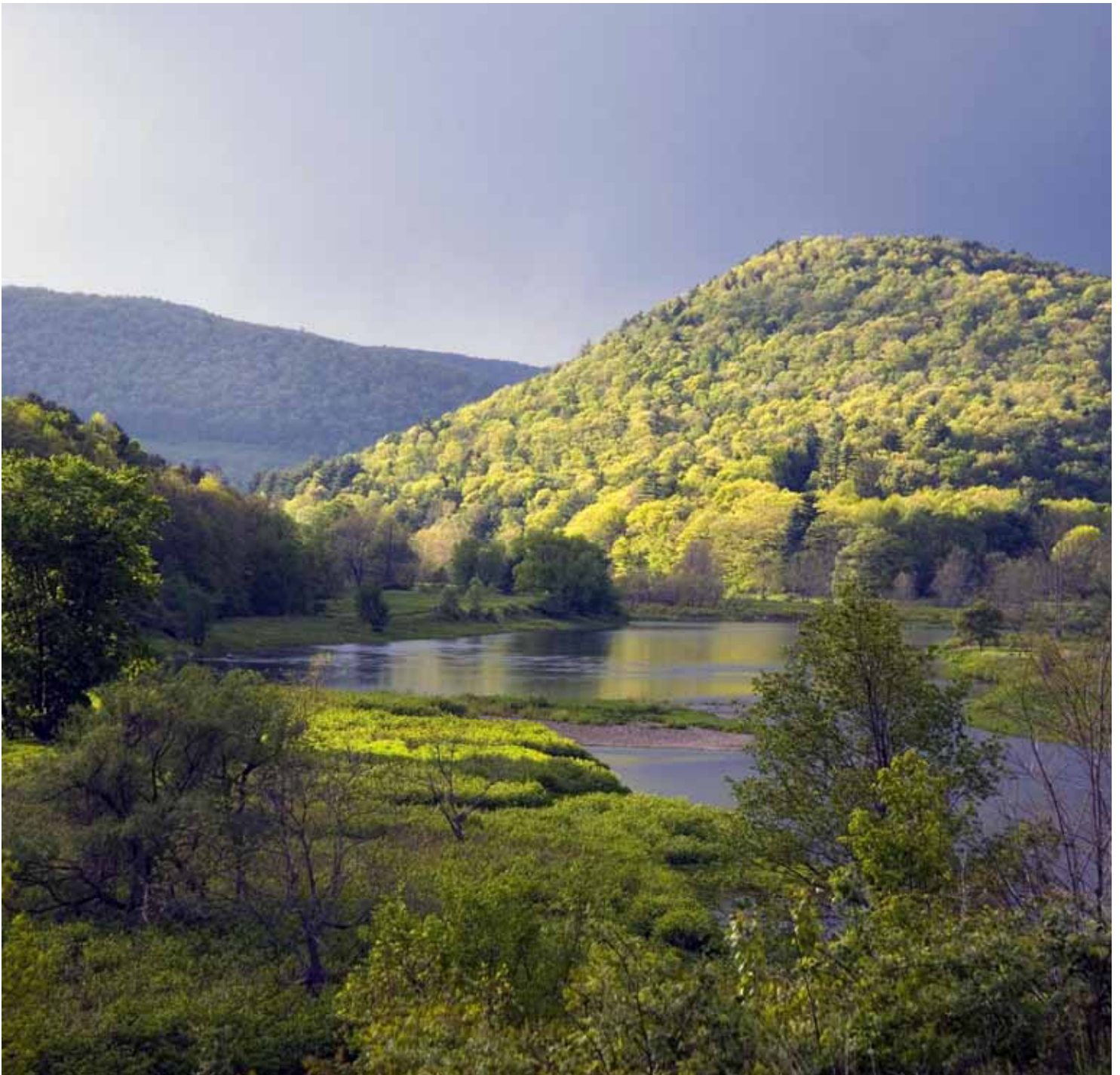




Development of the Natural Gas Resources in the Marcellus Shale

New York, Pennsylvania, Virginia, West Virginia, Ohio, Tennessee, and Maryland

November 2009





THIS PAGE & ON THE COVER:
Upper Delaware Scenic and Recreational River,
New York & Pennsylvania.

(Photos by David B. Soete)

Notice:

This report was produced for informational purposes only and does not support or oppose development of the Marcellus Shale natural gas resource. The report is intended to provide NPS field staff and management with technical and environmental information regarding shale gas well development, ancillary facilities associated with that development, and potential environmental impacts.

Development of the Marcellus Shale

I. Introduction

Approximately 35 units of the National Park System overlie or are in the vicinity of the geologic formation known as the “Marcellus Shale.” In addition, a number of special status areas (e.g., sites on the National Register of Historic Places, National Trails, and other affiliated areas) also overlie or are near the shale deposit. The Marcellus Shale formation occurs primarily beneath the states of New York, Pennsylvania, West Virginia, and eastern Ohio with lesser occurrences in Virginia, Maryland, and Tennessee.

Oil and gas industry interest is increasing as this geologic formation becomes better understood. In early 2008, two professors at Pennsylvania State University and the State University of New York (SUNY) Fredonia estimated that about 50 TCF (trillion cubic feet) of recoverable natural gas could be extracted from the Marcellus Shale (Engelder and Lash, 2008). By November 2008, on the basis of production information from Chesapeake Energy Corporation, the estimate of recoverable gas from the Marcellus Shale was raised to more than 363 TCF (Esch, 2008). The United States uses about 23 TCF of natural gas per year (U.S. Energy Information Administration, 2009), so the Marcellus gas resource may be large enough to supply the needs of the entire Nation for roughly 15 years at the current rates of consumption.

Development of the natural gas resource from the Marcellus Shale poses numerous environmental and socioeconomic issues for the areas that overlie what may be the most productive areas of the shale. The large amount of industrial activity necessary for shale gas development may result in impacts to air, water, wildlife, sound, night sky, and cultural resources. In addition, an influx of oil and gas industry workers could result in housing shortages, overcrowding in schools, and may strain available infrastructure such as shopping, lodging and eating establishments. Units of the National Park System and other affiliated areas may also experience visitor use conflicts with the potentially large amount of drilling-related industrial activity occurring in and around parks. This activity may degrade the visitor experience. The large amount of traffic supporting drilling activities may also pose visitor safety risks.

The states of New York, Pennsylvania, West Virginia, Virginia, Ohio, Maryland and Tennessee each regulate the development of oil and gas to varying degrees. Each of these six states require permits to explore for and develop the oil and gas resource and also conditions each permit with stipulations to protect the environment and public health and safety. Since the NPS has no direct regulatory control over oil and gas operations external to its boundaries, it is advantageous for the NPS to participate in the “public comment” process offered during the permitting process by the six states listed above. In addition, some states have state environmental quality acts which may offer the NPS another opportunity to provide input to help minimize impacts to parks associated with oil and gas development permitted by these states.

If exploration or development activities are proposed within park boundaries pursuant to privately held oil and gas rights, the NPS may be able to apply its regulations at 36 CFR Part 9, Subpart B to ensure protection of park resources and values. However, because these regulations only apply when an entity must cross federally owned or controlled lands or waters to reach its private property rights, the 9B regulations may not be applicable in all cases.

Due to the significant number of units of the National Park System and affiliated areas overlying and near the Marcellus formation, it is important for the NPS to become well informed and stay abreast of Marcellus shale development issues. For a detailed list of NPS units located both in and near the vicinity of the Marcellus Shale occurrence, please see Appendix 1.



