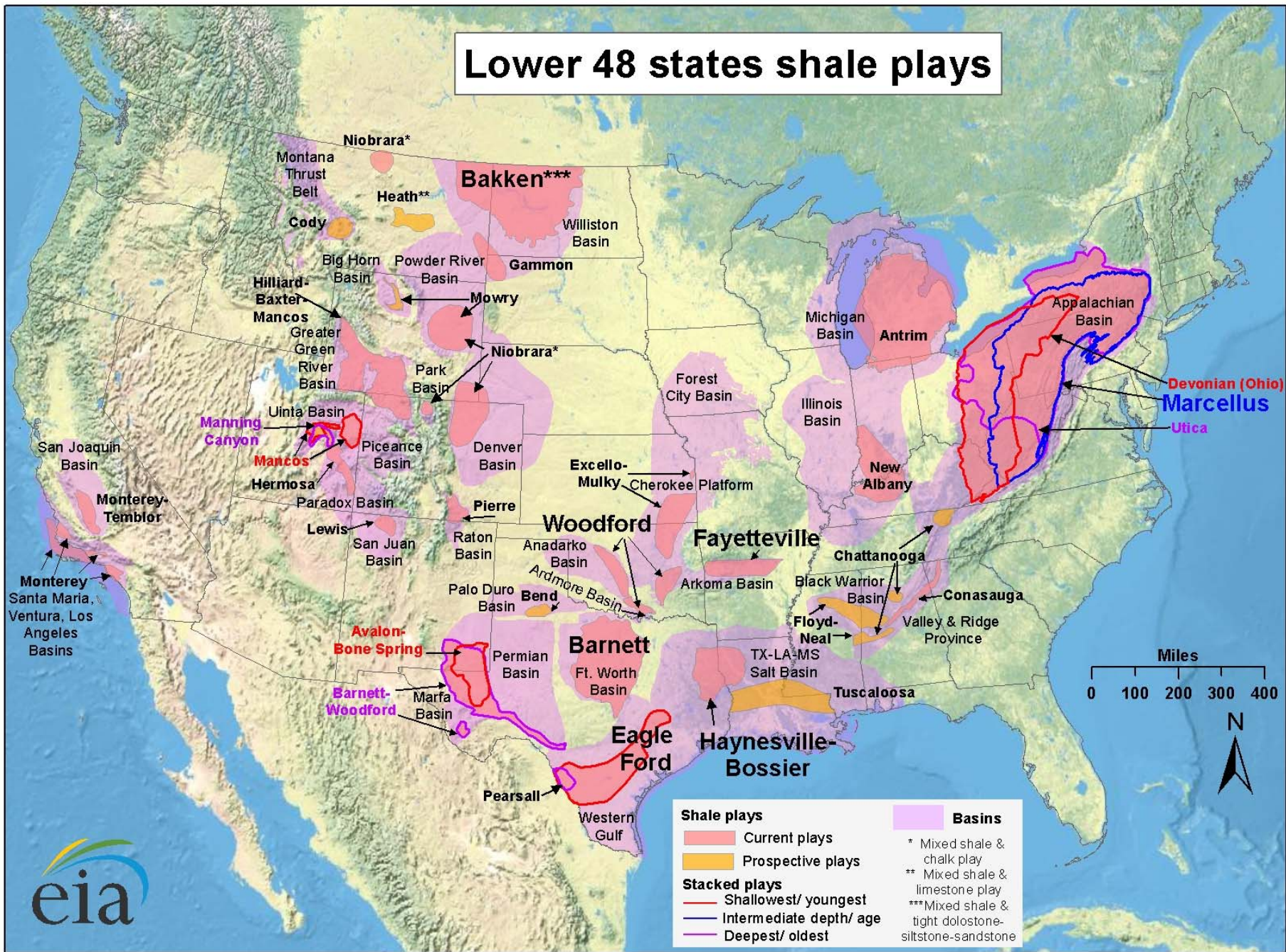


# The Petroleum Industry: Overview of Current Events

*Issues and Updates-Drilling and  
Fracking, Energy use, and Minnesota  
Impacts*

# Lower 48 states shale plays



Source: Energy Information Administration based on data from various published studies.  
 Updated: May 9, 2011



