Hydraulic Fracking and its implications for Virginia

WILLIAMSBURG, Feb. 6, 2017

Sue Delos

LEAGUE OF WOMEN VOTERS®
OF VIRGINIA

Hydraulic Fracking Committee Members

Ackerman, Rona – Editor, LWV Fairfax
Caywood, Carolyn, LWV South Hampton Roads
Delos, Sue, LWV Williamsburg Area
Lindstrom, Carol – Chair, LWV Richmond Metropolitan Area
Outline

• What is Fracking?
• Why should we care?
• Steps in the fracking cycle and associated issues
• Indirect issues
• Fracking Laws
• 12/2016 reports and regulations
• Bills now before legislature
• Final Thoughts
What is Fracking?

Fracking is shorthand for hydraulic fracturing, a type of drilling that has been used commercially for 65 years.

Today, the combination of advanced hydraulic fracturing and horizontal drilling, employing cutting-edge technologies, is mostly responsible for surging U.S. oil and natural gas production. The process involves the horizontal directional drilling of wells in addition to the use of water, sand and chemicals at high pressures to fracture rock and release hydrocarbons.
History of Fracking

“exploding torpedo” patented in 1865-1866. by Lt. Col. Edward A. Roberts

“Hydrafrac” process patented in 1949, with Halliburton holding an exclusive license. A typical early fracture took 750 gallons of fluid (water, gelled crude oil, or gelled kerosene) and 400 pounds of sand.

1980s and 1990s, Mitchell Energy experimented with alternative methods of hydraulically fracturing the Barnett Shale. By 2000, the company had developed a hydraulic fracturing technique that produced commercial volumes of shale gas.
The Change in Drilling Technique

Vertical    Horizontal

Traditional Vertical Well Spacing: 32 Separate Padsites Needed For 32 Wells.

Idealized Horizontal Well Spacing: 1 Padsite Yields Up To 32 Wells.
**HOW FRACKING WORKS**

**STAGE 1**
It takes around a month to drill down to the gas-rich shale beds that lie between one and two and a half kilometres beneath the surface.

Freshwater aquifers, which typically lie no deeper than 100 metres underground, are protected from possible pollution from the wellbore by triple-layered steel casings.

The well is turned and drilled horizontally into the shale layer for up to three kilometres.

A perforation gun is fed through the well and punches holes into the surrounding rock using explosive charges. The well is then cleared of debris in preparation for fracking.

**STAGE 2**
A mixture of water, sand and chemicals is pumped into the well to a pressure of around 1,500 lbs per square inch. This forces the rock apart, releasing the gases stored within its pores.

An average well will use up 20,000 cubic metres of water, around 500 tankers’ worth.

**STAGE 3**
The liquid is pumped out of the well and the remaining sand keeps the fractures open, allowing gas to seep out of the broken shale layer to be piped to the surface.

A well can remain productive for 20 to 40 years, pumping out thousands of cubic metres of gas every day.
Why Should We Care About Fracking?

8,062 producing wells in Virginia All located in Buchanan, Dickenson, Lee, Russell, Scott, Tazewell and Wise counties Remaining basins will require advanced fracking methods to extract.
Shore Exploration & Production Corp.

- Opened a field office in Caroline
- Paid over $1.26 million for 84,000 acres of land in leases
  - Caroline (40,000 acres)
  - Essex (13,000 acres)
  - King and Queen (6,000 acres)
  - King George (10,000 acres)
  - Westmoreland (14,000 acres)
- 7 year leases at $15 per acre
- Productive wells could yield $400,000 per year to landowner
- Shore has the right to sell the leases to a partner who would determine the drilling methods to be used.