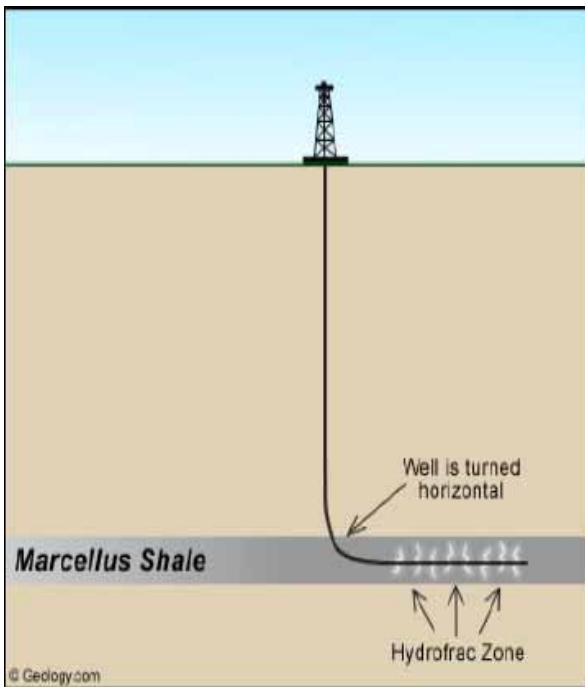
Location of the Marcellus Shale

II. Geology & Estimated Size of the Marcellus Shale

The geology of the Marcellus Shale is well defined and its capacity to store large amounts of natural gas is explained through a process that occurred approximately 390 million years ago. Geologists believe that sediments sank to the bottom of the shallow sea that covered the Appalachian Basin and formed the Marcellus Shale. Those sediments, along with the remains of tiny sea plants and animals, were deposited over large areas in Pennsylvania, West Virginia, New York, and Ohio, and small areas in Virginia, Maryland, and Tennessee.

As sea plants and animals died, they sank to the bottom of the ocean and were buried along with the layers of sediments that over time turned into rock. There was very little oxygen in the water at the bottom of the ocean to oxidize organic matter, so much was preserved in the sediment and subsequent rock. Eventually, the layers of sedimentary rock became thousands of feet thick, subjecting the plant and animal remains to enormous heat and pressure. The pressure, the heat of the earth, and the lack of oxygen, combined to change this organic mixture into petroleum and natural gas. Generally speaking, lower temperatures and pressures generate petroleum while higher temperatures and pressures generate natural gas, but this is also a function of the “type” of organic matter present. Over time, concentrations of natural gas became trapped in the rock layers now called the Marcellus Shale.

If it were not for fracturing of the rock, the natural gas would have remained trapped in the extremely small pore spaces of the rock. However, as pressure built in the rock pores as natural gas formed, very



Horizontal Drilling Technology

fine cracks occurred in the rock which gradually enlarged into what are known as “joints and fractures.” Mountain building caused a second set of joints and fractures to form in the rock. This second set formed almost 90 degrees to the original joint set. These two joint sets in combination with artificially induced fractures from in-situ hydraulic fracturing, now allow a tremendous amount of natural gas to be extracted from the fractures in the Marcellus Shale.

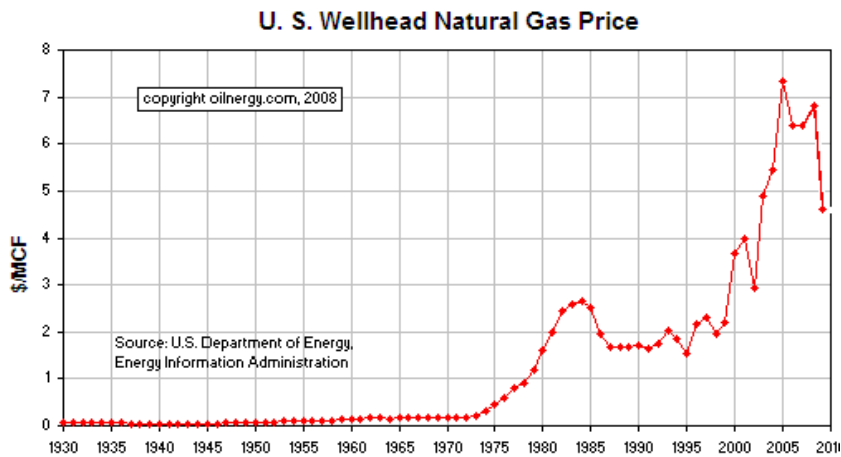
The Marcellus Shale in New York, Pennsylvania, West Virginia, Virginia, Tennessee, Maryland, and eastern Ohio covers roughly 48,000 square miles (31 million acres). The formation has an average thickness of approximately 100 feet. Its true natural gas producing potential will not be known until a significant number of wells are drilled. A 2002 USGS assessment (USGS Fact Sheet FS-009-03) calculated that the Marcellus Shale contained an estimated 1.9 TCF of recoverable natural gas.

However, as the shale formations were further studied, a 2006 USGS assessment placed the recoverable gas resources at approximately 31 TCF (USGS Open File Report Series 2006-1237). Most

recent USGS Fact Sheets acknowledge the potential that over 300 TCF could ultimately be recovered.

III. Technology Associated with Gas Production

While limited production has occurred in the Marcellus Shale to date, drillers in the Barnett Shale of Texas have demonstrated that new technology in the form of horizontal drilling and hydraulic fracturing of the shale (fracturing through the use of high pressure liquids) has helped overcome the flow capacity problem of gas shales. Horizontal drilling is a technique used to expose long sections of the reservoir rock to the wellbore. While a conventional vertical well penetrates and exposes only the thickness of a



pay zone (e.g., 50 to 300 feet in the Marcellus Shale), horizontal drilling can expose over a mile of reservoir rock for production by steering a drill bit to follow the pay zone.

Hydraulic fracture stimulation creates additional flow paths to the well. In this process, fluid is pumped into the formation at high enough pressures and rates to split the rock. Sized particles such as sand are also mixed with the fracturing fluid to hold the cracks open once

pumping stops. In addition, wells can be oriented to intersect natural fractures that occur in many formations. The higher demand and increased prices for natural gas will support the higher costs of using the new horizontal drilling technology as shown in the graph of historical natural gas prices.

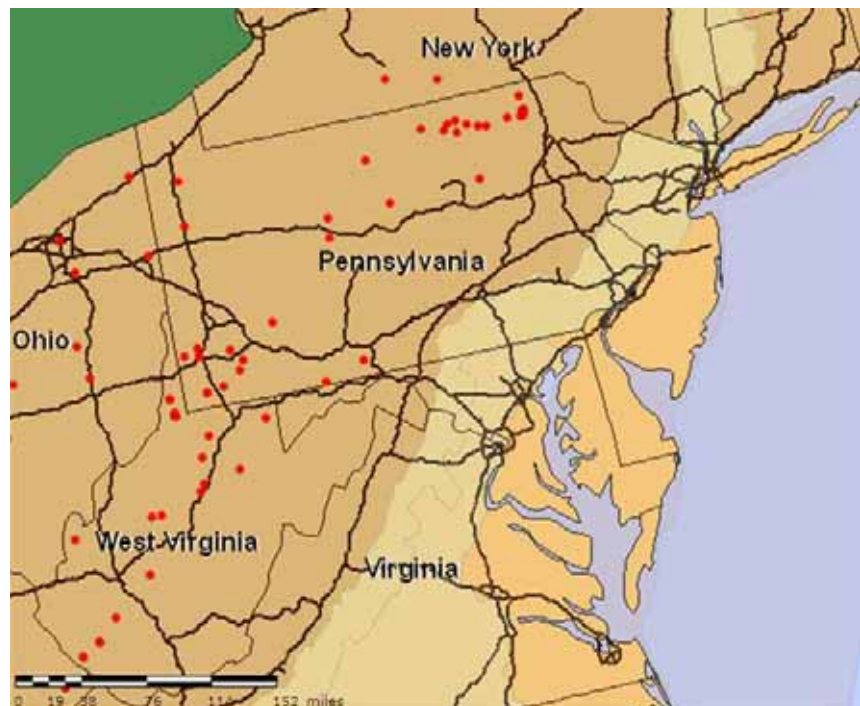
During this early testing and development phase of the Marcellus Shale, operators will experiment with both vertical wells and varying length horizontal well completions as well as different hydraulic fracturing techniques and job sizes. Gradually drillers will determine the best methods for extracting the most gas per investment dollar. The best methods will likely vary across the Marcellus Shale play due to differences in thickness, composition, water content, pressure, and depth to name a few factors.

