

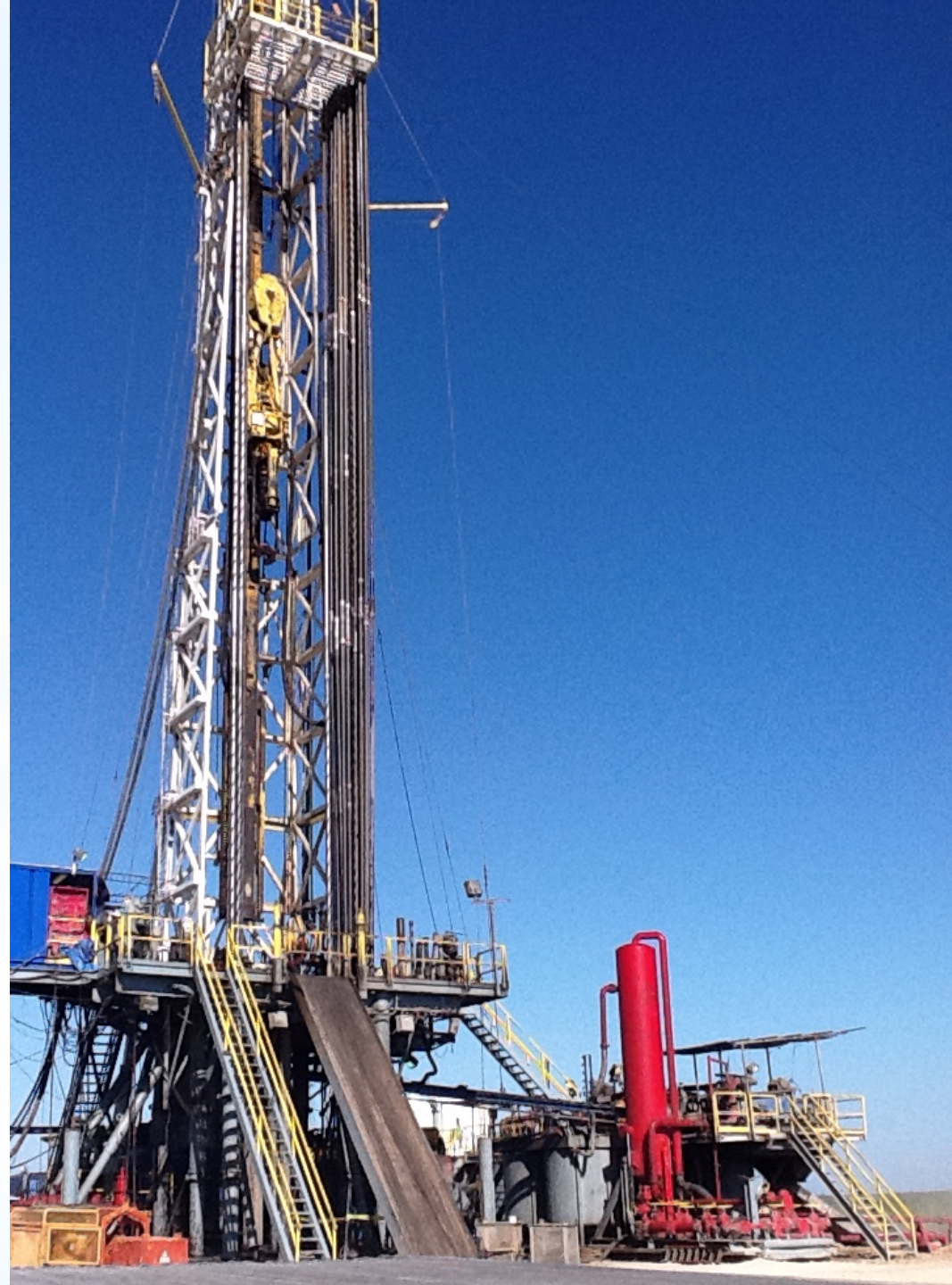
Environmental Issues Associated
with Natural Gas Operations

Hype or Health Hazard

Texas Groundwater Protection Committee

Dr. Susan Stuver

April 17, 2013



Who We Are



UNIVERSITIES



HEALTH SCIENCES



AGENCIES



Hydraulic Fracturing 101

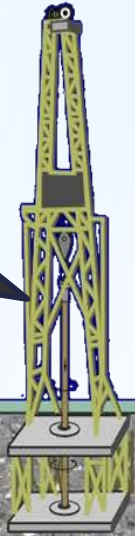


Shale Gas Well: *Horizontal Well Installation*

1

Site Preparation

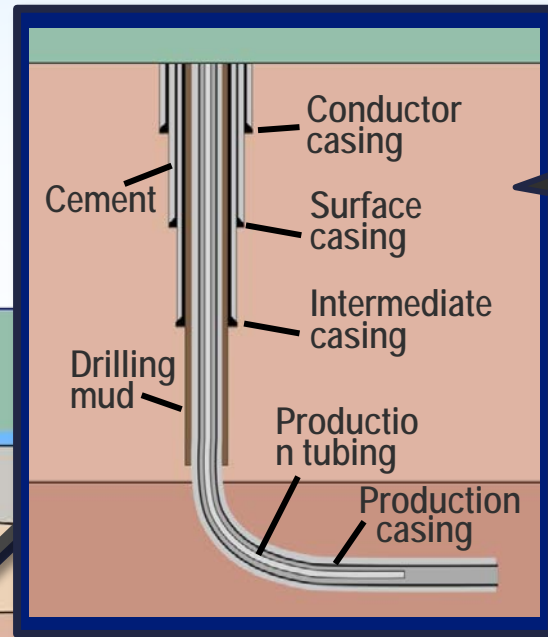
Access roads, well pad (300 ft x 300 ft) for drill rig and laydown area.



Well pad

2

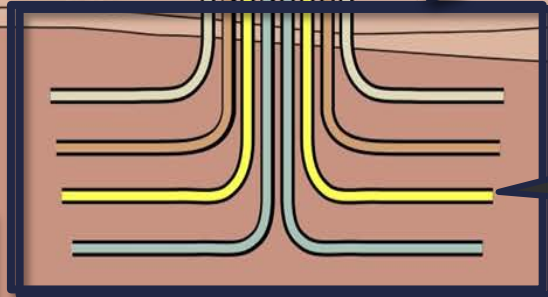
Vertical Drilling, Casing, & Cement
Install drill rig. Use steel casing, cement, and production tubing to protect groundwater.



3

Horizontal Drilling

Using horizontal drilling, multiple boreholes can be drilled from a single well site.



Shale Gas: *Hydraulic Fracturing Process*

Water Supply

Water from stream or public supply.