# Changes with Bakken Shale Oil

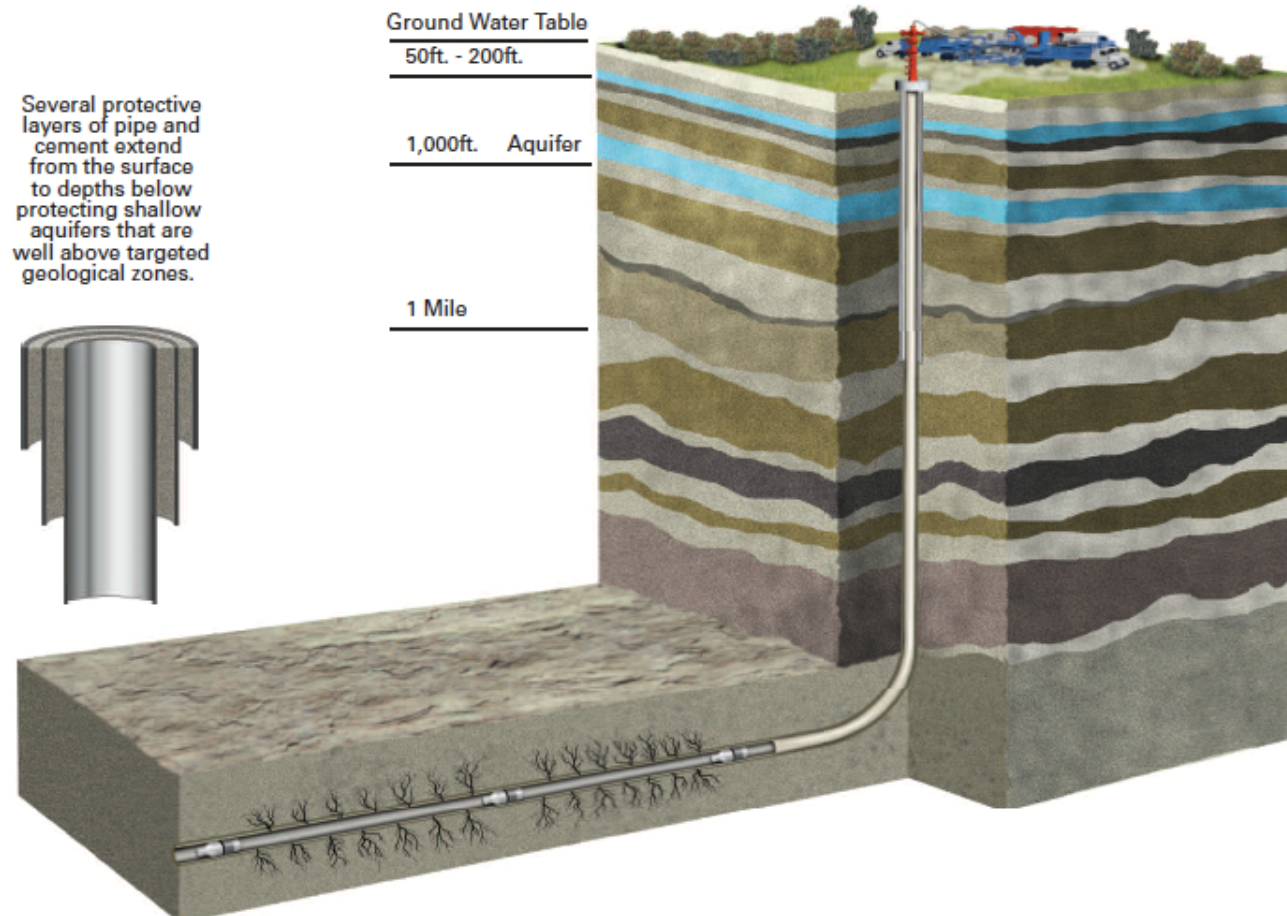
## 2013

- Bakken; 900,000 B/D
- Production growth; 10%/yr
- 8,000 wells drilled; 40-60,000 planned
- ND Drill Rigs; 195
- Days to complete; 18-22
- Unfracked wells; 100
- Gas flared, 30%
- ND Breakeven cost; \$60/Bbl
- Average price of gasoline; \$3.49

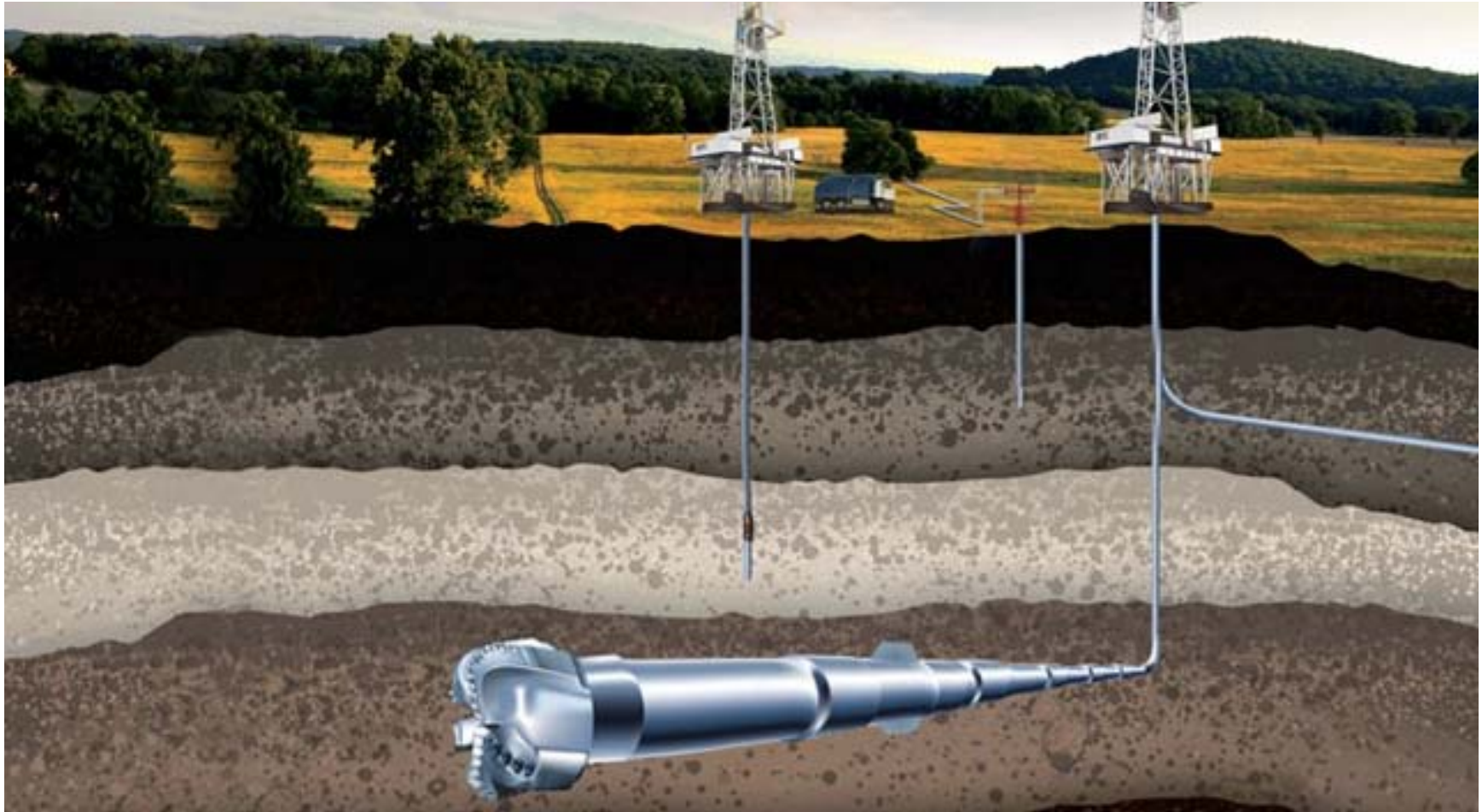
## 2015

- Bakken; 1,240,000 B/D
- Production growth; 1.5%/yr
- 10,000 wells drilled; 60-100,000 planned
- ND Drill Rigs; 65
- Days to complete; 15-18
- Unfracked wells; 850
- Gas flared, 20%
- ND Breakeven cost; \$28/Bbl
- Average price of gasoline; \$2.35