IV. Current Activity to Extract Gas

Drilling in the Marcellus Shale is in its second year. Companies seem to be focused on Pennsylvania, though drilling is also occurring in West Virginia and Ohio, and New York. Over the past decade, it was common for Pennsylvania to have about 10 active drilling rigs at any point in time drilling conventional oil and gas wells. In the past year, rig count has steadily increased to nearly 40 active rigs. Pennsylvania's Bureau of Oil and Gas

Management reports that 1,516 wells have been drilled to the Marcellus Shale as of November 2009. However, the Bureau has very limited information on the production rates (success) of the completed wells. In these early stages of Marcellus development, well operators are choosing to keep well information confidential. The Bureau also indicated it has issued an additional 1669 drilling permits as of November 2009.

The figure to the right is an example of a map from the Baker Hughes website, a company that provides the oil and gas industry with geologic formation evaluation. The red dots



June 2009 locations of active drill rigs in the Marcellus Shale area. (Illustration: Baker Hughes)

represent active rig locations as of June 12, 2009. Leasing activity is the leading indicator of future drilling activity. However, since most leases in the vicinity of the Marcellus Shale are occurring on private property, the state permitting agency may not learn about the leases until a lessee applies for a permit to drill.

V. Likely Affected Parks and Special Status Areas

Units of the National Park System and special status areas (e.g., sites on the National Register of Historic Places, National Trails, and other affiliated areas) located in southern New York, western and central Pennsylvania, eastern Ohio, and most of West Virginia may be affected most by development of the natural gas resource of the Marcellus Shale. In 2008, landowners in and near Upper Delaware Scenic and Recreational River began receiving offers from developers to lease the privately held natural gas resource. These sometimes lucrative offers may include a “bonus bid” to hold the property until development occurs, and contracted “royalties” on gas produced in the future. The lease offers have split some communities between those who see this as an opportunity to make a significant amount of money from their property, and those who wish their land to remain untouched, in a more natural condition.

Upper Delaware Scenic and Recreational River is one of numerous NPS units in the Marcellus Shale area that is vulnerable to impacts from development of nonfederal mineral rights within park boundaries on privately held mineral estate. It is important that park resource managers from the parks listed in Appendix 1 be aware of any nonfederal mineral ownership which may occur in their parks. Special status areas may also be faced with such development due to split estate ownership of the surface and mineral estate.

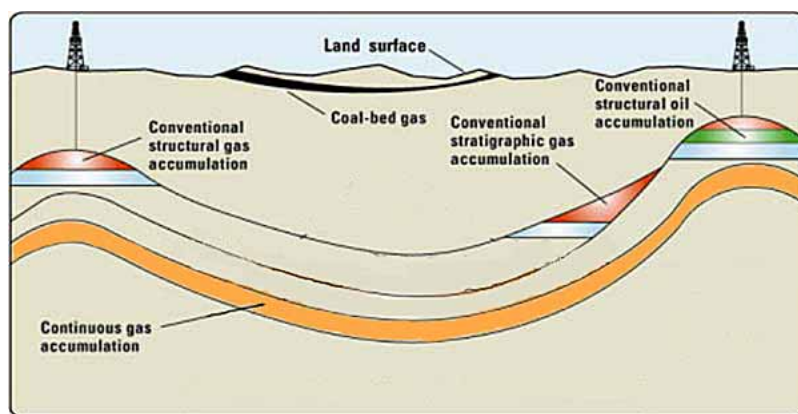
VI. Potential Environmental Effects

Natural gas drilling and production is an industrial activity with a host of environmental consequences. Effects include water contamination related to drilling and disposal of drilling fluids, reductions in stream flow and ground water levels from operational water requirements, air quality degradation from internal combustion engines on drill rigs and trucks, excess dust from equipment transportation, impacts to terrestrial and aquatic wildlife, disruption of solitude, impacts to night skies, impacts to cultural resources, and safety concerns associated with the large number of trucks needed to support drilling operations (*see* Section VI., Truck Transportation Needs). While the horizontal drilling and hydraulic fracturing practices expected to be used in developing the Marcellus Shale may have negative environmental effects on the surrounding area, when compared to development of conventional oil and gas resources this development method could result in fewer impacts than conventional vertical wells due to greater flexibility in well location.

Appendix 2 provides a summary of impacts from the various phases of natural gas operations and common mitigation strategies. The list is by no means exhaustive nor does every concern and strategy apply to every operation. The following pages contain information on the most likely effects associated with Marcellus gas production. The Geologic Resources Division is available to help park managers identify specific impacts relative to specific proposals and identify mitigation measures. In doing so, GRD will coordinate with other experts in the Natural Resource Program Center and the affected regions.

Widespread Development and Well Spacing

Well spacing requirements vary by state (see the table below). Conventional gas reservoirs are scattered over a trend and rely on geology to trap and hold gas that has migrated to relatively small areas of a rock formation. Conventional reservoirs are relatively limited in areal extent. On the other hand, unconventional (continuous) or “resource” plays contain natural gas throughout the formation. They are both the source of natural gas and the reservoir. The Marcellus Shale is continuously deposited over vast areas of New York, Pennsylvania, Ohio, and West Virginia. It is conceivable that over the course of many years wells could be drilled on every available spacing unit. A spacing unit is the number of acres per well required to efficiently develop the natural gas resource. In most cases, state regulatory agencies initially define allowable spacing units. This often results in wells being spaced closer together over time.



Conventional well spacing (Source: United States Geological Survey)

The spacing histories of the Barnett, Fayetteville, Antrim, New Albany, Ohio, and Woodford shales all trend from larger to smaller spacing units. For the Marcellus Shale, it is reasonable to expect 320-acre or 160-acre spacing initially, and eventually some areas experiencing infill drilling to 80-acre or even 40-acre spacing should infill drilling be economic.

Sample of Well Spacing Requirements

Gas Shale Name	State(s)	Well Spacing
Barnett Shale	TX	<ul style="list-style-type: none"> ▪ 40- to 160-acre spacing typical ▪ 20-acre spacing being tested
Fayetteville Shale	AR	<ul style="list-style-type: none"> ▪ 40-acre spacing by rule (Arkansas Oil and Gas Commission Rule B-43) ▪ 80- to 160-acre spacing in practice ▪ 60-acre spacing being tested
New Albany Shale	IL, IN, KY	<ul style="list-style-type: none"> ▪ 160-acre spacing initially ▪ 80-acre spacing now common
Antrim Shale	MI	<ul style="list-style-type: none"> ▪ 40- to 80-acre spacing
Ohio Shale	OH	<ul style="list-style-type: none"> ▪ 40- to 160-acre spacing
Woodford Shale	OK	<ul style="list-style-type: none"> ▪ 640-acre spacing initially ▪ 160-acre spacing now common ▪ 80-acre spacing proving effective ▪ 40-acre spacing being tested
Marcellus Shale	NY, PA, OH, WV	<ul style="list-style-type: none"> ▪ 160- to 320-acre spacing initially ▪ 40- to 80-acre spacing can be expected

Larger Sites in Support of Bigger Rigs and Hydraulic Fracture Stimulation Equipment

The rigs being used to drill horizontal sections are larger and require more space than conventional drilling techniques. The dimensions of a drill site also need to take into account the space needed for equipment and material storage necessary for large fracture stimulations. Whereas conventional oil and gas wells result in 1-1/2 to 3 acres of disturbance at the drill site, Marcellus well sites are likely to range from 4 to 6 acres.

