Fracing: Facts and Myths

Responsible Development of Unconventional Oil and Gas Resources

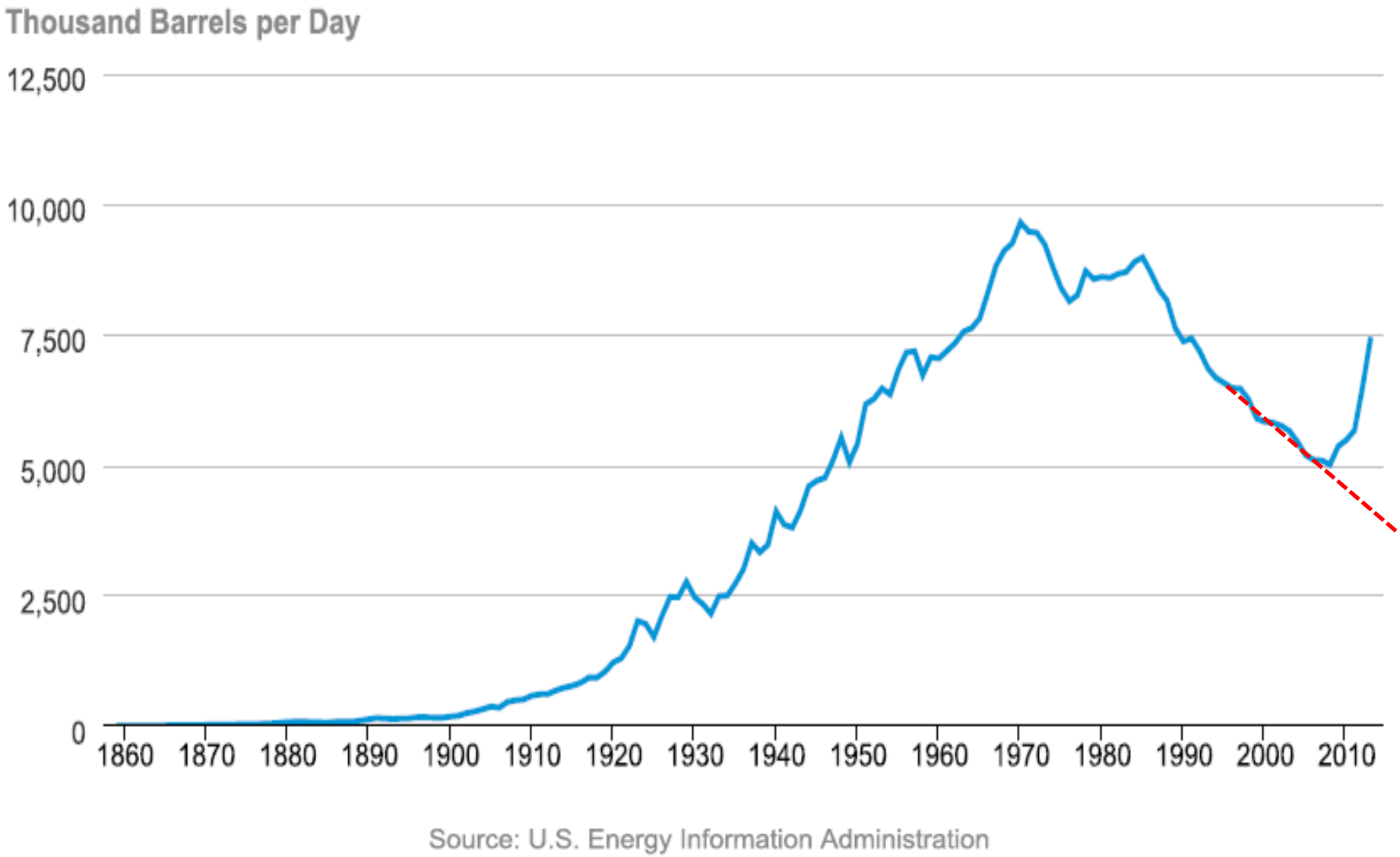
Mukul M. Sharma

Professor, Department of Petroleum and Geosystems Engineering

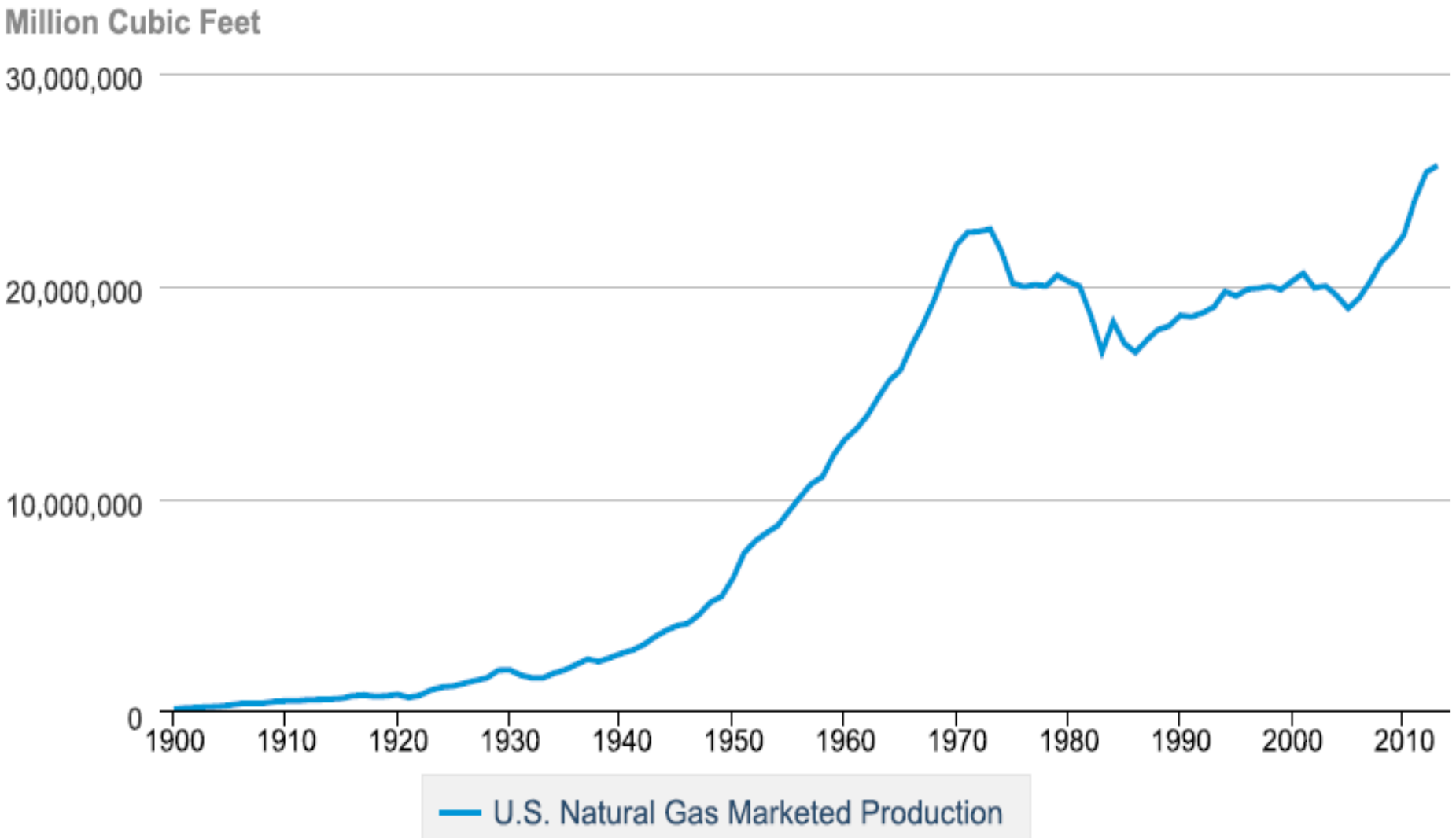
University of Texas at Austin

msharma@mail.utexas.edu

US Daily Crude Oil Production

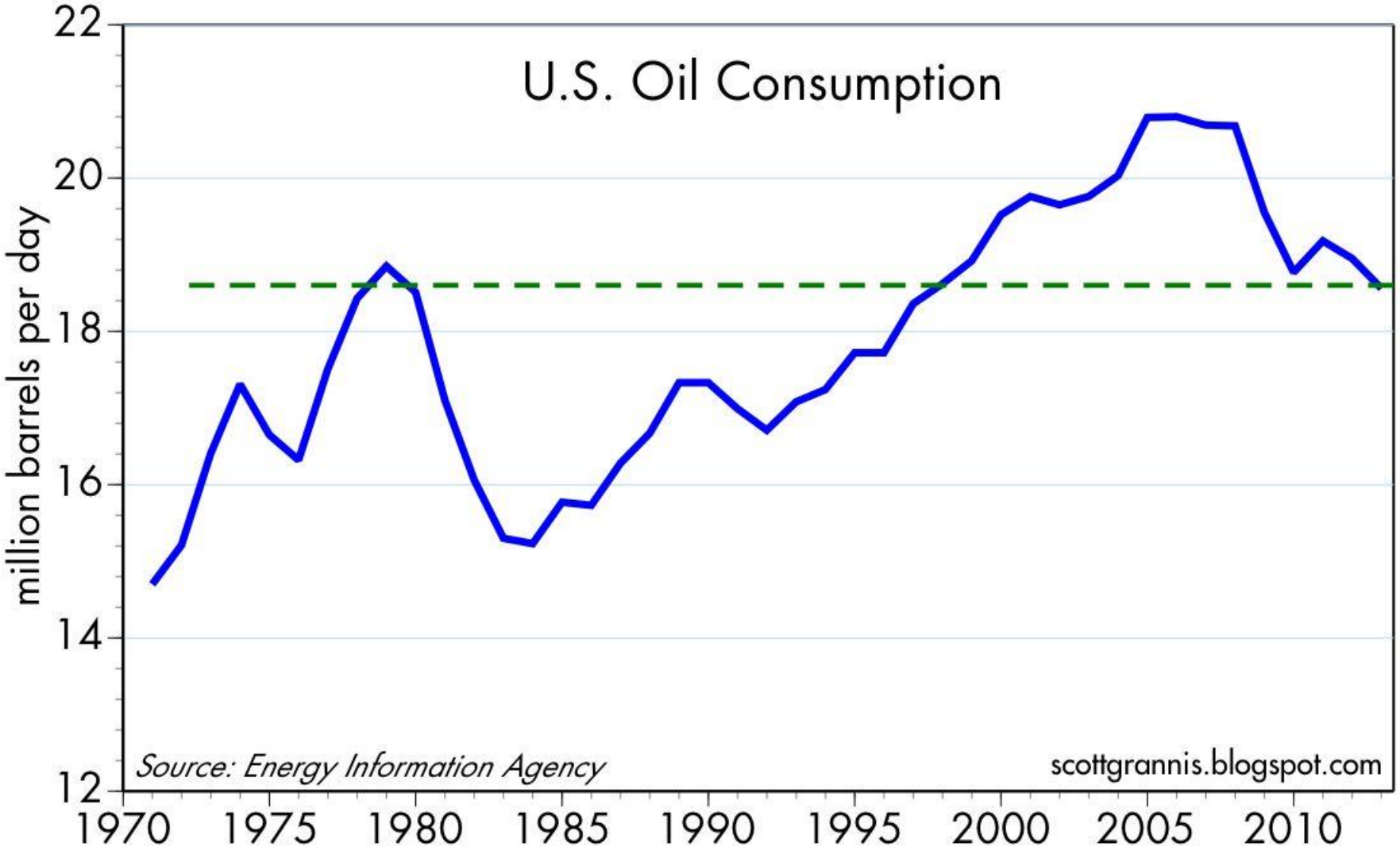


US Daily Natural Gas Production

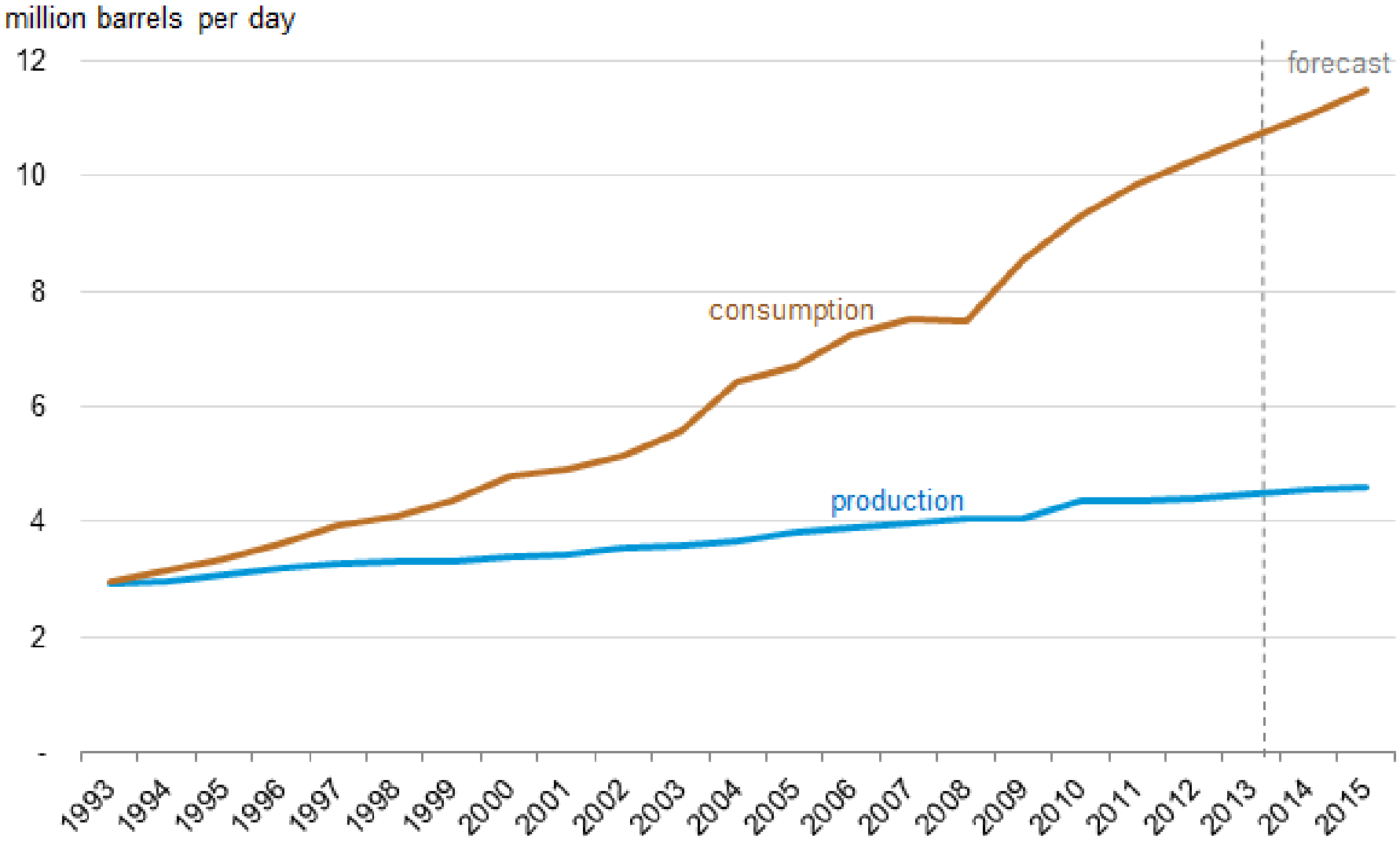


Source: U.S. Energy Information Administration

US Oil Consumption



China's oil production and consumption, 1993-2015



eia Source: EIA *International Energy Statistics* and *Short-Term Energy Outlook, January 2014.*

Impact of Fracturing on US Economy