2011 USGS Assessment estimated:

<table>
<thead>
<tr>
<th>Location</th>
<th>Natural Gas</th>
<th>Liquid Natural Gas (ethane, butane, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taylorsville</td>
<td>1 Tcf</td>
<td>37 m barrels</td>
</tr>
<tr>
<td>Richmond</td>
<td>0.2 Tcf</td>
<td>11 m barrels</td>
</tr>
</tbody>
</table>
These leases are in the Chesapeake Bay watershed

- prime aquaculture
- prime agriculture
- prime recreation

Gov. McCauliffe placed moritorium on fracking ordered DMME to upgrade regs DMME requested STRONGER review Results: 12/2016

Figure ES-1. General timeline and summary of activities at a hydraulically fractured oil or gas production well.
Figure ES-3. The five stages of the hydraulic fracturing water cycle. The stages (shown in the insets) identify activities involving water that support hydraulic fracturing for oil and gas. Activities may take place in the same watershed or different watersheds and close to or far from drinking water resources. Thin arrows in the insets depict the movement of water and chemicals. Specific activities in the “Wastewater Disposal and Reuse” inset include (a) disposal of wastewater through underground injection, (b) wastewater treatment followed by reuse in other hydraulic fracturing operations or discharge to surface waters, and (c) disposal through evaporation or percolation pits.
Fracking Fluids

Traditional fracking fluids are composed of mostly water with added proppants and chemicals. Proppants are small granular particles such as sand or glass beads. They are used to keep the cracks open.

Flowback is fracking fluid that returns to the earth's surface along with the oil or natural gas that is extracted.

Produced water is the salty water or brine that has been under the earth for millions of years and is released when extracting oil or natural gas. It contains many substances trapped in the rock, including naturally occurring radioactive material (NORM), such as radium.

Wastewater includes both produced water and flowback. This contaminated water is stored in injection wells. It has also been sent to municipal sewage plants (a practice banned by the EPA in June 2016) or used as a deicer in road spray.
Text Box ES-1: Drinking Water Resources

In this report, drinking water resources are considered to be any water that now serves, or in the future could serve, as a source of drinking water for public or private use. This includes both surface water bodies and underground rock formations that contain water.

Surface water resources include water bodies located on the surface of the Earth. Rivers, springs, lakes, and reservoirs are examples of surface water resources. Water quality and quantity are often considered when determining whether a surface water resource could be used as a drinking water resource.

Groundwater resources are underground rock formations that contain water. Groundwater resources are found at different depths nearly everywhere in the United States. Resource depth, water quality, and water yield are often considered when determining whether a groundwater resource could be used as a drinking water resource.

Water Issues in Tidewater

• Aquifers are already overused
• Aquifer overuse leads to salt water intrusion and well contamination
• Inadequate surface water storage to meet projected population needs
• Shellfish exquisitely sensitive to changes in salinity
• No current VA plan or incentive to promote recycling of produced water
Text Box ES-6: Examples of Hydraulic Fracturing Fluids

Hydraulic fracturing fluids are engineered to create and extend fractures in the targeted rock formation and to carry proppant through the production well into the newly-created fractures. While there is no universal hydraulic fracturing fluid, there are general types of hydraulic fracturing fluids. Two types of hydraulic fracturing fluids are described below.

**Slickwater**

Slickwater hydraulic fracturing fluids are water-based fluids that generally contain a friction reducer. The friction reducer makes it easier for the fluid to be pumped down the oil and gas production well at high rates. Slickwater is commonly used to hydraulically fracture shale formations.

- **16% Reused Wastewater**
- **13% Sand**
- **71% Fresh Water**

Bradford County, Pennsylvania
Well depth = 7,255 feet
Total water volume = 4,763,000 gallons

**Energized Fluid**

Energized fluids are mixtures of liquids and gases. They can be used for hydraulic fracturing in under-pressured gas formations.

- **28% Nitrogen (gas)**
- **13% Sand**
- **58% Water**

Rio Arriba County, New Mexico
Well depth = 7,640 feet
Total water volume = 105,000 gallons

*Maximum percent by mass of the total hydraulic fracturing fluid. Data obtained from FracFocus.org.

**Additive Dictionary**

- **Acid**: Dissolves minerals and creates pre-fractures in the rock
- **Biocide**: Controls or eliminates bacteria in the hydraulic fracturing fluid
- **Breaker**: Reduces the thickness of the hydraulic fracturing fluid
- **Clay control**: Prevents swelling and migration of formation clays
- **Corrosion inhibitor**: Protects iron and steel equipment from rusting
- **Foamer**: Creates a foam hydraulic fracturing fluid
- **Friction reducer**: Reduces friction between the hydraulic fracturing fluid and pipes during pumping
- **Iron control**: Prevents the precipitation of iron-containing chemicals
- **Scale inhibitor**: Prevents the formation of scale buildup within the well
- **Surfactant**: Reduces the surface tension of the hydraulic fracturing fluid
Fracking Fluid Chemicals

Chemicals are added to fracking fluids to control viscosity, and prevent build-up of particulates, fouling, and corrosion of pipes.