Water Transport

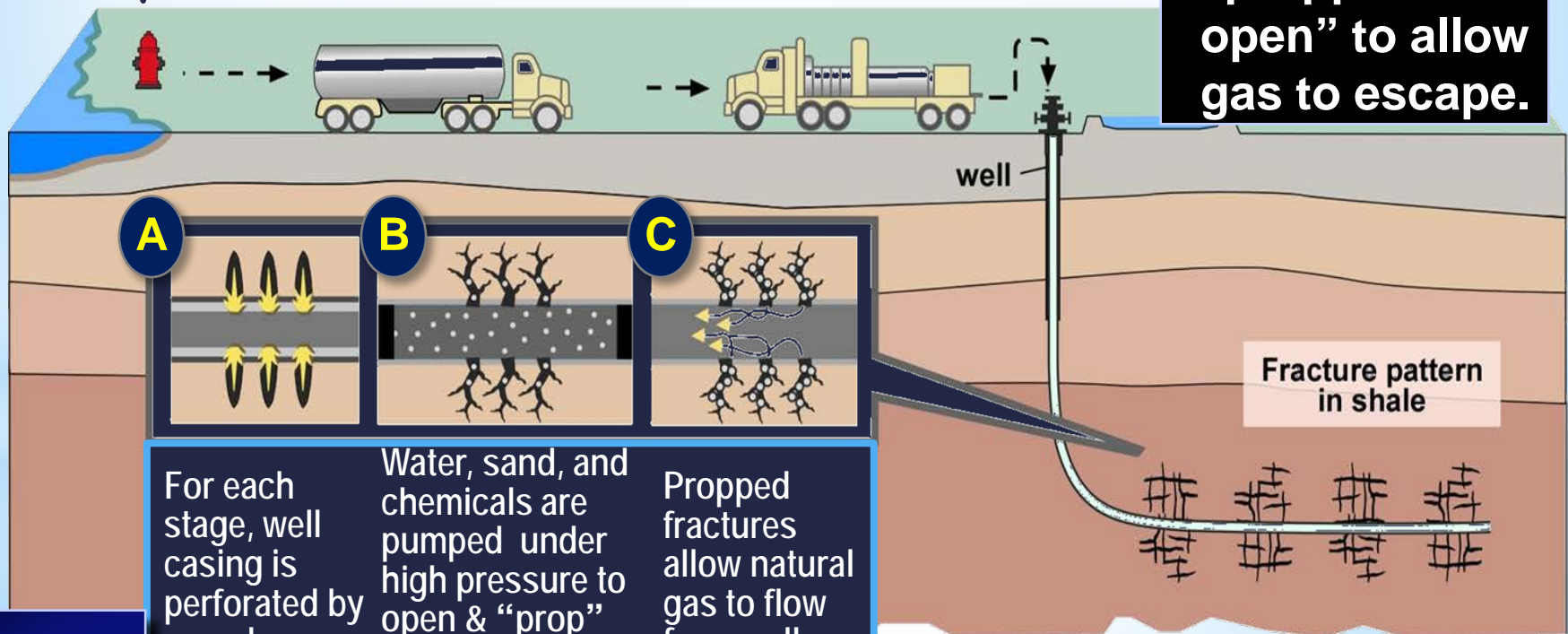
Tank trucks or pipes bring water to site.

High-Pressure Injection

Mixture of water, sand, and chemical additives is pumped into well to fracture formation.

Key Point:

Tight formation is fractured and “propped open” to allow gas to escape.

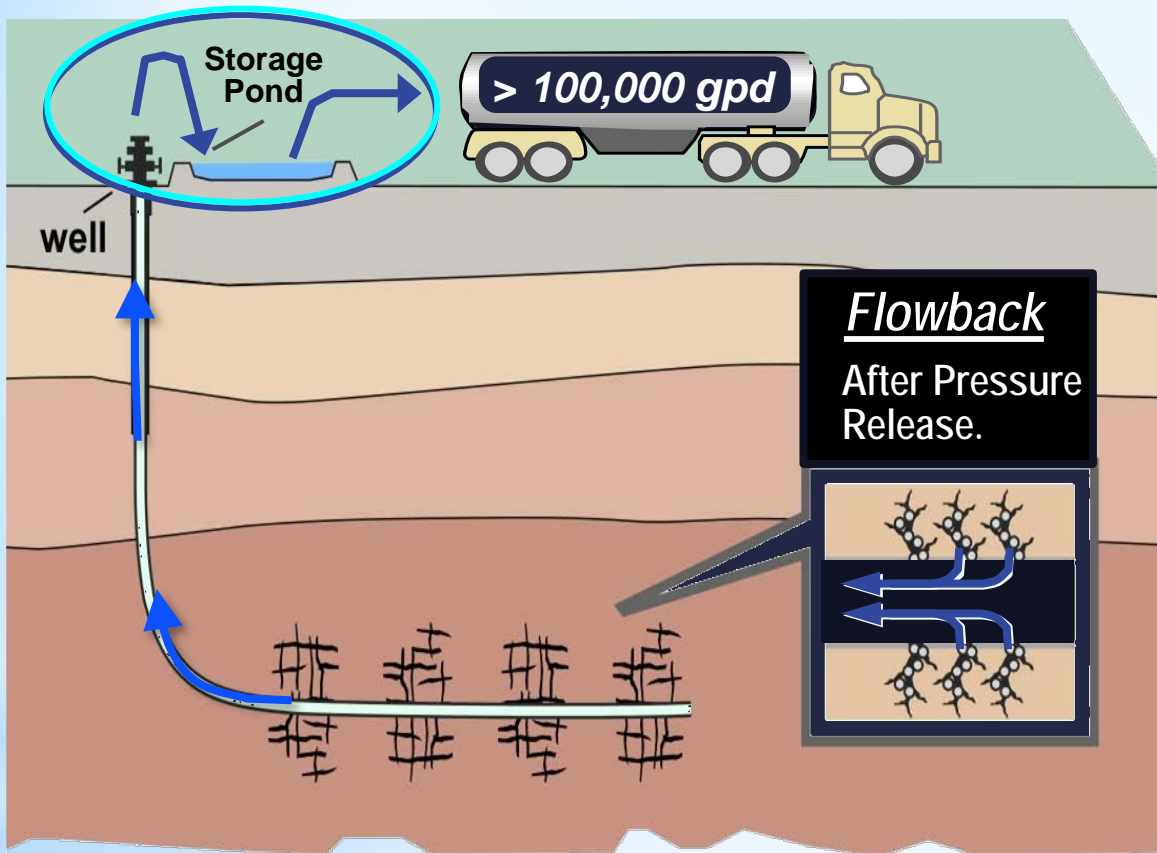


For each stage, well casing is perforated by gun charges.

Water, sand, and chemicals are pumped under high pressure to open & “prop” fractures in shale.

Propped fractures allow natural gas to flow from well.

Shale Gas: *Flowback of Injection Fluids After Fracturing*



Flowback Water

- **Return Flow:** After pressure release, 15 to 80% of injected water “flows back” to surface within 30 days.
- **Water Quality:** Flowback water can be highly saline, with low levels of radionuclides.
- **Management:** Treatment or disposal of large volume of saline water required.

Management of flowback water is greatest environmental challenge for shale gas development.

