

Fracing: Basics and Concerns

Towards a Responsible Policy for the Development of Unconventional Oil and Gas Resources

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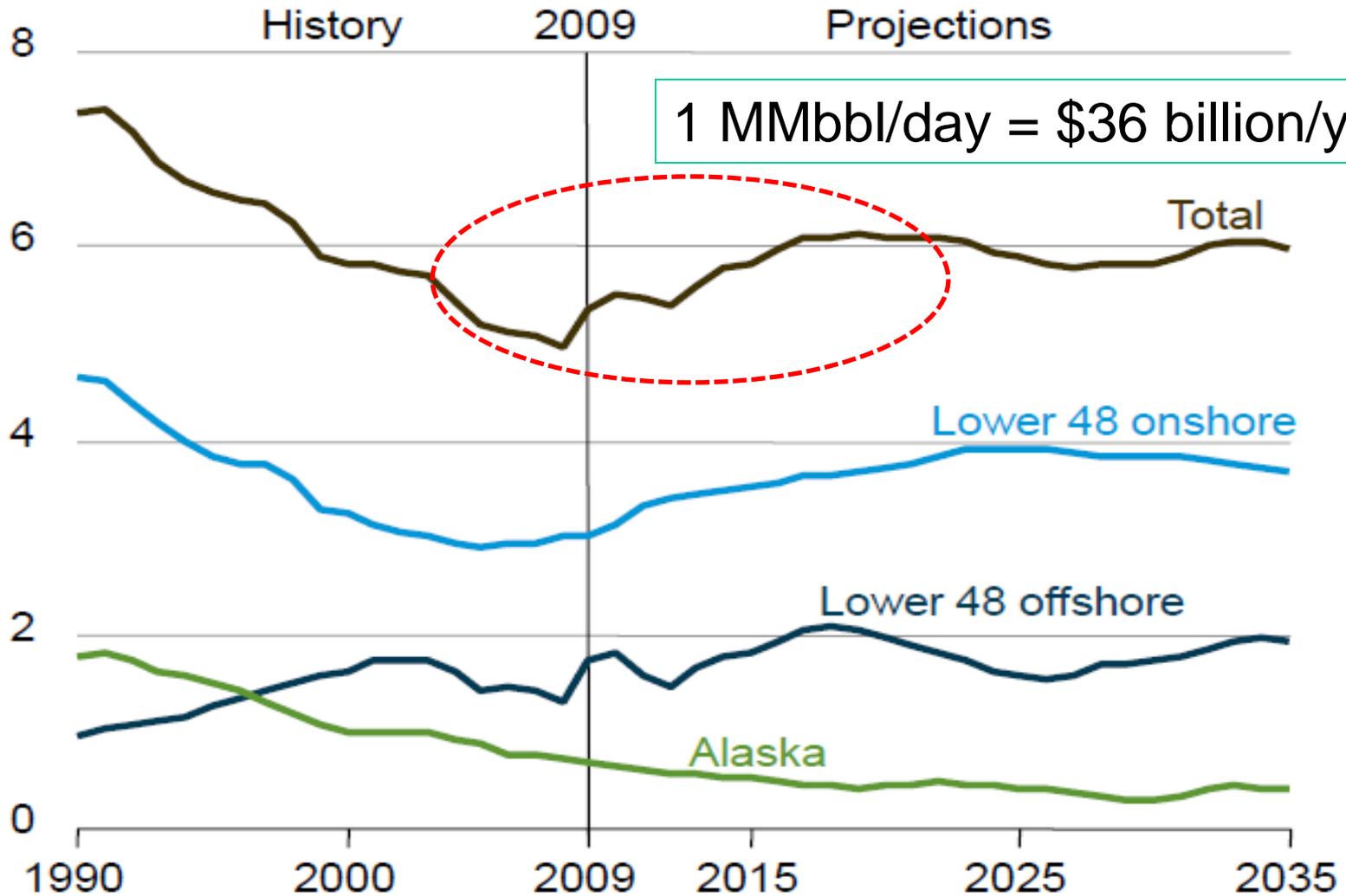
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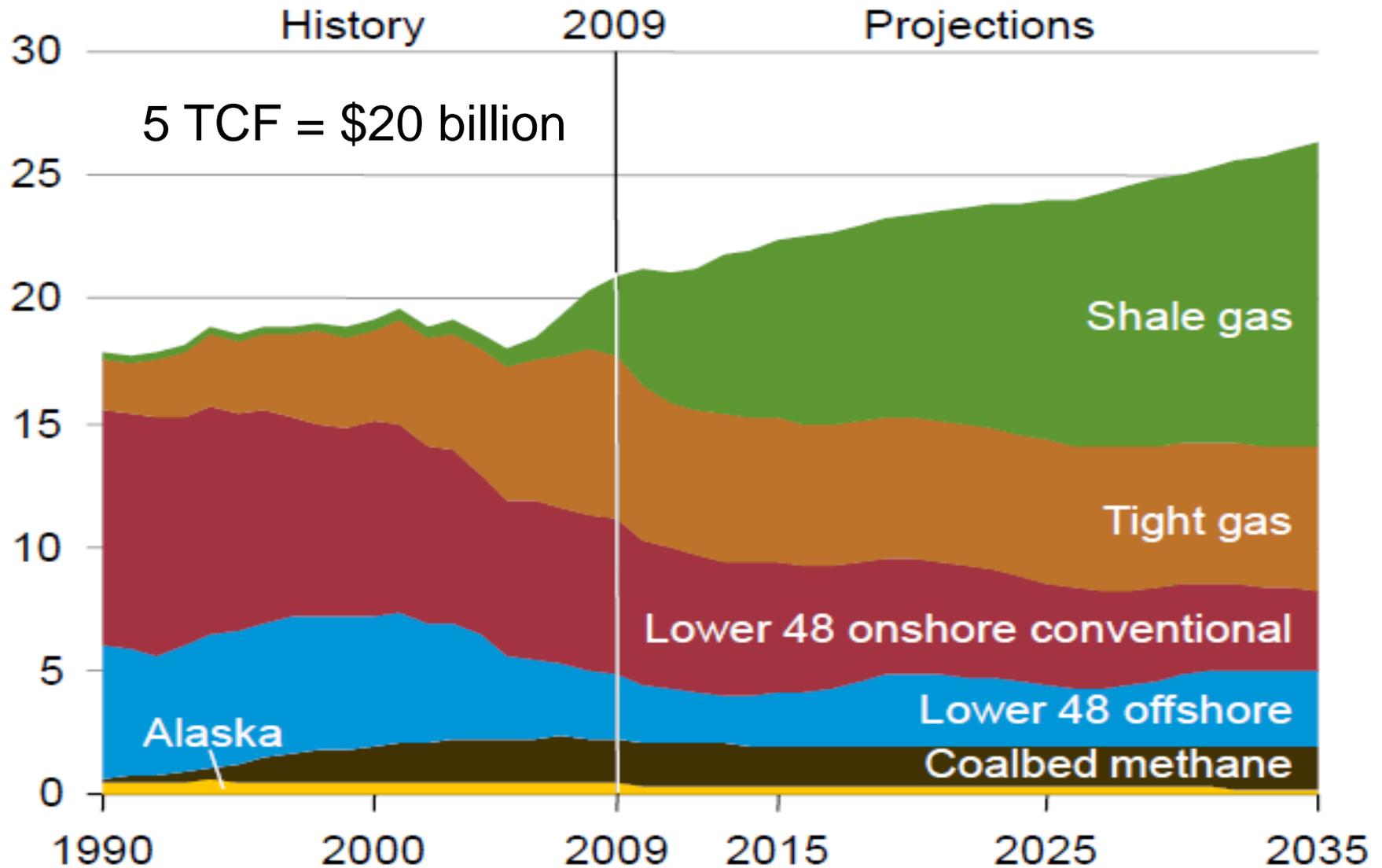
US Crude Oil Production