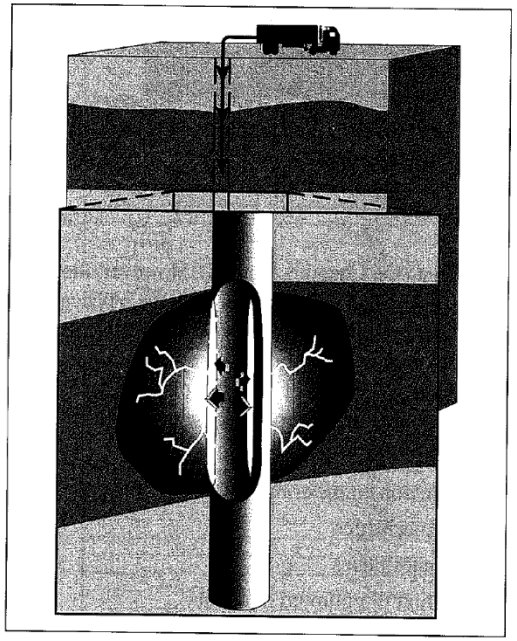
- Jobs: 2.1 million jobs created in 2012, 3.3 million jobs attributed to higher oil and gas production by 2020.
- Tax revenues: $75 billion in state and federal revenues in 2012.
- GDP: $283 billion added to GDP
- $346 billion of direct capital investment 2012 – 2025.
- Disposable household income increased by $1,200 in 2012, and is expected to increase by $2,700 in 2020 and $3,500 in 2025 due to lower energy costs.
- Industrial production to increase by 3.5% by the end of the decade.
  - Resurgence of chemical plants and energy intensive industries in the US.

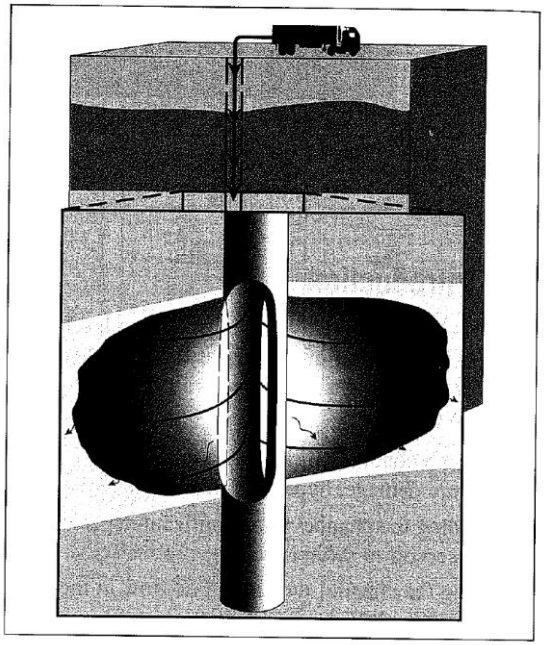
Source: American Petroleum Institute, IHS

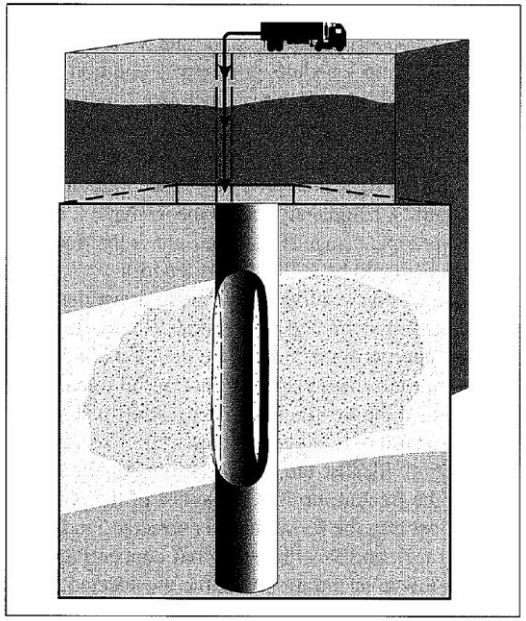
What is Fracing?

