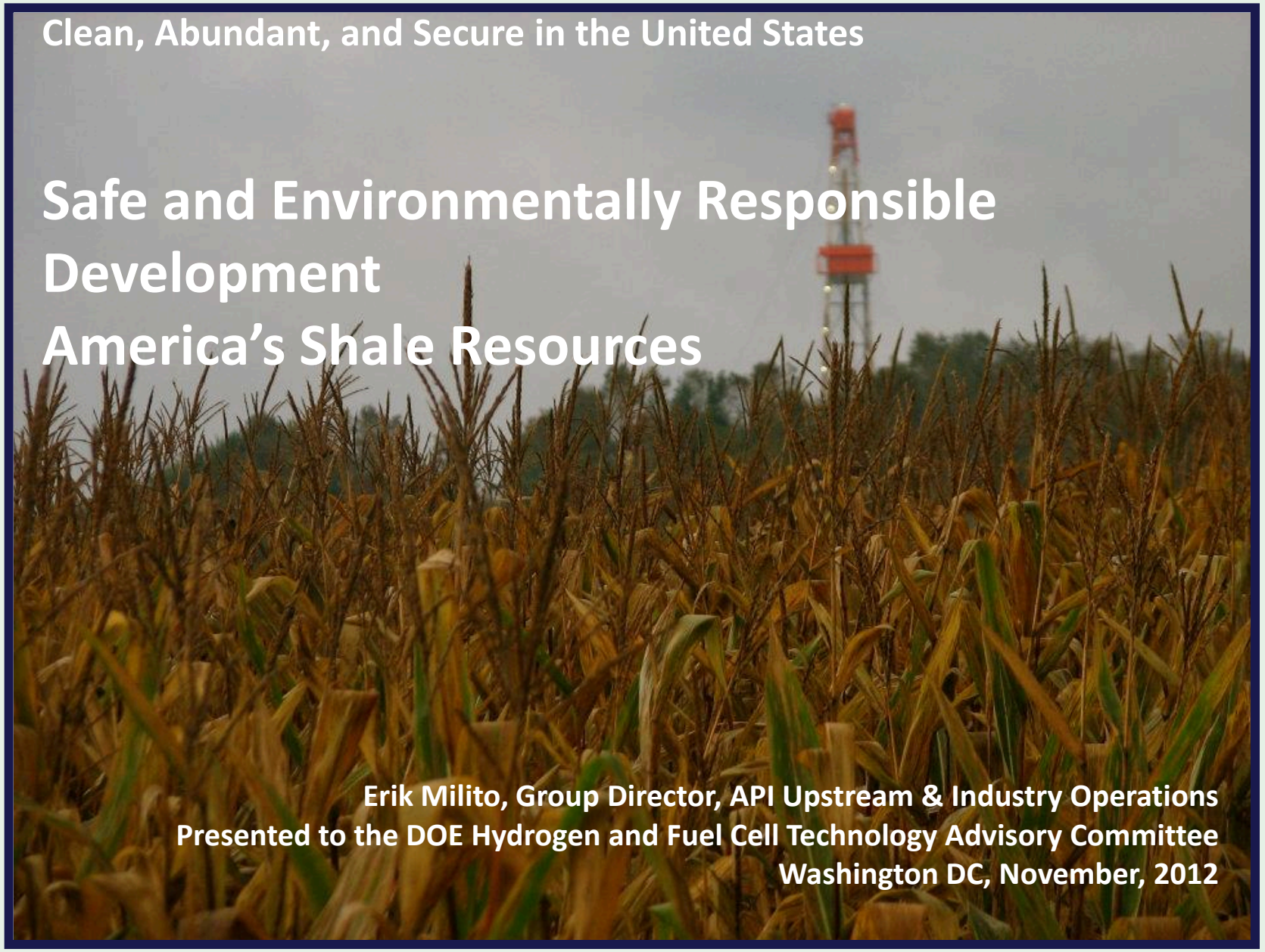


Clean, Abundant, and Secure in the United States

Safe and Environmentally Responsible Development America's Shale Resources

Erik Milito, Group Director, API Upstream & Industry Operations

Presented to the DOE Hydrogen and Fuel Cell Technology Advisory Committee

Washington DC, November, 2012

2002 to 2012
A Decade Makes a Difference

Then

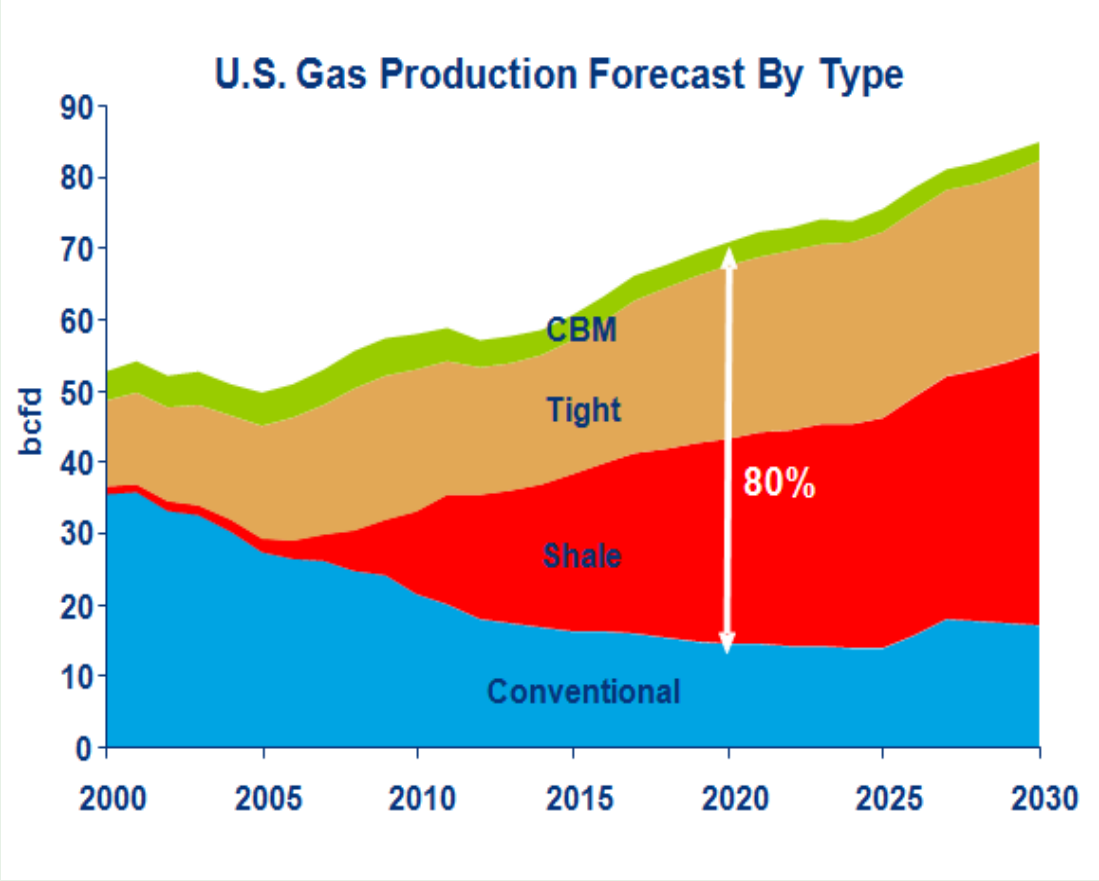
- 60-year supply and falling
- Shale known but uneconomic to develop
- Underground gas storage primarily traditional reservoir, operationally not very flexible
- Pipeline capacity growing incrementally
- Rising prices with several spikes

Now

- 100+ years supply and growing
- Flourishing production, vast shale resources now accessible
- Storage boom with more flexible salt-cavern facilities and additional market area storage
- 16,000+ miles of interstate pipeline added since 2000
- Plentiful supplies moderate prices and provide supply diversity