(million barrels per day)



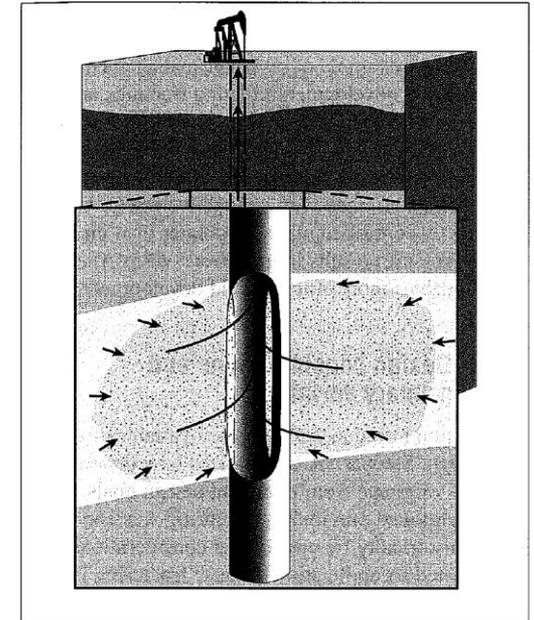
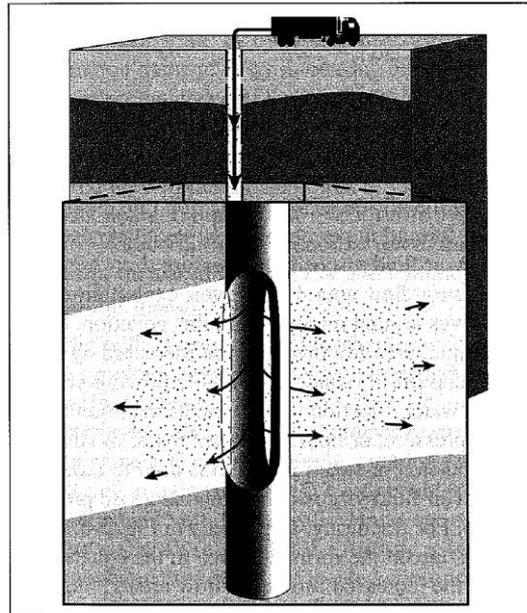
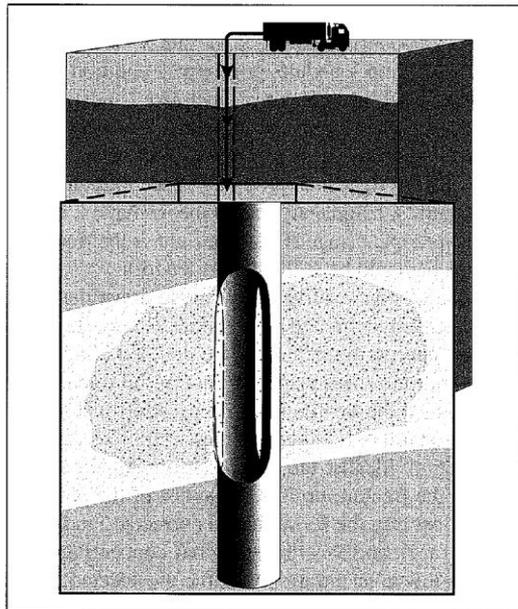
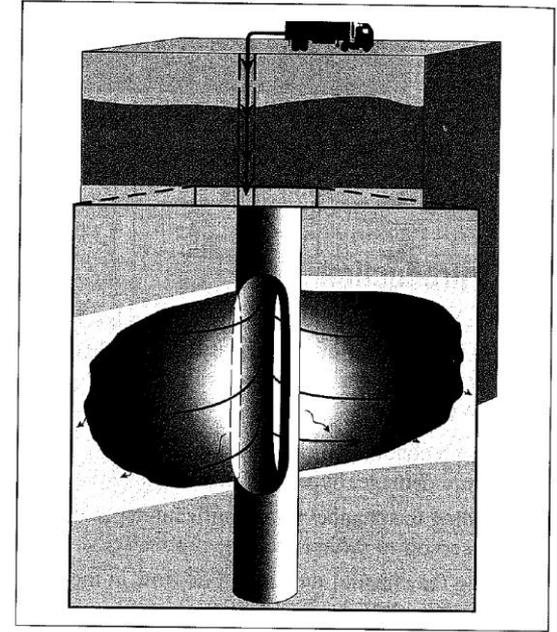
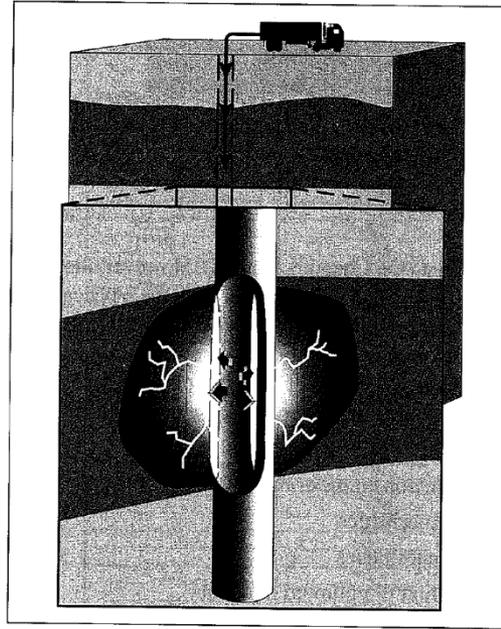
US Natural Gas Production