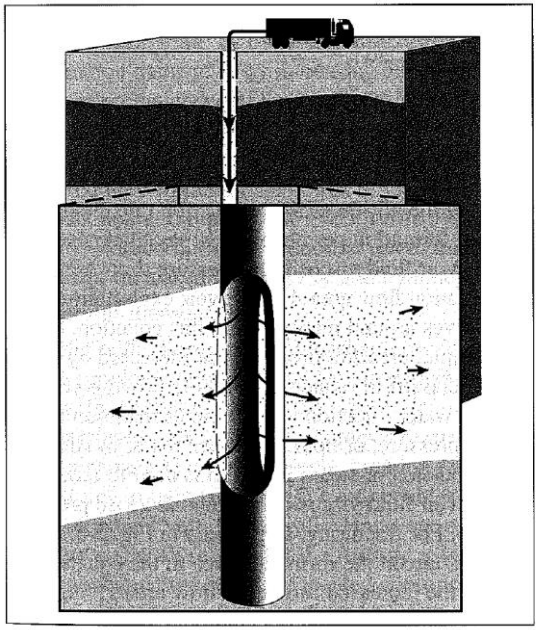
What is Fracturing?

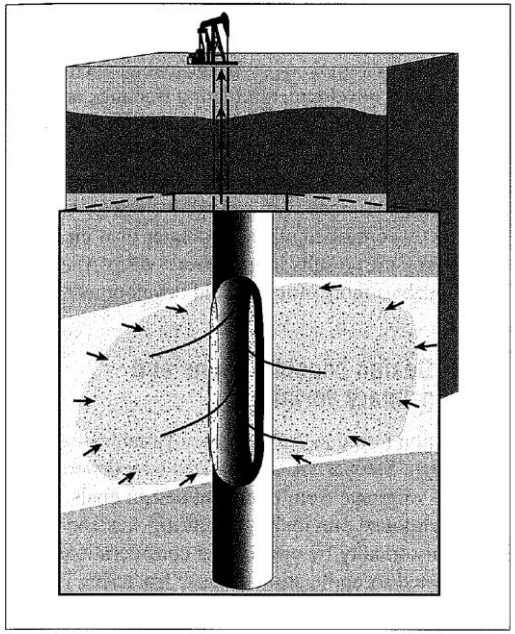
1. Fracture initiation
2. The pad stage (cross-linked polymer or water)
3. The proppant stages (sand and polymer or water)
4. Over-flush (polymer or water to displace the proppant from the wellbore.
5. Flow-back (reservoir fluids flowing back to the surface)

