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### SLIDES: Hydrofracking: Air Issues and Community Exposure

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# Hydrofracking: Air Issues and Community Exposure



**Debra A. Kaden, Ph.D., ENVIRON**

**Hot Topic! Air Quality Impacts From Oil & Gas Development**

**January 27, 2012**

**ENVIRON**

# This morning.....

- *Air pollutants of potential concern surrounding oil and gas development activities*
- *How do we assess exposure and health effects?*
- *Concentrations, temporal and spatial patterns of these chemicals in the ambient air*
  - *Such information is necessary to evaluate possible health impacts of the drilling process on air in surrounding communities.*
- *What can we conclude today?*
- *What should we be doing for the future?*

# Air Pollutants from the Oil and Gas Sector



Pollutant	Emissions (tpy)
VOCs	2.2 million
Air Toxics	130,000
GHG (Methane)	16 million (300,000 MMTCO <sub>2</sub> e)

From: EPA (July 2011) Overview of proposed new regulations

EPA notes that the Oil and Natural Gas Sector accounts for 40% of all U.S. methane emissions, or ~ 4% of all U.S. GHG emissions

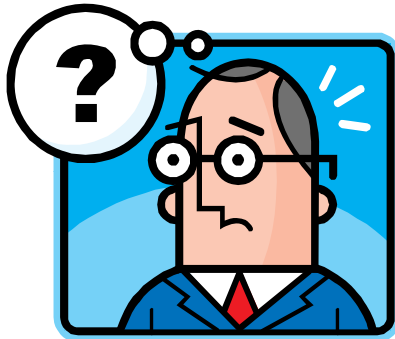
# Air Pollutants from the Oil and Gas Sector



Pollutant	Health concerns
VOCs	<p>VOCs react in the air to form ozone and PM<sub>2.5</sub>.</p> <p>Ozone (regulated as a criteria pollutant) can cause asthma attacks, hospital and emergency department visits, school loss days, and premature mortality</p> <p>PM<sub>2.5</sub> (regulated as a criteria pollutant) can cause premature mortality for adults and infants, heart attacks and hospital admissions. Also can cause asthma attacks, acute and chronic bronchitis, hospital and emergency room visits, work loss days, restricted activity days, and respiratory symptoms.</p>
Air Toxics	<p>Including benzene, acetaldehyde, toluene, xylenes, 1,3-butadiene, ethyl benzene, others.</p> <p>Can cause cancer and other serious, irreversible health effects .</p> <p>Regulated through the Clean Air Act.</p>
GHG (Methane)	<p>Reacts in the air to form ozone (see above).</p> <p>A potent GHG. Once emitted into the atmosphere, it absorbs terrestrial infrared radiation, which contributes to increased global warming and continuing climate change.</p>

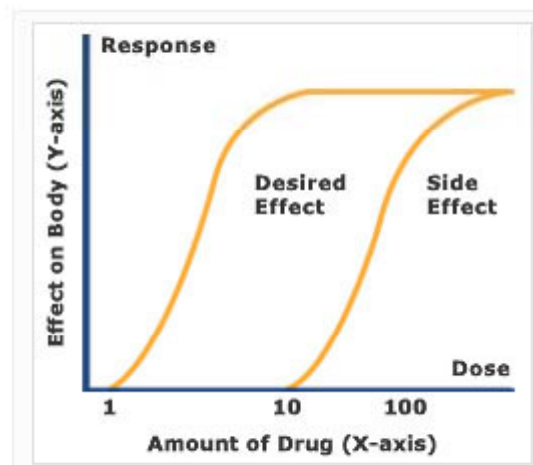
Adapted From: EPA (July 2011) Overview of proposed new regulations