Hydraulic Fracturing

*Actually
looks
more
like
this...*

Well Completion - Unconventional



National Energy
Board

Office national
de l'énergie

Source: Canadian Society for Unconventional Gas

Canada

Hype or Health Hazard

Hydraulic Fracturing is a new and unregulated technology.

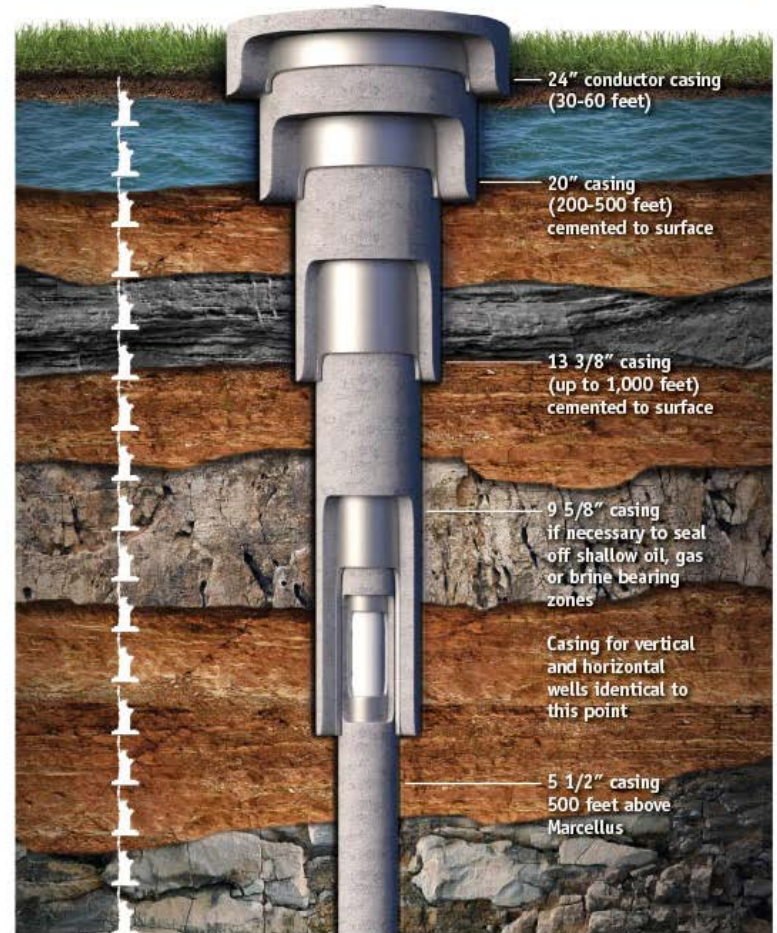


State regulation of hydraulic fracturing began over 50 years ago. These regulations created casing systems that To protect ground water and drinking water sources

-Dept. of Energy

General Casing Design for a Marcellus Shale Well

The Marcellus Shale is more than a mile below the Earth's surface. It would take 17 Statues of Liberty on top of one another to reach the formation.



However, not all areas are regulated

Approximately 1.5 and 1.0 hectare of land at the OSPER "A" (depleted Lester lease) and "B" (active Branstetter lease) sites, respectively, are affected by salt scarring, tree kills, soil salinization and brine and petroleum contamination due to the leakage of produced water and associated hydrocarbons from brine pits and accidental releases from active and inactive pipes and tank batteries. The leases are typical of many depleted and aging petroleum fields in Osage County, which ranks among the top oil and gas producing counties in Oklahoma with about 39,000 wells.

Osage Reservation in Osage County, Oklahoma.



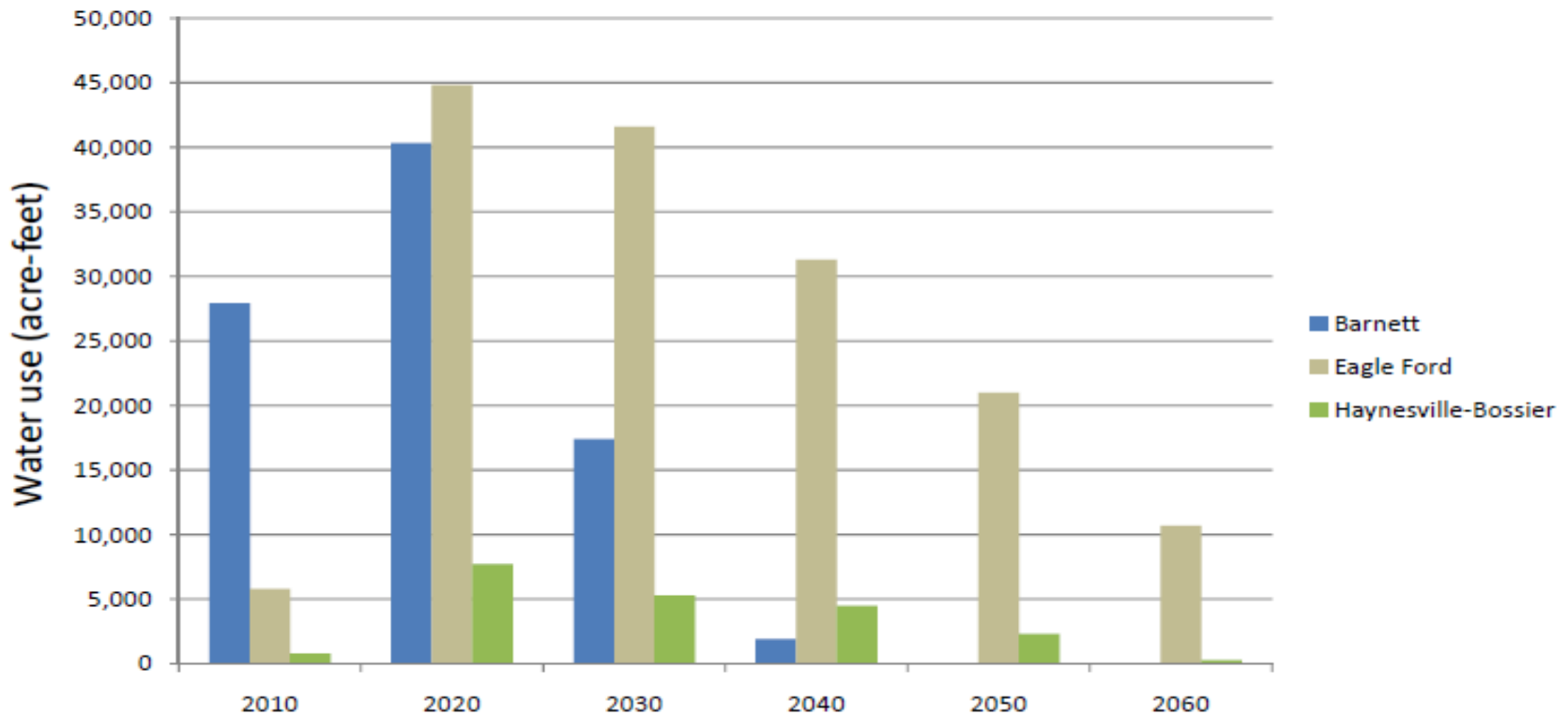
Hype or Health Hazard

Hydraulic Fracturing uses a significant amount of water.