One of the benefits of horizontal well completions is the ability to site multiple wells on one location. So while the individual sites may be much larger, the overall disturbance on an acres/well basis could end up being less than in the past. Also, with the horizontal sections ranging from 2000 to 4000 feet in length, there may be opportunities to site the surface operations away from sensitive areas without losing the ability to recover the gas.

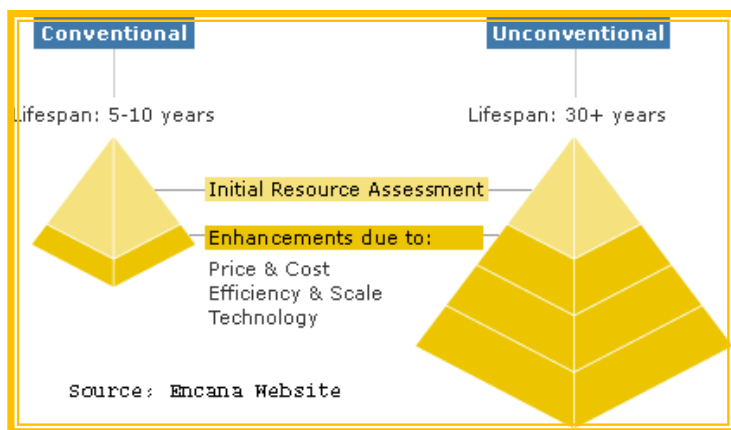


Typical equipment on a horizontal gas well site (Photo: catskillmountainkeeper.org)

Longer Well Life

Shale gas wells will invariably produce for a much longer period than wells drilled in conventional reservoirs. Unconventional reservoirs like the Marcellus are capable of delivering profitable production for decades through the application of advanced technology and large manufacturing-like development programs that capture economies of scale. Original assessments of recoverable reserves from conventional reservoirs typically identify the majority of the resource in place, with a somewhat limited upside potential. These reservoirs are typically produced over a five-to ten-year lifespan.

In contrast, original assessments of unconventional gas reservoirs often show only a small percentage of what is ultimately recoverable. Unconventional development involves drilling numerous wells in a repeatable manner that captures economies of scale. These reservoirs are produced over 30 years or more. As a result, the company can take advantage of operational efficiencies and new technologies, developed over time, to reduce costs, extend the life of the wells, and increase recoveries. The diagram to the left compares the potential of a conventional gas reservoir to that of an unconventional reservoir.



Life span: Conventional vs. unconventional shale gas wells

High Water Use Needs

Water related issues rank high among concerns associated with the development of gas wells in the Marcellus Shale. These issues include water quantity, quality, rights, and disposal of contaminated water.

Development of the natural gas resource from shale often requires large volumes of water. Water is used primarily in the hydraulic fracturing process of well development. Hydraulic fracturing is when fluids are forced under high pressure into the well to fracture the shale surrounding the borehole in an effort to liberate more gas from the low permeability shale gas reservoirs.

State permitting agencies have projected that the horizontal drilling method that will likely be employed in the Marcellus Shale may require extensive amounts of water to develop and recover natural gas. Traditional (i.e., vertical) gas wells typically use less than one million gallons, but horizontal wells can require up to 3 to 5 million gallons per well. In addition, the potentially large volumes of water would be mixed with one or multiple chemical additives to optimize well bore and fracture treatment to achieve the desired gas production rate.



Water storage at a typical gas well (used by permission, West Virginia Surface Owners Rights Organization: www.wvsoro.org)

Drilling methods will most likely involve slick water fracturing (also called sand fracturing), a method using a mixture of sand and the carrier fluid of water or brine. Fracture fluids typically also contain numerous additives such as demulsifiers, corrosion inhibitors, friction reducers, clay stabilizers, scale inhibitors, biocides, breaker aids, mutual solvents, alcohols, surfactants, anti-foam agents, defoamers, viscosity stabilizers, iron control agents, diverters, emulsifiers, foamers, oxygen scavengers, pH control agents, and buffers.

Hydraulic fracturing waste water containing any of the above listed constituents may be disposed of by various methods. One method is to capture the waste water in tanks and haul it to a licensed disposal or treatment facility. This option will increase the amount of truck traffic (*see* Section VI., Truck Transportation Needs) at the site and on surrounding roads, but minimizes the possibility of onsite impacts from leakage or spills. Operators may also opt for onsite storage and treatment in lined storage ponds. As in the management of any liquid waste and particularly those of large volume, there is both an increased potential for a release to the environment in handling the larger volumes and the potential for greater effects should a larger release occur (e.g., in breaching of some retaining structure). A larger

surface use area will also be needed for water storage. It is possible that more than fifty percent of the recovered water can be reused in subsequent well fracturing. Studies show that up to a quarter of the water used can be recovered as fresh water for beneficial uses such as irrigation.

If, as projected, a large number of gas wells are drilled in the Marcellus Shale, a significant amount of water will be needed to develop well fields. The ability to obtain water rights to support a large number of wells may become an issue. For example, the Susquehanna River Basin Commission manages basin water resources in Pennsylvania, New York and Maryland; and seventy-two percent of that basin is underlain by the Marcellus Shale. Two important regulations overseen by the Commission include the regulation of consumptive water use (806.4(a)(1)) and the regulation of water withdrawals (806.4(a)(2) (iii)). Numerous other federal, state, local, and private water rights could also compete for the large amount of water that will be needed for significant gas development in the Marcellus Shale.

Potential Aquifer Contamination Associated with the Hydraulic Fracturing Process

In most areas of the Marcellus Shale play, induced fractures from treatments should not create a geological pathway to usable quality aquifers. This is because there are often thousands of feet of rock between the usable quality aquifers and the shale being treated. There are reported cases of aquifer contamination associated with hydraulic fracture programs, but these are limited to areas similar to the coalbed methane basins where the zones being treated are in close proximity to the aquifers. If development with hydraulic fracture treatments occurs where the Marcellus is shallow and in close proximity to usable quality water zones, the potential effects on aquifers must be addressed.

An appropriate concern in all cases is that companies must utilize proper surface casing design and cementing to isolate and protect aquifers from downhole pathways of contamination. It is equally important that operators monitor casing pressures throughout the life of a well to identify and correct any downhole leaks that might establish a pathway.

The state regulations of New York, Pennsylvania, Ohio, West Virginia, Virginia, Tennessee, and Maryland have safeguards in place for the protection of aquifers. However, the oversight capacity of agencies strained by a substantial increase in drilling activity is a legitimate concern.