Each well requires a unique blend (usually between 10 and 25 total) of these components that depend upon the type of rock, the material being extracted, and the flow-back viscosity desired, but a typical ratio would be ~90% water: ~9.5% proppant: ~0.5% chemicals.

In 2005-2009, 650 out of 2500 fracking products contained known or possible human carcinogens regulated under the Safe Drinking Water Act, or listed as hazardous air pollutants.

Fracfocus.org
Website where fracking operators are required by some states to post their ingredients (though not their quantities). A new DMME regulation requires operators in VA to post the chemicals they use on this website.
Figure ES-7. Examples of different subsurface environments in which hydraulic fracturing takes place. In panel a, there are thousands of feet between the base of the underground drinking water resource and the part of the well that is hydraulically fractured. Panel b illustrates the co-location of ground water and oil and gas resources. In these types of situations, there is no separation between the shallowest point of hydraulic fracturing within the well and the bottom of the underground drinking water resource. Panel c shows the estimated distribution of separation distances for approximately 23,000 oil and gas production wells hydraulically fractured by nine service companies between 2009 and 2019 (U.S. EPA, 2015d). The separation distance is the distance along the well between the point of shallowest hydraulic fracturing in the well and the base of the protected groundwater resource (illustrated in panel a). The error bars in panel c display 95% confidence intervals.
No clear evidence that contamination of drinking water wells more than 1 km away is a result of fracking.

There remains a concern that, over time, fracking materials from deep wells or faulty casings may find its way into aquifers and wells by travelling through underground channels.
**Text Box ES-10: On-Site Storage ofProduced Water**

Water that returns to the surface after hydraulic fracturing is collected and stored on site in pits or tanks.

Above: Flowback pit. (Source: U.S. DOE/NETL) 
Right: Flowback tanks. (Source: U.S. EPA)

---

**Produced Water Storage Immediately after Hydraulic Fracturing**

After hydraulic fracturing, water is returned to the surface. Water initially produced from the well after hydraulic fracturing is sometimes called "flowback." This water can be stored onsite in tanks or pits before being taken offsite for injection in Class II wells, reuse in other hydraulic fracturing operations, or aboveground disposal.

Source: Adopted from Olson (2011) and BJ Services Company (2009)

---

**Produced Water Storage During Oil or Gas Production**

Water is generally produced throughout the life of an oil and gas production well. During oil and gas production, the equipment on the well pad often includes the wellhead and storage tanks or pits for gas, oil, and produced water.

Above: Produced water storage pit. (Source: U.S. EPA)  
Left: Produced water storage tanks. (Source: U.S. EPA)
Surface water contamination

Accidents or spills from wastewater storage pits are minimal and transient

- Contaminants in produced water have low mobility, solubility, or high volatility
- Do not, in general, spread far from the spill site
- Allow for feasible cleanup with minimal long-range effects
- Contaminants include salts, hydrocarbons (oil and grease), inorganic and organic additives, and NORM
- Chemicals used in each well are unique—each spill must be treated for its specific contaminants.
Waste disposal

Minimization and recycling/reuse
- Increasingly popular as the costs of obtaining input water and treating wastewater increases
- However, at some point the now highly concentrated waste must be treated.

Wastewater treatment plants
- EPA banned use of municipal treatment plants
- Increasingly being done in centralized treatment plants dedicated to handling brines and industrial waste.

“Beneficial” uses:
- Brines are applied to road surfaces for deicing or dust control.
- Decreased use because the efficacy is inferior to that of commercial products and contaminants left behind are detrimental to the environment.