Water Needs for Frac

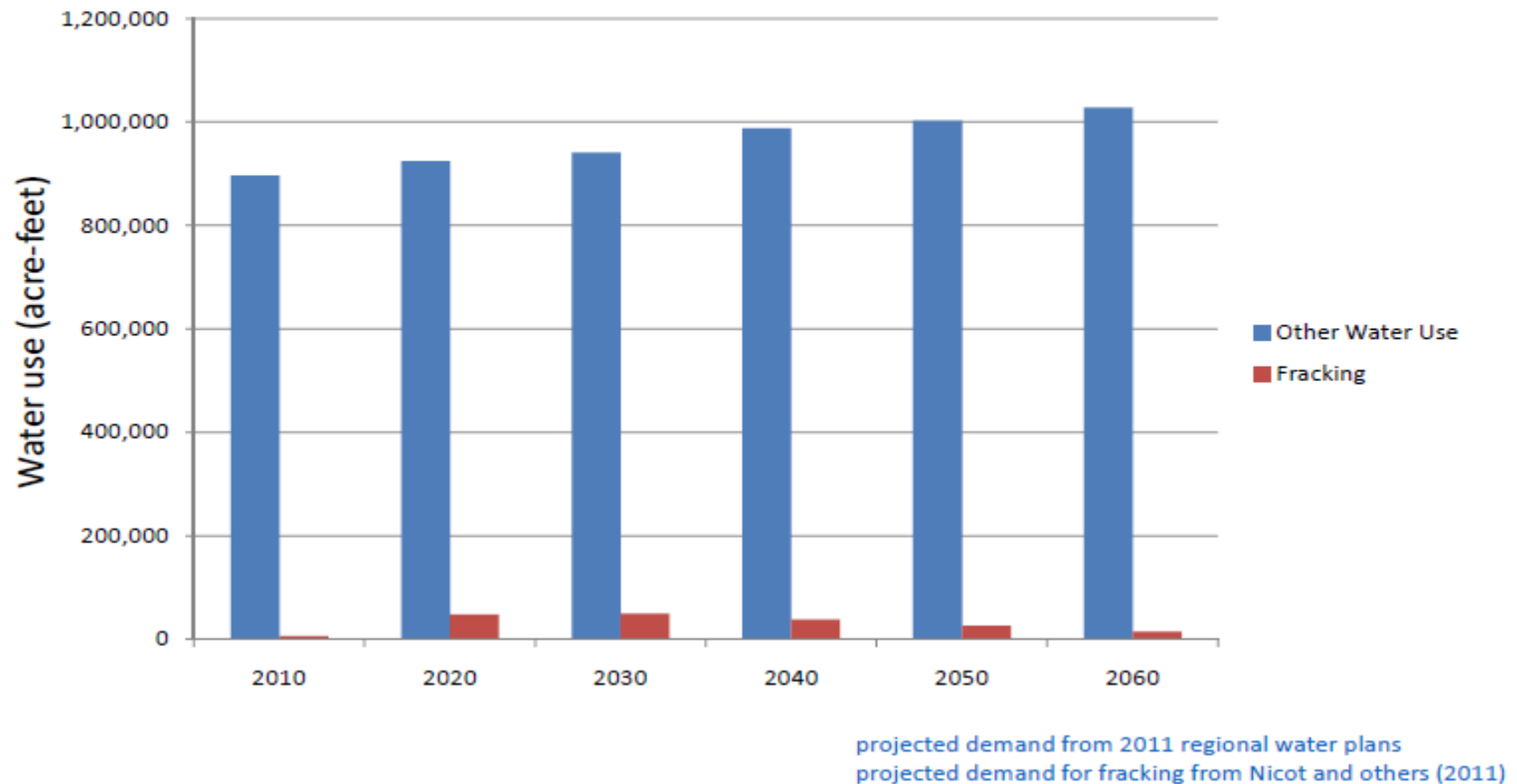
Projected water use in the major shale plays



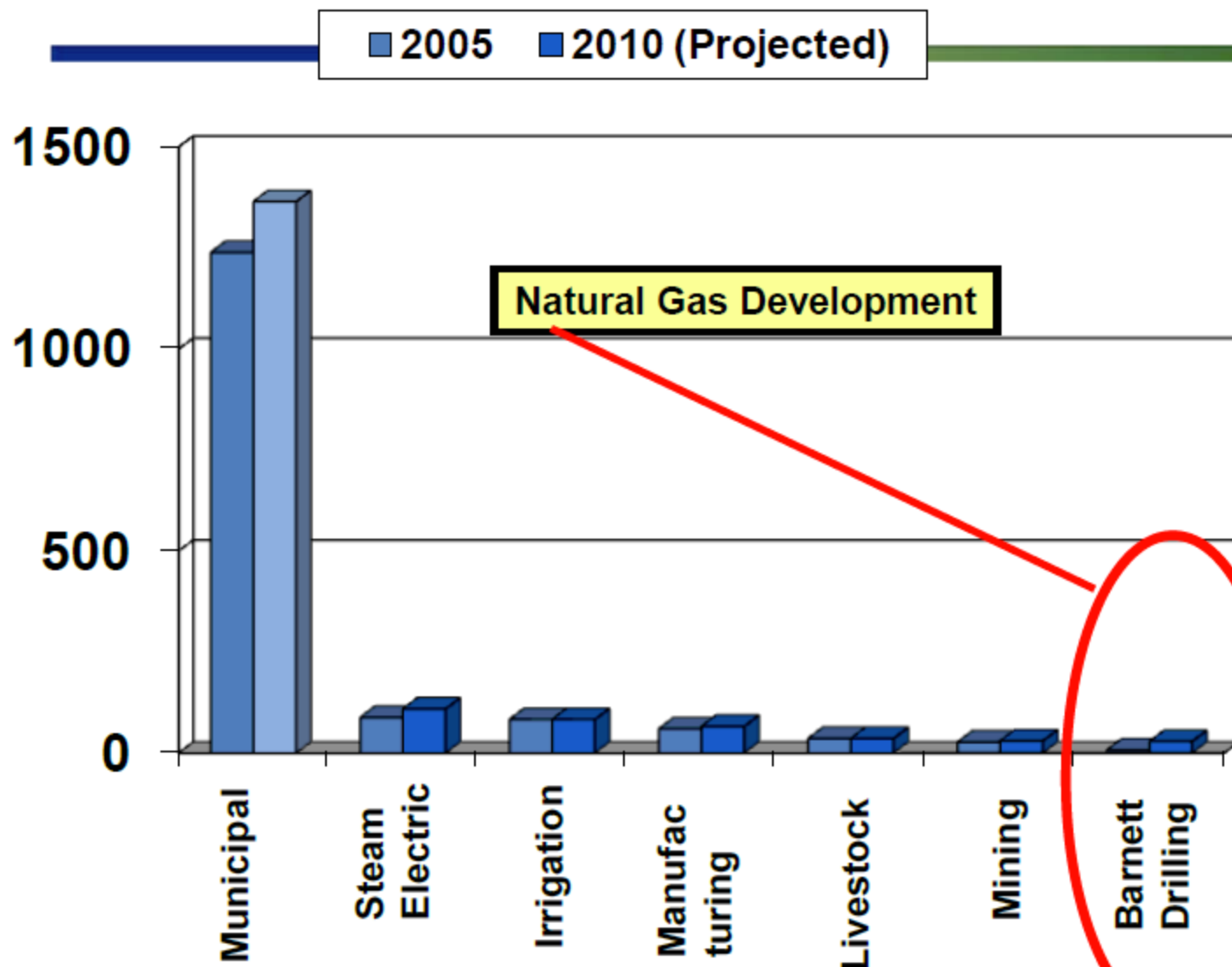
data from Nicot and others (2011)