# How Do We Assess Health Effects



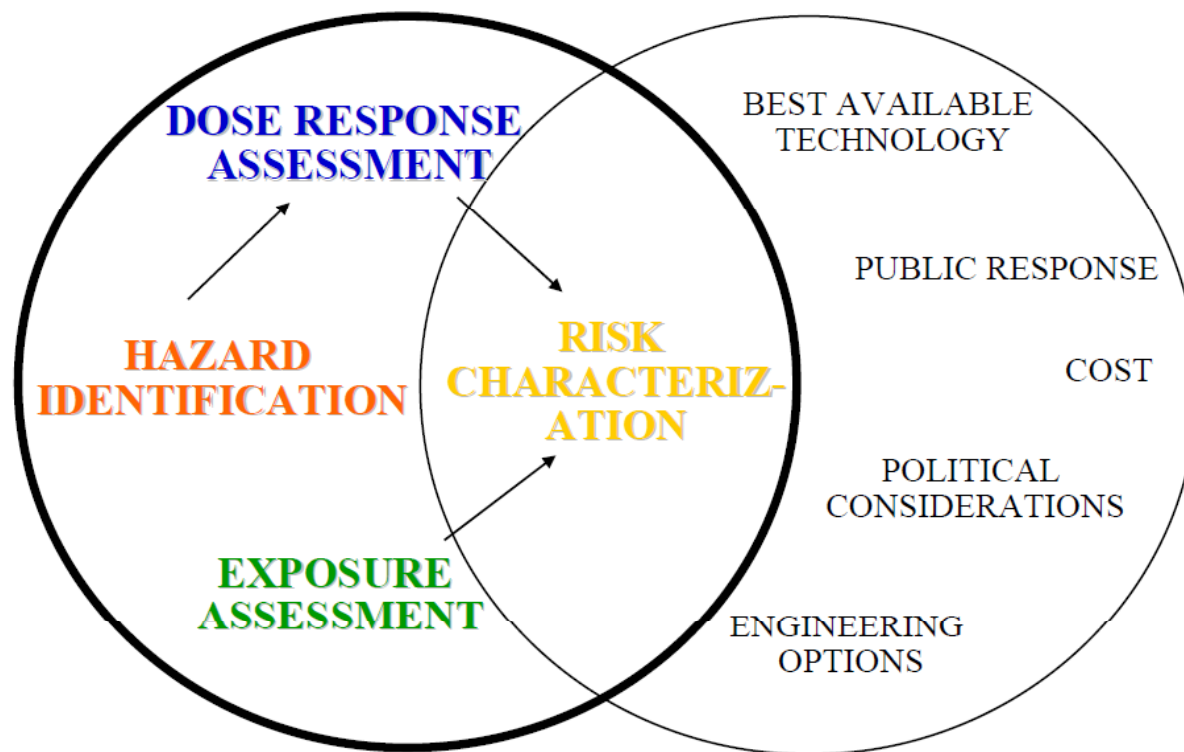
Exposure: To what? How much? For how long? Where?

Toxicity: How toxic? At what exposure concentrations? Which health effects?



# Risk Assessment

Ethane  
Isopentane  
Propane  
Isobutane  
N-Butane  
Toluene  
Ethylene  
N-Pentane  
Acetaldehyde  
Methane  
Benzene  
Xylene



**NAS 1983**





Air exposure data

Concentrations, sources, and spatial patterns of these chemicals in the ambient air

# TCEQ Investigations: Triggered by odor



- December 2009 VOC sampling
  - Downwind monitoring for 84 VOC over a 3 day period.
  - Mobile monitoring of 22 VOC
  - All but 1 either not detected or detected below short term AMCVs.
  - *p*-Diethylbenzene measured above the odor-based AMCV at 1 location, but not above the health-based AMCV.
- November 2010 carbonyl sampling
  - 31 one-hour samples downwind of possible combustion processes at natural gas-related production facilities
  - 18 target carbonyls analyzed
  - All non-detects or below short-term AMCVs
    - Formaldehyde concentrations 1-.0 – 5.4 ppbv.
    - Note, limit of detection of isovaldehyde above AMCV, but characteristic odor not detected.

# City of Fort Worth Natural Gas AQ Study



## July 13, 2011 – Eastern Research Group

- ~140 pollutants (> 40 HAPs) measured in Sept/ Oct 2010 at 8 locations in Fort Worth.
- Highest concentrations: Methane, ethane, propane, butane.
  - Some pollutants with greater toxicity (e.g., benzene) also found, but at much lower concentrations.
- High-level activity area site had generally higher concentrations than other sites.
- 2 Medium activity sites (within 350 ft of active well pads) “surprisingly low “relative to the other sites.



## Non-methane volatile organic compounds (NM VOC) examined near gas well sources

- >90% ethane, propane, *n*-butane, *iso*-butane, *iso*-pentane, and *n*-pentane
- ~10% of VOC were mostly C6-C8 n-alkanes, branched- and cyclo-alkanes.
- ~0.1 - 0.2% benzene, toluene, and xylenes (part of BTEX)