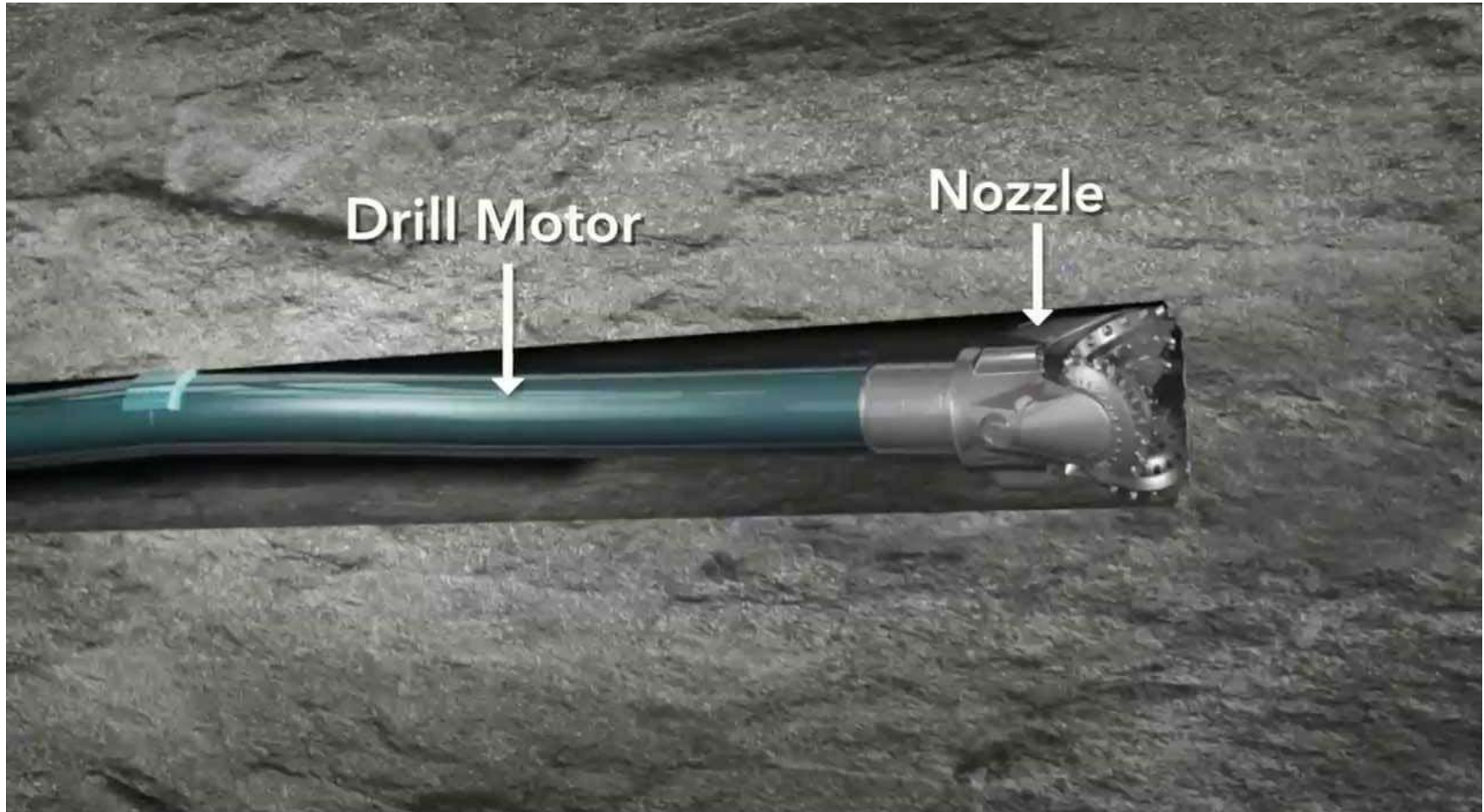
# Shale Oil Well Components



# Directional Drilling: Developing Geotech

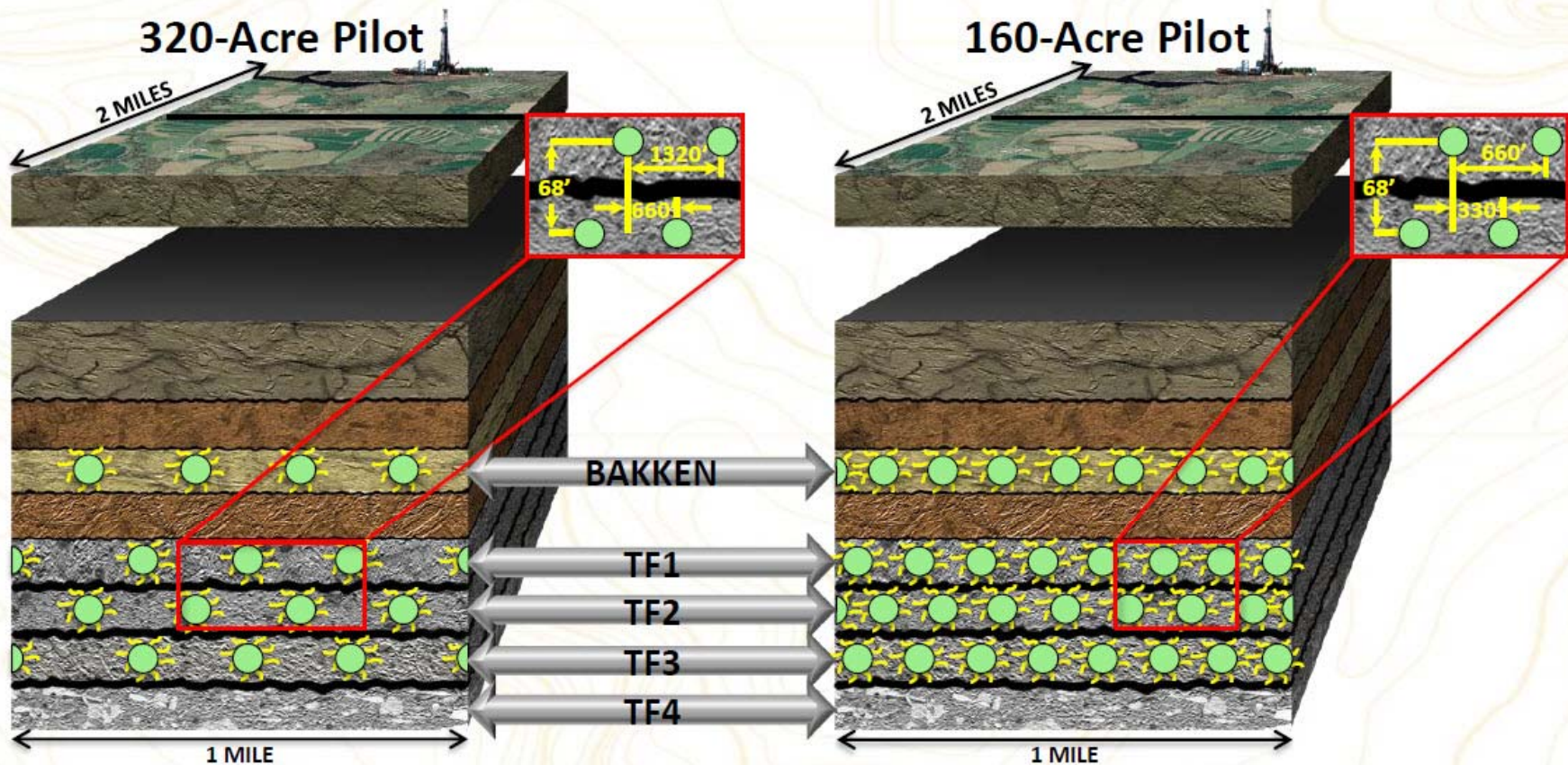


# Steerable Bottom Hole Assembly





# 160 & 320-Acre Pilot Density Projects: 2013-14



- 💧 3 project areas, \$123MM net cost
- 💧 1,320 ft. same-zone spacing
- 💧 34 gross (23 net) wells
- 💧 Microseismic monitoring

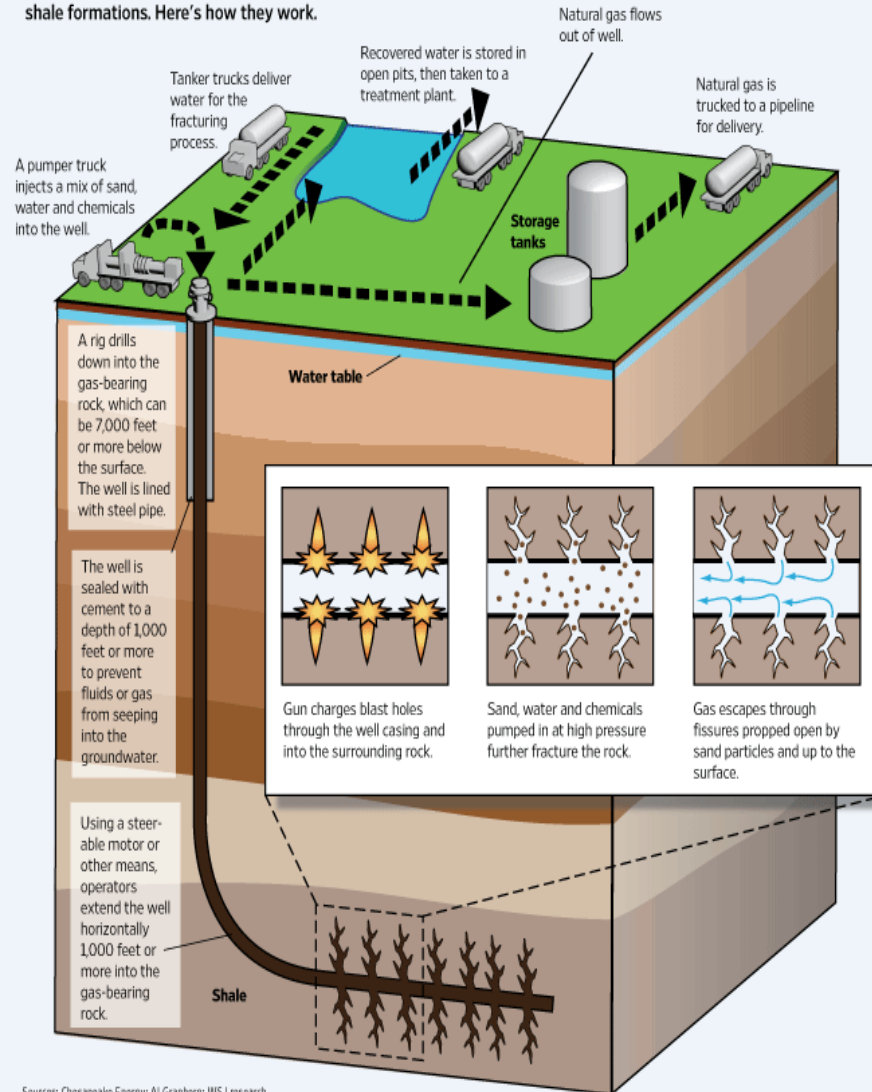
- 💧 1 project area, \$36MM net cost
- 💧 660 ft. same-zone spacing
- 💧 13 gross (6 net) wells