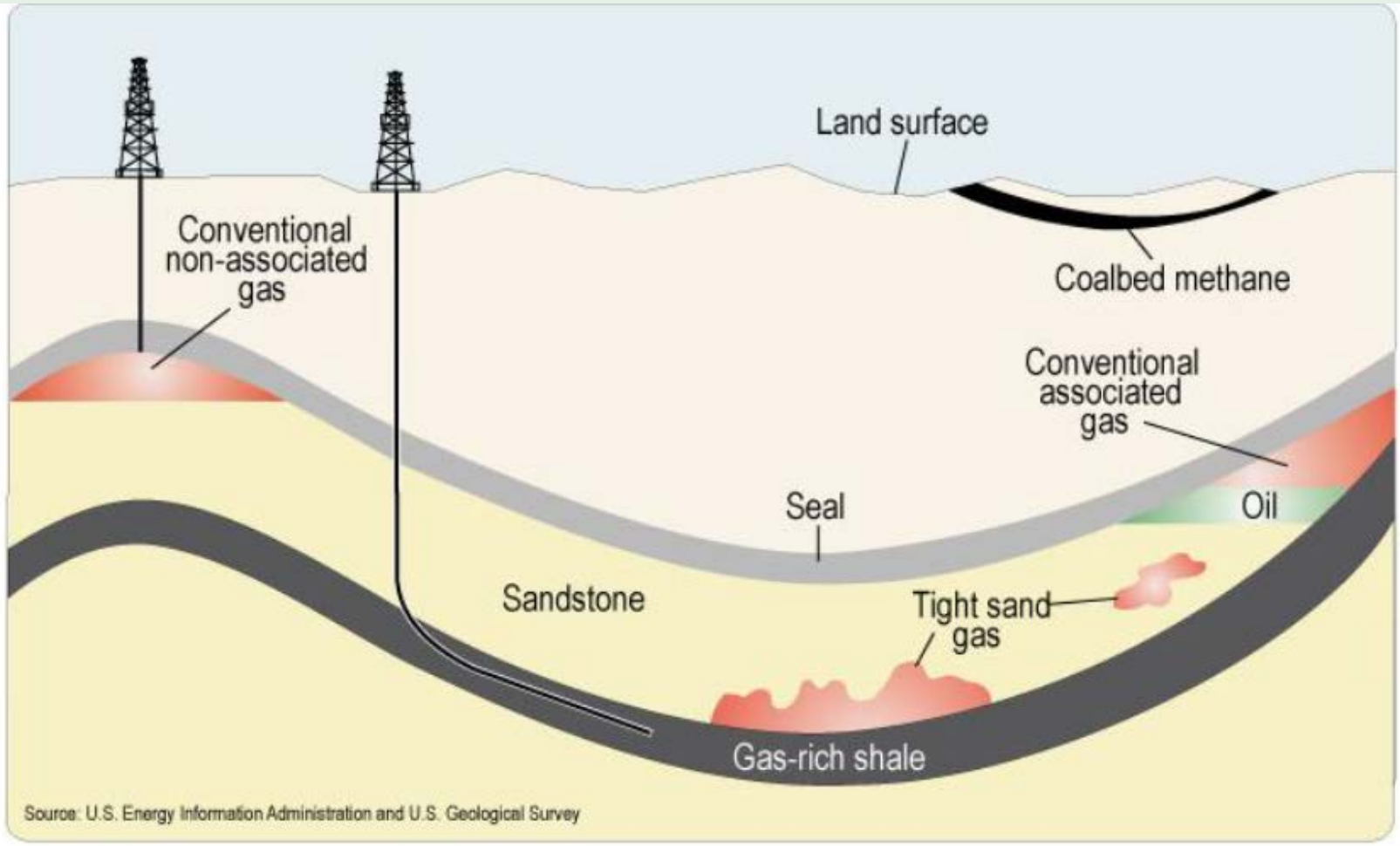
How The Game Has Changed

- **Improvements in technology**
  - brought down costs and greatly increased the scope of resource development
- **2006-2010 quadrupling of shale gas production**
  - Shale gas is poised to comprise more than 40% of U.S. gas production in 2020
  - Shale and other "unconventional' gases could account for over 80% of U.S. gas production by 2020, compared to 66% today
- **Diversity of supply and growing pipeline system**
  - reduces vulnerability to hurricanes, brings natural gas closer to consumers