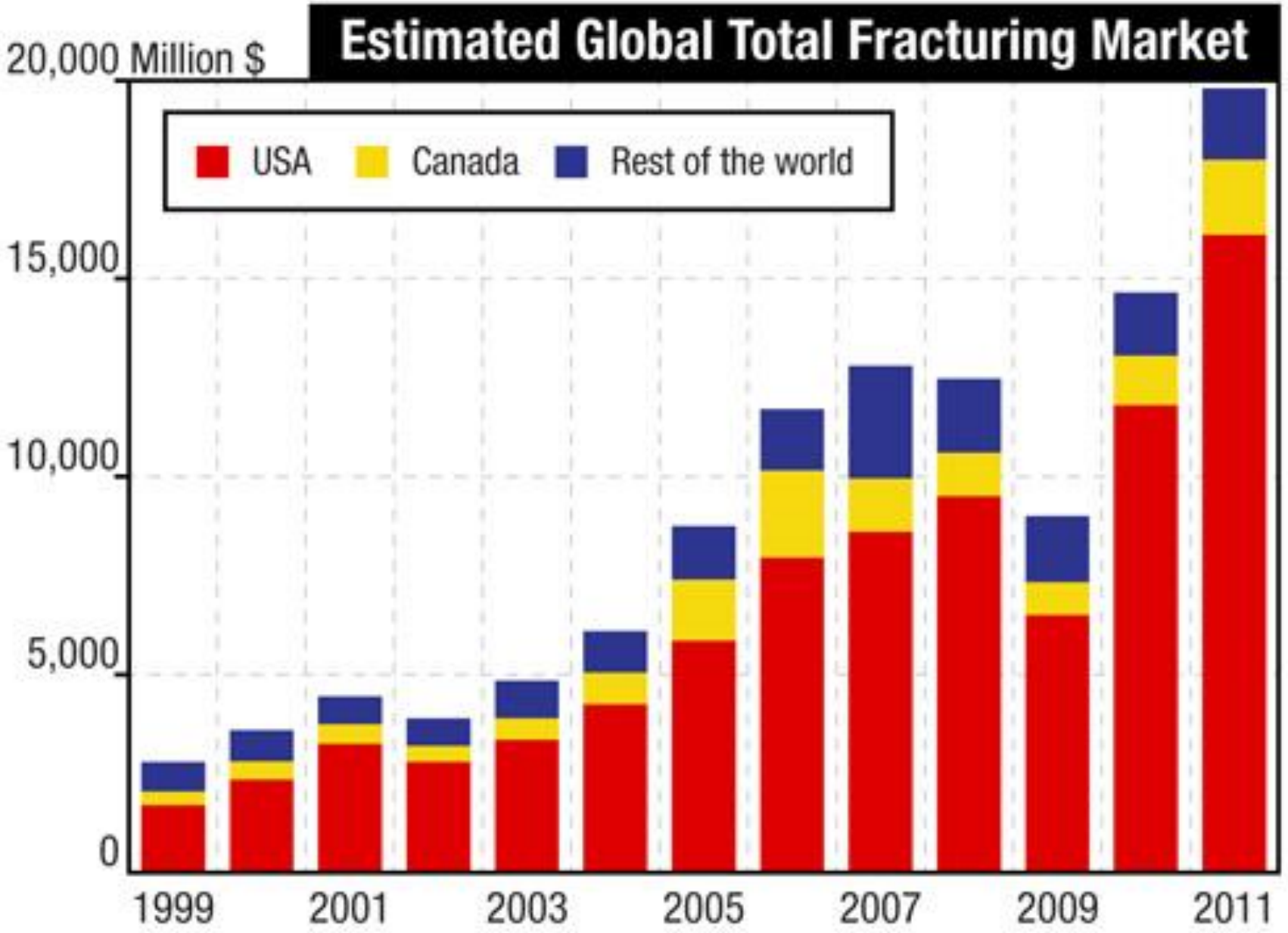




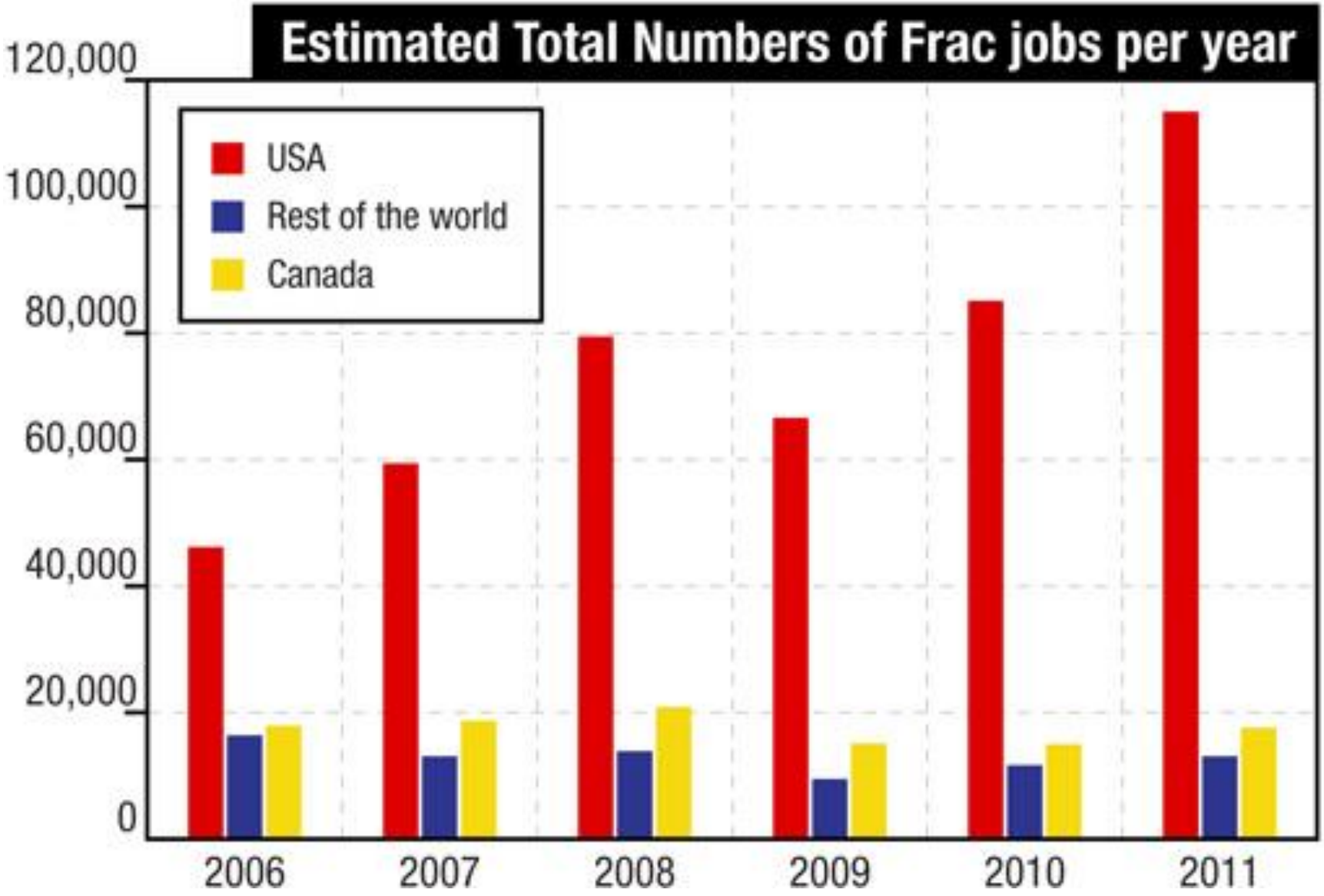








Ref: Economides, Energy Tribune, 2011



Ref: Economides, Energy Tribune, 2011

Concerns About Hydraulic Fracturing

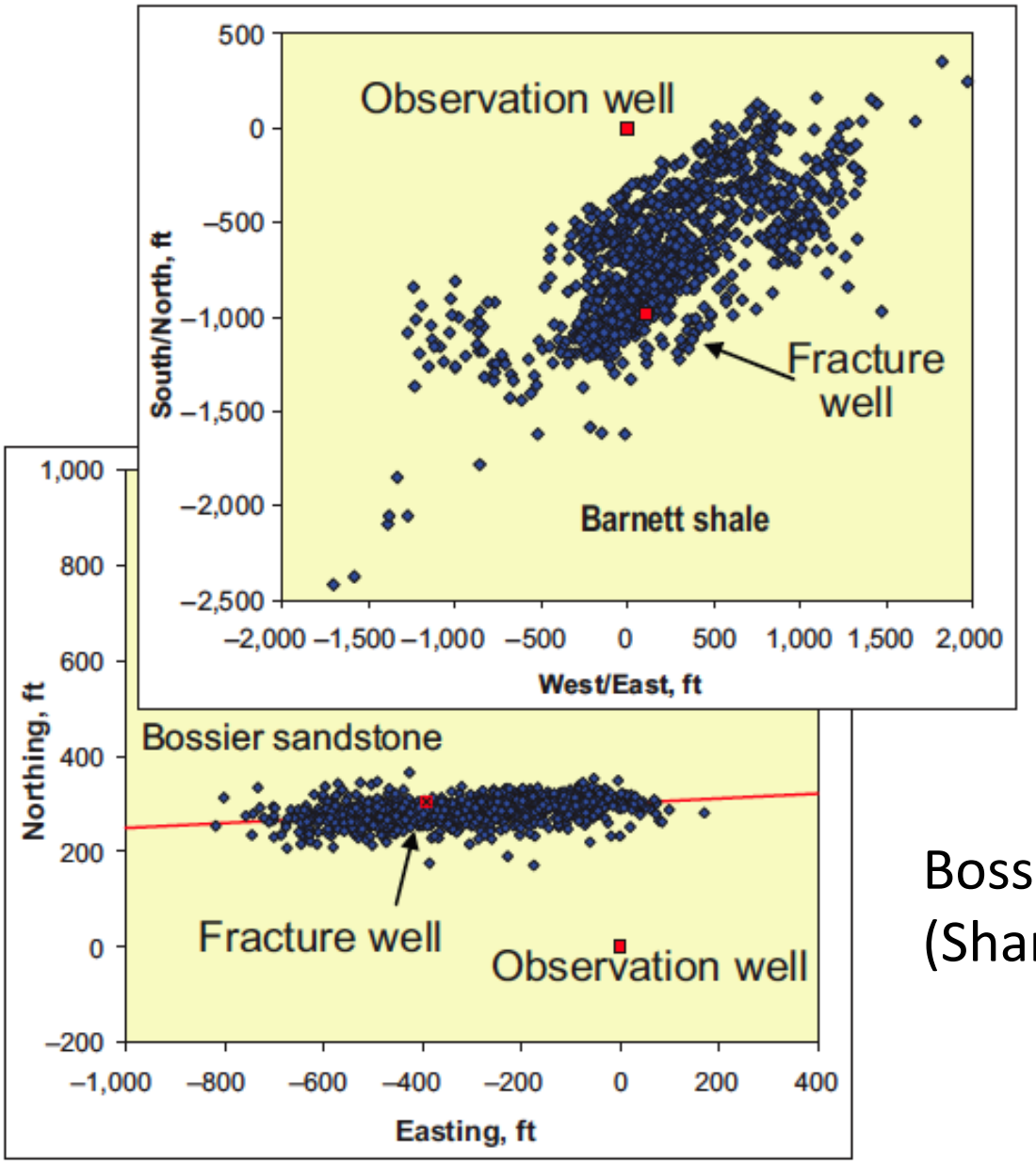
Some Background

- We have been fracturing wells for over 50 years in the US.
- There have been over 1 million fracture treatments pumped in the US alone.
- There have been thousands of well documented studies and technical papers written on every aspect of fracturing over this period of time.
- Some opinions / concerns expressed in the media are a result of a lack of awareness of this rich literature available to us all.
- Many of these concerns have been addressed in the past but need further discussion.
- http://thecolbertreport.cc.com/videos/5f3kap/tom-ridge

Concern # 1
Hydraulic fracturing causes earthquakes.

- This is true.
- We can measure the earthquakes caused by fracturing and thousands of such data sets are available.
- This technique is called “micro-seismic monitoring” and it has been used to detect where the fracture is going.
- The magnitude of these “earthquakes” are typically much smaller than the “quakes” a car passing by would cause on the earth’s surface.
- On a Richter scale they would register a negative number, or about 1 million times smaller than a typical California tremor.
- Exceptions: Large fracs created at shallow depths by long term injection of water or waste in tectonically active regions.

Example Microseismic Maps

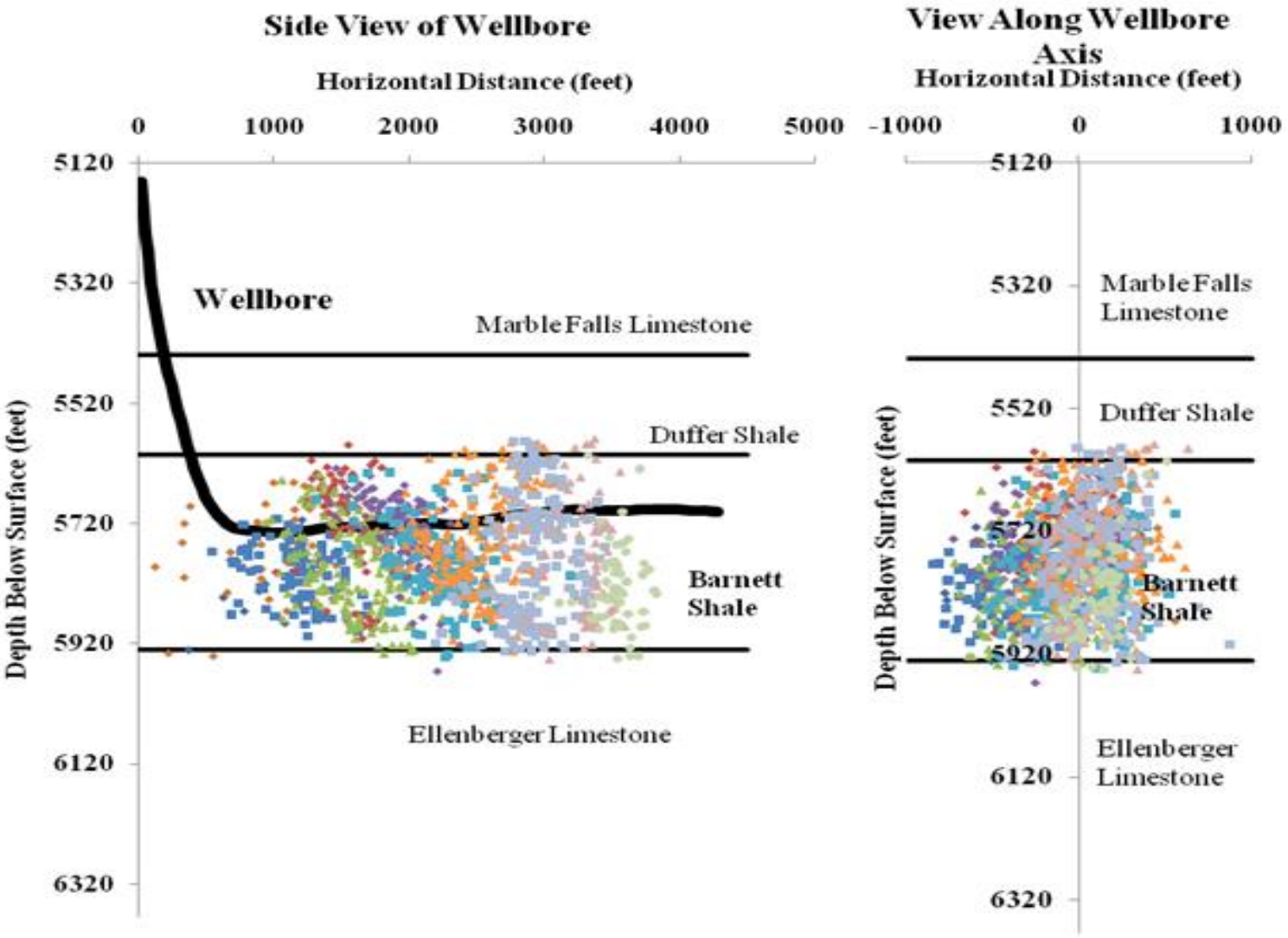


(Ref: Warpinski, 2009)