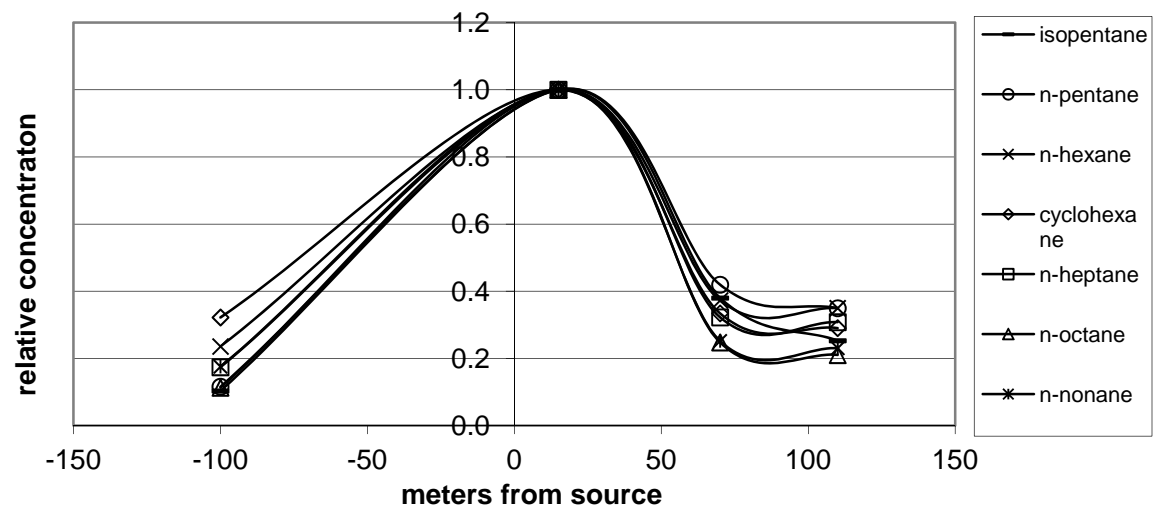
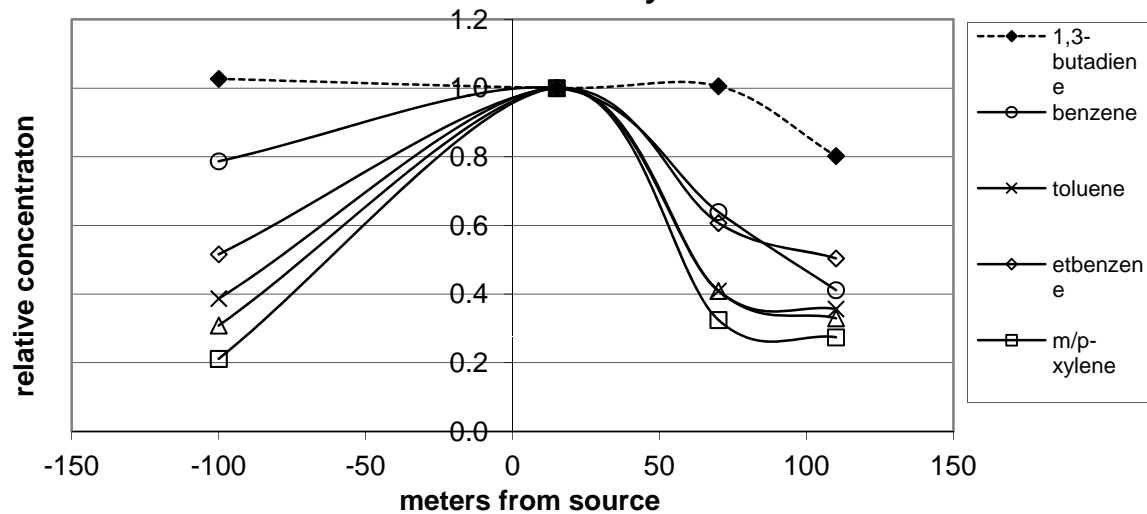
4-week average individual VOC concentrations were low, generally <1 ppb

- Comparable or slightly higher than TCEQ sites (same time period)

Monitoring at a nearby residential community found average speciated VOC concentrations generally <1 ppb.

# Zielinska et al 2010

Week of May 13



# University of Colorado Air Toxics Study (2007-2008)



- Collaboration between BCPH, U Colorado, EPA Region 8
- Measured VOC, carbonyls, ozone
- Source apportionment to tie back to sources

Potential Pollution Source Rank by Site			
	1st	2nd	3rd
<b>Boulder</b>	Mobile Source	Secondary Formation	Evaporative
<b>Longmont</b>	Evaporative	Secondary Formation	Mobile Source
<b>Lyons</b>	Secondary Formation	Evaporative	Mobile Source
<b>Niwot Ridge</b>	Secondary Formation	Mobile Source	Evaporative
<b>South Boulder</b>	Mobile Source	Evaporative	Secondary Formation

- From PCA results, mobile source exhaust, natural gas condensate emissions, and meteorology are significant pollution source