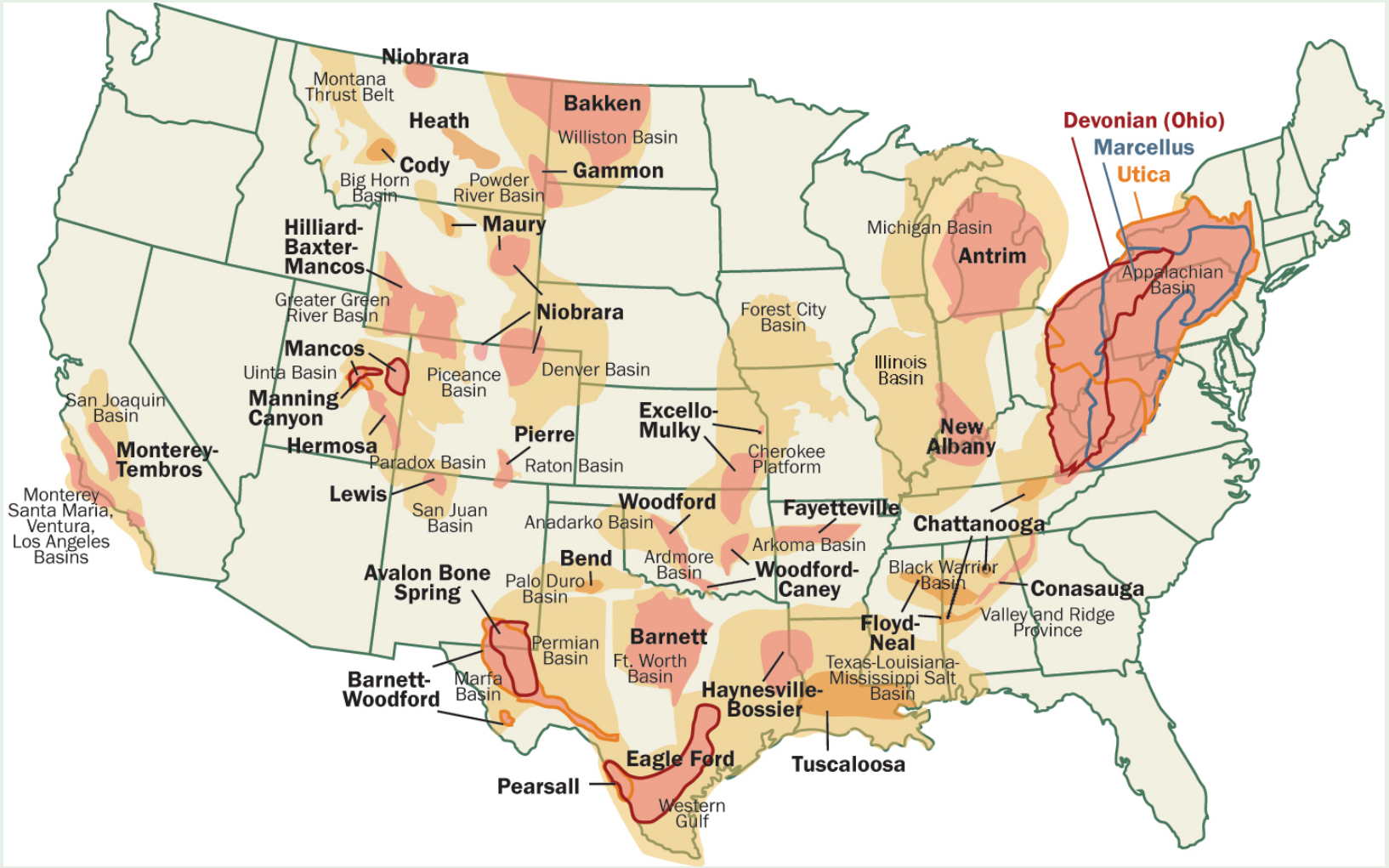
Source: Wood Mackenzie 2010

Underground Sources of Natural Gas

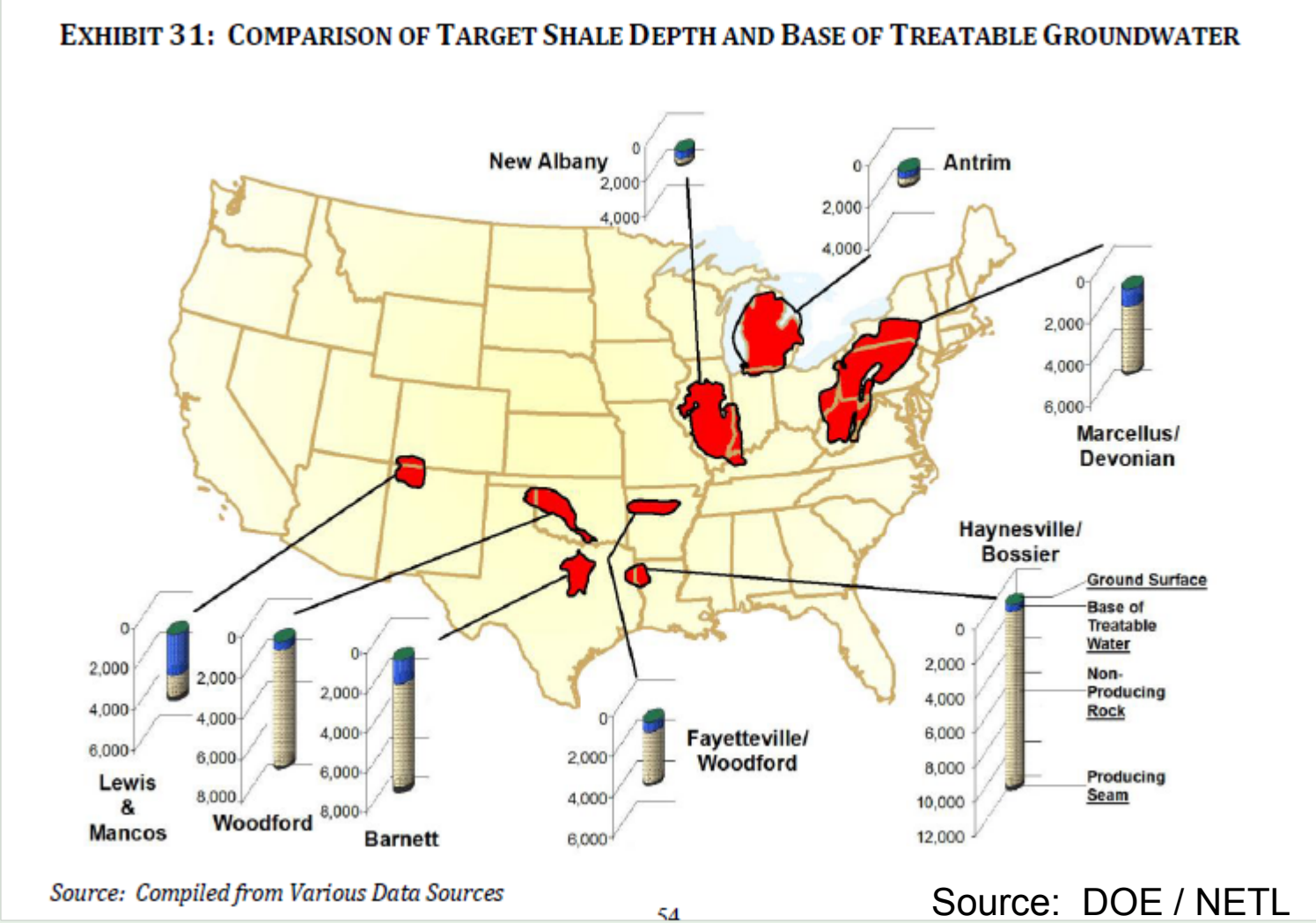


Source: modified from U.S. Geological Survey Fact Sheet 0113-01

An Abundant Resource Endowment



Some Differences Among Shale Plays



Source: DOE / NETL

What Shale Resources Provide America

ENVIRONMENT

Smaller production footprints.

Lower lifecycle emissions for electricity generation

Lower lifecycle water use for electricity generation.

ECONOMY

U.S. energy security.

Domestic jobs.

Cheaper natural gas for consumers.

Keys to Exploration Success

Include:

Safe Operations

Proper Well Construction

Prevention of Pollution

Appropriate Site Footprint

Impacts Controlled or Mitigated

Efficient Development of Resource

Effective Community Engagement

To Achieve Success: Manage Risks Effectively

Records of the Pennsylvania Department of Environmental Protection show that from 2008 to 2010, the typical Marcellus shale gas well generated:

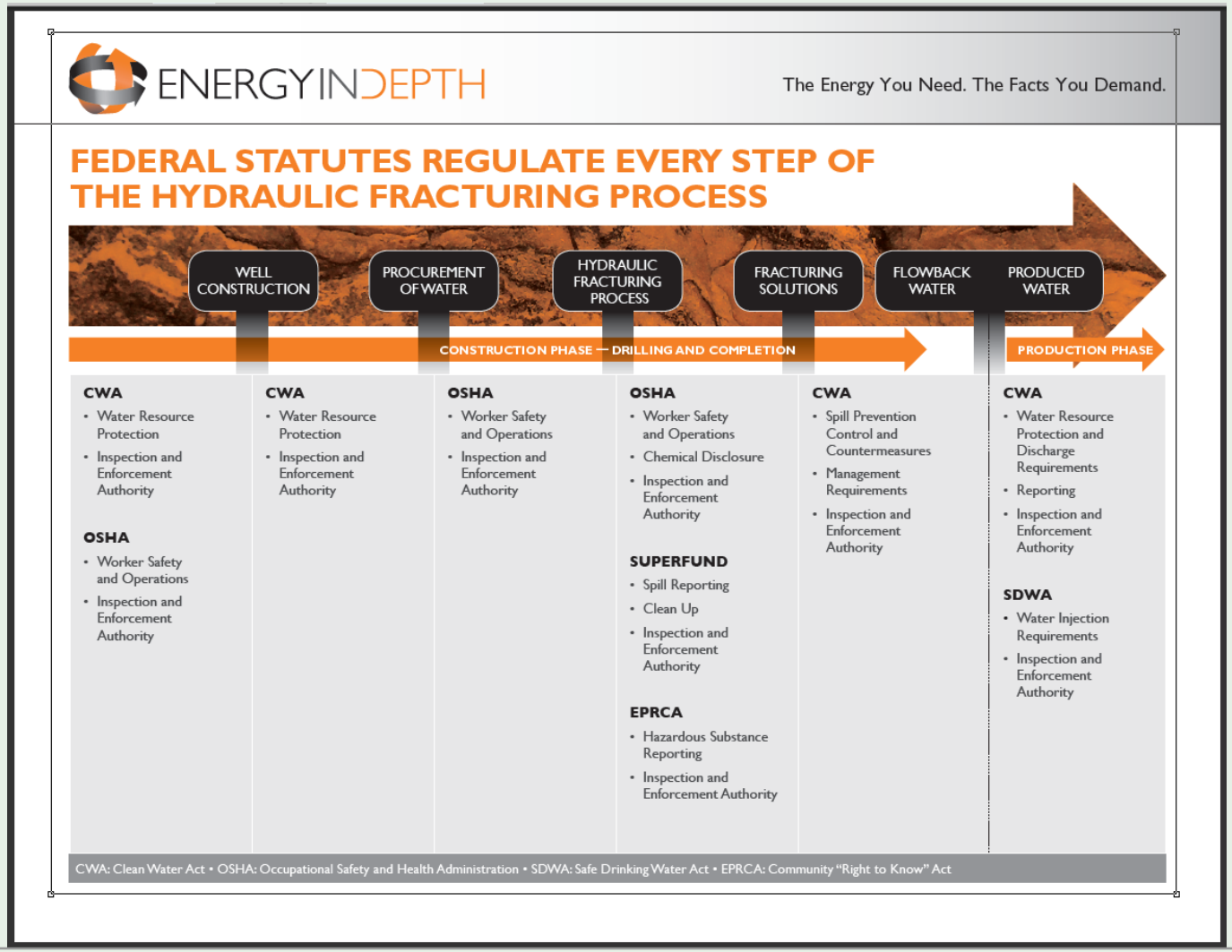
$14,000 in mainly reversible environmental impacts

$4 million in economic benefits

http://www.manhattan-institute.org/pdf/eper_09.pdf

How Federal Regulations DO Apply

On federal public land (chiefly in Western states), additional measures like the FLMPA and NEPA also apply.



