MARCELLUS SHALE PRIMER

A public service of the **Churchill Area Environmental Council (C.A.E.C.)**
www.CPEG-Inc.com/caec
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BACKGROUND

Development of Pennsylvania's **Marcellus Shale** (**MS**) natural gas resources has begun. Along with portions of Ohio, New York, West Virginia, and Maryland, two-thirds of our state sits on top of a Devonian era, black shale deposit, 350 million years old and 5,000 to 8,000 feet deep, estimated by the U.S. Department of Energy to hold 500 to 800 trillion cu. ft. of natural gas within its pores – the energy equivalent of 140+ billion barrels of oil. This ancient geological formation was named for Marcellus, New York where it can be seen as a surface outcropping. Utica Shale, 2,000 feet beneath the MS, is estimated by some geologists to hold even greater reserves than the MS.

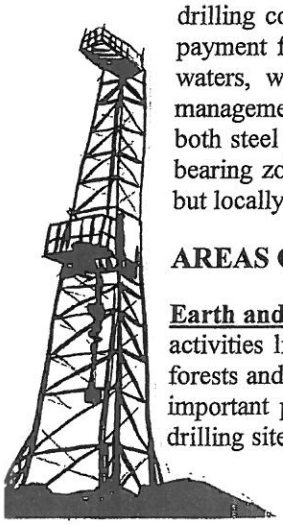
Despite significant technological advances and more competitive pricing in renewable energy sources, the U.S. continues to depend on fossil fuels, e.g. coal, oil, and natural gas, for about 75% of its energy needs, with 20% nuclear, and 5% hydro, solar, and wind making up the rest. Fossil fuels have powered our economic prosperity but have left a bleak legacy of air and water pollution, explosions, fires, cave-ins, mountaintop removals, deaths, and illnesses. Beyond the checkbook price of our fossil fuel use, we pay for the ongoing environmental and human costs of mining, drilling, and generating operations. This primer examines the economic and environmental impacts of developing the vast natural gas-bearing **MS** deposits in our area and the laws/regulations aimed at responsible extraction and avoidance of past mistakes.

Although natural gas is often cited as a cleaner burning fuel than coal or oil, the abundant MS deposits have long been considered prohibitively expensive to access. Recent advances in drilling technology now appear to allow for economical production. Both **vertical and horizontal drilling**, combined with **hydraulic fracturing** or **"fracking"** (also spelled **frac-ing**) are used. After a well is drilled and cased to protect groundwater and prevent the escape of gas and fluids, large amounts of pressurized water (one to five million gallons per well) mixed with sand and chemical additives are pumped in to crack (fracture) the shale around the base of the well and release the contained gas. The sand props open the fractures to improve gas flow to the well. According to Jack Ward of PetroEdge Energy, the MS rock layer is thinnest in southwestern Pa. and northern W. Va., so gas extraction from its fissures is easier (requiring less force) and less costly – making our area very attractive for drilling. Each well with horizontal reach can drain gas from large areas of shale over many acres – as much as eight times more than a traditional vertical well. On a cautionary note, researchers like Robert Howarth of Cornell Univ. (*Climatic Change*, 2011) have calculated that fugitive methane emissions from natural gas wells and distribution lines may have greenhouse gas and climate consequences greater than coal per energy unit when the whole production/use life cycle of both fuels is compared.

DRILLING LAWS, REGULATIONS

The key to responsible extraction of MS gas resources lies in adequately funded, vigorous enforcement of Pennsylvania's oil/gas laws and regulations, some of which (e.g. specifications for well construction) are among the most stringent in the nation. Examples include the Clean Streams Law, Oil and Gas Act, Oil and Gas Conservation Law, Gas Resource Coordination Act, Dam Safety and Encroachments Act, Solid Waste Management Act, and Water Resources Planning Act.

The **Pennsylvania Department of Environmental Protection (PaDEP)** is the designated regulator, requiring each drilling company to obtain a well permit and post a bond (money or insurance to guarantee job performance and payment for damages). The permit application must show the well location and proximity to coal seams, surface waters, water supplies, and stream buffer zones. Operators must submit reports on well completion, waste management, annual gas production, and well plugging. To protect groundwater, well design requirements include both steel pipe and concrete casings around MS wells through fresh water aquifers before drilling into deeper gas-bearing zones. Drillers are required to replace or restore any water supplies adversely affected by drilling, a rare, but locally urgent occurrence. The PaDEP investigates and acts on complaints within ten days.