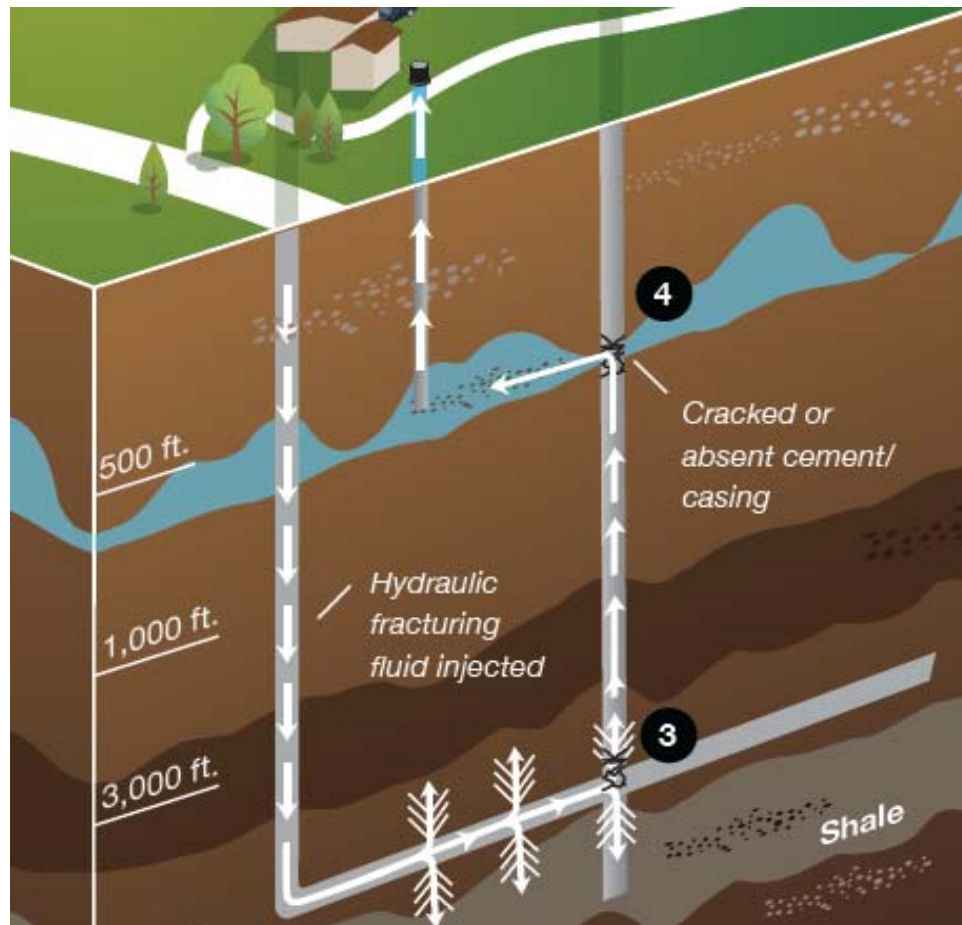
# After Drilling, Step 2: Fracturing

## Tapping the Gas

Horizontal drilling and hydraulic fracturing have made it feasible to extract huge amounts of natural gas trapped in shale formations. Here's how they work.