TCF per year

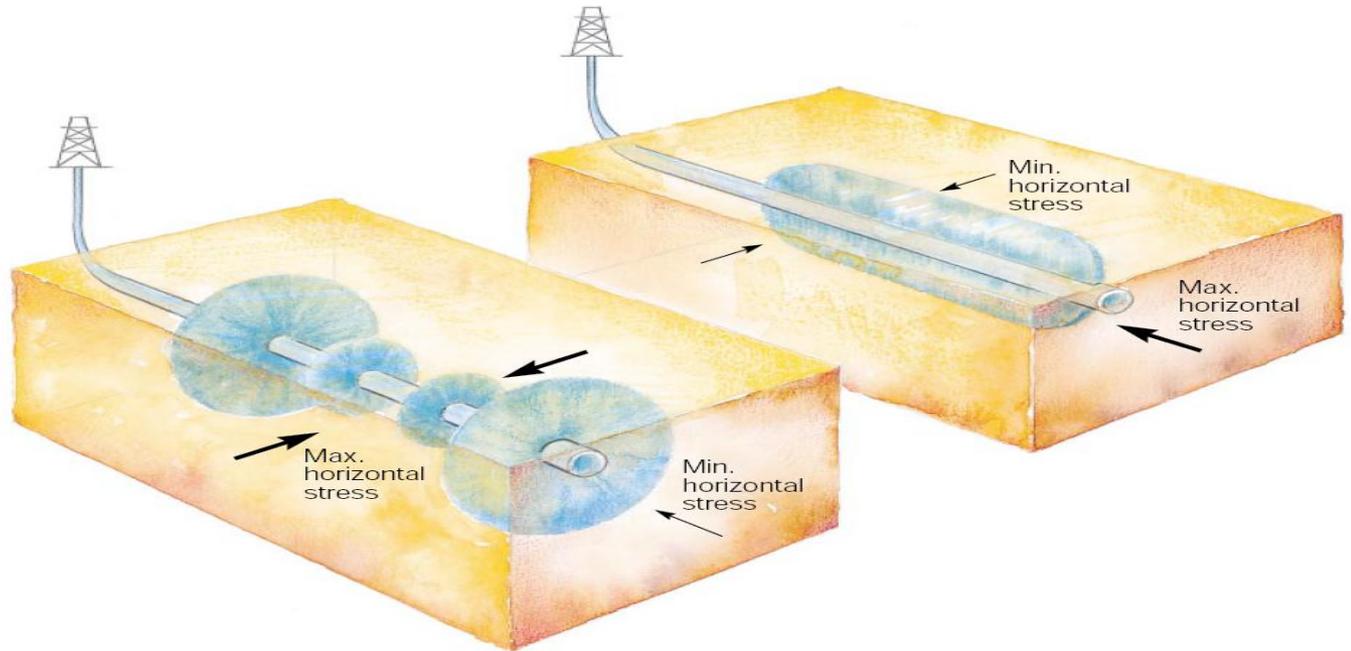


What is Fracturing?

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)