Define “Significant”

Projected water use in the Eagle Ford Shale



Freshwater Users in the Barnett Shale Region



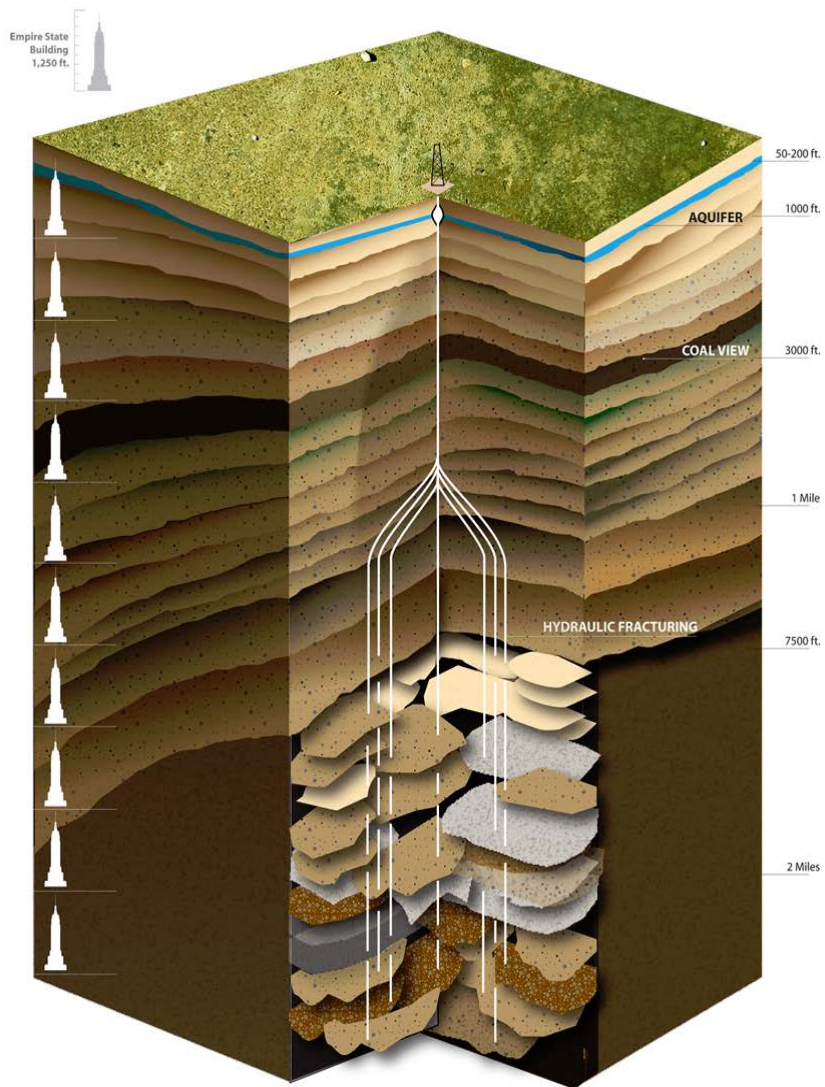
Hype or Health Hazard

Hydraulic Fracturing contaminates
Drinking water and ground water.



Going Deep:

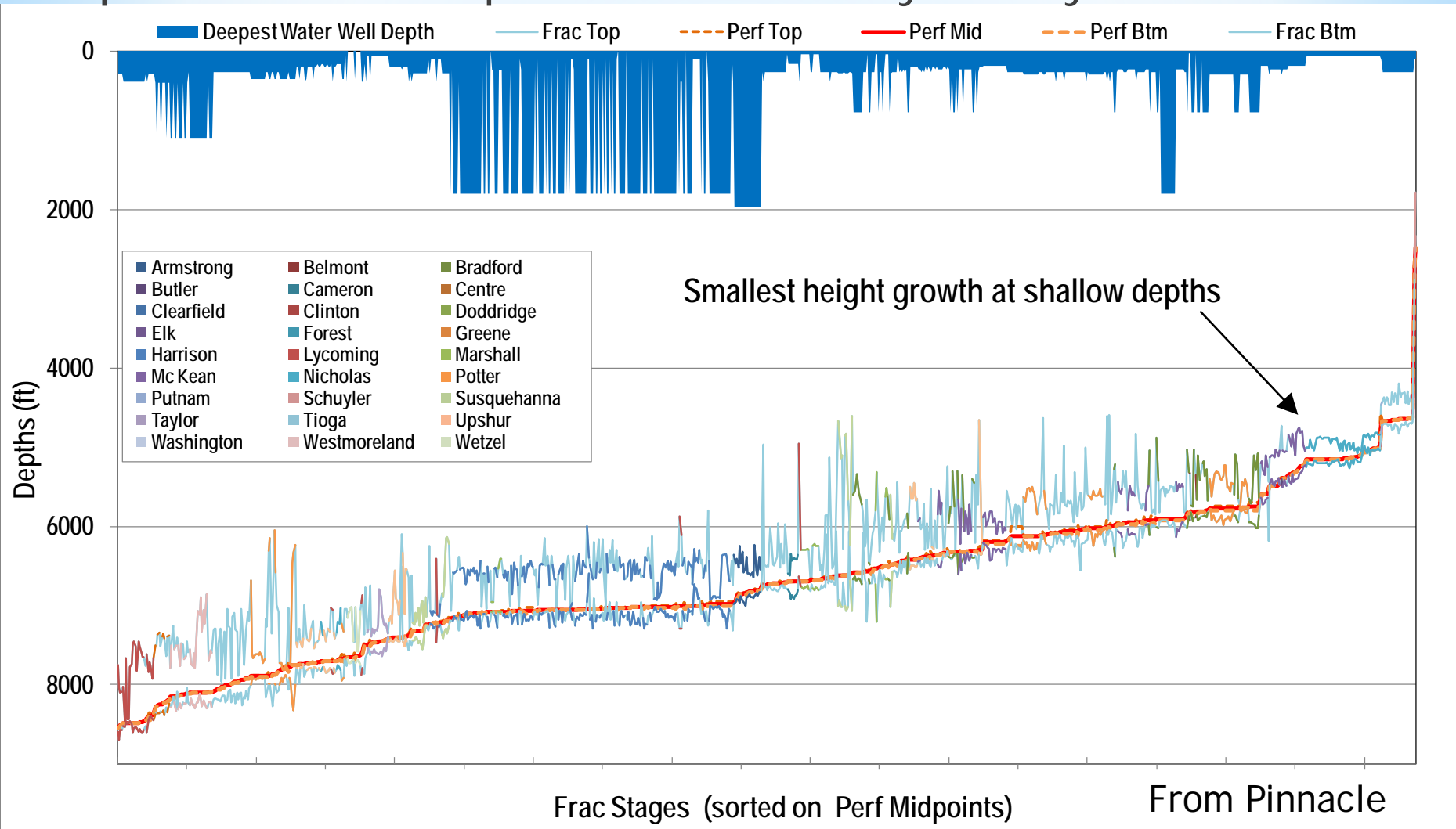
WELL STIMULATION TECHNOLOGY DEPLOYED THOUSANDS OF FEET BELOW THE WATER TABLE.