# Environmental Impacts: High Pressure blowouts, aquifer and ground water contamination, well waste treatment

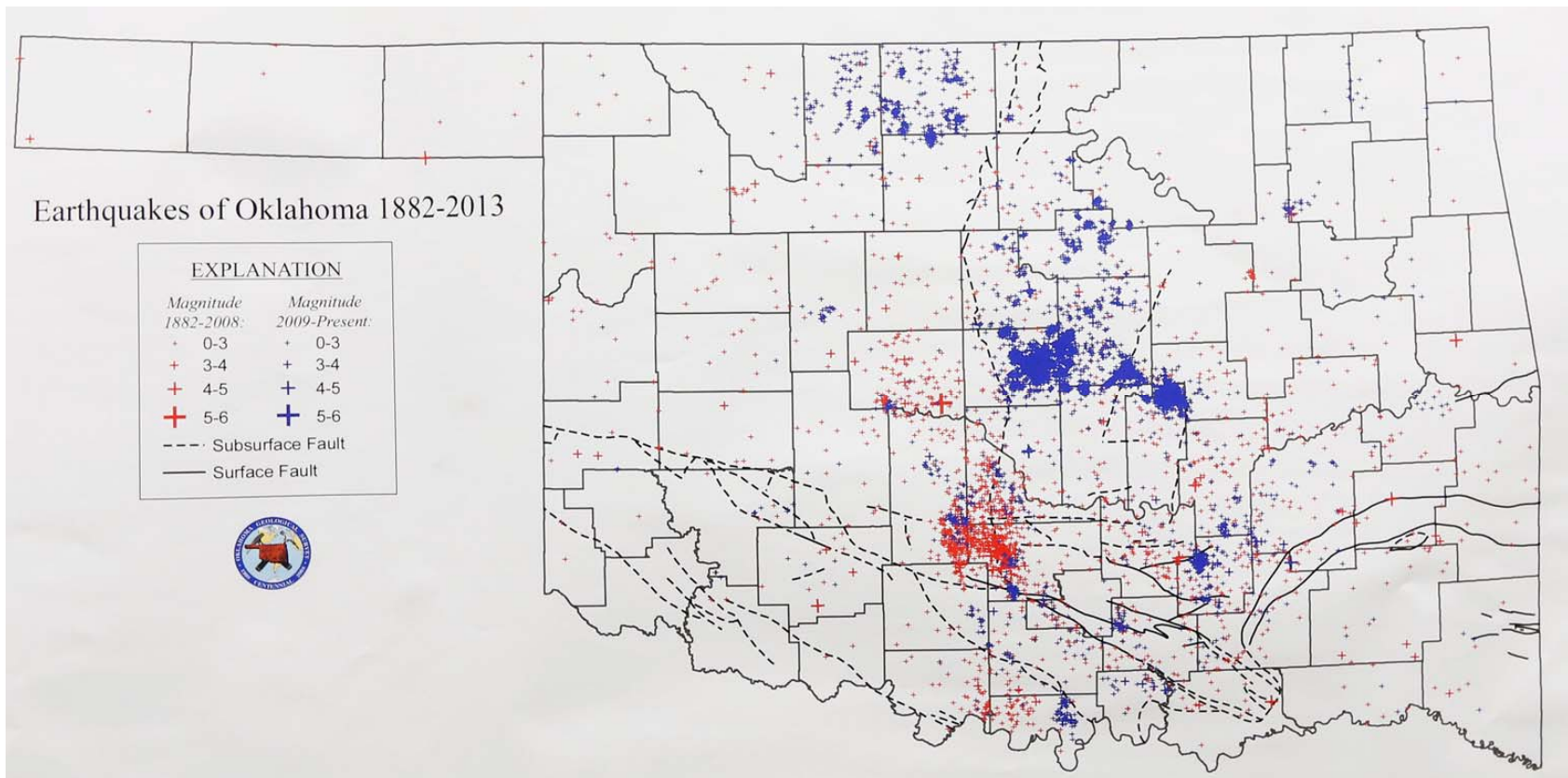


# Differences in fracked vs. conventional wells

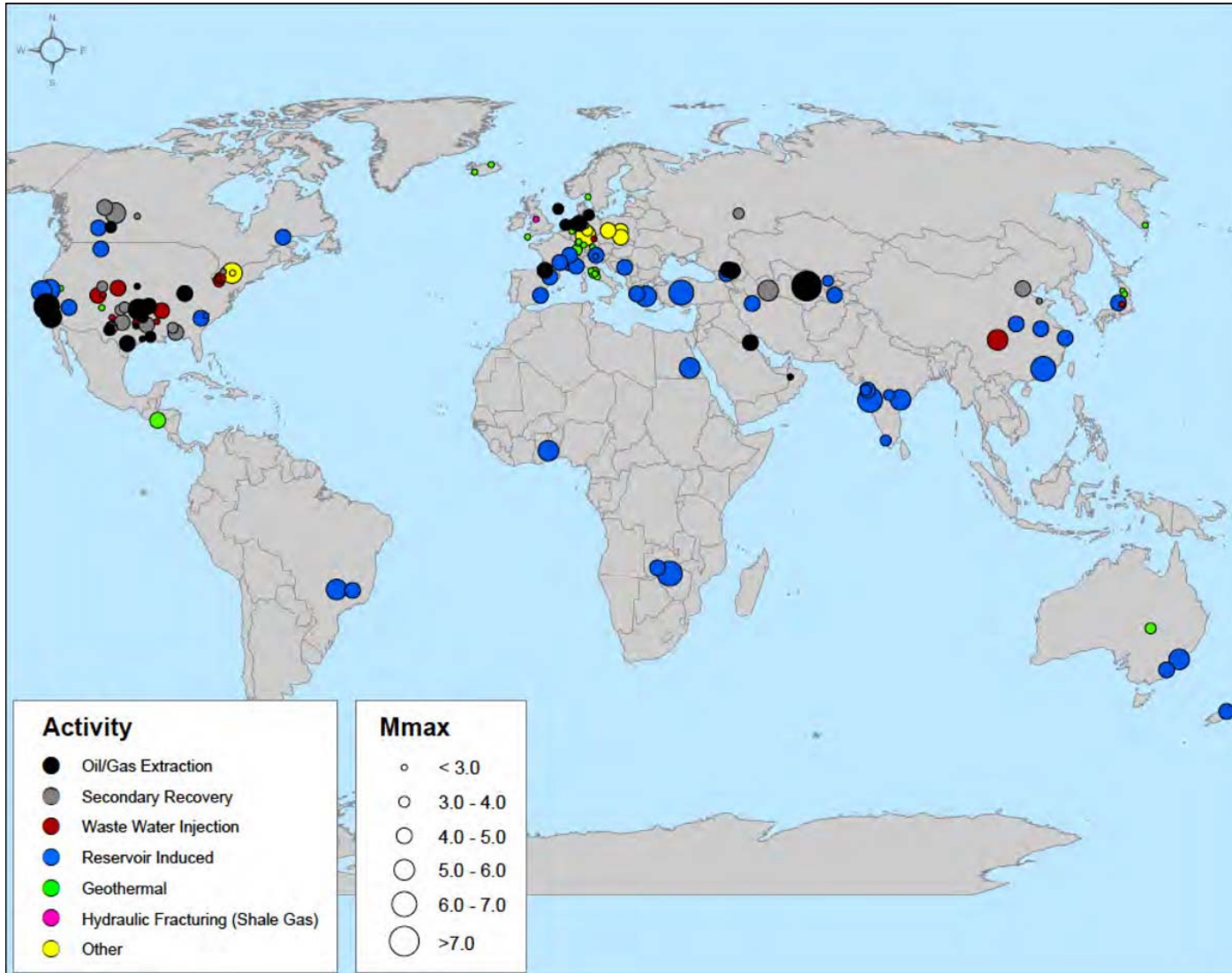
- Use of extreme high pressures in hydraulic fracturing; potential for leakage
- High water use; depletion of local aquifers and need for high volume waste water processing
- Need for large volumes of supplies, especially proppants (sand or synthetic)
- Low-footprint but high-intensity well site activity

# Fracking-Related Quakes

- Oklahoma, Texas, Ohio due to fracking, injection
- Most <2.5 Richter; some 'felt' quakes, up to 3.0



# Man-Made Earthquakes





# StarTribune

## U.S. could soon overtake Saudi Arabia as world's top oil producer

Article by: JONATHAN FAHEY  
Associated Press  
October 23, 2012 - 4:32 PM

NEW YORK - U.S. oil output is surging so fast that the United States could soon overtake Saudi Arabia as the world's biggest producer.