AREAS OF CONCERN AND INTEREST

Earth and Local Disturbance: Each drill pad with its rig(s) occupies 3 to 5 acres and can house multiple wells, so activities like gas well construction have an extensive impact on land and access roads, often in public or private forests and other wildlife/plant habitats. These include disruptive fragmentation of habitats and potential damage to important parks and recreation areas, e.g. Ohiopyle State Park and Allegheny National Forest. Preparation of a drilling site may include vegetation clearing, soil compaction, and erosion, plus sedimentation at the pads and along

miles of new, buried pipelines. Drillers are required (Pa. Code Chapter 102) to use "Best Management Practices" (BMPs) to restore the site and its plant cover within nine months of well completion. Drillers using BMPs must minimize point source discharges to surface waters and protect the quality of receiving waterways. Possible **local concerns** include noise, lighting, and the heavy tanker truck traffic that can raise dust and degrade roads. Tensions may emerge between leasing and non-leasing residents in an area, those making and not making financial gains from gas extraction. Increases in non-violent crimes such as drug violations and workers "driving under the influence" are associated with the introduction of drilling. Property values may fluctuate, and in some areas, where land has been leased, residents have had problems buying and selling property.

Water Use and Waste Water Disposal: The permit application requires companies to identify where they plan to obtain and store the water used in drilling and to disclose where wastewater (**frack** [or **frac**] return) will be treated, stored, or deposited. New, approved treatment facilities are expected by 2013, but current municipal water treatment plants that receive drilling wastewater may have neither a large enough capacity nor the technical capability for removing all the contaminants, including radioactive elements. Storage pits or impoundments must meet DEP standards and may require a DEP dam permit. Wastewater may be reused at another well or collected and delivered to permitted underground injection sites (regulated under the U.S. Safe Drinking Water Act). Some Pennsylvania gas producers reuse as much as 70 to 90% of the water that returns to the surface from drilling.

Water pollution: With best practices in place, surface waters and underground aquifers should not be affected by MS drilling since the shale is located at depths well below these supplies, and permitted drilling occurs only within hardened casings. However, potential **problems** may include:

- **Leakage of wastewater and gas migration** through fissures in the ground and poorly made casings, especially over the long term. A Duke University study (*Proceedings of the National Academy of Sciences*, May 2011) of 68 drinking wells showed an increase of methane gas to dangerous levels when wells were within 0.6 miles (1 km) of active drill sites in their study areas.
- **Odors and fumes** from fracking fluids stored in containment ponds.
- **Fracking fluid**, a portion of which remains in the ground with unknown long-term effects on water supplies and underground aquifers.
- **Accidents**, e.g., the well blowout on state forest land in north central Pa. on Jan. 17, 2011, and **illegal actions**, e.g., improper drilling methods and improper disposal of used fracking fluids in Dimock [northeastern] Pa. in 2009 by Houston-based Cabot Oil and Gas Co. that resulted in methane contamination of residential wells for which Cabot paid residents $4.1 million and is providing delivered, potable water.
- **Chemicals** comprising up to one percent of the fracturing mixture that have been described by critics of MS drilling as a "toxic" and "secret" brew. However, **a list of all chemicals must be disclosed in writing** to agencies such as the PaDEP as part of the permitting process, and is available to landowners, local governments, and emergency responders upon request. The proprietary mixture of chemicals used in drilling may include sodium chloride, potassium chloride, ethylene glycol, hydrochloric acid, methanol, propanol, ammonia, sodium bicarbonate, formaldehyde, benzene, barium, isobutane, et al. Some of these chemicals are found in household products and solvents, but none of them should be in drinking water. Although 99% of the fracturing mix is water and sand, considering the large volume of water used at each well, there can be significant chemical content in the wastewater. In addition, the frack wastewater may contain bromide salts. Wilkinsburg-Penn Joint Water Authority has upgraded its final treatment process, substituting chloramine for chlorine to avoid the formation of toxic brominated organic compounds.
- **Radiation** from radium, uranium, and other elements that occur naturally in rocks deep in the earth. Radiation monitoring has been ordered by the PaDEP at several points in the gas production cycle and at waste treatment and drinking water plants. Radiation testing has been recommended for fertilizer and de-icing sludges from treatment plants and for sediments at the bottom of rivers that receive drilling wastewater. The DEP has reported that potable water sources tested so far have met drinking water standards for radiation. The EPA urges "expedited and more frequent radiation testing" in all seasons of the year, particularly near sewage treatment facilities receiving MS wastewater

Water sourcing: Availability of adequate supply may pose problems in view of the huge water demands of drilling. Nearby streams and local ponds/lakes have competing uses from aquatic life, vegetation, and people. In addition, there is seasonal and annual variability in supply and flow rate. A proposed approach is to use water from inactive coal mines, which might reduce acid mine drainage into some local creeks and streams.