Ok - were game...lets map the fractures

*Top: shallowest microseism; Bottom: deepest microseism

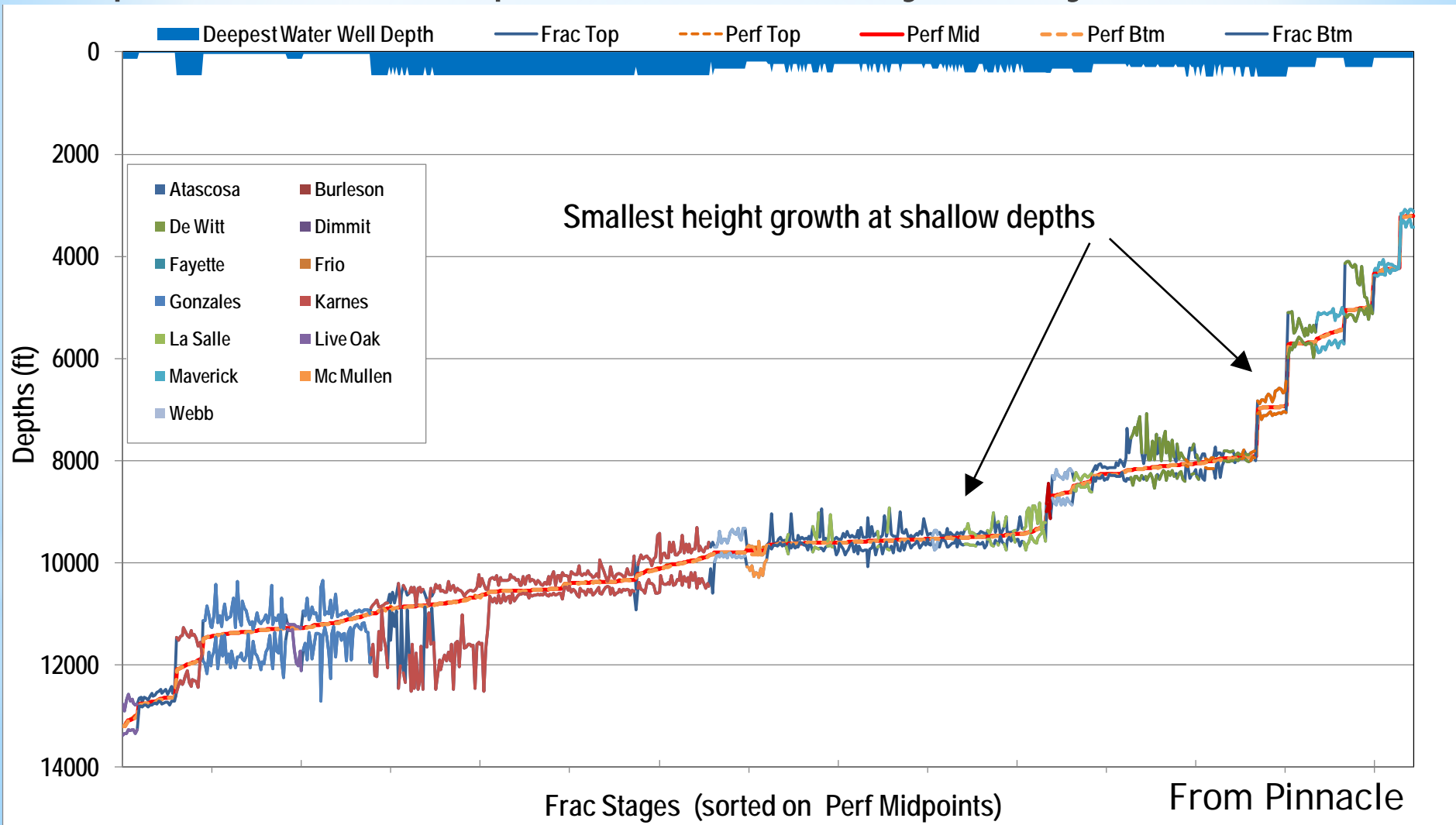
*Aquifers: USGS deepest water wells by county **MARCELLUS**



Ok - were game...lets map the fractures

* Top: shallowest microseism; Bottom: deepest microseism

* Aquifers: USGS deepest water wells by county **EAGLE FORD**



Yeah, But what about that flaming faucet?