Barnett Shale, Devon
(Fisher et al. 2005)

Bossier TGS, Anadarko
(Sharma et al. 2004)

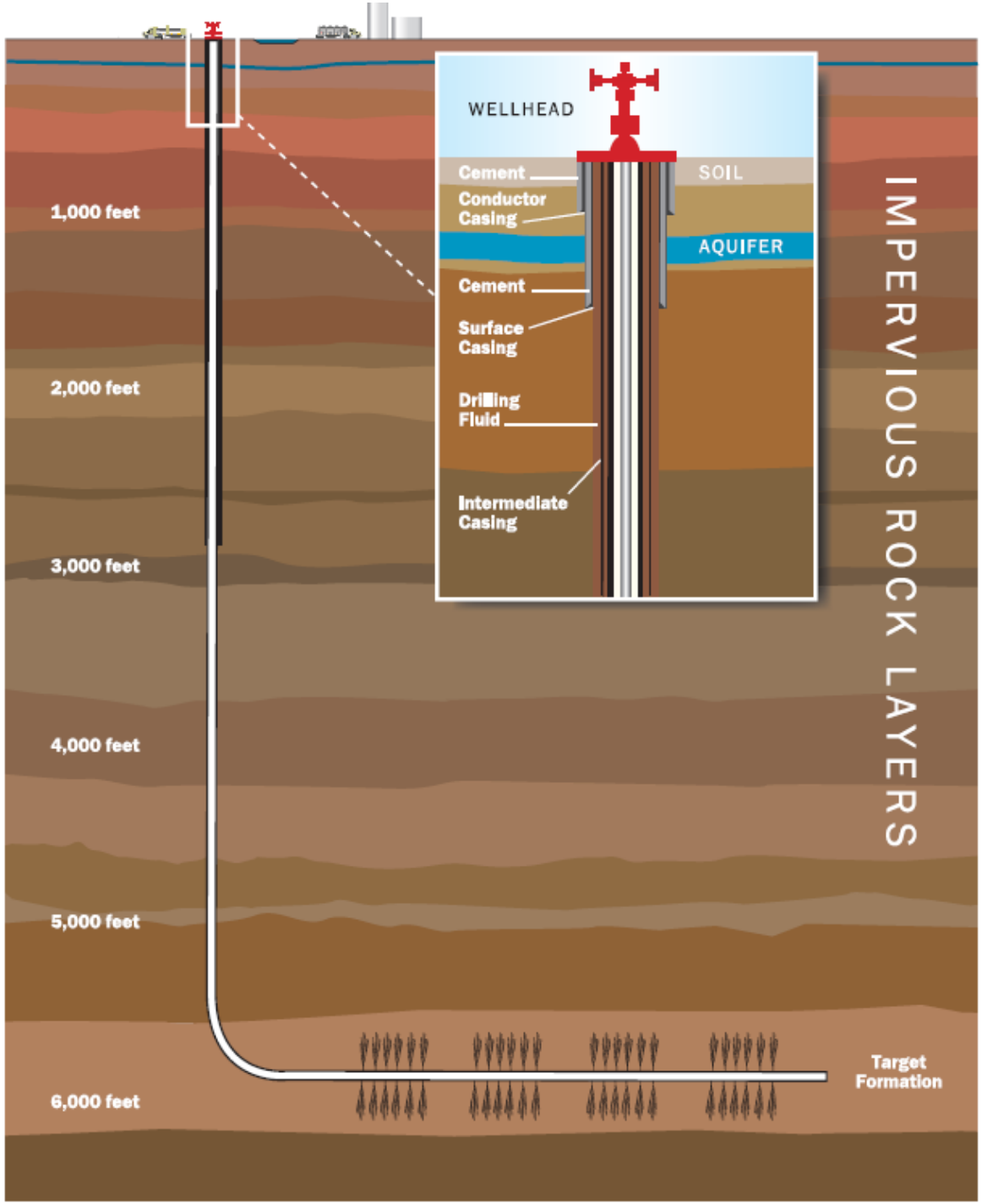
Micro-seismic events recorded during a hydraulic fracture treatment



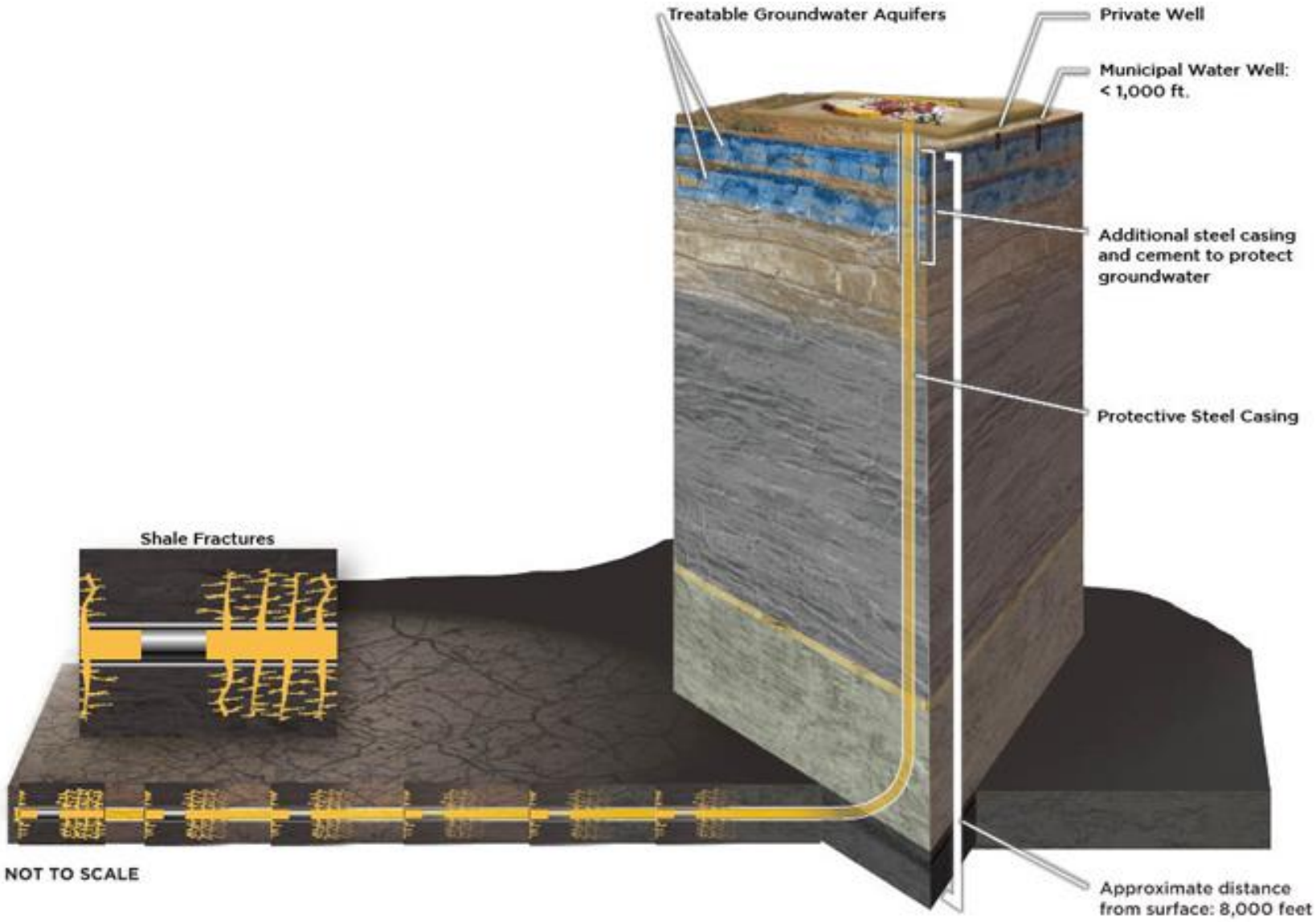
Concern # 2
Hydraulic fracturing contaminates groundwater

- There have been over 1 million wells fraced in the US. To my knowledge there have been no proven cases of groundwater contamination due to fracing.
- We have several things working for us:
  - Vertical migration of fractures through thick layers of rock with different stresses is extremely difficult.
  - The volumes of fluids pumped make it physically impossible for these fractures to propagate such long distances.
  - Existing laws currently in place strictly regulate the requirements for drilling, cementing and fracturing wells.
  - Operators are required by law to check the integrity of wellbores, casing and cement and there are well established remedies. Cement squeezes, casing patches, replacement of tubulars are some of the options available.
- We should continue to strictly implement these existing regulations.