Air Pollution: Air quality can be affected by the drilling process, compressor operations, and heavy truck traffic, especially on gravel roads. Increased particulates and smog have been noted in other states where hydraulic fracturing has been prominent. Volatile carcinogens and neurotoxins can vaporize from poorly managed frack water. High levels of fracking chemicals, such as benzene, xylene, carbon disulfide, and naphthalene have been

measured in the air over DISH, Texas, where there are several large compressors. The Pittsburgh-based Group Against Smog and Pollution (GASP) has noted, however, that air pollution can be mitigated, and drillers can recapture these valuable organics, although most do not do so now. Oil and gas companies are required to start tracking emissions this year (2011) and report findings to **U.S. Environmental Protection Agency (EPA).**

Leasing: An oil and gas lease is a contractual agreement between the owner of a property's oil and gas rights and a drilling company. A fee is paid to the owner by the company for the right to extract the underlying gas, typically on a per acre basis for up to five years. Lease prices have been negotiated in Pennsylvania for as little as a few hundred dollars up to many thousands of dollars per acre. Leaseholders typically request the right to install pipelines and other distribution equipment on the property. Most urban/suburban residents do not own the mineral rights under their properties, which, in any case, are usually too small to interest drillers. At this time more than a quarter of Pennsylvania (mostly rural areas, and including one third of state forest land) has been leased for gas exploration, with over 5,000 permits issued since 2005. The PaDEP estimates that 50,000 natural gas wells may be drilled over the next 20 years and recommends that property owners consult an attorney familiar with oil and gas law before signing any document or accepting money from any company offering to lease or purchase mineral rights.

Gas Royalties: These are shares of a well's production income over time. Royalties, by law, must be a minimum of 12.5% of the gas value but can be negotiated higher. They can be a significant, ongoing source of income for private and public landowners, but the money can prompt government to consider leasing what some environmental groups consider sensitive conservation lands. A forestry study by the Pa. Dept. of Conservation and Natural Resources (PaDCNR) concluded, "No additional leasing can occur without significantly altering the ecological integrity and wild character of our state forest system."

Monitoring: Field operation staff members of the PaDEP inspect well sites from construction to reclamation for compliance with all regulations. There were over 5,000 such inspections in 2010 (double that of the previous year) according to former Governor Ed Rendell. Permitting staff members review all required reports during the gas production process, investigate complaints, and, when necessary, use progressive enforcement to ensure compliance with Pennsylvania's standards for sound well construction, maintenance, and long-term well integrity. Don Hopey (*Pittsburgh Post-Gazette*, May 15, 2011) reported a significant drop in shale drilling fines by the PaDEP this year. The article also noted that the agency is conducting an analysis of the data. On May 17, 2011 the largest single fine to date was levied on Chesapeake Energy - $900,000 for private water supply contamination in Bradford County. An additional $188,000 fine (highest allowable under the Oil and Gas Act) was imposed for a tank fire on Feb. 23 at the company's drilling site in Avella, Washington County. DEP secretary Michael Krancer said, "Natural gas drilling presents a valuable opportunity for Pennsylvania and the nation. But, with this opportunity comes responsibilities that we… expect and insist are met; we have an obligation to enforce our regulations and protect our environment."

Economic Impact: Increased fuel consumption and additional reliance on imported fuels create real pressure for rapid development of MS natural gas reserves. MS gas has been called a "bridge to planned energy independence" and sustainability. It can reduce our current reliance on foreign countries that are often unreliable or unstable. President Jimmy Carter once called dependence on foreign sources a "clear and present danger" to our national security and every recent president has considered greater energy independence a priority. According to financial columnist Christopher Swann (*New York Times*, Jan. 17, 2011), "shifting America's gasoline-guzzling heavy truck and bus fleets to natural gas [currently in trial stages in the U.S., including in Pittsburgh] could cancel imports by 3 million barrels of oil per day and shave $100 billion off the annual trade deficit at current oil prices." Increased use of energy-efficient products and expanded conservation efforts across the country could yield even more savings.

Jobs: MS exploration added an estimated **88,000 jobs in Pennsylvania** over the past two years. Researchers at Penn State have predicted that number will climb to 110,000 in 2011. Due to a current deficit of trained local workers, some employees, especially experienced drillers, are imported by out-of-state firms. Of the ten largest drilling companies operating here, only two are from Pennsylvania while six are from Texas. However, many jobs are located along the local supply chain - people who forge steel, manufacture pipe, sell sand, provide transportation, operate equipment, perform environmental work, research deeds, sell food/personal items, and operate hotels. Currently, companies are training local talent for skilled drilling jobs, and several local colleges have received grants to provide classes for MS workers at a low- or no-cost basis to increase the supply of qualified local employees. At the regulatory end, the PaDEP hired 37 additional inspectors and permitting staff members in 2009 and 68 more enforcement officers in 2010. Funding for the additional regulators comes from new, higher, permitting fees.