# Garfield County 2008 Monitoring



- CO Department of Public Health & Environment and ATSDR
- 4 Locations within 1.5 miles of oil & gas development activities:
  - 2 urban, near I 70 (Parachute, Rifle)
  - 2 rural, close to oil & gas activities (Brock, Bell)
- Measured 90 speciated NM VOCs every 6 days
- Measured carbonyls every 12 days

Acetaldehyde	1,3-Butadiene	Toluene
Formaldehyde	Benzene	1,2,4-Trimethylbenzene
Crotonaldehyde	Ethylbenzene	1,3,5-Trimethylbenzene

# Garfield County 2008 Monitoring



- Conservative assumptions
  - 95% upper confidence level of mean (chronic)
  - Maximum values (acute)
  - Assumed 24/7, 30 years
  - Cancer risk found within EPA acceptable range
  - Noncancer risk (acute or chronic) below health-based guidelines
- Cautions:
  - Measurements only once every 6 (or 12) days.
  - Measurements at single station for each location
  - Reflect emissions from other sources too
  - Risk estimates use conservative, regulatory values



# Conclusions

A close-up photograph of a bright green lizard, possibly a tree anole, resting on a large green leaf. The lizard's head is in profile, facing right, with its eye clearly visible. The background is a soft-focus green, suggesting a natural outdoor setting.

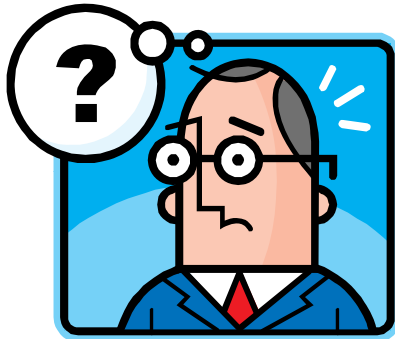
- While many of the chemicals associated with fracking are toxic (at some concentration)....
  - Benzene, toluene, ethylbenzene, xylene (BTEX), other VOC
    - Stationary and truck Diesel engines, flaring, venting, produced water storage, dehydration of natural gas
  - Methane
    - Greenhouse gas (GHG)
  - Hydrogen sulfide
    - Occurs in formations with lots of pyrite, like the Marcellus
  - Others: formaldehyde, diesel exhaust, 1,4-dioxane, hydrochloric acid, methanol

# Conclusions

A close-up photograph of a bright green lizard, possibly a tree anole, resting on a large green leaf. The lizard's head is in profile, facing right, with its eye clearly visible. The background is a soft-focus green, suggesting a natural outdoor setting.

- Air exposures found to be minimal
  - Often not detectable
  - Below health-based benchmarks
  - Dissipate as you move away from the site
  - Other sources of same VOC
- Odor detection is not necessarily toxic
- *Precautionary Principle* often cited...
  - Do no harm
  - Prove scientifically that what you are doing is not harmful...but to date the facts do not support health risks
- Still, need to move forward cautiously with air monitoring to make sure....

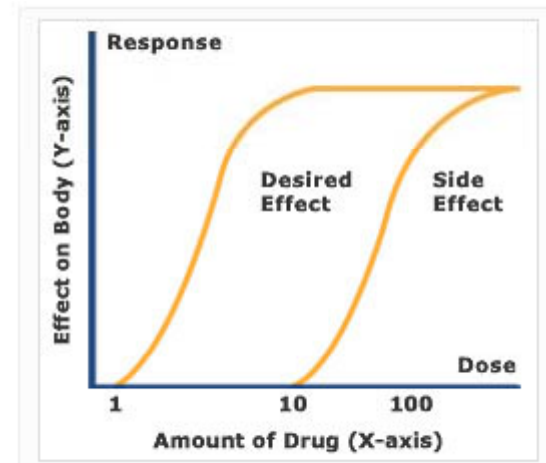
# How Do We Assess Health Effects



Exposure: To what? How much? For how long? Where?

Toxicity: How toxic? At what exposure concentrations? Which health effects?

“No exposure = No toxicity”  
or  
“The dose makes the poison”





# Other Federal Activities

- DOE Shale Gas Subcommittee: Recommendations for immediate implementation
  - Federal Agencies
    - Measures to reduce emissions of air pollutants, ozone precursors, and methane as quickly as practicable. (EPA)
    - Interagency planning effort to acquire data and analyze the overall greenhouse gas footprint of natural gas use.
  - States
    - Encourage shale-gas production companies and regulators to expand immediately efforts to reduce air emissions using proven technologies and practices. Federal funding at \$5m/y for state regulators/NGOs/industry will encourage planning.
  - Industry
    - Enlisting a subset of producers in different basins to design and field a system to collect air emissions data.

Thank you!

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