Injection wells:
- Difficult to treat industrial waste has been disposed of in this manner for many years; method preferred in the industry.
- Two types of injection wells:
  - Class I: highly regulated and the EPA has deemed them safe for the disposal of waste materials
  - Class II: less tightly regulated. All fracking waste is currently being injected into Class II wells.
When Recycling of Waste Water is Encouraged

Figure ES-8. Changes in wastewater management practices over time in the Marcellus Shale area of Pennsylvania.


VA: No regulations or plans to encourage recycling of fracking waste water.
Additional Fracking Issues

- Geologic Setting
- Greenhouse gases
- Transportation
- Air Quality
- Effect on Communities
Existing and Proposed Gas Pipelines & Reserves Relative To Virginia Seismic Zones

Sources: Virginia DMME, USGS, VADEQ, VADCR
Spectra Energy, Dominion, Mountain Valley
©2016. League of Women Voters of Virginia
Earthquakes: Seismic Issues

Earthquakes are not directly associated with the process of fracking.

Earthquakes appear to be caused by rapid injection of waste fluids inducing a local high pressure that destabilizes fragile existing fault lines.

This pressure differential can be exaggerated if large volume water withdrawals occur nearby.

Vertical leakage can occur from fracking in fracture-rich soils.

Should fracking or waste water injection be allowed in a seismic zone?
Methane and Greenhouse Gas Leaks

Methane
- a key constituent of natural gas
- second most prevalent greenhouse gas emitted by humans in the US
- one-third of methane emissions are from the oil and gas industry

Global Fossil Carbon Emissions by Year
Air Quality

Emissions are associated with four shale gas-related activities:

1. Diesel and road dust emissions from trucks
2. Emissions from well drilling and hydraulic fracturing
3. Emissions from the production of natural gas
4. Combustion emissions from natural gas powered compressor stations

More than half of emissions damages come from compressor stations

Need to consider emissions from ongoing, long-term activities.
Transportation Infrastructure

For each well, trucks must haul in gravel, pipes, water, and chemicals, then haul out liquid fuels and waste — anywhere from 600 to 1,000 one-way trips for the fracking phase alone.

Damage to local transportation infrastructure:

• Heavier vehicles cause exponentially greater roadway damage: a 30,000-pound single-axle does about 7,500 times more damage than a 3,000-pound single axle

• In PA, estimated road reconstruction costs per well range from $13,000 - $23,000.

• In 2011, the estimates of fracking-related PA road costs paid by state transportation authorities, and thus taxpayers, range up to $39 million.
Other traffic-related issues that need to be considered include:

- Congestion
- Noise
- Air pollution
- Accidents: injury and damage to property, or accidental spillage of materials or chemicals.

“An Associated Press analysis of traffic deaths…in six drilling states shows that in some places, fatalities have more than quadrupled since 2004 — a period when most American roads have become much safer…The industry acknowledges the problem, and traffic agencies and oil companies say they are taking steps to improve safety.”

Potential approaches:

- Additional fee or tax on top of current per-well impact fees
- Limiting truck size and weight
- Encouraging the use of pipelines rather than trucks
Taxes, fees and revenues

Fracking booms can increase local government revenue through property and sales taxes.

Mineral leasing revenues and severance taxes—go to state and federal governments.
Mineral leasing revenue: income generated by those who lease their property.
Severance taxes: intended to compensate citizens for the loss of resources extracted ("severed")

As of June 2013, Virginia employed the following city and county license taxes on severed resources:
- 1.5% gross severance tax on oil
- 1% on gross severance tax on coal or gas
- Counties and cities can levy an additional maximum 1% gross tax on gas
- Cities and counties may adopt a maximum 1% gross tax on every person engaged in the business of severing coal or gas.

The revenue collected from an additional gas tax is deposited in the general fund of the respective county or city. Revenue from an additional county or city coal or gas tax is deposited into the Coal and Gas Road Improvement Fund. Areas that comprise the Virginia Coalfield Economic Development Authority have 75 percent of their tax deposited into the Coal and Gas Road Improvement Fund. The remaining 25 percent is deposited into the Virginia Coalfield Economic Development Fund.