Taxes and Fees: A **severance tax** on the amount or value of non-renewable gas severed (removed) from Marcellus Shale was defeated in the Pa. Legislature in 2010, and Governor Tom Corbett opposes the tax. Pennsylvania is the only MS state that does not have a severance tax. Some form of **impact fee** may be enacted in the near future, critical for "mitigation of local [costs]…over the lifetime of natural gas extraction," according to Julia Haggerty in

the *Pittsburgh Post-Gazette* (Feb. 8, 2011). She also advocates closing a loophole in state law excusing natural gas developers from local property taxes. Money generated from such taxes could support local infrastructure (e.g. roads), assist local governments in responding to the impacts of drilling, and increase funding for the PaDEP whose budget is inadequate for crucial oversight responsibilities as MS drilling expands. John Hanger (former director of the PaDEP) said recently, "There is no such thing as zero-impact drilling, even when it goes well." A Pennsylvania Land Trust Association review of DEP records revealed 1,430 gas exploration/drilling violations from January 2008 through June 2010. Over 950 of them were judged likely to have adverse environmental impacts.

Disputes Over Regulatory Jurisdiction: Senator Robert Casey's proposed "FRAC Act" would bring hydraulic fracturing under **federal** (EPA) standards and oversight nationwide. It would close the 2005 "Halliburton loophole" that exempts MS fracturing from the Safe Drinking Water Act. **States** want to retain individual control and Governor Tom Corbett has appointed a Marcellus Shale Advisory Commission to report in mid-July on policy changes needed to "balance job growth and environmental protection." The commission has been criticized for top-heavy representation by industry, but The Nature Conservancy (TNC) will also be at the table, along with its new analysis (from digital mapping) of where and how energy development will affect rural communities and wildlife hot spots. TNC analyst Nels Johnson said, "It's possible to use these new data to help inform decisions in developing much of [our] energy potential without destroying what's best in our globally important forests." New York has a statewide moratorium on Marcellus drilling until the federal EPA completes a study of hydraulic fracturing in 2012. Previous studies of fracking technology, some potentially tainted by gas industry connections or funding, have yielded favorable (Penn State, 2009), mixed (M.I.T., 2006), or cautionary results (previously mentioned research at Cornell and Duke, 2011). **Counties, Cities, and Municipalities** are grappling with their own regulation of Marcellus drilling. Pittsburgh City Council passed a ban on natural gas production in November 2010. Allegheny County is holding hearings as it considers its approach to the drilling issue. Fayette County (home to Ohiopyle and Fallingwater), Findlay Township (location of the Pittsburgh Airport), and municipalities, including Murrysville, Elizabeth, Churchill, and Wilkins in southwestern Pennsylvania, have passed ordinances regulating drilling locations, minimum acreages, pollution, and safety hazards. In a case involving Oakmont, the Pennsylvania Supreme Court ruled that municipalities can use their zoning laws to prohibit gas wells in R-1 residential areas. South Fayette Township (Allegheny County) passed an inclusive ordinance (November 15, 2010) that addresses many of the concerns discussed above and is becoming a model for others.

SUMMARY

Marcellus Shale offers an abundant fuel source that can boost local economies and energy independence, at least temporarily. Its responsible, regulated development has been described as "key to the economic future" of our region and nation. Like most large-scale energy ventures, it comes with environmental costs and potential public health hazards, so it is critical that our state officials "get it right." It takes time and resources to assemble a full quiver of regulations and trained staff to ensure that our air and water remain safe, and our ecosystems remain functional and intact.

Responsible producers in Pennsylvania can call on current, advanced technologies to meet environmental standards. Regulation is critical and laws are in place with enforcement and penalty provisions intended to hold the industry accountable. Citizen organizations such as Pittsburgh-based GASP, the University of Pittsburgh's Marcellus Stewardship Project, Fayette County's Mountain Watershed Association, and many others are serving as local watchdogs, providing field training, instruction in air and water monitoring, and an on-line venue, for people to report what they see. < www.fractracker.org>

Even assuming the best available technology, regulation, and enforcement, the development of such a huge and widespread resource as MS natural gas is certain to leave a large footprint on our land, water, and air. Risks of pollution, accidents, or illegal actions are always worrisome. No energy form is free in any sense. As responsible citizens we must all commit to using our energy resources conservatively, in every sense.

USEFUL WEB SITES FOR MORE INFORMATION

http://fracfocus.org
www.dep.state.pa.us (Click "Oil and Gas")
www.riverreporter.com/issues/news-fracking
http://shale.sites.post-gazette.com
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