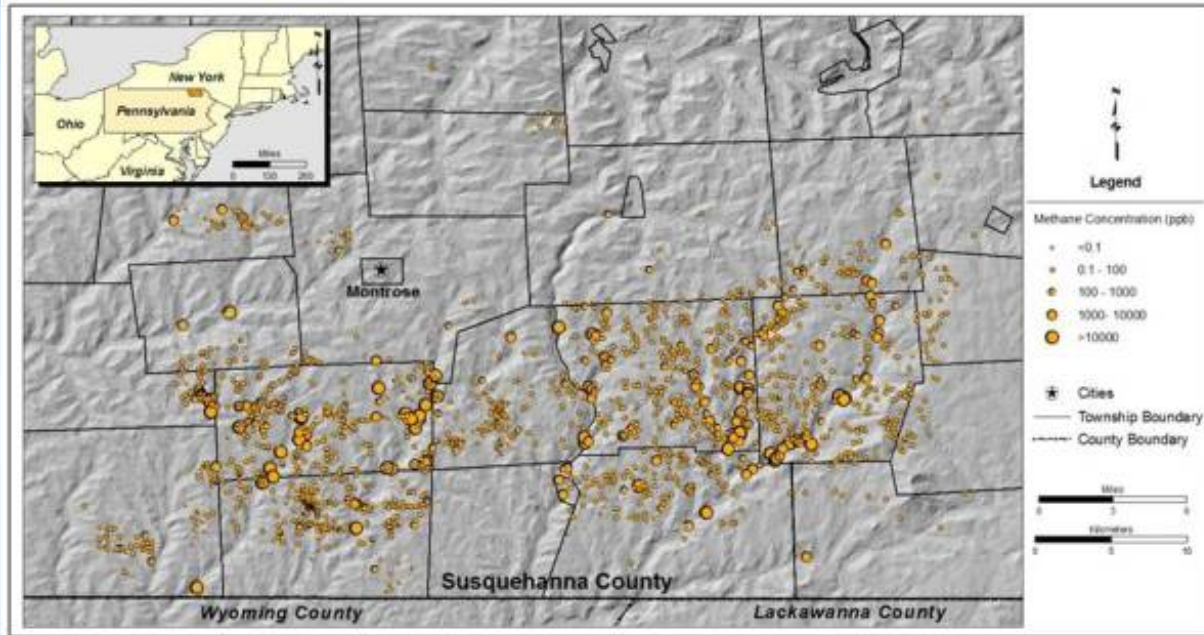
- Inquiring scientists want to know...
- The famous flaming faucet from the Gasland video is from a coal seam gas reservoir that produced secondary biogenic methane.
- There are cases in Colorado, highlighted by a flaming tap in Fort Lupton in the film Gasland, where gas in domestic drinking water from an aquifer can be ignited.
- Testing has shown that in Fort Lupton the water well penetrates several coal seams and the gas is `biogenic' gas (from coal) with a chemical signature different from the `thermogenic' deep shale gas.
- Remember - Shale is not the only source of unconventional gas

How Common is Flaming Water?



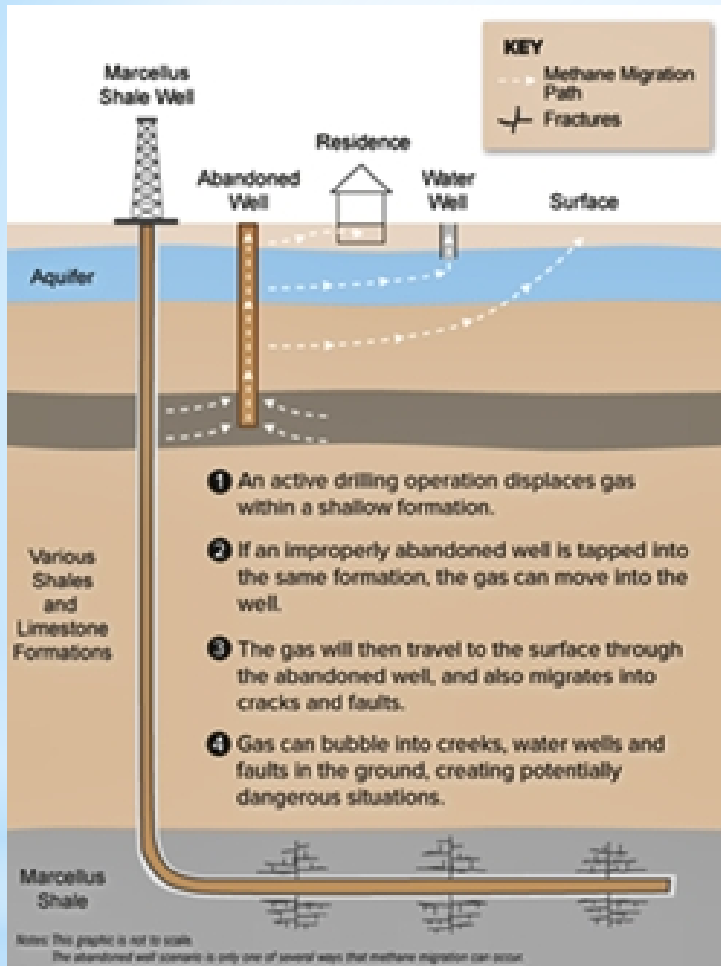
- Eternal Flame Falls - Shale Creek Preserve, Chestnut Ridge Park - NY
- While the fire doesn't come naturally, the methane gas that keeps it burning is natural, coming out through a split in the rock. According to Earth Science website, 'the flame goes out from time to time (it's not really eternal) but is easy to relight'.
- As long as there are teenagers and lighters - we can anticipate an eternal flame!

How Common is Methane in Water?



- A study conducted in West Virginia by the U.S. Geological Survey from 1997 to 2005 sampled 170 water wells, finding methane concentrations exceeding 10,000 ppb "only in wells located in valleys and hillsides, rather than hilltops
- Drilling started in 2006
- Another study sampled 1,713 water wells for presence of pre-drilling Methane in PA
- 80% of samples showed concentrations of methane without any industrial activity
- Revealed a correlation between methane concentrations and topography
- "Specifically, water wells located in lowland valley areas exhibit significantly higher dissolved methane levels than water wells in upland areas

So are we in the clear?