Driven by high prices and new drilling methods, U.S. production of crude and other liquid hydrocarbons is on track to rise 7 percent this year to an average of 10.9 million barrels per day. This will be the fourth straight year of crude increases and the biggest single-year gain since 1951.

The boom has surprised even the experts.

"Five years ago, if I or anyone had predicted today's production growth, people would have thought we were crazy," said Burkhard, head of oil markets research at IHS CERA, an energy consulting firm.

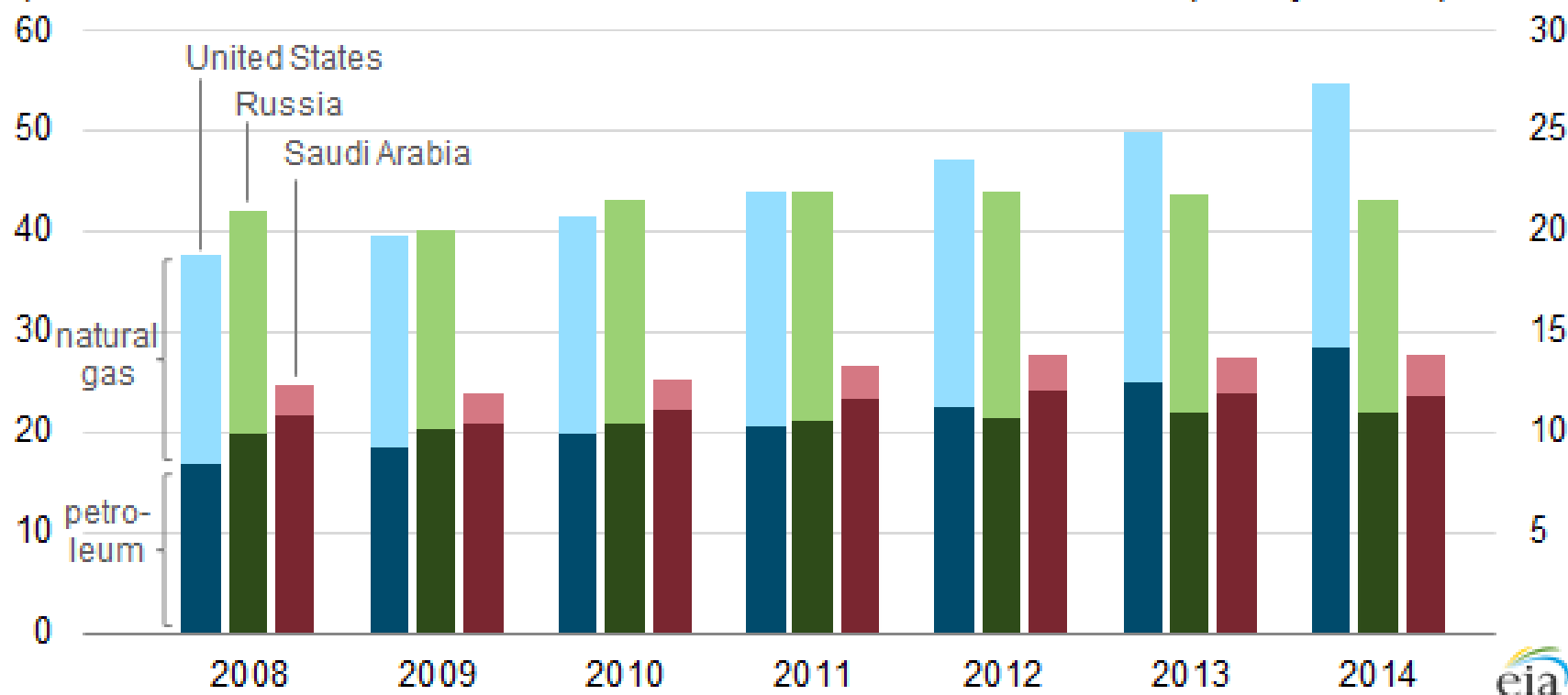
The Energy Department forecasts that U.S. production of crude and other liquid hydrocarbons, which includes biofuels, average 11.4 million barrels per day next year. That would be a record for the U.S. and just below Saudi Arabia's output of 11.6 million barrels. Citibank forecasts U.S. production could reach 13 million to 15 million barrels per day by 2020, helping make North America "the new Middle East."