State Laws Address Local Concerns with Local Expertise

- Geology
- Hydrology
- Property Rights
- Water Laws
- Communities

STRONGER
State Review of Oil & Natural Gas Environmental Regulations

GROUNDWATER PROTECTION COUNCIL

INTERSTATE Oil & Gas COMPACT COMMISSION

Strong Permitting Is Paramount

SOME of the permits required for a well in Pennsylvania are:

- Well drilling permit (w/ well location plat, casing and cementing plan, PNDI for threatened or endangered species, landowner/water well owner notifications, coal owner or operator notification and gas storage field owner notification)
- Water management plan for Marcellus Shale wells
- Proposed alternate method of casing, plugging, venting or equipping a well
- Bond for Oil and Gas Well(s) (individual or blanket, various bond types allowed)
- Waiver of distance requirements from spring, stream, body of water, or wetland (to put the well closer than 200 feet)
- Variance from distance restriction from existing building or water supply (to put the well closer than 100 feet)
- Proposed alternate method or material for casing, plugging, venting or equipping a well
- Approval for alternative waste management practices
- Approval of a pit for control, handling or storage of production fluids
- Use of alternate pit liner
- NPDES GP-1 for discharges from stripper oil wells
- Water Quality Management Permit for treatment facilities
- Alternative pit liners
- Inactive status
- Roadspreading plan approval
- Transfer of well permit or registration
- Orphan well classification
- Off-site solids disposal
- Residual waste transfer stations and processing facilities
- Transportation of residual waste
- Road use permit – construction of access to state roadway
- Road use bond (PennDOT or municipality)
- Surface use permit (if in the Allegheny National Forest)
- PASPGP-3 or PASPGP-4 for pipelines crossing streams (if < 1 acre)
- Water Obstruction – Encroachment – US Army Corps of Engineers Section 404 Joint Permit
- Dam permit for a centralized impoundment dam for Marcellus Shale gas wells
- GP-11 for non-road engine air emissions
- GP-05 for natural gas compression facilities emissions
- Earth disturbance permit (if > 5 acres)
- Erosion and sedimentation control permit (if > 25 acres)
- NPDES storm water for construction activities
- Water allocation (SRBC, DRBC or DEP for Ohio River basin)
- GP-3 for bank rehabilitation, bank protection, and gravel bar removal
- GP-4 for intake and outfall structures
- GP-5 for utility line stream crossings
- GP-7 for minor road crossings
- GP-8 for temporary road crossings
- GP-11 Maintenance, Testing, Repair, Rehabilitation or Replacement of Water Obstructions and Encroachments

API Standards: 88 Years of Describing Sound Practice

- ~600 technical standards covering all aspects of the oil and natural gas industry

- National Technology Transfer and Advancement Act
  - NTTAA requires Federal Agencies to use voluntary consensus standards, encourages participation
    - API standards are cited in regulations by agencies including OSHA, EPA, DOT and BSEE
    - 100 API standards are cited over 270 times in the U.S. Code of Federal Regulations

  - API Standards also widely cited by States
    - 184 API standards are cited over 3300 times in state regulations

HF Related Documents and Standards

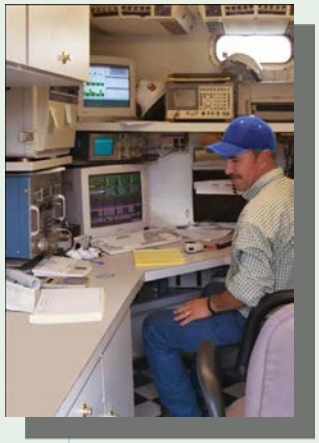
- HF1, *Hydraulic Fracturing Operations – Well Construction and Integrity Guidelines*, 1st Edition, October 2009
- HF2, *Water Management Associated with Hydraulic Fracturing*, 1st Edition, June 2010
- HF3, *Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing*, 1st Edition, January 2011
- 51R, *Environmental Protection for Onshore Oil and Gas Production Operations and Leases, 1st* Edition, July 2009
- 65-2, *Isolating Potential Flow Zones During Well Construction, 2nd* Edition, December 2010

Use of API Standards

- Future Actions:
  - API has begun work on a “stray gas migration” standard (RP 90 Part 2)
  - HF1, HF2, and HF3 included on the 2012 Standards Plan
  - HF4, “Community Engagement”, is in planning stages
  - API has provided training on its standards to state regulators