In fiscal year (FY) 2014, Virginia collected ~ $2.2 million in severance taxes, which accounted for 0.01 percent of the state's tax revenue.
# Fracking Laws and Regulations-Federal

<table>
<thead>
<tr>
<th>Act</th>
<th>Purpose</th>
<th>Fracking Exemption</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clean Air Act of 1963</strong></td>
<td>Control air pollution at the federal level.</td>
<td>Treats each individual well as a source of pollutants and does not require well operators to consider the aggregate impact of many wells in a specific area.</td>
</tr>
<tr>
<td><strong>Clean Water Act of 1972</strong></td>
<td>Ensure that surface waters meet minimum pollution standards.</td>
<td>Fracking fluids are exempt from classification as pollutants even though more common pollutants such as storm run-off are included.</td>
</tr>
<tr>
<td><strong>Safe Water Drinking Act of 1974</strong></td>
<td>Protect the quality of the country's groundwater and drinking water supply.</td>
<td>Amended in 2005 to exclude injection wells.</td>
</tr>
<tr>
<td><strong>The Energy Policy Act of 2005</strong></td>
<td>Regulates many aspects of federal energy policy.</td>
<td>Only regulates fracking when diesel fuels are used in the fracking fluids.</td>
</tr>
</tbody>
</table>

### June 2016- A federal judge ruled that 2015 federal regulations to ensure that wells are properly constructed to:

- protect water supplies
- make certain that flowback fluids are managed in an environmentally responsible way
- provide public disclosure of the chemicals used in hydraulic fracturing **violated the Energy Policy Act of 2005.**

### June 2016- EPA banned unconventional oil and gas extraction wastewater from municipal sewage plants, citing the inability of these plants to handle toxic and radioactive pollutants. This rule does not address underground injection of wastewater since such activity is not subject to the Clean Water Act but rather the Safe Drinking Water Act.
Massachusetts and Vermont (states without shale resources), and New York have banned fracking. Maryland has a moratorium in place until October 2017. North Carolina, Oklahoma, and Texas have passed restrictions on local communities’ ability to limit fracking. The Delaware River Basin Commission (Delaware, New Jersey, New York, Pennsylvania) has had a de facto moratorium on gas drilling in the Delaware River Basin since 2009, but this is being challenged in federal court.
Fracking Laws and Regulations - Virginia

All oil and gas operators must comply with:

The Virginia Gas and Oil Act of 1990
Virginia Gas and Oil Regulation
Virginia Gas and Oil Board Regulations
State Water Control Law
Virginia Pollution Discharge Elimination System Regulations
Additional requirements for the Tidewater Region
What regulatory authority do Virginia localities have?

2013: Virginia Attorney General Ken Cuccinelli:
Local governing bodies could place reasonable restrictions but “cannot ban altogether” the exploration for or drilling of oil and natural gas.

2014: King George County Attorney Eric Gregory:
Virginia localities may regulate oil and gas drilling activities via their zoning and land use authority under state law, so long as such regulation does not encroach upon those areas regulated by state (DMME and DEQ) and federal law and regulatory agencies.” He cited VA Code § 15.2-2280: Any locality may...regulate, restrict, permit, prohibit and determine...
1. The use of land...for...industrial..uses;...
4. The excavation of mining of soil or other natural resources

2015: Virginia Attorney General Mark Herring:
Counties have the authority to prohibit fracking through duly enacted land use or zoning ordinances.

2016: DMME
Applications for new fracking must comply with local zoning laws
County Actions

August 16, 2016: King George Board of Supervisors voted to amend their zoning ordinance and Comprehensive Plan, prohibit drilling within 750 feet from resource protected areas, such as rivers and creeks, as well as roads, buildings and schools, ➔ only 9 percent of the county potentially eligible for drilling.

Dec., 2016: The Westmoreland Planning Commission opted to recommend strict regulatory measures rather than prohibition of drilling for natural gas and oil altogether
• Gas wells in Westmoreland would have to be at least 1,000 feet from structures or any type of waterway.
• permit requires two processes requiring public hearings and special approval
  1. land sought for drilling would have to be made part of a new zoning district
  2. companies would have to get a special exception permit.
EPA found scientific evidence that hydraulic fracturing activities can impact drinking water resources under some circumstances. The report identifies certain conditions under which impacts from hydraulic fracturing activities can be more frequent or severe:

- Water withdrawals for hydraulic fracturing in times or areas of low water availability, particularly in areas with limited or declining groundwater resources;
- Spills during the handling of hydraulic fracturing fluids and chemicals or produced water that result in large volumes or high concentrations of chemicals reaching groundwater resources;
- Injection of hydraulic fracturing fluids into wells with inadequate mechanical integrity, allowing gases or liquids to move to groundwater resources;
- Injection of hydraulic fracturing fluids directly into groundwater resources;
- Discharge of inadequately treated hydraulic fracturing wastewater to surface water; and
- Disposal or storage of hydraulic fracturing wastewater in unlined pits resulting in contamination of groundwater resources.
New DMME Regulations effective Dec. 28, 2016

• Division of Gas and Oil (DGO) and Department of Environmental Quality (DEQ) must jointly convene local public meeting prior to appl. approval
• Must comply with local land use ordinances
• Must disclose fracking fluid ingredients, list chemicals on FracFocus, and update as applicable
• Must establish base line water quality sampling up to ¼ mi around well; follow-up sampling; remediation as necessary
• Must use centralizers, increase casing strength
• Must keep cement bond log and pressure testing results
• Must place fencing around all retention pits
• Must provide a full well description
• Must post application on web site

Key Recommendations

- **Recommendation 4.1.2**
  The review team recommends that the DGO consider developing a publicly accessible complaint database on the DGO website that allows the public to track both the type and resolution of public complaints.

- **Recommendation 4.2.4.b**
  If development begins in the Tidewater region, the DGO should evaluate whether additional bond requirements should be implemented for that area above and beyond what is required in the southwest region of the state.

- **Recommendation 4.4**
  The review team recommends that the DGO consider developing mechanisms and agreements with local governments in order to make communications and understanding more robust and transparent.

- **Recommendation 6.4**
  The General Assembly should take action to raise the DGO's orphan well permit fee, and allocate additional resources in order to plug the remaining orphaned wells in a more timely fashion before they become environmental hazards or become more difficult and expensive to plug. The DGO should also consider seeking additional funding through the federal Oil Pollution Act of 1990 to remediate any leaking oil wells should that event occur.

- **Recommendation 7.2.a**
  The Review Team recommends that the DGO verify that there is no need for an oil and gas NORM program. The DGO should collaborate with other State/Federal agencies and industry to develop an initial field monitoring data collection program and scientific study to facilitate the determination of need.
<table>
<thead>
<tr>
<th>Bill</th>
<th>Description</th>
<th>House Action</th>
<th>Senate Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>HB1389</td>
<td>FOIA; record exclusion for trade secrets submitted to DMME; allows names of chemicals used in fracking to be protected as trade secrets.</td>
<td>12/01/16 House: Left in General Laws</td>
<td>01/30/17 House: Referred to Committee on Agriculture, Chesapeake and Natural Resources</td>
</tr>
<tr>
<td>SB910</td>
<td>Virginia Oil and Gas Act; sampling and replacing contaminated wells. Increases from 750 feet to 1,320 feet the radius of surface lands around gas wells on which gas well operators (i) have a right to enter and obtain water samples from water wells and (ii) are required to replace contaminated water supplies.</td>
<td>01/18/17 Senate: Read third time and passed Senate (40-Y 0-N)</td>
<td>01/30/17 House: Referred to Committee on Agriculture, Chesapeake and Natural Resources</td>
</tr>
<tr>
<td>SB911</td>
<td>Orphaned Well Fund; surcharge. Raises from $50 to $200 the surcharge to be paid by a gas or oil operator for a permit to conduct any activity other than geophysical operations.</td>
<td>01/18/17 Senate: Passed Senate (34-Y 6-N)</td>
<td>01/30/17 House: Referred to Committee on Agriculture, Chesapeake and Natural Resources</td>
</tr>
<tr>
<td>HB1678</td>
<td>FOIA; trade secrets submitted to the DMME; allows amount or concentration of chemicals or ingredients in fracking to be protected as trade secrets.</td>
<td>01/30/17 House: VOTE: PASSAGE (59-Y 37-N)</td>
<td>01/31/17 Senate: Referred to Committee on General Laws and Technology</td>
</tr>
<tr>
<td>SB1292</td>
<td>Identical to HB1678</td>
<td>02/02/17 Senate: Failed to report (defeated) in Finance (8-Y 8-N)</td>
<td></td>
</tr>
<tr>
<td>SB1291</td>
<td>Well permit applications; disclosure of trade secrets. If a fracking chemical is excluded from disclosure by FOIA, DMME may disseminate the chemical names to emergency responders, but all are prohibited from disclosing chemical name to the public.</td>
<td>02/02/17 Senate: Failed to report (defeated) in Finance (8-Y 8-N)</td>
<td></td>
</tr>
<tr>
<td>HB1679</td>
<td>Identical to SB1291</td>
<td>02/03/17 House: Passed by for the day</td>
<td></td>
</tr>
<tr>
<td>HB1509</td>
<td>Mineral mines reclamation, bonds and liens; increases operators bond lien on mined land from $200-1000 to mandatory $3000/acre</td>
<td>01/30/17 House: VOTE: PASSAGE (88-Y 10-N)</td>
<td>01/31/17 Senate, reported from Committee on Agriculture, Conservation and Natural resources (15-Y 0-N)</td>
</tr>
</tbody>
</table>
To Think About