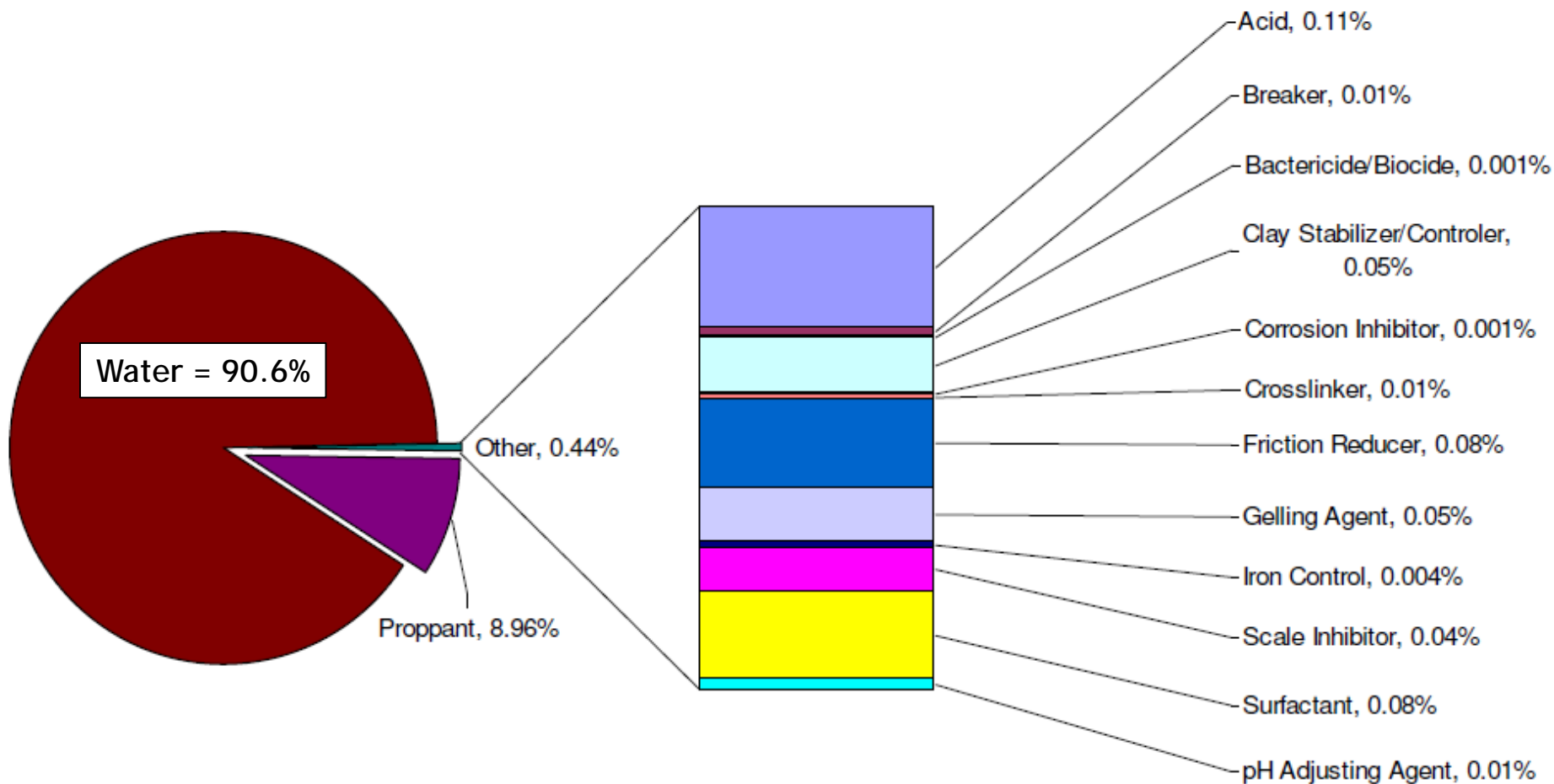


Hype or Health Hazard

Hydraulic Fracturing uses Highly Toxic Chemicals



Hydraulic Fracture Treatment Water Composition



Fracturing Fluid Additives and Usage



| Additive | Main Compound | Common Use |
|------------------|-------------------------------|--------------------------|
| Diluted Acid | Hydrochloric or Muriatic Acid | Swimming Pools |
| Biocide | Glutaraldehyde | Dental Disinfectant |
| Breaker | Ammonium Persulfate | Bleaching Hair |
| Crosslinker | Borate Salts | Laundry Detergents |
| Iron Control | Citric Acid | Food Additive |
| Gelling Agent | Guar Gum | Biscuits |
| Scale Inhibitor | Ethylene Glycol | Antifreeze |
| Surfactant | Isopropanol | Glass Cleaner |
| Friction Reducer | Polyacrylamide | Water and Soil Treatment |

Hype or Health Hazard

Hydraulic Fracturing causes Hazardous
Air Emissions



GW Pollution takes back seat to Air

Fracturing report looks at wells and emissions

By TOM FOWLER
HOUSTON CHRONICLE
Aug. 10, 2011

Air quality

*"When we started, the mantra we were following was to look at the hydraulic fracturing and the chemicals going into the ground," said Stephen Holditch, head of the Department of Petroleum Engineering at Texas A&M University. **"But it turns out it was almost a non-issue."***

*Rather, the group **"became convinced the cumulative air quality problems were the ones requiring the most attention."***

Some states also are addressing the air quality issues, particularly Wyoming and Colorado.

But little data is gathered concerning air and water issues tied to gas drilling and production, Deutch said.

Scientific consensus - Emissions is one of biggest issues

Emissions Include:

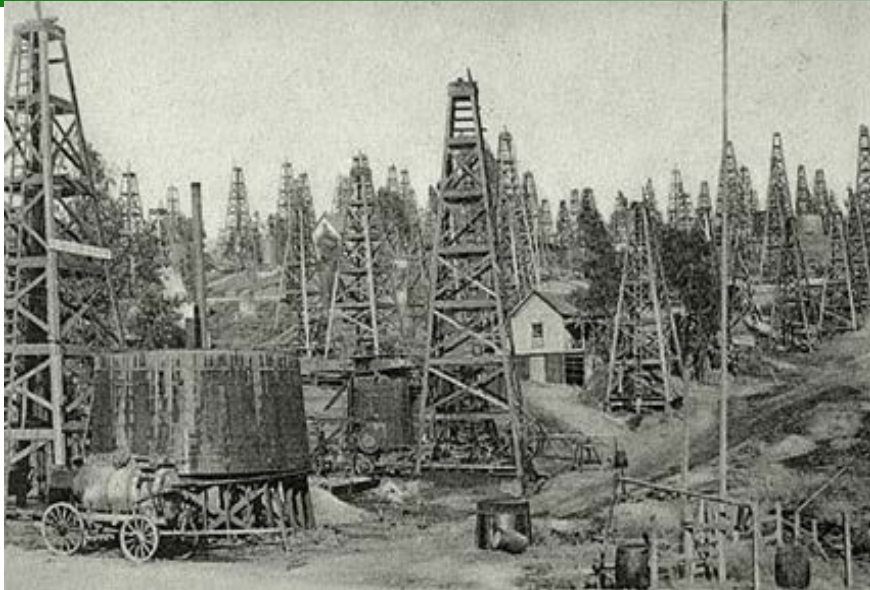
Volatile Organic Compounds
Nox
Green House Gases
Particulates

Sources Include:

Off-road mobile equipment
On-road trucks (water, sand, equipment hauling)
New O&G stationary sources (such as refining)
Sources related to economic growth (utilities, traffic etc.)
CNG infrastructure



Rig Evolution



- Rigs are cleaner, quieter and more efficient – surface usage reduced 70%
- Ability to drill as many as 22 wells in one location without “rigging down”
- Rail system to move from rig to rig in half the time with half the emissions

Well Evolution

- 26 Wells Online/Producing

Minimal Equipment

- No Tanks
- No Separation



Test and Evaluate New Tech

- * Improving and refining best management practices involves the testing and evaluation of new technology to include
 - * Mobile Microgrids use solar and wind to reduce fuel costs while improving air quality
 - * Sensors capture fugitive emissions while improving safety and loss of product
 - * Vapor recovery/resell (green completions) elimination of virtually all venting/flaring, even during the drillout phase. Reduces emissions while providing higher gas production and higher sales



Technology Driven



Apogee Leak Detection System



An innovative infrared-based method for detecting leaks from hydrocarbon liquids and gas pipelines, production and storage facilities, landfills, and coal-seam seeps.

Apogee Scientific

Directed Inspection and Maintenance

No-Bleed Pilot Valve For FMC Invalco Controllers

THE 10 MINUTE SOLUTION
Apogee Scientific's Patented NOBLE™ Pilot Valve is your controller and valve's another valve. Plus, improve the air quality in your system in 10 minutes.

Ultra MIZER™ Pilot Valve Available



NOBLE™ Pilot Valve

WellMark
CENTRO-AMERICA
wellmarkco.com

Retrofit Technology



Lean Burn Technology



Solar Technology