Timeline of a Well

EXPLORATION
3-5 years



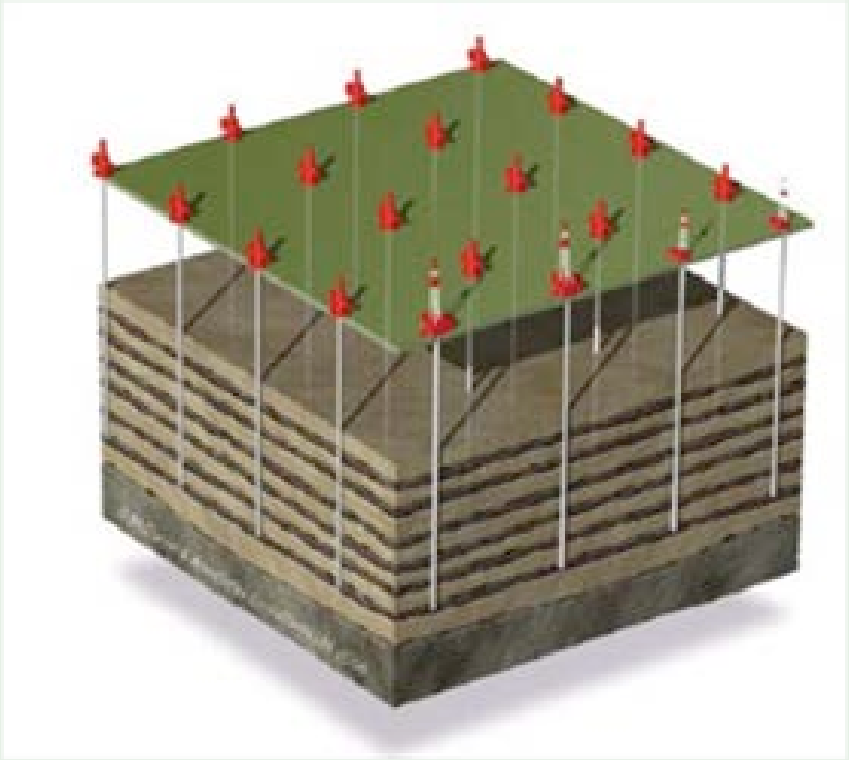
PLANNING
12 – 18 months

SITE & WELL CONSTRUCTION
2-3 months

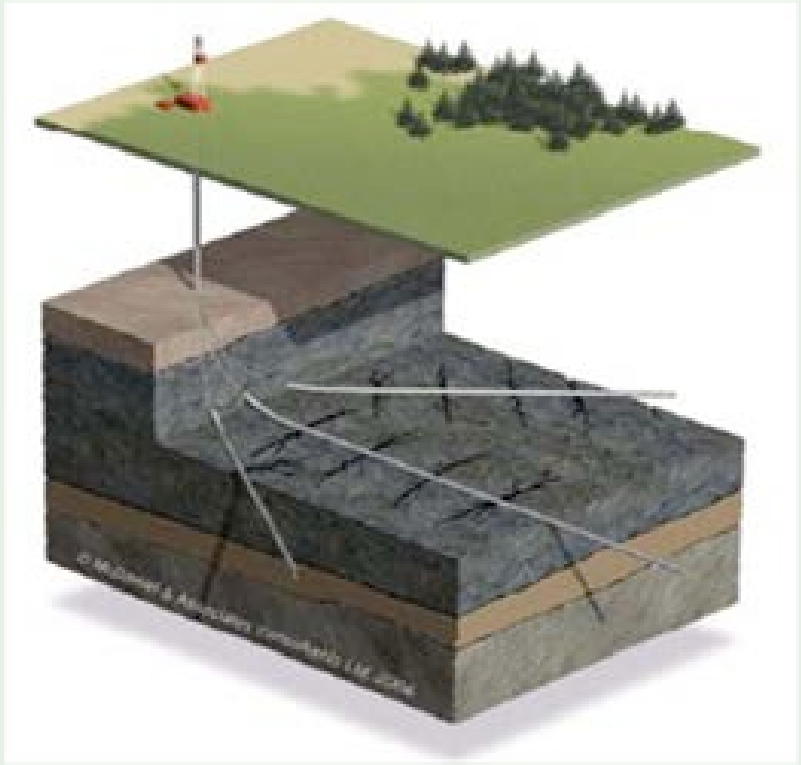
HYDRAULIC FRACTURING
3 – 5 DAYS

PRODUCTION
30 + Years

Horizontal Drilling = Lower Impact



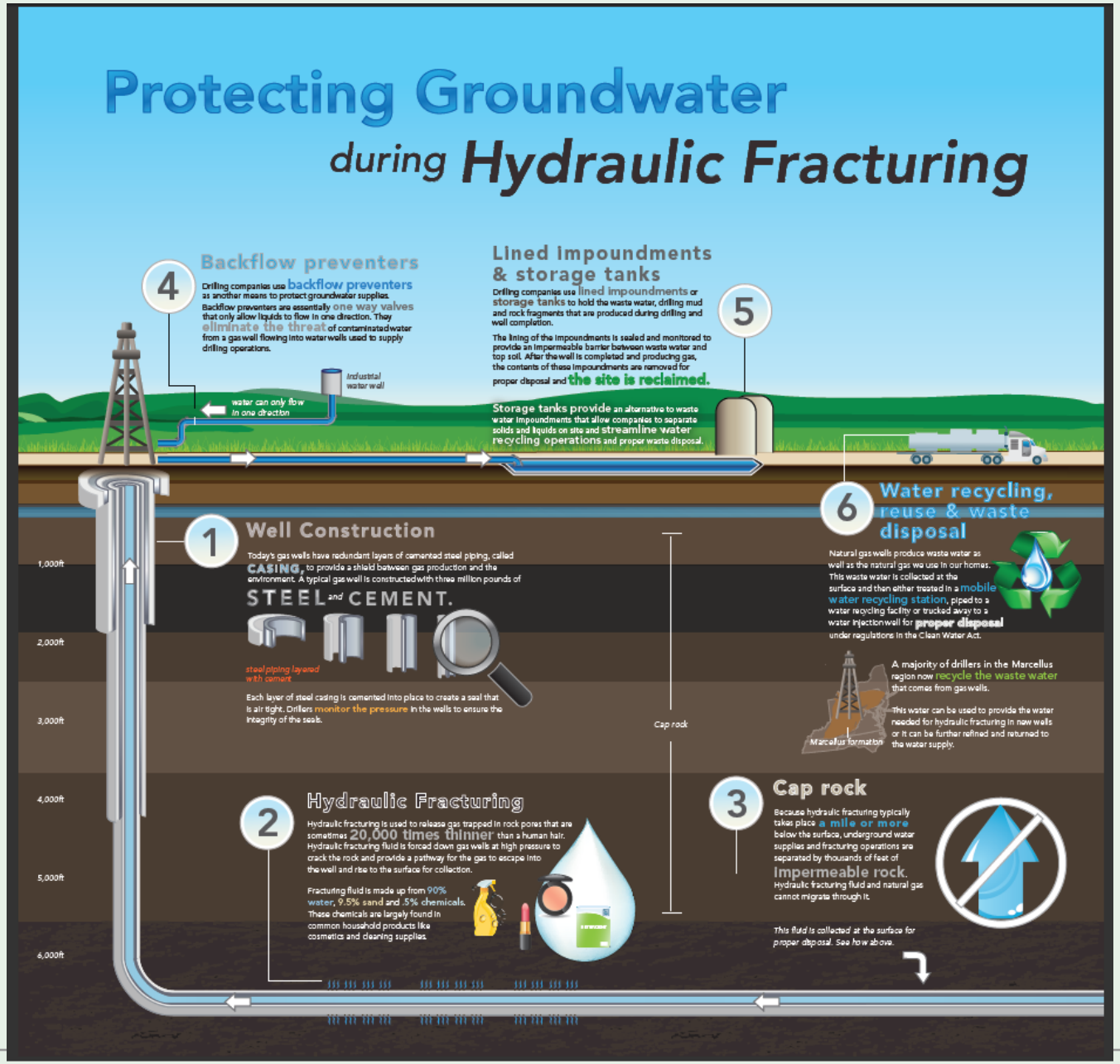
Traditional Wells



Horizontal Drilling

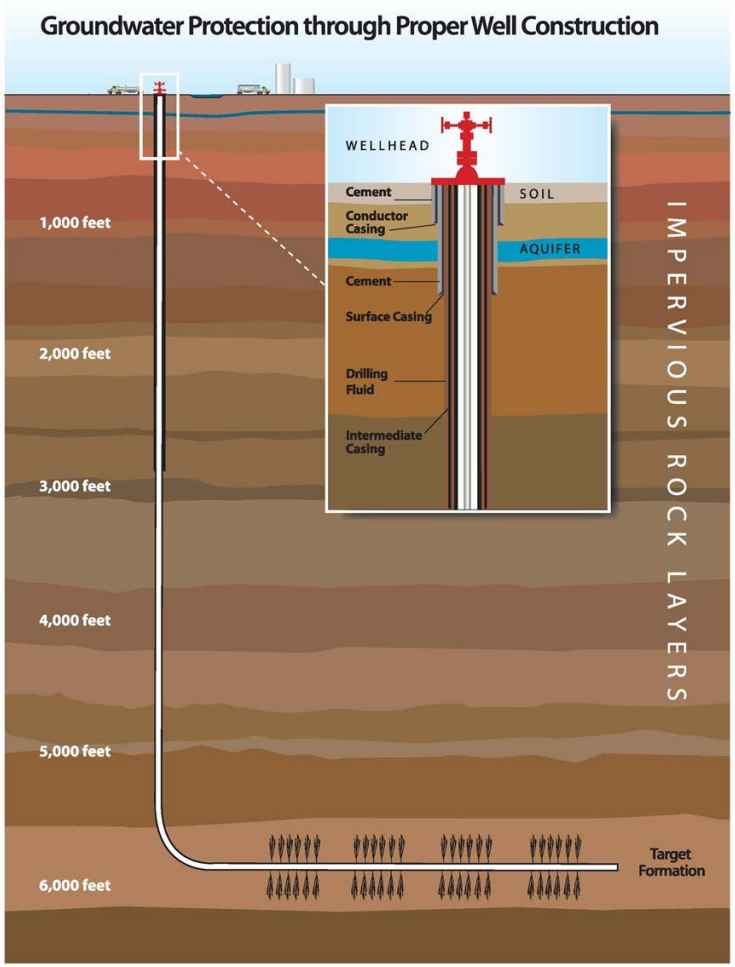
Multiple structural safeguards protect groundwater and surfaces.