Natural Gas Pipeline System

Large areas in the Marcellus Shale play have not experienced oil and gas production in the past and do not have the needed natural gas gathering and transportation pipeline infrastructure in place. Environmental issues associated with natural gas pipelines arise during siting, construction, operation, and maintenance of the lines. The greatest impacts associated with most pipelines typically occur during the construction phase, when vegetations is removed, a trench is dug, the pipe is laid, and the trench backfilled. However, during operation, numerous compressor stations will be necessary to move Marcellus gas from wells to gathering lines and eventually to large transmission lines. Emissions and noise from compressor stations are contentious issues in other shale developments. Pigging (internal pipeline cleaning) operations often generate waste water and liquid hydrocarbons, which must be captured and handled properly.

New pipeline rights-of-way may only be granted through park units under specific legislative authority from Congress. Very few parks have that authority in their enabling legislation.



The numerous truck-mounted pumps and temporary storage tanks needed to fracture-treat the Marcellus Shale will require larger well locations. The fracturing equipment and materials on location in this photograph represent over 100 round trips to location by large tractor trailer trucks. (Photo source—Unknown)

Air Quality

Air quality issues related to the development of the Marcellus Shale include emissions associated with drilling and pipeline compression operations. The main pollutant of concern is nitrogen oxides (NO_x), which can combine with volatile organic compounds (VOCs) to create ozone. Ozone formation may not be an issue on a site-by-site basis but it can have significant impacts to the air quality of the region, especially rural areas that have not traditionally violated the national ozone air quality standards. There are numerous large stationary point sources in the eastern United States that emit ozone-forming pollutants. Accordingly, existing control strategies in this region of the country put emphasis on point sources. Current analyses to predict future attainment status for ozone may not adequately account for large increases in emissions from the natural gas sector of the Marcellus Shale region. The NPS will need to work with air regulatory agencies to address this issue through air quality planning in the future. For more information on ozone pollution and to learn what areas of the Marcellus Shale region have been designated as violating the national standard for ozone, please visit the Environmental Protection Agency (EPA) website at <http://www.epa.gov/air/ozonepollution>.

Another important aspect of natural gas development in regards to air quality is the emissions produced by truck transportation. As will be discussed in the next section, a large number of trucks are needed to transport equipment, supplies and contaminated water to and from drilling sites. Emissions of concern from transportation include particulate matter (PM), NO_x and VOCs. Depending on the number of trucks needed, such emissions could be significant and may contribute to violations of National Ambient Air Quality Standards for both PM and ozone. Such violations may have impacts to visitor health and ecological effects, including impacts to ozone-sensitive plant species that have been identified in this area of the country. To identify what areas are currently in violation for National Ambient Air Quality Standards for particulate matter, please visit the EPA website at <http://www.epa.gov/oar/particulatepollution>.

There is also the potential for air quality issues related to hydrogen sulfide (H₂S or “sour gas”). The U.S. Department of Energy has reported that H₂S is not a problem for drilling operations in gas producing shale formations at this time. However, because gas development in the Marcellus Shale region is still in its early stages, it is unclear if such emissions may be an issue in the future.

Truck Transportation Needs

Exploration, drilling, and production activities associated with oil and gas wells are extremely “transportation intensive.” Large numbers of vehicles are needed to transport equipment and other supplies to the drilling site.

Many rural roads near park areas overlying and near the Marcellus Shale will not meet standards necessary for large trucks that will be used to haul equipment, water, and other supplies to and from drill pad sites. These roads will need to be upgraded through widening, and surfacing; and road curve angles may need to be reduced. If unpaved roads are not surfaced or watered regularly, air quality may be degraded by truck traffic related dust, and area residents and park visitors may be subjected to traffic hazards. Soundscapes in the area will be affected by the large amount of truck traffic.

Oil and gas specialists in the Geologic Resources Division estimate that the “average” oil and gas well requires 320 to 1,365 truckloads of equipment to bring a well into production. While the following information provides wide-ranging estimates, it is still helpful to understand the large amount of truck traffic that will be associated with any oil or gas well. Estimates are as follows:



Large trucks and equipment may conflict with existing traffic. (Photo: Utah Division of Oil, Gas, and Mining)

New Well Development

Drill Pad and Road Construction Equipment – 10 to 45 truckloads

Drilling Rig – 30 truckloads

Drilling Fluid and Materials – 25 to 50 truckloads

Drilling Equipment (casing, drill pipe, etc.) – 25 to 50 truckloads

Completion Rig – 15 truckloads

Completion Fluid and Materials – 10 to 20 truckloads

Completion Equipment (pipe, wellhead) – 5 truckloads

Fracture Stimulation Fluids and Materials – 100 to 1000 truckloads

Fracture Stimulation Equipment (pump trucks, tanks) – 100 to 150 truckloads

General Well Maintenance

Every 3 to 5 years – 25 to 40 truckloads

Numerous truck-mounted pumps and temporary storage tanks are needed on location to fracture-treat wells. Larger well locations may be needed if hydraulic fracturing is part of a well completion procedure. Refracturing wells after 3 or 4 years has proven effective in the Barnett Shale of Texas. If this practice extends to the Marcellus Shale, then truck traffic will have few lulls.

VII. Regulatory Framework

Each state has a distinct regulatory framework governing the development of gas from the Marcellus Shale and for addressing NPS (and other community) concerns. Although the information below is not an exhaustive explanation of the entire regulatory process for each state, locality, or of NPS-specific regulations, it is intended to inform the reader that there are options for addressing NPS concerns regarding gas development in most cases. See Appendix 3 for a quick reference to key provisions under each of the state regulations that provide a means for the NPS to raise park protection concerns.

NPS Regulations for In-Park Development (36 CFR Parts 9B & 6)

Regulations governing the extraction of oil or gas from the Marcellus Shale will vary depending upon ownership of the surface and mineral estate where operations will take place. It is possible that oil or gas extraction could occur in units of the National Park System if either private inholdings (fee simple ownership of both the surface and subsurface estate) or private or other nonfederal mineral estate occurs in park boundaries. If exploration or development activities are proposed within park boundaries pursuant to privately held oil and gas rights, the NPS will apply its regulations at 36 CFR Part 9, Subpart B to ensure protection of park resources and values. Note: The 9B regulations only apply when an entity must cross federally owned or controlled lands or waters to reach its private property rights. This “exemption” from the regulations could prove problematic for the NPS in trying to require operators to mitigate impacts. Where the exemption does apply, the NPS will need to use the power of persuasion with operators and work closely with state regulators to have mitigation measures included in permits to protect parks and other special status lands. Note: The NPS is working on eliminating this exemption from the 9B regulations.

Unlike the 9B regulations, the NPS will be able to apply its solid waste regulations at Part 6, without regard to whether an entity must cross federally owned lands or waters to extract private gas within a unit of the National Park System.

Operations External to Park Boundaries

In dealing with external oil and gas exploration and development with the potential for cross-boundary effects, the best option is to work directly with the state oil and gas permitting agency. Because the NPS has no direct regulatory control over oil and gas operations external to its boundaries, the NPS may take advantage of any “public comment” process or any other opportunity to provide input offered by the state permitting agency. It is at this stage that the NPS can offer mitigation or avoidance options for the state to include in the permit to reduce impacts on adjacent NPS managed areas.

It is important to note that the states that overlie the greatest portion of the Marcellus Shale, all have different procedures that provide for permitting and analyzing specific project proposals. The information below provides an overview of permitting/environmental review requirements and opportunities available to the NPS to provide input in the permitting or environmental review process of the various states in the Marcellus Shale area. For a more specific reference to applicable state regulations, please see Appendix 3.