Fracing Horizontal Wells



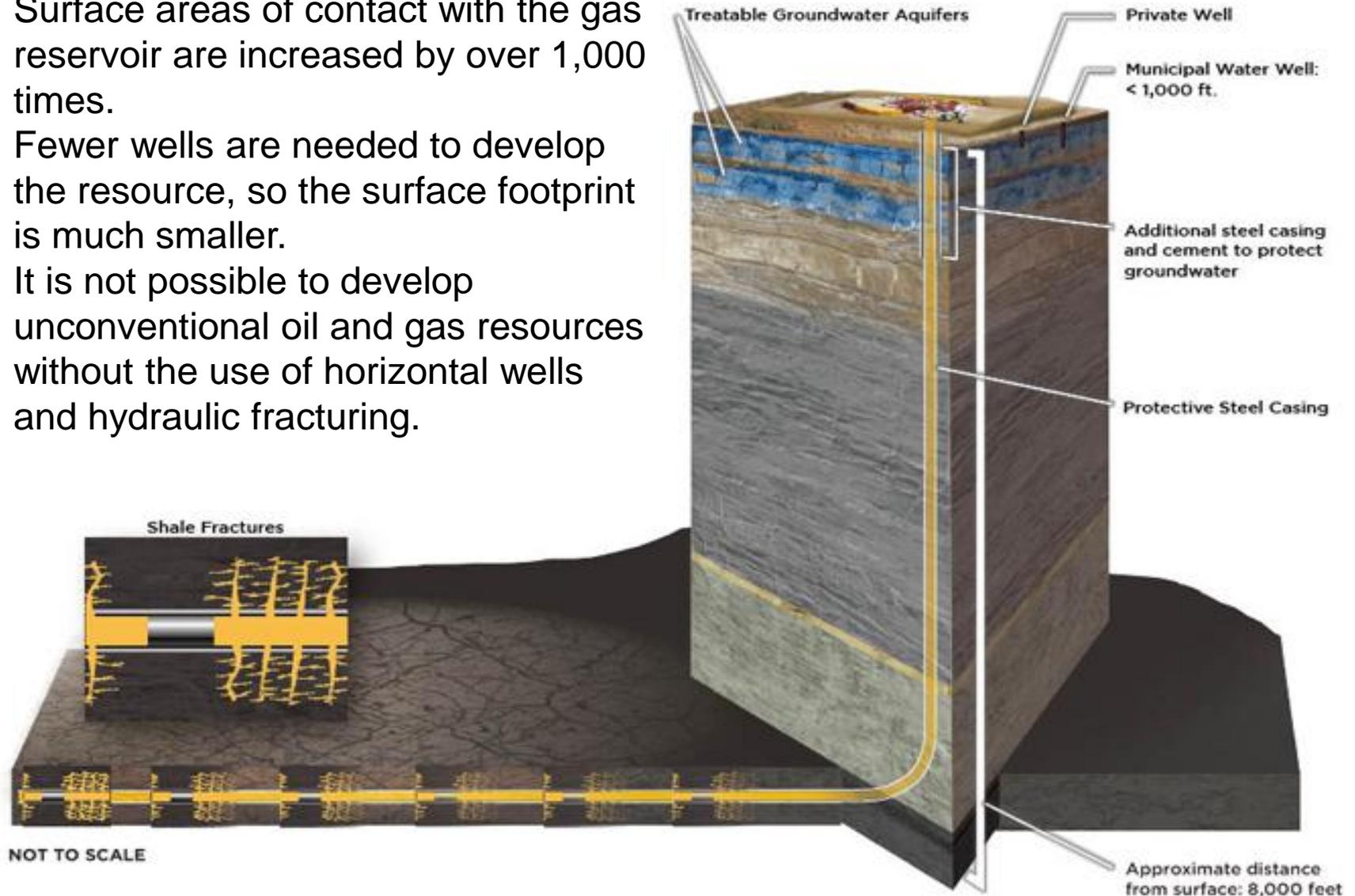
Time 1

Time 2

Time 3

Why do we Frac?

- Surface areas of contact with the gas reservoir are increased by over 1,000 times.
- Fewer wells are needed to develop the resource, so the surface footprint is much smaller.
- It is not possible to develop unconventional oil and gas resources without the use of horizontal wells and hydraulic fracturing.



Concerns About Hydraulic Fracturing

Some Background

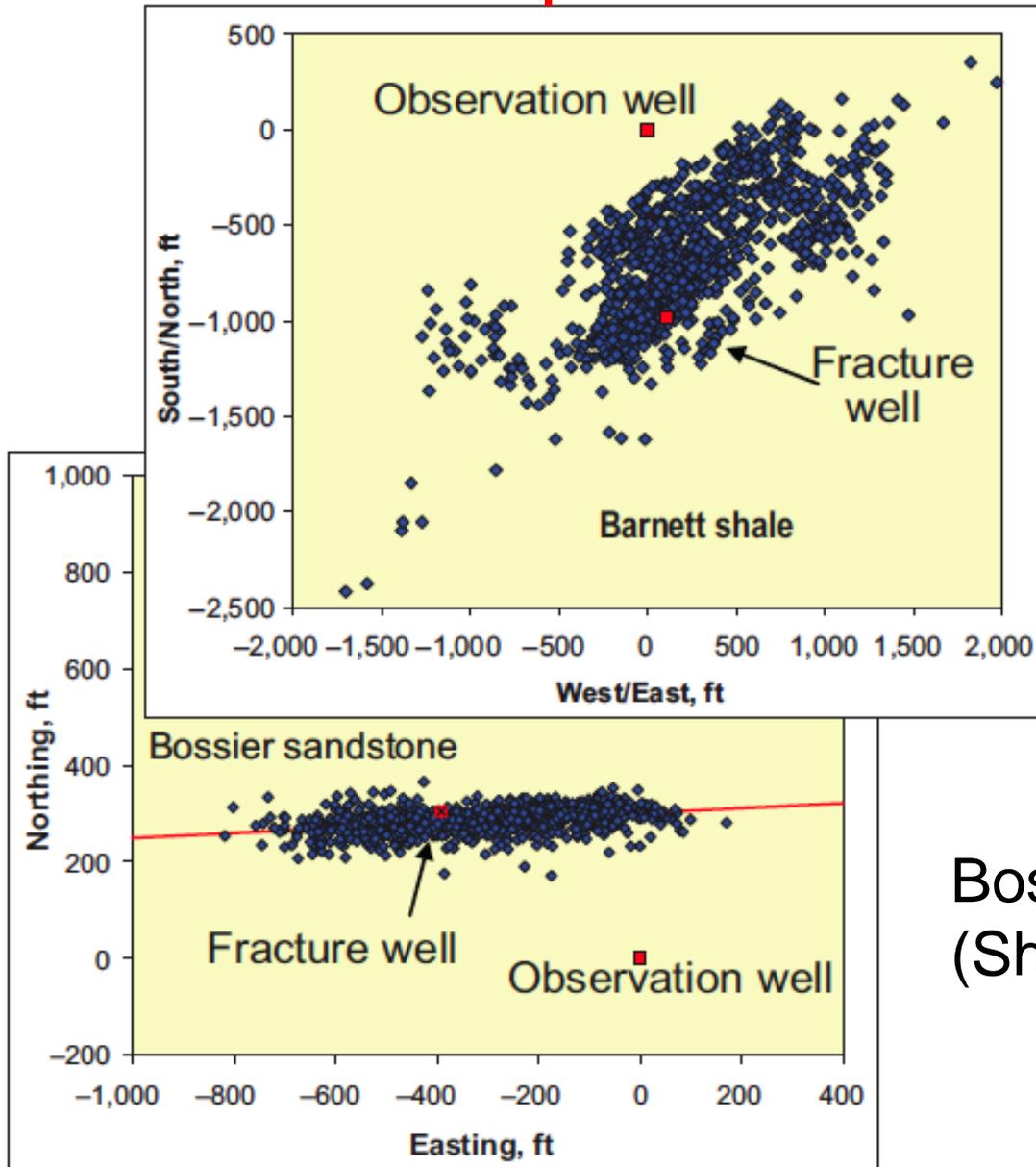
- ✓ We have been fracturing wells for over 50 years in the US.
- ✓ There have been over 1 million fracture treatments pumped in the US alone.
- ✓ There have been thousands of well documented studies and technical papers written on every aspect of fracturing over this period of time.
- ✓ Some opinions / concerns expressed in the media are clearly a result of a lack of awareness of this rich literature available to us all and some need further discussion.