Ben Shaw hangs from an oil derrick outside of Williston  
Gregory Bull, Associated Press

# Shale Oil & Gas Makes US #1 Producer

Estimated U.S., Russia, and Saudi Arabia petroleum and natural gas production  
quadrillion British thermal units      million barrels per day of oil equivalent

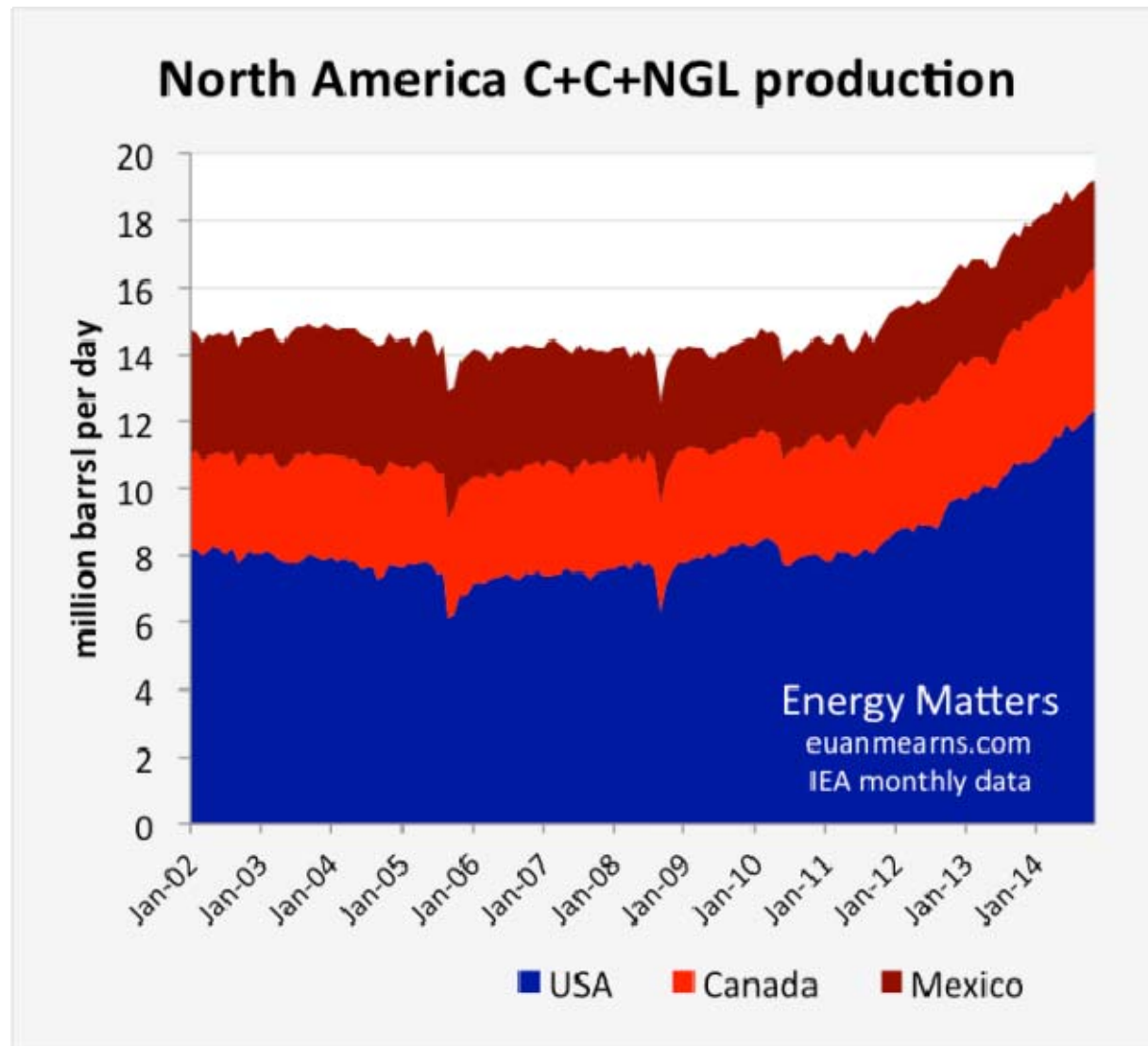




# Oil Consumption

- World oil consumption = 79.6 Million B/D
- U.S. oil consumption = 19 Million B/D (21%)
- 70% of U.S. petroleum consumption is for transportation
- Liquid petroleum accounts for 32% of all U.S. energy use
- North American sources now sufficient for U.S. needs

# Liquid Petroleum Production, North America



# Minnesota Refineries

- Flint Hills Refining (Koch) = 320,000 B/D
- Northern Tier Refining (Marathon) = 80,000 B/D
- 2 of only 4 in Upper Midwest
- Minnesota Pipeline supplies both from Clearbrook (Enbridge); 85% Canadian heavy, 15% Bakken light (Bakken use growing)
- Minnesota Consumption, 315,000 B/D (72% for transportation use)



# Safety and the Environment

- Hazardous materials; Flammable
- Spills toxic to environment, hard to contain
- Different problems for different modes
- Rail has more incidents, occupational injuries
- Pipeline has fewer but larger spills
- Pipelines carry most oil, but rail volumes have become significant and growing
- Rail exposure in urban areas, grade crossings create more conflict points