API has over 4,000 pages of standards applicable to each step in this process.



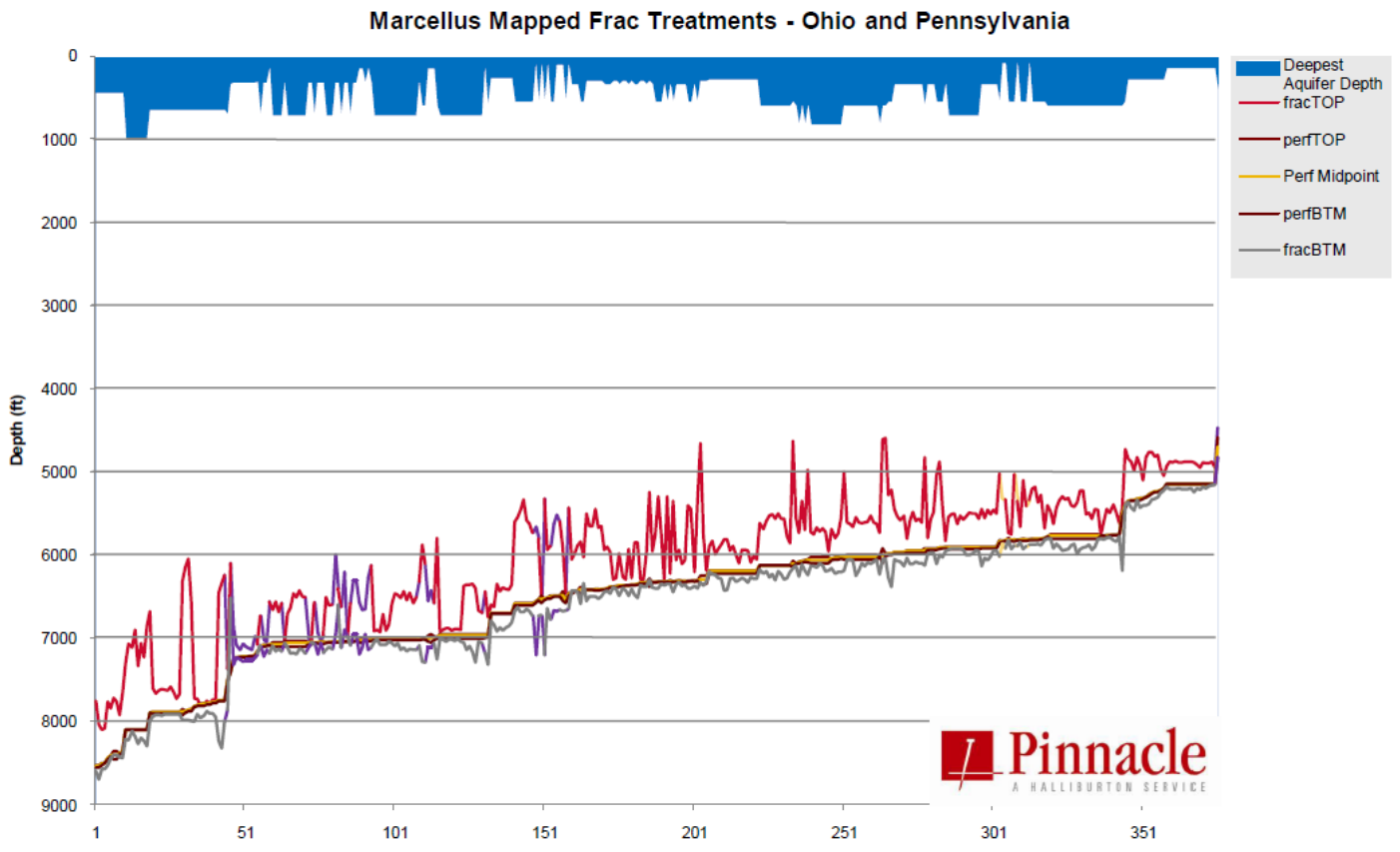
Good Well Construction and Careful Operations Protect Groundwater

- **API HF 1 (Well Construction) and Standard 65-2 (Zonal Isolation)**
- **Well construction:** material selection, performance, evaluation
- **Well integrity:** isolate internal conduit of well from surface & subsurface environment
  - Protect groundwater through a combination of redundant steel casing and cement sheaths, mechanical isolation devices
- **Well logging and other testing:** data gathering tools for formation evaluation, well design and construction



Below Ground….

Frac Jobs Don't Contaminate Groundwater!



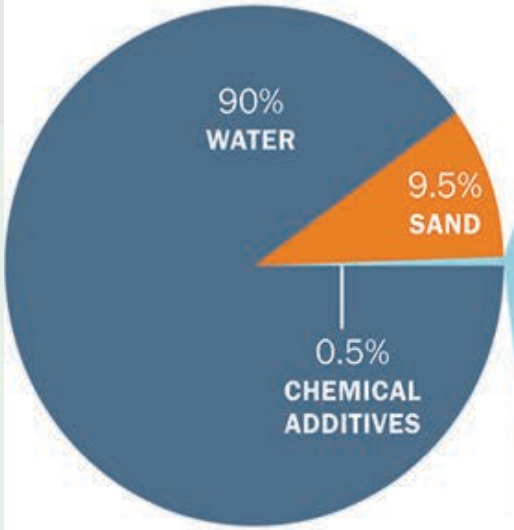
http://nwis.waterdata.usgs.gov/nwis/inventory?search_criteria=state_cd&submitted_form=introduction

HALLIBURTON

HF3: Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing

- Identify and describe practices currently used in the oil and gas industry to minimize surface environmental impacts – potential impacts on surface water, soils, wildlife, and other surface ecosystems and nearby communities – associated with hydraulic fracturing operations.

- **Stakeholder Engagement** - meetings, opportunity to comment, facts
- **Scale of Development** - regional collaboration, STRONGER, National Petroleum Council
- **Management of Chemicals & Materials** - total impact, surface handling, greener alternatives, disclosure through www.fracfocus.org (OSHA chemicals, context on volumes)
- **Transportation** – GPS units on vehicles, inspect equipment before moving
- **Equipment & Facilities** - maintenance & inspection
- **Minimization of Surface Disturbance** - air quality , noise abatement (distance, scheduling), road impacts (avoid peak hours, coordination)



Compound	Purpose	Common application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Sodium Chloride	Allows a delayed breakdown of the gel polymer chains	Table salt
Polyacrylamide	Minimizes the friction between fluid and pipe	Water treatment, soil conditioner
Ethylene Glycol	Prevents scale deposits in the pipe	Automotive anti-freeze, deicing agent, household cleaners
Borate Salts	Maintains fluid viscosity as temperature increases	Laundry detergent, hand soap, cosmetics
Sodium/Potassium Carbonate	Maintains effectiveness of other components, such as crosslinkers	Washing soda, detergent, soap, water softener, glass, ceramics
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant, sterilization of medical and dental equipment
Guar Gum	Thickens the water to suspend the sand	Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces
Citric Acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, hair coloring

energy API

FracFocus:

A searchable, online database for the contents of fracturing fluids

As of September 2012 –

1.5 years in operation

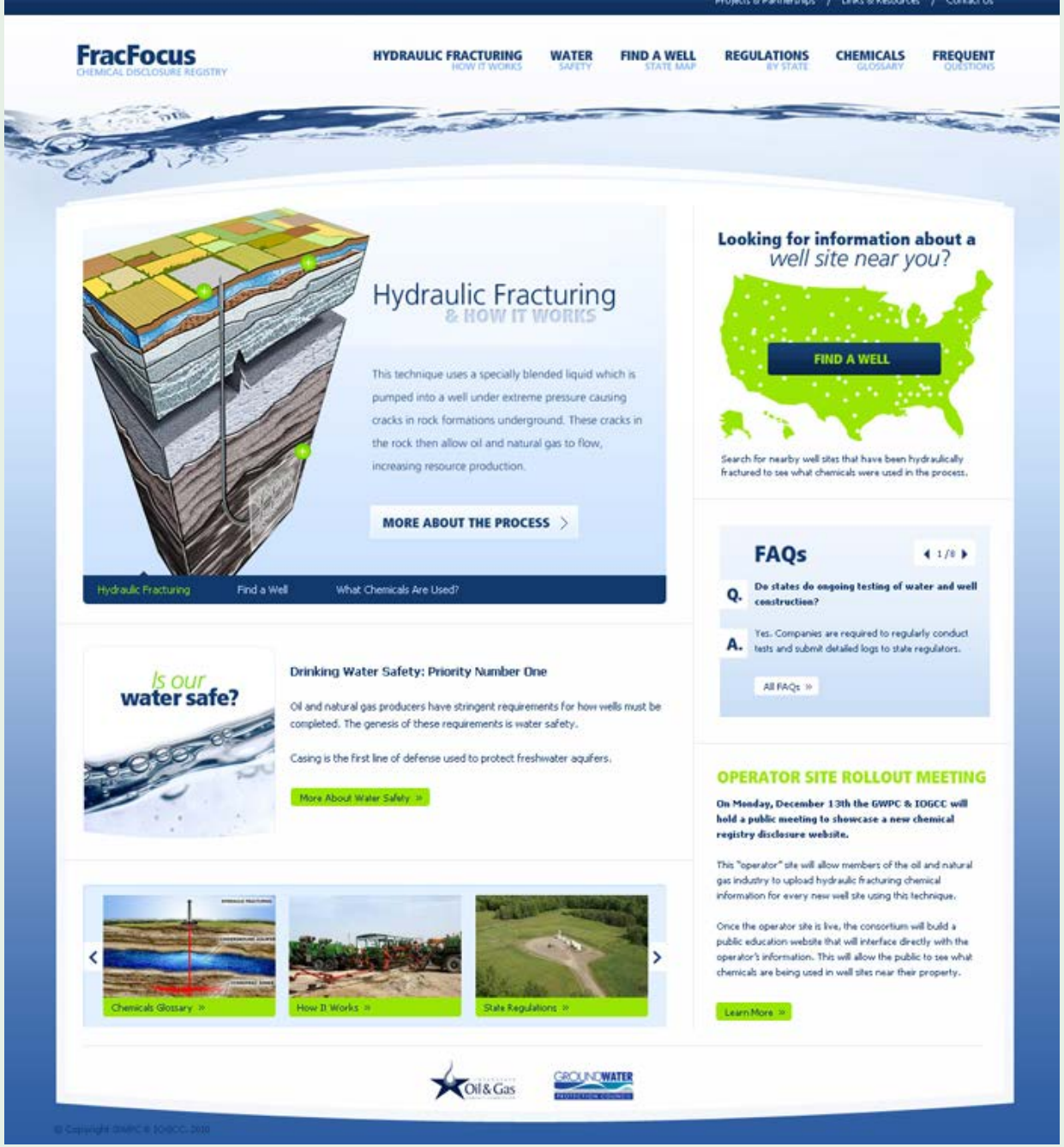
Companies:

367 participating

266 reporting

27,858 wells

221,459 ‘unique’ website visits



What FracFocus Discloses

Hydraulic Fracturing Fluid Product Component Information Disclosure

Fracture Date:	12/16/2011
State:	CO
County:	YUMA
API Number:	05-125-12006
Operator Name:	NOBLE ENERGY INC
Well Name and Number:	WAKEFIELD TRUST #33-06
Longitude:	-102.455509
Latitude:	39.994521
Long/Lat Projection:	NAD83
Production Type:	Gas
True Vertical Depth (TVD):	2,490
Total Water Volume (gal)*:	35,280

Hydraulic Fracturing Fluid Composition:

Trade Name	Supplier	Purpose	Ingredients	Chemical Abstract Service Number (CAS #)	Maximum Ingredient Concentration in Additive (% by mass)**	Maximum Ingredient Concentration in HF Fluid (% by mass)**	Comments
WATER	CUSTOMER	WATER	BASE FLUID	7732-18-5	100.00%	66.864199%	
BREAKER-503L	EES	LIQUID ENZYME BREAKER	sucrose	57-50-1	50.00%	0.000303%	
			ethylene gycol	107-21-1	50.00%	0.000303%	
CL-57	EES	CLAY CONTROL	WATER	773-18-2	34.00%	0.040767%	
			T-MAC	75-57-0	33.00%	0.039568%	
			METHANOL	67-56-1	33.00%	0.039568%	
CO2	PRAXAIR	CARBON DIOXIDE	CARBON DIOXIDE	124-38-9	100.00%	31.404292%	
MAV-3	INTERNATION PLOYMETRICS	FRAC GEL	GUAR	9000-30-0	100.00%	0.159264%	
MAVCIDE II	WEATHERFORD	BIOCIDE	2,2-dibromo-3-nitriloprpionamide	1022-01-2	100.00%	0.001365%	
						0.000000%	
						0.000000%	
						0.000000%	
						0.000000%	
						0.000000%	
						0.000000%	
HCL	INDUSTRIAL CHEMICAL	ACIDIZE THE FORAMTION	HCL	7647-01-0	7.50%	0.073422%	
			WATER	7732-18-5	92.10%	0.901618%	
MAVHIB 3	EES	ACID INHIBITOR	N-DIMETHY FORMAMIDE	68-12-2	0.10%	0.000003%	
			ISOPROPYL ALCOHOL	107-21-1	0.10%	0.000003%	
			CINNAMALDEHYDE	104-55-2	0.10%	0.000003%	
			METHANOL	67-56-1	0.10%	0.000003%	
S-1	EES	SURFACTANT	4-NONYLPHENYL	127087-87-0	25.00%	0.015317%	

Like other industries:

