax, make provisions for funds to come to local areas in order for local municipalities to address issues mentioned**
- Require companies doing business in the state to address healthcare insurance needs with employees or provide it (including primary care providers)
- Create industry health care case managers or navigators to assist with care locally and upon discharge to other states
- Establish a methodology for state MA to be reciprocal without separate applications each time
- Encourage local residency for long term workers
- Engage area healthcare providers in the provision of educational programs for industry employees focused upon prevention.
  - Signs and symptoms of infections, chest pain, hydration, smoking cessation
  - When to seek care
  - Where to seek care

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Endocrine disruption

- Extremely small concentrations
- Non-standard dose-response curves
- Critical windows of development
- Effects may be decades later
- Epigenetic pathways

EBM review 2003-2008

- Pubmed search widest terms “$frack”
- 5064 papers
- 863 reviewed
- “Fracking” 234 papers reviewed
- Yield = 0 papers

Witter R, Stinson K, Sackett H, Putter S, Kinney G, Teitelbaum D. Potential Exposure-Related Human Health Effects of Oil and Gas Development: A White Paper; NRDC

Public health studies

- Surrogate measures
- Anecdotal evidence/Surveys
- Association
  - ✦Cross-sectional, ecological-longitudinal
  - ✦Case-control
- Cohort/Longitudinal

Words not in SGEIS

- Epidemiology
- Endocrine/hormone
- Notifiable/Registry
- Asthma/anaphylactic
- Myocardial infarction
- Trauma/Catastrophe

Medical Ethics

- "*Primum, non nocere*" First, do no harm
- Informed consent

The Precautionary Principle

"When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships have not been fully established scientifically."

Wingspread conference 1998