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 at very shallow depths.

Example Microseismic Maps

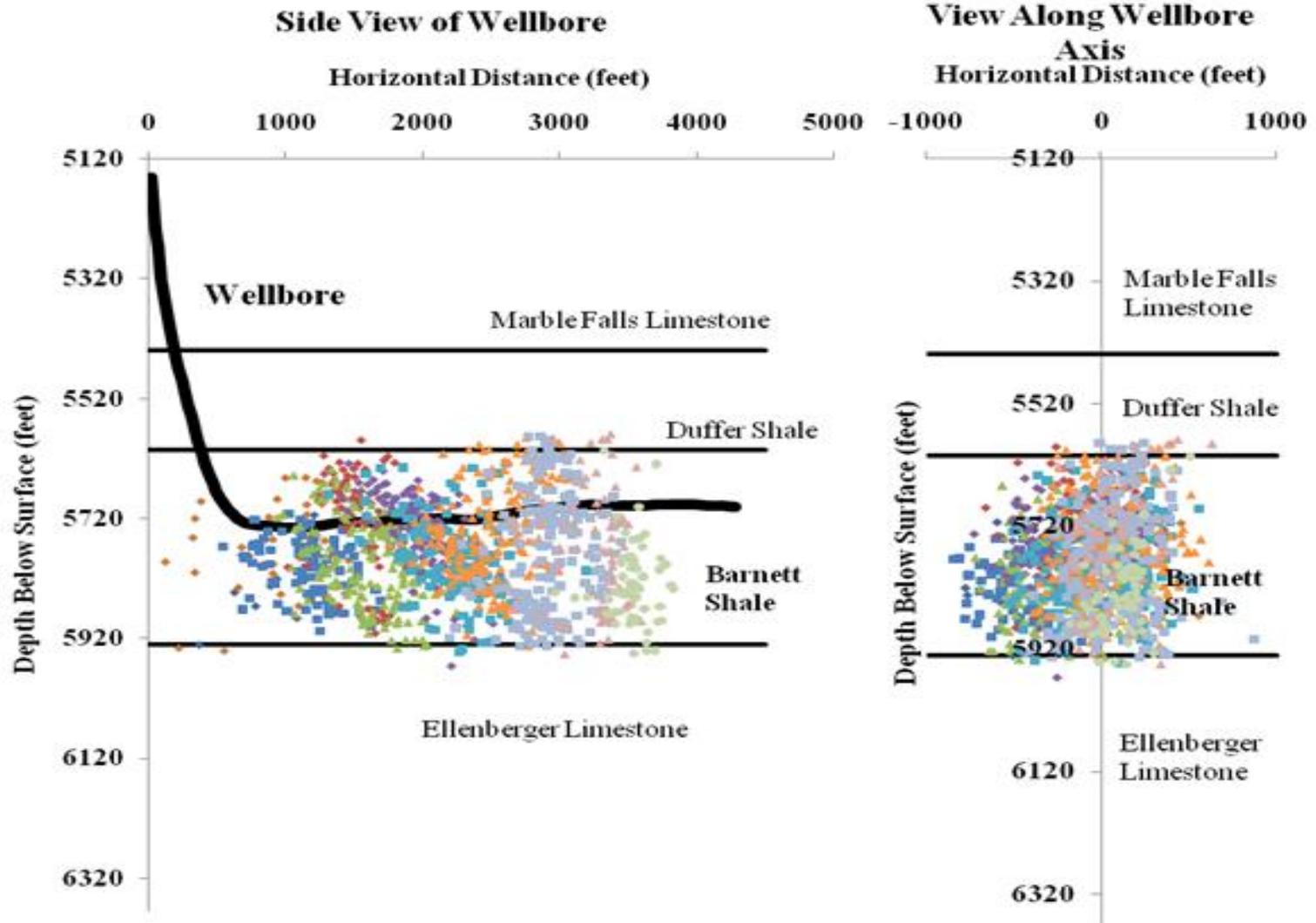


(Ref: Warpinski, 2009)

Barnett Shale, Devon
(Fisher et al. 2005)

Bossier TGS, Anadarko
(Sharma et al. 2004)