New York

Environmental and natural resource-related permits are required for oil and gas operations. The state requires over 20 different permits and licenses, as found in New York State, Department of Environmental Conservation General Regulations, Chapter VI., Section §624.5. Under the state rules, interested parties may submit written comments on individual permit applications. New York also has a State Environmental Quality Review Act (SEQR). However, as communicated to the NPS in a July 2008 conference call regarding Marcellus gas drilling, the state handles compliance with New York SEQR under a “generic” environmental impact statement (GEIS). Therefore, further environmental analysis is not undertaken on individual oil and gas operations that obtain permits to operate. New York is currently preparing a Supplemental GEIS. The NPS provided comments on scoping portion of this document with the draft Supplemental GEIS being released for review in September, 2009. Links to pertinent New York environmental and permitting web sites:

Environmental Quality Review – <http://www.dec.ny.gov/regs/4490.html>

Permits and Licenses: – <http://www.dec.ny.gov/permits/363.html>

Information on 2008 supplemental oil and gas EIS – <http://www.dec.ny.gov/energy/46288.html>

Pennsylvania

Any person proposing to drill an oil and gas well in the State of Pennsylvania must obtain the necessary permits found at the Pennsylvania Statutes and Consolidated Statutes Annotated, Title 58 – Oil and Gas, Chapter 11, Oil and Gas Act. Through the Pennsylvania Department of Environmental Protection citizens and other affected parties (e.g., the NPS) can obtain information on items including oil and gas permit updates—like changes in permit status—and environmental reviews associated with those permits. Changes in permit status are distributed by the state via e-mail alerts to users subscribed to the free service. In addition to necessary permits, Pennsylvania requires an environmental impact statement on proposals for state land subdivisions, rezoning, projects or other uses of land having or likely to have environmental impact (PA Code §.16-1605, Impact Statement). As with the permitting process, Pennsylvania offers the opportunity for public input throughout its state EIS process. Links to pertinent Pennsylvania environmental and permitting web sites:

Pennsylvania Oil and Gas Act –
<http://www.dep.state.pa.us/dep/DEPUTATE/MINRES/OILGAS/act223.htm>

Pennsylvania Environmental Impact Statement –
<http://www.pacode.com/secure/data/365/chapter41/s41.16-1605.html>

West Virginia

The West Virginia Office of Oil and Gas is responsible for regulating and monitoring all actions related to the exploration, drilling, storage, and production of oil and natural gas. It also ensures protection of groundwater from oil and gas activities. Title 35, Legislative Rule, West Virginia Division of Environmental Protection, Office of Oil and Gas, Section 10.5.c., (35CSR4) states that “. . . interested

persons may intervene in the application by filing written comments with the Office of Oil and Gas within fifteen (15) days from the date that the circular is published. If objections are made by any interested person, or by the Office of Oil and Gas, or if the chief determines that other information may be necessary in order to make a determination, a public hearing will be held in accordance with 35 CSR 20.” The State of West Virginia has no state environmental quality act.

West Virginia Oil and Gas Regulations – <http://www.wvsos.com/csrdocs/worddocs/35-04.doc>

Ohio

The Ohio Revised Code, Chapter 1509, Division of Mineral Resources Management, outlines the requirements for acquiring a state permit and operating an oil or gas well. Chapter 1509 does not provide for any type of public hearing or public input when an operator applies for a permit to drill. Hearings are initiated by the state only when an operator proposes to dispose of brine (produced waters) on the land surface, or if the disposal well is to be located in a suburban or urban area of more than 5000 inhabitants. According to the Ohio Department of Natural Resources, Division of Mineral Resources Management, the state does not have a “state environmental quality act” which would require an environmental review of drilling permits (telecon, 10/27/08).

Ohio Oil and Gas Regulations – <http://www.dnr.state.oh.us/Portals/11/publications/pdf/oil%20and%20gas%20laws%20and%20rules.pdf>

Virginia

The Virginia Department of Mines, Minerals, and Energy regulates oil and gas development in that state. The regulations require operators to apply for and secure a state permit before commencing operations. Almost all facets of well drilling, operation, and abandonment are addressed by the Virginia Code with the exception of well bore fracture processes (hydraulic fracturing). However, Va. Code 45.1-261.27, protection of resources (water, groundwater, etc.) should provide appropriate review of actions pertaining to hydraulic fracturing operations. The state of Virginia does not have an environmental impact review process for oil and gas operations, but does allow for public input in the permitting process.

Virginia Division of Gas and Oil - <http://www.dmme.virginia.gov/divisiongasoil.shtml>

Tennessee

Oil and gas exploration and production operations in the state of Tennessee are subject to the “General Rules and Regulations for Oil and Gas Exploration and Exploitation” as defined in Title 60, Tennessee Code Annotated. The Tennessee Oil and Gas Board, is responsible for preventing waste and protecting the waters and natural resources of the state from any adverse effects associated with drilling, deepening or reopening gas and oil wells. Oil and gas operators must file for a permit to drill, provide proof that the surface owner has been notified of planned surface disturbances, and provide a surveyed well location map, a reclamation plan and a plugging bond in the amount of \$2000.00. No public review of an application for and oil and gas permit is required.

Tennessee State Oil and Gas Board - <http://tennessee.gov/environment/boards/oilandgas.shtml>

Tennessee State Oil and Gas Board, General Rules and Regulations – <http://www.tennoil.com/Published%20Files/O&G%20RulRegs%20underlined1.pdf>

Maryland

The Minerals, Oil, and Gas Division of the Department of the Environment regulates oil and gas exploration, development, and production in Maryland. The Department’s regulations require operators to obtain a drilling and operating permit prior to any seismic exploration or drilling activities. The permit requires an operator to post a bond, adhere to operating conditions, and provide reclamation plans for all operations. In addition to the permit, operators must prepare and submit an environmental assessment detailing the impacts of the oil and gas operation.

Maryland Department of the Environment, Minerals, Oil and Gas Regulations - http://www.dsd.state.md.us/comar/subtitle_chapters/26_Chapters.aspx#Subtitle19

VIII. Recommendations

The following recommendations will help park resource managers be more prepared for potential development of the gas resource of the Marcellus Shale. While the NPS may not have the ability to preclude drilling, particularly adjacent to park boundaries, early involvement in the well permitting process by developing a close working relationship with the state permitting agency will pay dividends. Often, states will have no idea that the NPS may have resource or visitor-related concerns unless it is brought to the attention of the permitting agency. The Geologic Resources Division suggests the following steps:

Check your park's land/mineral ownership

It is important to know if units of the National Park System overlying the Marcellus Shale (*see* Appendix 1) have either private inholdings or state or private mineral estate underlying NPS surface. If these ownership conditions occur, shale gas or other mineral development is a possibility within park boundaries. If you are uncertain of your park's land status, your Regional Lands Office should have the information you need. The Service's 9B regulations will be triggered if a project proponent must cross federally owned or controlled lands or waters in a park. Note: The NPS is working on eliminating this exemption from the 9B regulations.

Be aware of land speculation, exploration, or drilling activity adjacent to park boundaries

Industry interest in securing lands for gas exploration or development could result in a quick upturn in requests for drilling permits adjacent to park units in the Marcellus area. If drilling activity appears, or is imminent, contact your state's Oil and Gas Division to communicate NPS concerns and issues to the decision maker.