Placement of fractures in a well relative to sources of groundwater

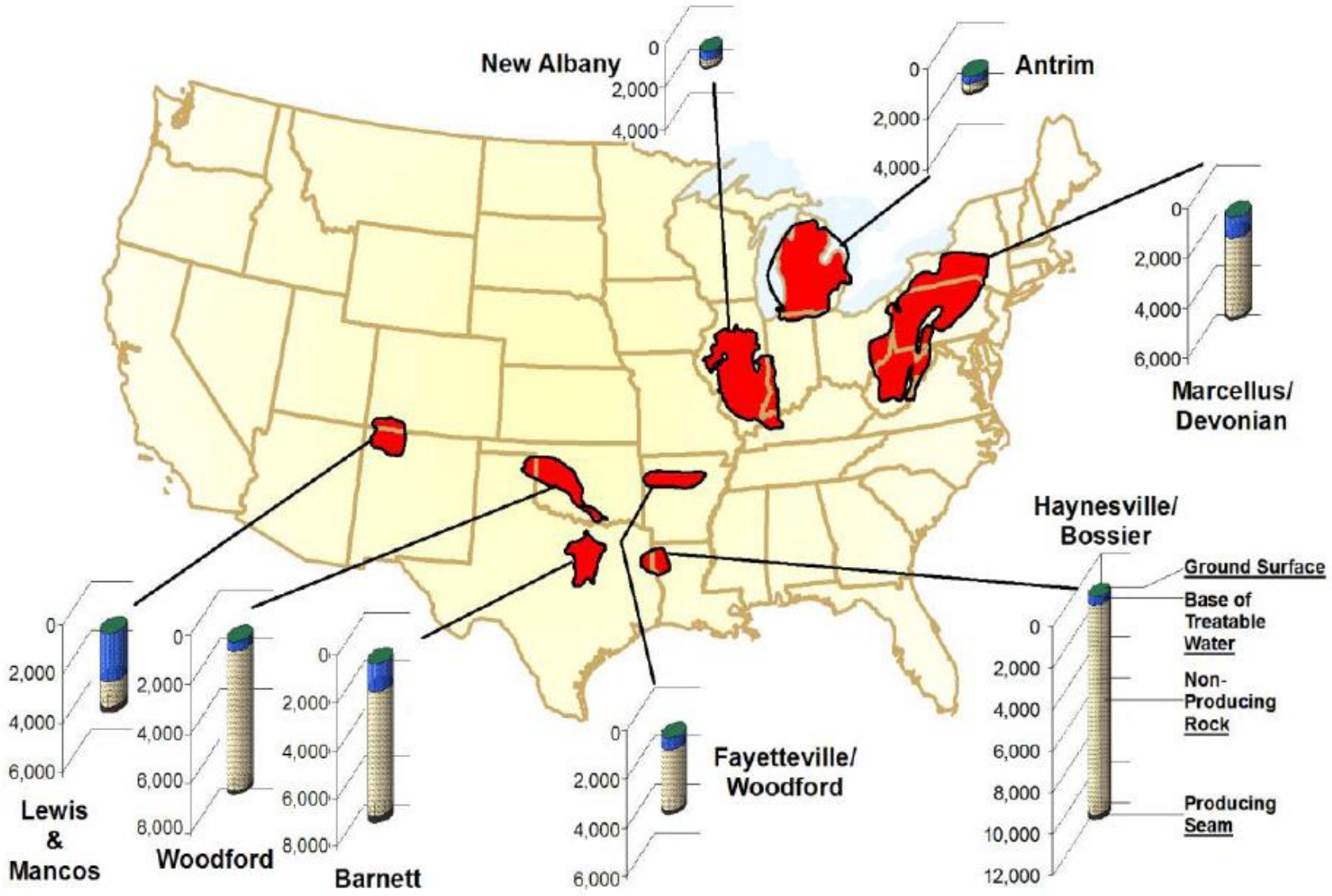


Impact on Groundwater



Depths of Gas Zone and Groundwater

(Ref: DOE / NETL report, April, 2009)



Some Quotes

Lisa Jackson, President Obama's Environmental Protection Agency Administrator: "*I'm not aware of any proven case where the fracking process itself has affected water*." (U.S. House testimony, 5/24/11)

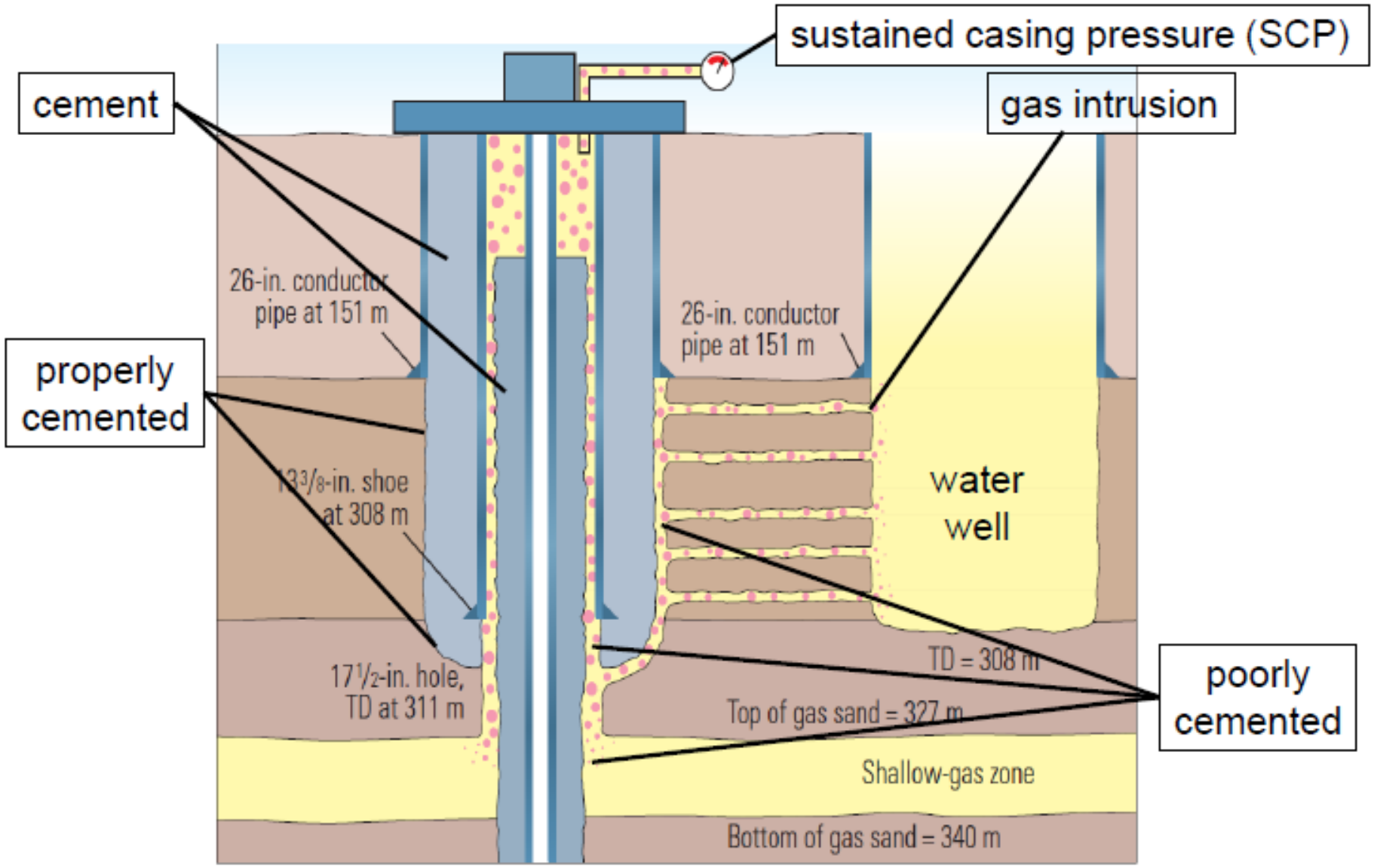
John Hanger, Founder & CEO of PennFuture and Fmr. PADEP Secretary: "*It's our experience in Pennsylvania that we have not had one case in which the fluids used to break off the gas from 5,000 to 8,000 feet underground have returned to contaminate ground water*." (Reuters, 10/4/10)

Taury Smith, NY State's Top Geologist: "*[Smith] said he has been examining the science of hydrofracturing the shale for three years and has found no cases in which the process has led to groundwater contamination*." (Albany Times Union, 3/14/11)

Peter Silva and Cynthia Giles, Top Obama Administration EPA Officials: "*No Documented Cases of Hydraulic Fracturing Contamination.*" When asked, "Do any one of you know of one case of ground water contamination that has resulted from hydraulic fracturing?", Mr. Silva said: "*Not that I'm aware of, no*." (U.S. Senate hearing, 12/8/09)

Scott Anderson, Environmental Defense Fund's Senior Policy Advisor: "*If wells are constructed right and operated right, hydraulic fracturing will not cause a problem. … Our natural gas supplies would plummet precipitously without hydraulic fracturing*." (E&E TV, 10/27/10)