Micro-seismic events recorded during a hydraulic fracture treatment

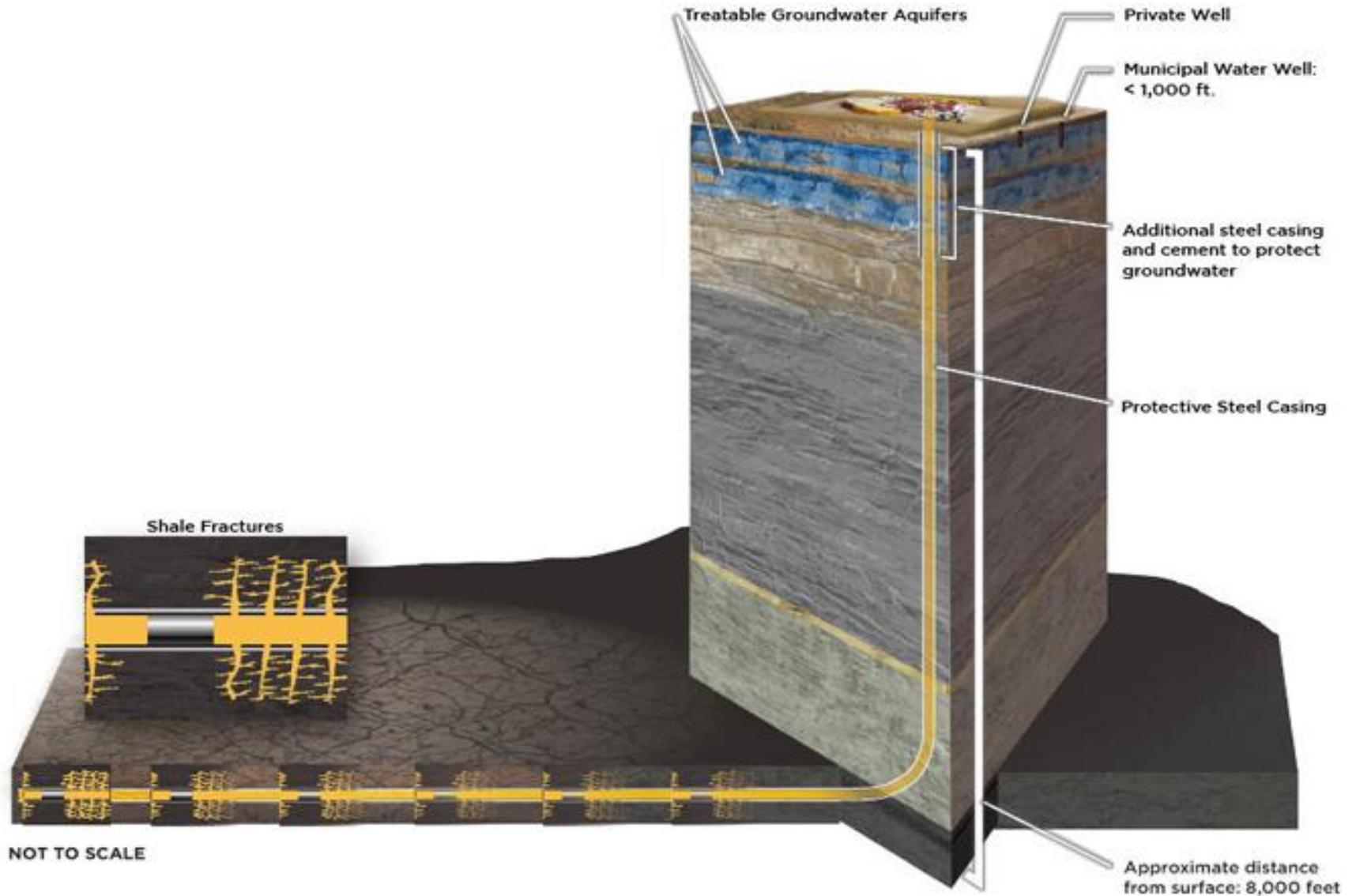


Concern # 2

Hydraulic fracturing contaminates groundwater

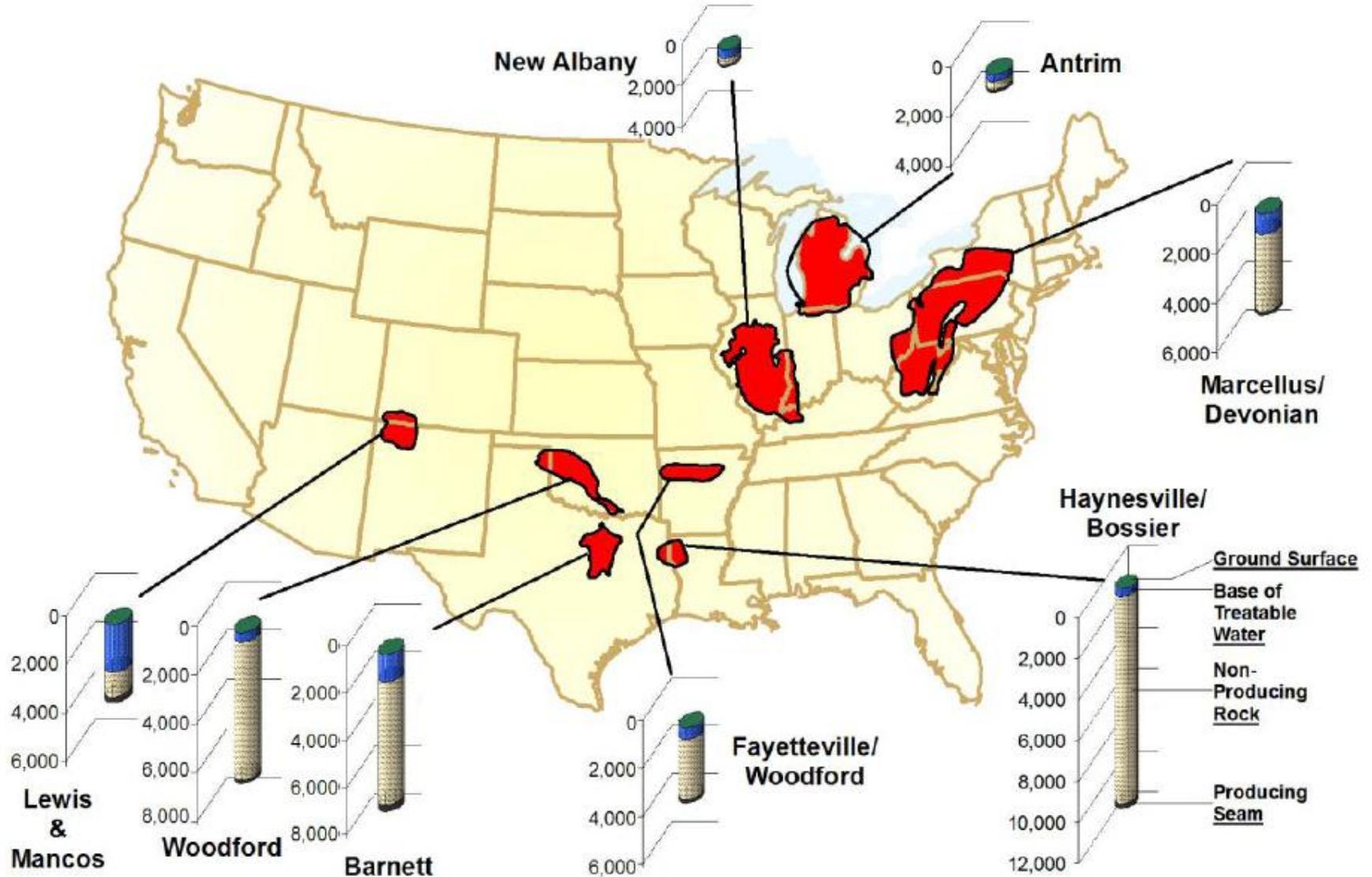
- ✓ There have been over 1 million wells fraced in the US. To my knowledge there have been no documented cases of groundwater contamination due to fracing.
- ✓ We have several things working for us:
 - Vertical migration of fractures through thick layers of rock with different stresses is extremely difficult.
 - 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.

Impact on Groundwater



Depths of Gas Zone and Groundwater

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



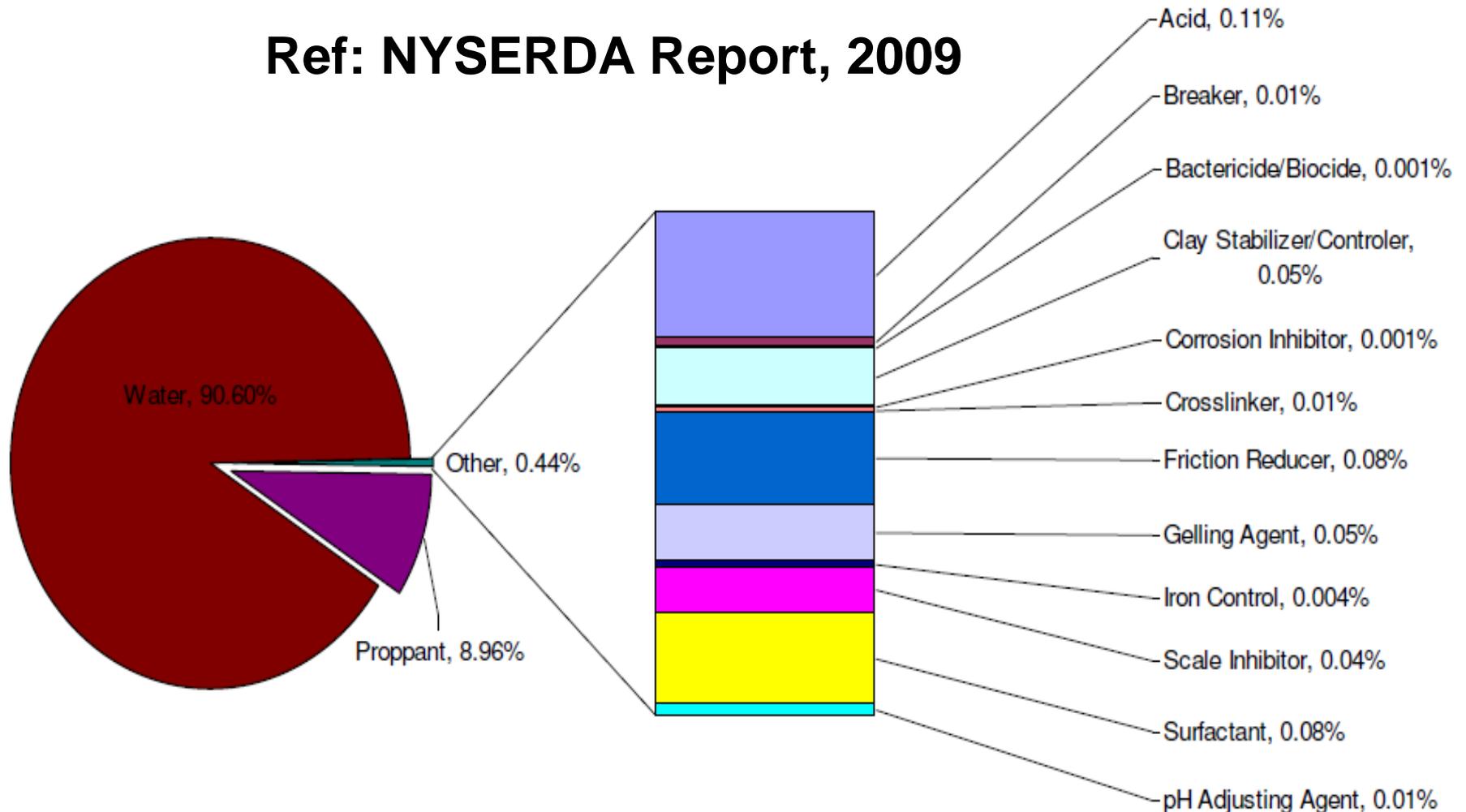
Concern # 3

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 shale gas fracs use 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 was recently passed in Texas).