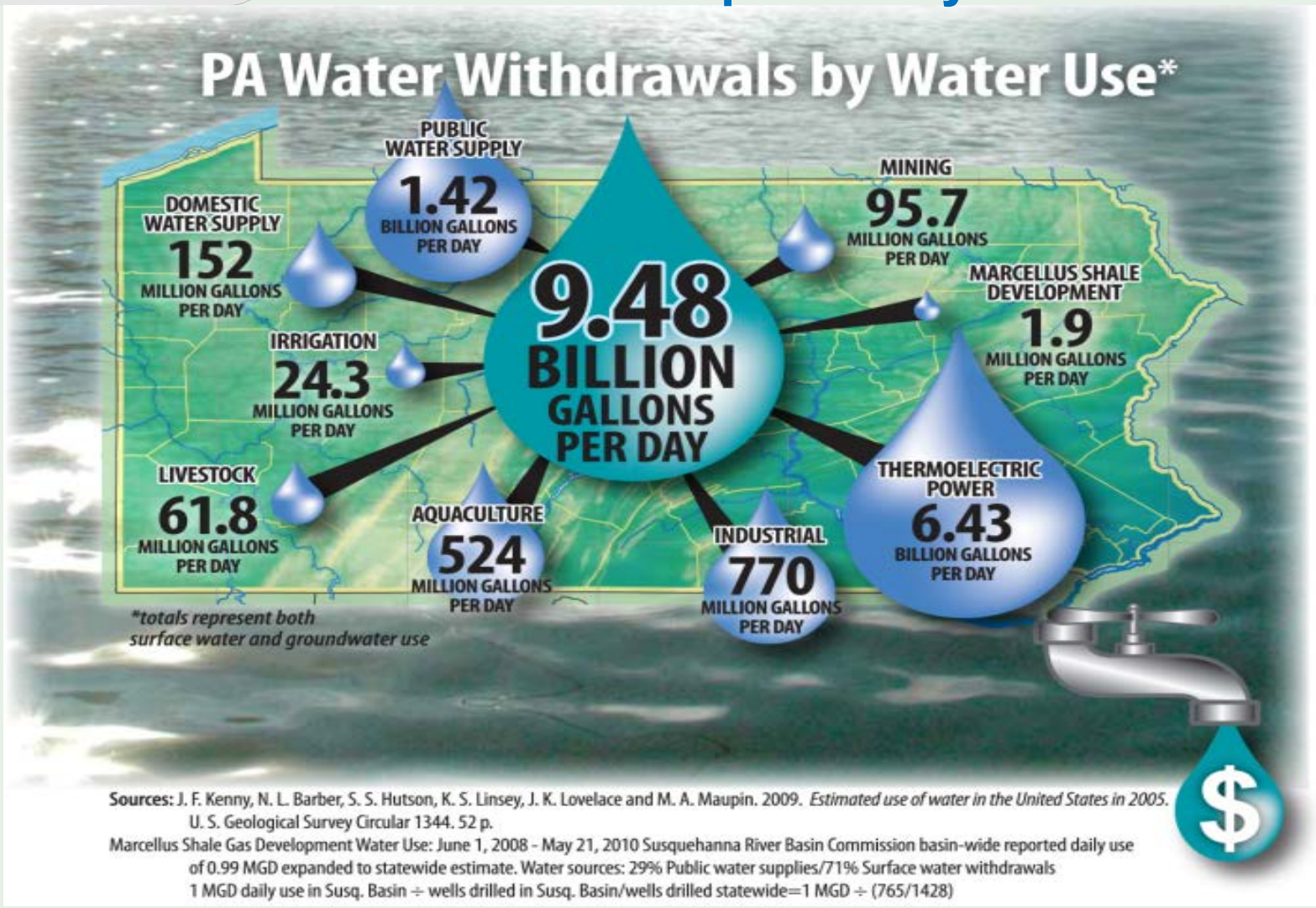
Ingredients, not a recipe

Key disclosures for 3rd party products available through other resources like MSDS sheets available to health care providers

HF2: Water Management Associated with Hydraulic Fracturing

- Best practices to minimize environmental and societal impacts associated with water & fluids.
- **Water Supply**
  - Source Water (comprehensive evaluation, impacts, transportation)
  - Fluid Handling (strive to minimize use of additives, disclosure)
  - Storage (safety and compliance)
- **Management & Disposal:**
  - Municipal & Industrial Waste Water Treatment Facilities
  - Flow Back Water Recycling / Reuse
  - Injection Wells

Our Industry's Water Use Is Comparatively Small



Sources: J. F. Kenny, N. L. Barber, S. S. Hutson, K. S. Linsey, J. K. Lovelace and M. A. Maupin. 2009. *Estimated use of water in the United States in 2005.* U. S. Geological Survey Circular 1344. 52 p.

Marcellus Shale Gas Development Water Use: June 1, 2008 - May 21, 2010 Susquehanna River Basin Commission basin-wide reported daily use of 0.99 MGD expanded to statewide estimate. Water sources: 29% Public water supplies/71% Surface water withdrawals
1 MGD daily use in Susq. Basin ÷ wells drilled in Susq. Basin/wells drilled statewide=1 MGD ÷ (765/1428)

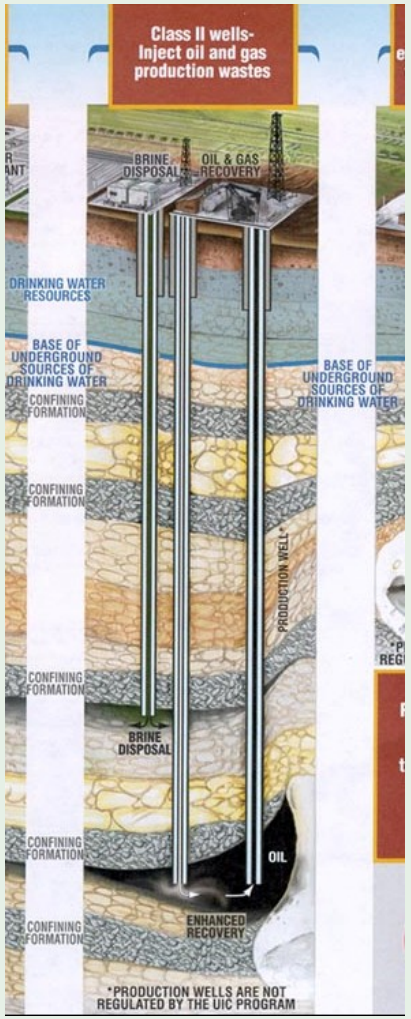
State, Federal Laws and OSHA Regulations Govern Management of Wastes

To the extent possible, fracturing fluid is recovered and recycled for use in future fracturing operations, or injected into Class II wells as authorized under the Safe Drinking Water Act (SDWA). For more on the UIC program, see http://water.epa.gov/type/groundwater/uic/index.cfm

Flowback is heavily regulated by state regimes covering characterization of "solid waste" and wastewater.

Many state authorities require companies to submit **waste management plans** as part of the permitting process. They typically cover on-site storage, disposal alternatives, spill prevention, and site remediation.

For more on waste management, see API RP51R and API HF3.



Source: EPA

Oil and Gas Emissions Must Remain within Prescribed State and Federal Limits

Corporate Mitigation Strategies

Voluntary measures

Green Completions

Additional data expected through the Mandatory Reporting Rule

Natural gas is considered a clean burning fuel because of its comparatively low emission of carbon dioxide, sulfur oxides, and nitrogen oxides.

API / ANGA 2012 – Activity data from 91,000 U.S. gas wells demonstrates that emissions from U.S. unconventional gas well production are approximately half of EPA's current estimate

Recent Developments in Federal Regulation

- On August 16th, EPA published the final New Source Performance Standards for the Oil and Natural Gas Sector.
- This rule is **effective October 15th** and will, over time, significantly reduce air emissions from common oil and gas productions sources such as:
  - Flowback emissions following hydraulic fracturing
  - Equipment leaks at gas processing plants
  - Storage tanks
  - Pneumatics
  - Compressors

Temporary Flaring in the Bakken: Infrastructure Catching Up to Development

- **Over the next 3 years, companies are planning to invest over $3 billion in pipelines and processing plants to bring the gas they are now flaring to market.**

- *The oil and gas research council is investing approximately $3 million on temporary capture technologies. About 94% of the volume of gas by btu content is currently captured.*

Natural gas generates cleaner power.

Tons per year per thousand households	Biomass (Wood)	Coal	Natural Gas	Nuclear & Renewables
Carbon Monoxide (CO)	51	5.8	1.5	0.0
Carbon Dioxide (CO2)	Low	9,362	3,558	0.0
Nitrogen Oxides (NOx)	28	3.4	0.3	0.0
Particulate Matter	2.7	0.9	0.0	0.0
Volatile Organic Compounds (VOC)	5.6	0.2	0.0	0.0
Sulfur Dioxide (SO2)	2.8	5.0	0.2	0.0
Mercury	0.0	0.0001	0.0000001	0.0

Most emissions

Middle emissions

Least emissions

Natural gas is clean burning

Source: R.W. Beck

Site Reclamation and Remediation

Before

After

Reclaimed Marcellus Well Site (PA)

RP 51R: Sound Engineering Judgment + Courtesy

Good Neighbor Guidance in API 51R

Developing Standard for Community Engagement

LISTEN AND COMMUNCIATE

- Be willing to discuss with land owners and surface users
- Designate company contact person
- Appropriate notification

Protect Public Safety

- Train personnel in safe operating practices
- Conduct emergency training and post signs

Protect the Environment

- Maintain equipment and utilize good work practices
- Follow waste management and environmental protection laws

Respect Property Rights of Others

- Minimize surface disturbances
- Take precautions to protect livestock
- Practice good housekeeping and site remediation
- Drive responsibly

Questions

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Upstream & Industry Ops
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(202) 682-8275

To Learn More:
www.api.org
www.energyfromshale.org

Drilling Video
http://www.youtube.com/watch?v=AYQcSz27Xp8&feature=relmfu
Fracturing Video
http://www.youtube.com/watch?v=7ned5L04o8w