How can we ensure that the benefits of fracking outweigh the costs for Virginia?

What regulations will financially protect communities that are potential sites for fracking?

How will being a Dillon Rule state affect Virginia communities' response to fracking?

Will Virginia see increased prosperity from fracked natural gas?

Will Virginia see an increase or a decrease in income inequality from fracking?

Will natural gas help or hinder us in responding to the costs of climate change?

Dillon Rule

• The Dillon Rule:
  – Virginia Supreme Court adopted in 1896, is a legal principle that
  – local governments have limited authority, and can pass ordinances only in areas where the General Assembly (which meets in the state capitol in Richmond) has granted clear authority
Nitrogen-based fracking

• There are 3 types of N\textsubscript{2} fracking.
  – Pure N\textsubscript{2} gas fracking: For wells < 5000 ft deep and of light sands or shales and coalbed methane.
  – N\textsubscript{2} foam fracking: N\textsubscript{2} is mixed with water and other additives, then cooled to form a dense foam-like fluid. N\textsubscript{2} makes up 53-95\% of the fluid, depending upon the proppant used and the nature of the shale being fracked. This material can be used at greater depths than pure N\textsubscript{2}.
  – N\textsubscript{2} energized fracking: <53\% N\textsubscript{2} is used to energize a more standard water-based fracking fluid to increase the flow-back and fracking efficiency of deep wells.

• N\textsubscript{2} foam fracking is currently being used in VA and is proposed for use in the Taylorsville basin.

• Advantages:
  – decreased H\textsubscript{2}O use,
  – can be safely released into the atmosphere,
  – less fracking waste to dispose of,
  – does not cause well blockage allowing for greater yield,

• Disadvantages: increased set-up costs
Table ES-2. Chemicals reported in 10% or more of disclosures in FracFocus 1.0. Disclosures provided information on chemicals used at individual well sites between January 1, 2011, and February 28, 2013.