Composition of Produced Frac Water

Ref: NYSERDA Report, 2009

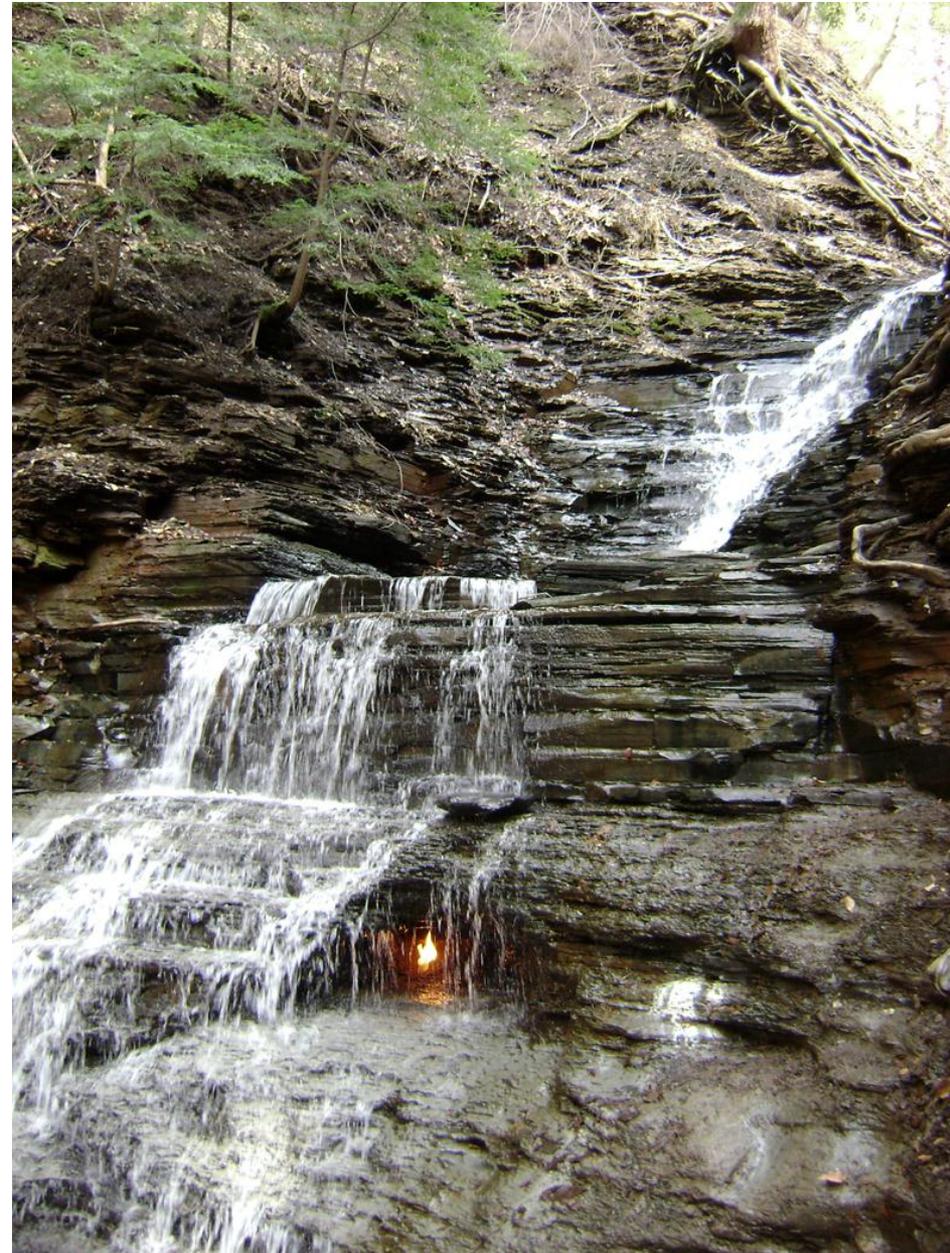


Concern # 4

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

- ✓ This notion was popularized by the dramatic footage in the movie Gasland.
- ✓ 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.
- ✓ There have been a large number of studies done on the source of surface gas seeps and we should continue to study the issue.

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.

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

Concern # 7

Hydraulic fracturing is a big drain on our groundwater resources

- ✓ 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.
- ✓ Water is a very precious commodity and it should be used with extreme care
 - Example: The drought conditions that now exist in Texas.
- ✓ 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.

Water Needs in Shale Gas Fracturing

Shale Gas Play	Volume of Drilling Water per well (gal)	Volume of Fracturing Water per well (gal)	Total Volumes of Water per well (gal)
Barnett Shale	400,000	2,300,000	2,700,000
Fayetteville Shale	60,000*	2,900,000	3,060,000
Haynesville Shale	1,000,000	2,700,000	3,700,000
Marcellus Shale	80,000*	3,800,000	3,880,000

* Drilling performed with an air “mist” and/or water-based or oil-based muds for deep horizontal well completions.

Note: These volumes are approximate and may vary substantially between wells.

Source: ALL Consulting from discussions with various operators, 2008

Barnett Area Municipal Use = 1 million acre.ft = 326 billion gallons of water.

Concern # 8

“Sand mining emerges as another fracking threat”

(Reuters) – “Fracking, the latest craze in the quest to produce oil and gas, has been blamed for environmental problems ranging from flammable tap water to minor earthquakes. Now a new risk is emerging: sand mining.”

"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 CO₂ emissions by up to 40%
- ✓ It provides us clean burning energy at one third 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

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

Thank You
Questions?