Proper & Improper Cementing



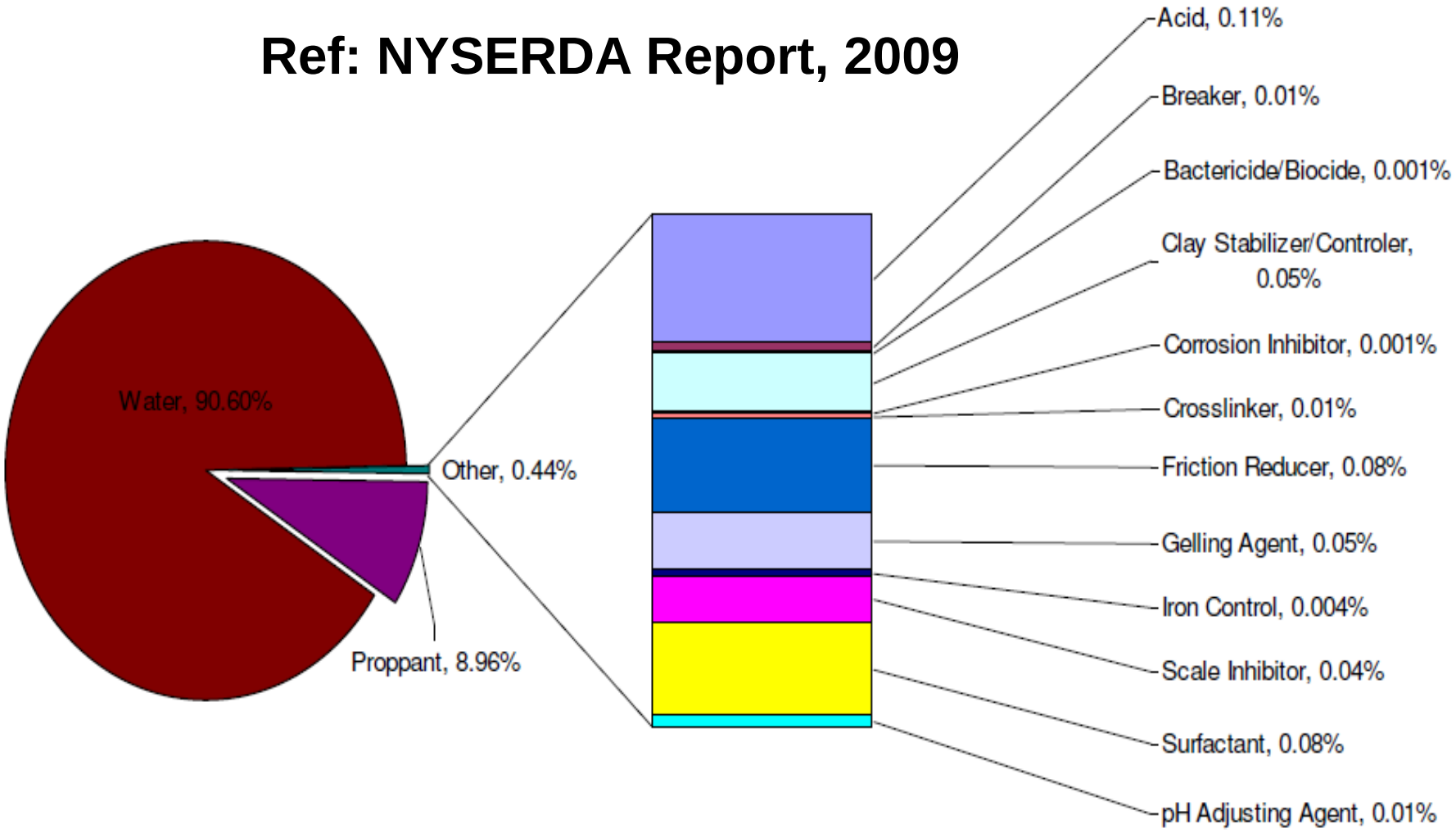
Schlumberger Oilfield Review, Autumn 2003

Concern # 3
Hydraulic fracturing uses toxic chemicals

- There are primarily 4 water soluble chemicals used in most hydraulic fractures: water, a non-toxic polymer (polyacrylamide), a cross-linking agent (a metal ion that cross-links the polymer and a breaker that breaks the gel.
- Most fractures in shales use slick-water, a small concentration of low MW polyacrylamide, biocides and corrosion inhibitors (a complete list is on the next slide).
- Service companies should disclose these chemicals to regulators and the public but this process should not be onerous (such regulation were recently passed in Texas).
- The website www.fracfocus.org provides a registry for voluntary disclosure of all chemicals being used in wells throughout the US.

Composition of Produced Frac Water

Ref: NYSERDA Report, 2009

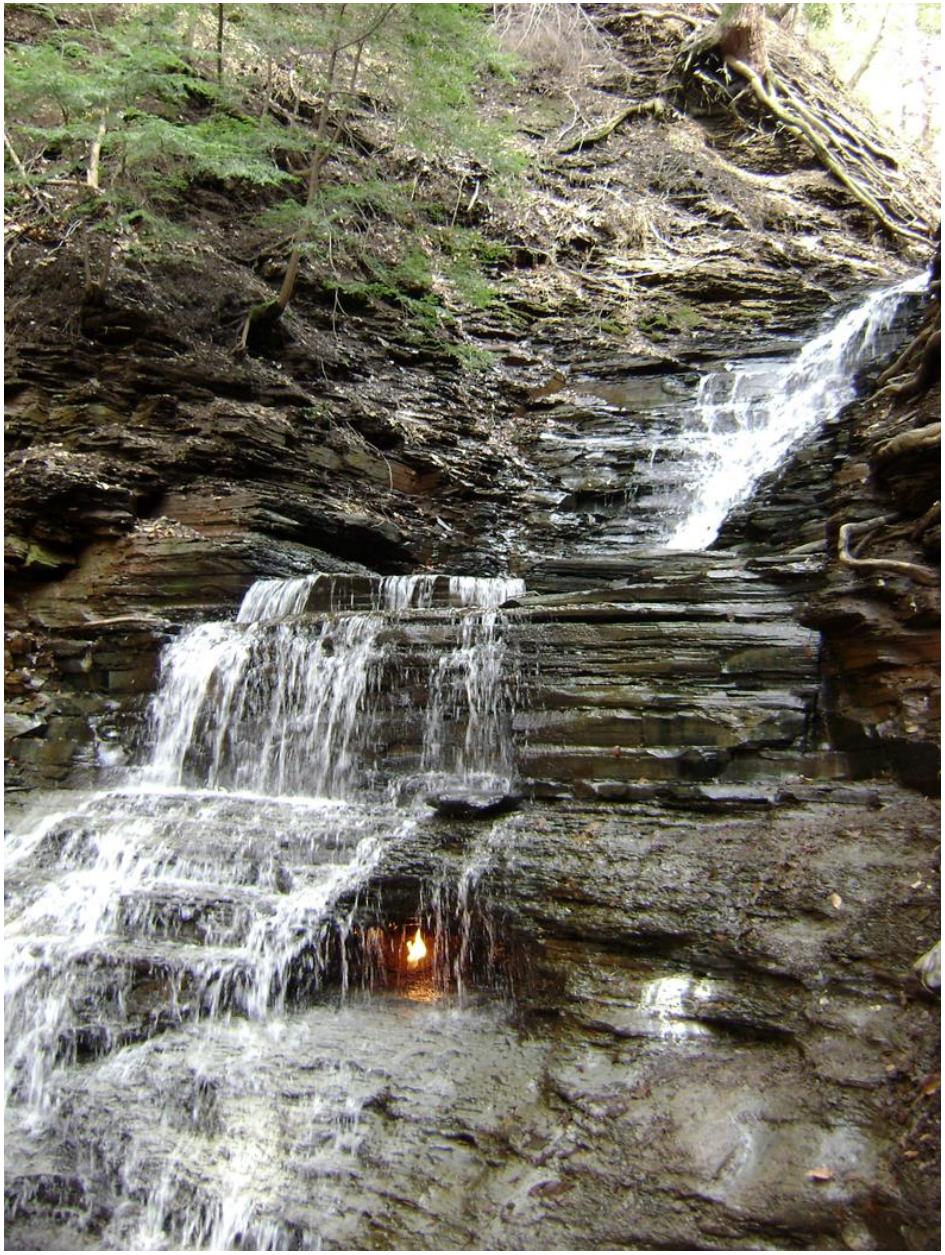


Concern # 4

Hydraulic fracturing causes gas to come up into our home water supply

- This notion was popularized by the dramatic footage in the movie Gasland (you should also see the counterpoint movie Truthland!)
- Drilling water wells in areas prone to natural gas seeps will result in gas in the water supply.
- Gas in home water supplies has been known to occur in water wells due to natural gas seeps much earlier than hydraulic fracturing was ever used.
- There are famous examples of natural gas seeps in Pennsylvania and New York that burn naturally or can be ignited on the surface.
- Proper permitting of water wells in areas prone to natural gas seeps will help prevent gas in home and ranch water supplies.

The Eternal Flame falls at the Shale Creek Preserve in Western New York



Concern # 5
Salt water produced from natural gas wells will contaminate the surface

- Most water produced from unconventional oil or gas wells is either re-injected or re-used for frac jobs.
- Spills on the surface are rare and when they do occur the volume of water lost is small.
- The amount of salt used to de-ice roads in New York and Pennsylvania every winter exceeds any potential surface spill of produced saline water by at least a million times.
- Operators need to continue to redouble their efforts to re-use as much of the produced water as possible.

Concern # 6
There is no “k” in Fracing.

- Anyone who writes fracing with a “k” (fracking) is new to the business of fracturing ☺
- No one in the hydraulic fracturing technical literature has ever used a “k” in fracing over the past 50 years!
- English is not a phonetic language and spelling of words is almost always based on “tradition” rather than “sounds”.

Concern # 7

Hydraulic fracturing is a big drain on our groundwater resources

- Water is a very precious commodity and it should be used with extreme care
  - Example: The drought conditions that now exist in Texas.
- A typical well uses 4 million gallons (12 acre-ft) of water.
- Barnett Area Municipal Use = 1 million acre-ft = 326 billion gallons of water per year.
- The water used in hydraulic fracturing in the Barnett shale is less than 1% of the municipal water use.
- There is more water used to water golf courses in New York and Pennsylvania than is used in hydraulic fracturing.
- Operators should make every effort to (a) reduce water usage by recycling water and (b) design fracs that use less water. This is a very active area of research.

Concern # 7

Hydraulic Fracturing and Water Usage

Steps being taken to reduce water usage

- The use of fresh water in fracturing has decreased dramatically through the use of new salinity tolerant polymers for slick water fracs.
- The use of non-aqueous frac fluids such as CO_2 and N_2.
- Optimization of fracture designs
- Reuse and recycling of frac water and produced water after water treatment. This can be cost prohibitive.
  - Filtration, evaporation, RO membranes etc.