<table>
<thead>
<tr>
<th>Chemical Name (CASRN)a</th>
<th>Percent of FracFocus 1.0 Disclosuresb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol (67-56-1)</td>
<td>72</td>
</tr>
<tr>
<td>Hydrotreated light petroleum distillates (64742-47-8)</td>
<td>65</td>
</tr>
<tr>
<td>Hydrochloric acid (7647-01-0)</td>
<td>65</td>
</tr>
<tr>
<td>Water (7732-18-5)c</td>
<td>48</td>
</tr>
<tr>
<td>Isopropanol (67-63-0)</td>
<td>47</td>
</tr>
<tr>
<td>Ethylene glycol (107-21-1)</td>
<td>46</td>
</tr>
<tr>
<td>Peroxydisulfuric acid, diammonium salt (7727-54-0)</td>
<td>44</td>
</tr>
<tr>
<td>Sodium hydroxide (1310-73-2)</td>
<td>39</td>
</tr>
<tr>
<td>Guar gum (9000-30-0)</td>
<td>37</td>
</tr>
<tr>
<td>Quartz (14808-60-7)c</td>
<td>36</td>
</tr>
<tr>
<td>Glutaraldehyde (111-30-8)</td>
<td>34</td>
</tr>
<tr>
<td>Proprang alcohol (107-19-7)</td>
<td>33</td>
</tr>
<tr>
<td>Potassium hydroxide (1310-58-3)</td>
<td>29</td>
</tr>
<tr>
<td>Ethanol (64-17-5)</td>
<td>29</td>
</tr>
<tr>
<td>Acetic acid (64-19-7)</td>
<td>24</td>
</tr>
<tr>
<td>Citric acid (77-92-9)</td>
<td>24</td>
</tr>
<tr>
<td>2-Butoxyethanol (111-76-2)</td>
<td>21</td>
</tr>
<tr>
<td>Sodium chloride (7647-14-5)</td>
<td>21</td>
</tr>
<tr>
<td>Solvent naphtha, petroleum, heavy aromatic (64742-94-5)</td>
<td>21</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemical Name (CASRN)a</th>
<th>Percent of FracFocus 1.0 Disclosuresb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naphthalene (91-20-3)</td>
<td>19</td>
</tr>
<tr>
<td>2,2-Dibromo-3-nitrilopropionamide (10222-01-2)</td>
<td>16</td>
</tr>
<tr>
<td>Phenolic resin (9003-35-4)</td>
<td>14</td>
</tr>
<tr>
<td>Choline chloride (67-48-1)</td>
<td>14</td>
</tr>
<tr>
<td>Methenamine (100-97-0)</td>
<td>14</td>
</tr>
<tr>
<td>Carbonic acid, dipotassium salt (584-08-7)</td>
<td>13</td>
</tr>
<tr>
<td>1,2,4-Trimethylbenzene (95-63-6)</td>
<td>13</td>
</tr>
<tr>
<td>Quaternary ammonium compounds, benzyl-C12-16-alkydimethylchlorides (68424-85-1)</td>
<td>12</td>
</tr>
<tr>
<td>Poly(oxy-1,2-ethanediyl)-nonylphenylhydroxy (mixture) (127087-87-0)</td>
<td>12</td>
</tr>
<tr>
<td>Formic acid (64-18-6)</td>
<td>12</td>
</tr>
<tr>
<td>Sodium chlorate (7758-19-2)</td>
<td>11</td>
</tr>
<tr>
<td>Nonyl phenol ethoxylate (9016-45-9)</td>
<td>11</td>
</tr>
<tr>
<td>Tetrakis(hydroxymethyl)phosphonium sulfate (55566-30-8)</td>
<td>11</td>
</tr>
<tr>
<td>Polyethylene glycol (25322-68-3)</td>
<td>11</td>
</tr>
<tr>
<td>Ammonium chloride (12125-02-9)</td>
<td>10</td>
</tr>
<tr>
<td>Sodium persulfate (7775-27-1)</td>
<td>10</td>
</tr>
</tbody>
</table>

*aChemical* refers to chemical substances with a single CASRN; these may be pure chemicals (e.g., methanol) or chemical mixtures (e.g., hydrotreated light petroleum distillates).

*Analysis considered 34,675 disclosures that met selected quality assurance criteria. See Table 5-2 in Chapter 5.

*cQuartz and water were reported as ingredients in additives, in addition to proppants and base fluids.*
Local Benefits

Revenue from property, sales and severance taxes

Jobs creation:
- Goods and services suppliers—healthcare, amusement, food, merchandise
- Construction
- Oil and gas extraction
- Environmental hydro-geologists
- Ecologists
- Drill site managers
- Pipeline engineers
- Metal fabrication
- Truck transport
- Financial, administrative, HR, IT, legal
- Real estate
- Sales managers

Local Costs

Local government costs:
- Increased demand for public services
- Police, emergency and medical personnel, and other government workers
- Road repair associated with truck traffic
- Sewer and water services associated with industry-driven population growth
- Raising compensation to compete with high-paying jobs in the oil and gas sector

Other costs:
- Negative effect on other businesses, property values, current land uses
- Land remediation
- Water pollution treatment
- Noise
- Traffic
- Night-time lighting
- Demand on water supplies