# Minnesota; Crossroads of North American Oil



# Shale Gas-Driven Technology Changes

- Cheap, plentiful gas drives onshoring of petrochemical production, plastics
- “Gas-to-Liquid” (GTL) plants to convert natural gas to liquid fuels – diesel and jet fuel
- High-speed ships & ferries – gas turbine power; rail electrification
- Decline in thermal coal production & end of “clean” coal power generation new-builds
- High-efficiency, low-cost solar and wind energy development intensifying

# Other Factors in Play

- Distance to market: Marcellus (biggest field) on East Coast, new finds in California, Midwest
- High quality: light, sweet Bakken; “Rich, wet” Marcellus & Utica gas - high BTU & natural gas liquids – chemical feedstocks (isobutane, ethylene)
- Environmental benefit: gas has ½ of coal carbon emissions, slow greenhouse gases in short term
- Lower cost for US industry: fuel & chemicals
- Extensive reserves: “energy independence by 2017”; major improvement in trade balances

# The Big Picture

- Fossil Fuels use driving global warming; petroleum second largest source of CO<sub>2</sub> emissions after coal
- 'Peak Oil' tipping point may extend to 2050-3000 period; reserves of deep ocean, shale oil & gas, tar sand deposits are significant
- Economic savings from current oil glut a positive for U.S., third world
- Long term environmental costs, technology options not yet quantified



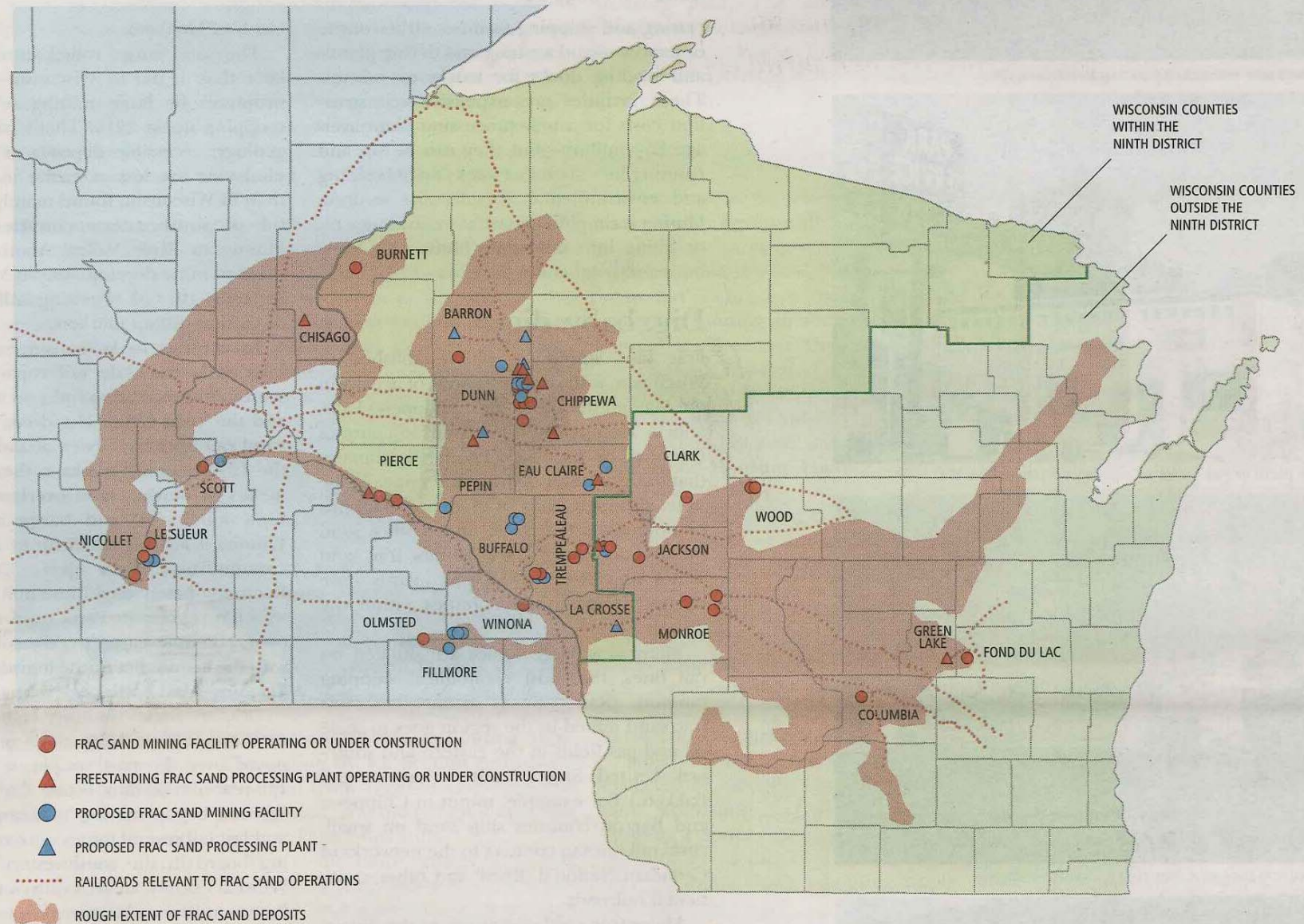
# Frac Sand – Ongoing Issue

*Frac sand and industrial sand mining in Wisconsin and Minnesota is in a lull, but has the potential for a rapid rebound*

- Frac sand use per well dropping from 40,000 tons per well to as low as 5,000 due to efficiency and technology changes, options for re-use of recovered sand
- Use of synthetics (resin-coated and ceramic proppants) declining in favor of natural sand

# The district's sandbox

*Existing and proposed frac sand mine operations*



Sources:

Mine locations: State and county permitting records; industry contacts / Sand deposits: U.S. Geological Survey / Rail data: Minnesota and Wisconsin departments of transportation





# Projected Frac Sand Demand

- 2014 Wisconsin & Minnesota production at 28-30 Million tons/year (90% Wisconsin)
- Estimated 2015 demand, 15-20 MMT/Yr
- Estimated production if all prospective WI mines brought on line, 60-70 MMT/Yr
- Life of current Shale Oil & Gas exploration trend, 25-55 Years (?- new discoveries indicate more)
- Volume of sand resources – 100+ Years or more

# Frac Sand Mining Issues

- High water use; aquifer depletion
- Contamination of surface, underground water (settling pond leakage documented)
- Suspected air contamination – 4 micron particulate dust
- traffic conflicts
- Visual pollution
- Land reclamation

*Questions?*

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