Concern # 7
Reusing or Recycling Frac Water

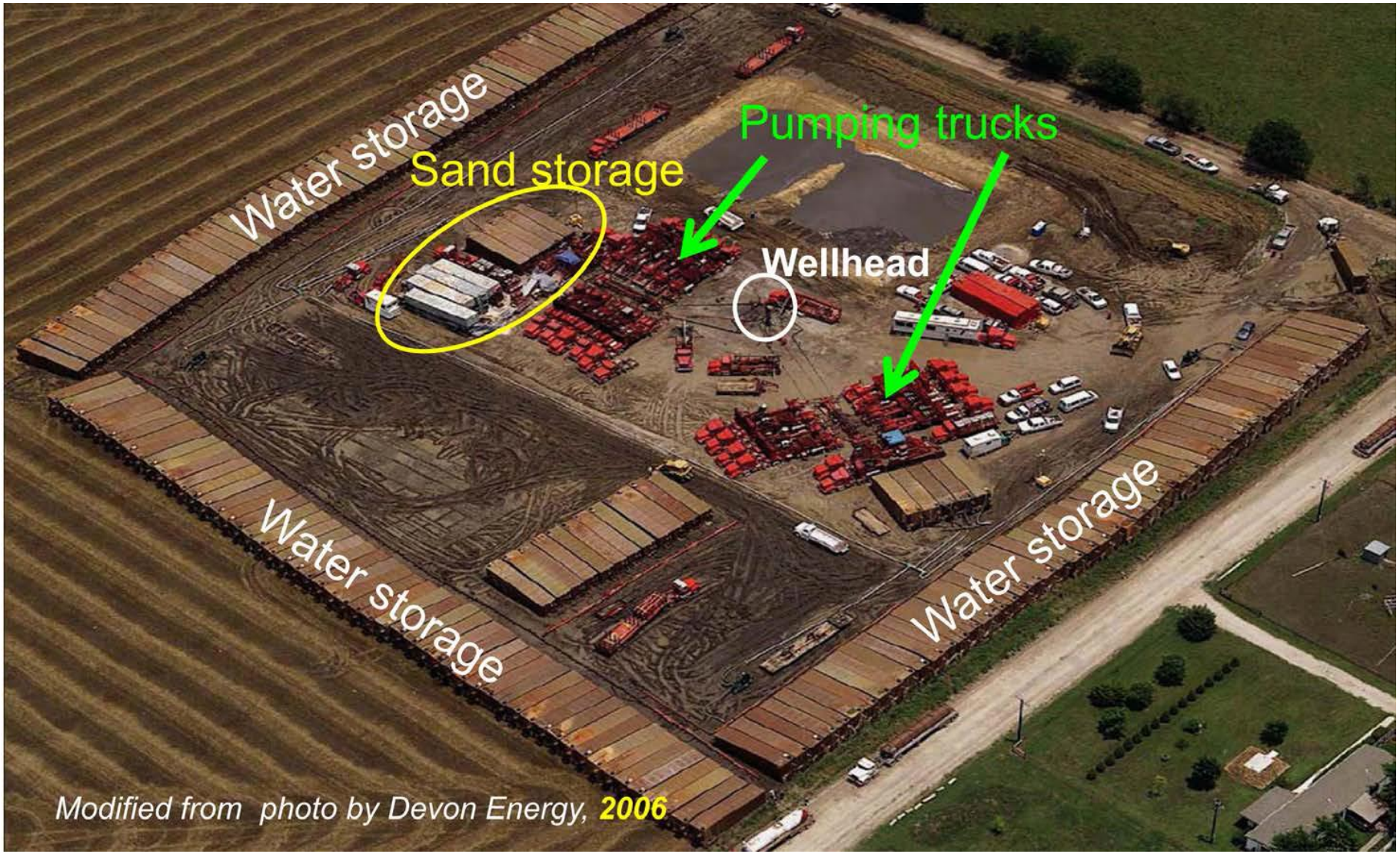
reuse	flowback water reconditioned for subsequent hydraulic fracturing	$8,000-$16,000 per acre-ft
recycle	flowback or produced water purified for discharge to environment	$24,000-$48,000 per acre-ft

Slutz, SPE 157532 (2012)
& industry estimates

Cost of California Agricultural Water: $24 per acre-ft
OECD, Agricultural Water Pricing: United States (2010)
http://www.oecd.org/unitedstates/45016437.pdf

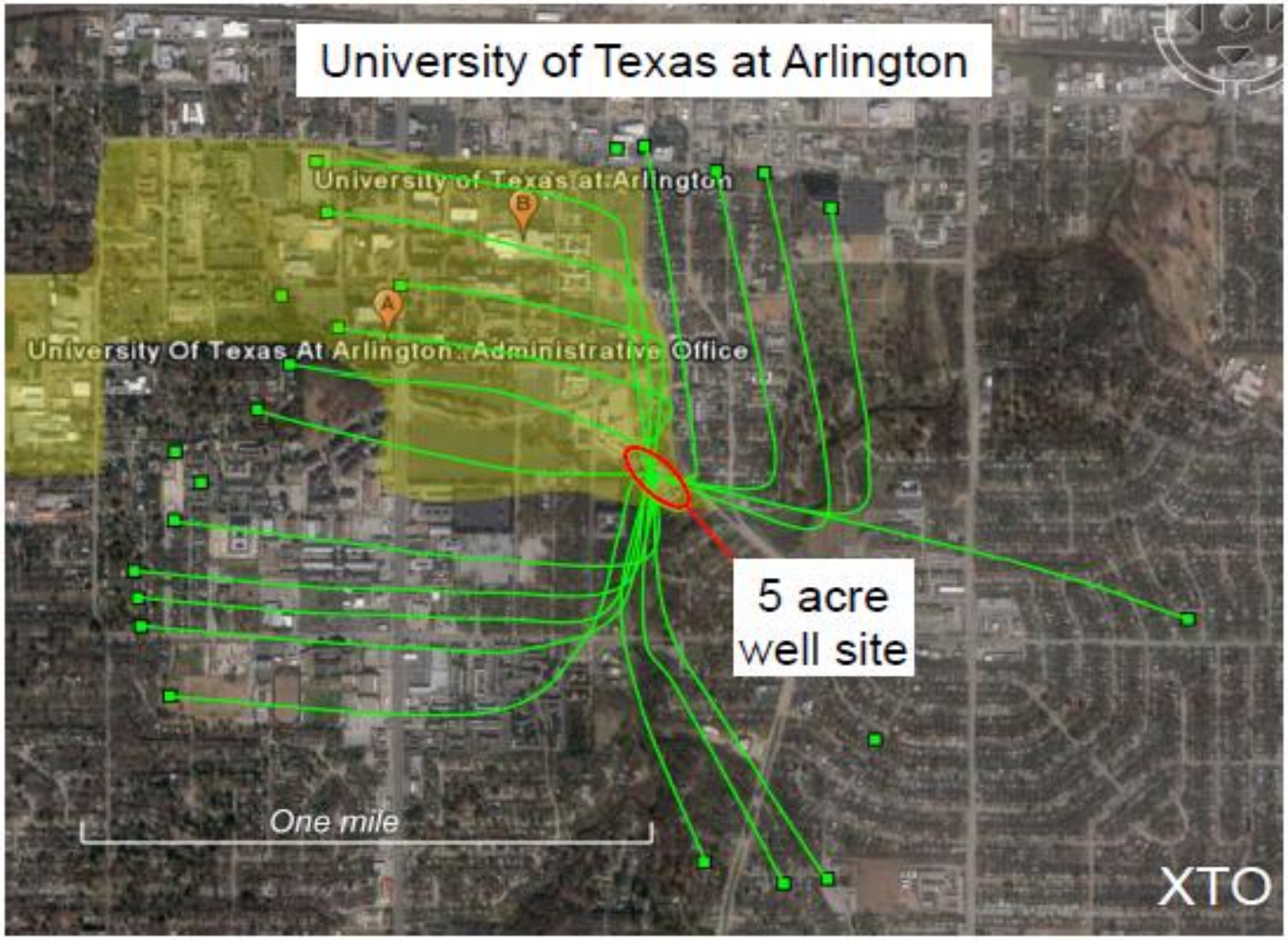
Ref: Robert Kleinberg, Schlumberger, 2014

Concern # 8: Surface Footprint



3 million gallons = 150 water tanks = 600 water trucks

Concern # 8: Reducing the Surface Footprint
19 wells Drilled from a 5 Acre Well Site



Concern # 9:
Truck Traffic, Noise, Air Pollution

- Wear and tear of roads
- Truck traffic
- Noise from traffic
- Noise from drilling and fracing
- Air pollution from trucks
- These are all valid concerns and must be addressed by the operator in coordination with the local community.
- Most surface owners are happy to temporarily tolerate the inconveniences mentioned above for the royalty / other payments they receive.

Concern # 10

“Sand mining emerges as another fracking threat”

"One of the big concerns is the impact on the air," said Jessie Thomas-Blate of the conservation group American Rivers. "Mining kicks up a lot of dust, and the people in the area can breathe in that dust.“…
“If inhaled, crystalline silica, a building block in so-called frac sand, is a potential carcinogen and can cause lung and other diseases, according to the U.S. Occupational Safety and Health Administration.”

By Anna Driver
HOUSTON | Wed Sep 21, 2011 1:48pm EDT

Is this a real risk?

Some Things to Consider

- Unconventional gas provides a way to cut CO_2 emissions by up to 40%
- It provides us clean burning energy at one-fifth the cost of oil (on a per BTU basis)
- It provides domestic jobs
- It provides states and counties with revenue from royalties and taxes.
- With proper policies in place, it has the potential to reduce our dependence on imported oil
- Unconventional oil and gas resources cannot be developed without the use of hydraulic fracturing.

Some Final Thoughts

- The safe deployment of fracturing is essential to the development of unconventional oil and gas resources.
- Domestic unconventional oil and gas have some clear economic, environmental and strategic advantages over other forms of energy.
- All human activity, and certainly all forms of energy production, have risks, so our decisions should always be based on the risks and associated rewards.
- Do the benefits of unconventional oil and gas development outweigh the environmental risks of horizontal drilling and fracing?
- In my view and based on my understanding of the subject, they clearly do.

Thank you for your attention.

Questions?