Work with state agencies

It is important to establish sound working relationships with state permitting agencies. State agency personnel can alert you early to expressions of interest to develop the Marcellus Shale resource in and adjacent to your park. To help solidify your working relationship with state agencies, the Geologic Resources Division recommends the following:

- Meet with state permitting agency personnel and state leasing agency personnel to discuss the park's resources and values, how oil and gas exploration and development activities may affect those resources and values, and mitigation measures that could be used to minimize or avoid impacts to park resources and values. It would be advantageous for park and state personnel to also discuss the state's specific procedure for approving permit applications and for offering leases on state lands, and for soliciting their ideas on how to best protect units of the National Park System and other nationally significant areas. It would be helpful to follow-up the meeting with a written explanation of the park's goals and objectives and any strategies park and state personnel may have discussed regarding protection of park resources and values. In these discussions, it is to the NPS' advantage to highlight whether proposed development could occur in a park unit and whether NPS regulatory authority would be triggered. It is important to note that the Service's nonfederal oil and gas regulations only apply to operations within units of the National Park System. They do not apply to operations on special status areas. Also, as noted above, the regulations contain limitations.
- Establish an agreement, formal (e.g., MOU) or informal, with the state permitting or leasing agencies, under which the state agency agrees to timely exchange of information regarding proposed activities.
- Engage the state regarding the exercise of privately held mineral rights prior to the issuance of a state permit. We recommend that the park seek to have state permitting agency personnel inform park staff of pending permit applications for proposed operations within a reasonable distance from the park boundary, e.g., within the park's immediate view shed. The park can provide the state with a map indicating tracts and locations that would be of concern.
- For state owned leaseable lands, the park's most effective strategy is to try to convince the state to

include park protective mitigation measures directly in the lease. It would be helpful to ask the state's leasing agency personnel to inform the park when leases will be advertised for auction on tracts within a reasonable distance from the park boundary, e.g., within the park's immediate view shed. The park could then identify specific park protection concerns, and provide the state with a map indicating tracts and locations that would be of concern.

- When informed of pending permitting actions or advertisement for lease auction, we recommend that park staff work with state agencies to include measures that mitigate or avoid impacts to park resources and values. If the park is faced with operations on state leased lands and did not have the opportunity to work with the state prior to lease issuance, park staff could still be engaged in the state permitting process and see if park protective measures can be included in the permit.

Additional Available Resources

The Geologic Resources Division is available to assist parks with policy and technical assistance with minerals and energy issues. GRD will review and comment on permitting and environmental documents with an eye toward mitigating or eliminating adverse impacts arising from the exploration and development of natural gas from the Marcellus Shale. For assistance contact the Division.



The Millennium Pipeline will allow for increased amounts of natural gas to be transported in New York State. (Photo by David B. Soete)

Appendix 1

National Park System units overlying or near the Marcellus Shale

National Park System Site	Comment
Allegheny Portage Railroad NHS	Within, but near edge
Andrew Johnson NHS	Near southern edge
Appalachian NST	Mostly near, short section within
Blue Ridge PKWY	Near, but no closer than about 25 miles
Bluestone NSR	Within the Marcellus (about 20-30 miles)
Booker T Washington NM	Near, but about 30 miles east
Cedar Creek & Belle Grove NHP	Near eastern edge (about five miles)
Cumberland Gap NHP	About 30 miles west, but in black shale
Cuyahoga Valley NRA	Near, and within black shale
Delaware Water Gap NRA	Near eastern edge (about five miles)
Eisenhower NHS	Near, but about 40 miles east
Eleanor Roosevelt NHS	Near, but about 30 miles east
Flight 93 NMem	Within, but near edge
Fort Necessity NB	Within (center of the Marcellus)
Fort Stanwix NM	Within, but near edge
Friendship Hills NHS	Within (center of the Marcellus)
Gauley River NRA	Within the south central Marcellus
Gettysburg NMP	Near, but about 40 miles east
Great Smoky Mountains NP	Near southern edge
Harpers Ferry NHP	Near, but about 40 miles east
Home of Franklin D Roosevelt NHS	Near, but about 30 miles east
Hopewell Culture NHP	About 50 miles west, but in black shale
James A Garfield NHS	Within, but near edge
Johnstown Flood NMem	Within, but near edge
Martin Van Buren NHS	Near, but about 30 miles east
Middle Delaware NSR	Within, but near edge
Morristown NHP	Near, but about 30 miles east
New River Gorge NR	Within the south central Marcellus
Saratoga NHP	Near (about 20 miles northeast)
Shenandoah NP	Near (about 20 miles east on Trail)
Steamtown NHS	Within boundary, about 40 miles from edge
Theodore Roosevelt Inaugural NHS	Near northern edge (about five miles)
Upper Delaware SSR	Within (from edge to about 60 miles in)
Vanderbilt Mansion NHS	Near, but about 30 miles east
Women's Rights NHP	Near (about ten miles north)

The Marcellus shale boundary is approximate. Therefore, sites within and near the boundary, may be affected. Parks highlighted in yellow are most at risk because the deposit exists within and immediately adjacent to their boundaries.

Appendix 2

Resource Concerns and Mitigation Techniques

This table provides a general summary of impacts from the various phases of natural gas operations and common mitigation strategies. The list is by no means exhaustive nor does every concern and strategy apply to every operation.

Resource Concern	Development Phase				Mitigation Techniques
	Exploration	Drilling	Production	Plugging / Reclamation	
Soils (Contamination, Compaction, Erosion and Sedimentation)	X	X	X		Use Existing Roads Limit Travel Routes Vehicular Limitations Seasonal Restrictions Timely Reclamation Multi-Well Pads Minimize Vegetation Clearing Closed-Loop Mud Systems Offsite Disposal of Waste Berms and Liners Stormwater Control Erosion Control
Surface Water	X	X	X	X	Closed-Loop Mud Systems Offsite Disposal of Waste Berms and Liners Stormwater Control Erosion Control Controlled location and quantities of source water for operations
Ground Water	X	X	X		Good casing/cementing practices for drilling and plugging Well monitoring during production Liners under storage tanks Closed-Loop Mud Systems Offsite Disposal of Waste Berms and Liners
Vegetation Loss	X	X	X		Minimize Vegetative Clearing Minimize Disturbed Areas Multi-well drilling pads Implement Timely Reclamation Avoidance Seasonal Timing Restrictions Erosion Control Maintain soil & water quality
Introduction of Exotics		X	X	X	Implement Timely Reclamation Remove Exotics Manually or Chemically
Air Quality		X	X		Speed Limits Water Roads & Pads Flare Gas (Rather than Vent)

Resource Concern	Development Phase				Mitigation Techniques
	Exploration	Drilling	Production	Plugging / Reclamation	
Noise Increases	X	X	X	X	Seasonal Restrictions Use man-made or natural sound barriers Mufflers on engines
Reduction in Roadless Areas		X	X		Temporary access roads and trails Timely Reclamation Avoidance
Noise & Human presence effects on animal behavior and habitat	X	X	X	X	Timing Restrictions Mitigations for soil, water, air, noise, vegetation apply
Disruption of wildlife migration and mating	X	X	X	X	Timing Restrictions Identify and Avoid wildlife corridors
Effects on sensitive and endangered species	X	X	X	X	Timing Restrictions Mitigations for soil, water, air, noise, vegetation apply
Viewshed and scenic intrusions		X	X	X	Seasonal Timing Restrictions Natural Surrounding Facility Colors Vegetative or Topographical Cover Use Existing Roads or Trails Minimize Surface Disturbance
Night sky intrusion		X	X	X	Light Shields Location Selection Limit operations to daytime
Disturbance to archeological and cultural resources	X	X	X		Avoidance Directional Drilling Limit public access
Visitor Safety	X	X	X	X	Limit public access with fences or guards Timing Restrictions

Appendix 3

State Regulatory Requirements

The table below serves as a quick reference to key provisions from state drilling and production regulations governing Marcellus Shale development—November 2008.

	New York	Pennsylvania	W. Virginia	Ohio	Virginia	Tennessee	Maryland	NPS
Permitting: Drill, Deepen, Plug Back, etc...	NYCRR = Compilation of Codes, Rules & Regulations; ECL = Environmental Conservation Law	Pa Code = Pennsylvania Code; P.S PA ST = PA Oil & Gas Act	WV ST = West Virginia Statutes; CSR = Code of State Rules	ORC = Ohio Revised Code; OAC = Ohio Administrative Code	Va. Code=Virginia Code	TC = Tennessee Code	COMAR = Code Of Maryland Regulations Md Code Ann = Annotated Code of Maryland	36 CFR 9B
	6 NYCRR 552.1 - .4 ECL 23-1101	58 P.S PA ST 406, 601.201 Pa. Code 78.11, 12, 13, 15, 16, 17	WV ST 22-6-6, 11 CSR 35-4-5; 39-1 -4-4	ORC 1509.5, 6 OAC 1501:9-1- 02	Va. Code 45.1 – 361.29	TC 60-1-103	COMAR 26.19.01.02 & 26.19.01.06 Md Code Ann 14 -104 & 14-109	36 CFR 9.36, 9.37, 9.38
O&G Well Reporting	6 NYCRR 551.1 - .3 & 554.7	58 P.S PA ST 601.212 Pa. Code 78.121- 125	WV ST 22-6-22; CSR 35-4-12, 15	ORC 1509.10	Va. Code 45.1 – 361.38	TC 60-1-209	COMAR 26.19.01.10 (V) & (Y)	36 CFR 9.42
Bonding or Financial Assurance	6 NYCRR 551.4 - .7	58 P.S PA ST 601.215 Pa. Code 78.301- 314	WV ST 22-6-6(b), 12, 13, 14, 23, 26 CSR 35-4-5.2a3; 35-4-10.1,,2	ORC 1509.7 OAC 1501:9-1- 03	Va. Code 45.1- 363.31	TC 60-1-704, 705	COMAR 26.19.01.06 (C) (5) & 26.19.01.13, Md Code Ann – 14-108 & 14-111	36 CFR 9.48
Permit Hearings	6 NYCRR 624.3, 624.5 & 552	58 P.S PA ST 410, 411		ORC 1509.6	Va. Code 45.1- 361.35	TC 60-1-204(b)	COMAR 26.19.01.07 (B) (5) & (E)	
Well Spacing & Location	6 NYCRR 553.1 - .4 ECL 23-0503	58 P.S PA ST 407, 601.205 Pa. Code 79.21- 28	CSR 39-1-4-2, 3	ORC 1509.24, 072 OAC 1501:9-1- 04	Va. Code 45.1- 361.12, 361.17	TC 60-1-106	COMAR 26.19.01.09 (C) > (G), Md Code Ann – 14-112	36 CFR 9.41

	New York	Pennsylvania	W. Virginia	Ohio	Virginia	Tennessee	Maryland	NPS
Pooling & Unitization	ECL 23-0701, 0901	58 P.S PA ST 408, 409 Pa Code 79.31-33	CSR 39-1-4.9; 39-1-6	ORC 1509.25-29	Va. Code 45.1-361.21, 361.22	TC 60-1-202(0); 66-7-103	Md Code Ann – 14-113	
Operating Practices and Standards	6 NYCRR 554.1 - .6 & 556.2 - .7	Pa Code 78.81-87	CSR 35-4-11			TC 60-1-204	COMAR 26.19.01.10	36 CFR 9.41
Plugging & Abandonment	6 NYCRR 555.1 - .6	58 P.S PA ST 1, 4, 5, 8, 601.210 Pa. Code 78.91-98	WVST 22-6-6, 23, 24 CSR 35-4-5.2d1, 35-4-13, 14	ORC 1509.12-.19; OAC 1501:9-11	Va. Code 45.1-361.34		COMAR 26.19.01.12	36 CFR 9.41
Secondary / Tertiary Recovery	6 NYCRR 557.1 - .4		WV ST 22-6-25; CSR 39-1-5	ORC 1509.20, 21; OAC 1501:9-5		TC 60-1-202(4) (k)	COMAR 26.19.01.06 & 26.19.01.14	36 CFR 9.41
Transportation	6 NYCRR 558.1 & .2							
Pipelines				OAC 1501:9-10	Va. Code 56-257.2	TC 68-215-124		
Penalties & Enforcement	ECL 71-1301, 1305, 1307, 1309, 1311	58 P.S PA ST 2, 3, 10, 412, 601.501 - 511	WVST 22-6-34, 39	ORC 1509.32, 33, 99	Va. Code 45.1-361.8	TC 60-1-401, 402, 403, 404	COMAR 26.19.01.15, Md Code Ann – 14-120	36 CFR 9.52
Lease Royalties		58 P.S PA ST 33, 34, 35	CSR 35-4-5.3	ORC 1509.30, 31	Va. Code 53.1-31	TC 66-7-103(b) (1); 12-2-101	Md Code Ann – 14-113	
Restoration & Reclamation		58 P.S PA ST 601.206	WV ST 22-6-30; CSR 35-4-5.2c4, 35-4-16	ORC 1509.072	Va. Code 45.1-263	TC 60-1-703	COMAR 26.19.01.06 (C) (14) & (F)	36 CFR 9.39
Protection of Resources: Groundwater, Water, etc...	ECL 23-0501, 0305	58 P.S PA ST 601.207, 601.208 Pa. Code 78.51	WV ST 22-6-6 CSR 35-4-20	ORC 1509.22, 23 OAC 1501:9-1-07	Va. Code 45.1-261.27	TC 60-1-701	COMAR 26.19.01.09 (H)	36 CFR 9.41, 9.45, 9.46, 9.47
Safety		58 P.S PA ST 601.209 Pa Code 78.71,72	WV ST 22-6-28, 19, 20, 21	OAC 1501:9-1-05, 1501:9-9	Va. Code 45.1-361.42		COMAR 26.19.01.10	36 CFR 9.43, 9.44

	New York	Pennsylvania	W. Virginia	Ohio	Virginia	Tennessee	Maryland	NPS
Underground Storage	ECL 23-1301, 1303, 1305, 1307	58 P.S PA ST 601.301 – 307 Pa. Code 78.401-407	WVST 22-9-1 to 22-9-13	ORC Chapter 1571	Va. Code 45.1-61.205	TC 60-1-102	Mid Code Ann – 14-201 > 14-209	
Fracturing			WV ST 22-6-12, 13					
Transfer of Ownership or Interest		Pa. Code 78.13,14	CSR 35-4-10.3,.5	ORC 1509.31, 071		TC 66-7-103(a) (1)	COMAR 26.19.01.14	36 CFR 9.34
Saltwater Operations				OAC 1501:9-3	Va. Code 62.1-195.1			
Environmental Review Required	6 NYCRR 617.3	Pa Code 41.16-1605			Va. Code 45.1-361.27	TC 60-1-202(Q)	COMAR 26.19.01.06 (C) (3) Mid Code Ann 14-104	36 CFR 9.37
Lead Agency Establishment	6 NYCRR 617.6 (b)				Va. Code 45.1-361.13, 14, 15	TC 60-1-201		
Scoping	6 NYCRR 617.8							
EIS Preparation and Content	6 617.9 & .10 (Generic EIS)							36 CFR 9.37
EIS Decision-making/Public Participation	6 NYCRR 617.11							36 CFR 9.37
EIS Notice & Publication	6 NYCRR 617.12							
Fees & Costs	6 NYCRR 617.13 & 618.1		WV ST 22-6-6	ORC 1509.06	Va. Code 45.1-361.32	TC 60-1-105		
NEPA/Federal Agency Cooperation	6 NYCRR 617.15							



Upper Delaware Scenic and Recreational River. (Photo by Scott Rando)

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