The Marcellus Shale Formation: Boom or Bust

Five thousand feet below the ground lies an enormous amount of natural gas. This could mean a massive potential for today’s society to sustain energy production for future generations.

Formation/Geology

Marcellus Shale is a rock formation that occurs in the subsurface of Ohio, West Virginia, Pennsylvania, and New York (DEP FAQ’s). Pennsylvania contains the largest field of natural gas amongst these states. The Marcellus Shale was formed approximately 390 million years ago during the Devonian ages (The Marcellus Shale Formation Information Site, 2008). During this time, much of the earth was covered by water. Having been transformed through compression over time, sediment that was deposited on the bottom of the ocean floor formed into Marcellus Shale. It is located in between two impervious layers of limestone which have “naturally trapped a great quantity of natural gas inside the shale” (The Marcellus Shale Formation Information Site, 2008).

History

“Geologists estimate that the entire Marcellus Shale formation may contain up to 489 trillion cubic feet of natural gas throughout its entire extent. It is not yet known how much gas will be commercially recoverable… to put this into context, New York State uses about 1.1 trillion cubic feet of natural gas a year” (Department of Environmental Conservation: Marcellus Shale, 2011). However, the longevity of the Marcellus Shale is largely debated. Being a nonrenewable resource, estimates between how much gas in beneath the ground and how long it will sustain out consumption habits are still questioned. The disparity between projections by different organizations can be quite large. In a report released in 2011, the United States Geological Survey changed their initial prediction of Marcellus Shale Gas, made in 2002, to a whopping 40 times higher (Phillips, 2012). Their final statement predicts 84 trillion cubic feet of natural gas within the Marcellus Shale. This is far less than the estimate made by the Department of Environmental Conservation. A representative from the Marcellus Shale Coalition write, “There’s a lot of variables, there’s a lot of unknowns,” said Windle (Phillips, 2012). There’s a lot of information we’re trying to gather about the host of geological factors that determine how much natural gas is viable and can be produced in a way that’s economical.”

Extraction

The process that is undertaken to release the gas that is trapped deep within the shale is known as hydraulic fracturing, or fracking. After casing or heavy pipe has been run into the recently drilled hole to line it, a large amount of water is mixed with sand and other chemicals are put under an extreme amount of pressure is rushed downwards through the pipe. Once reaching the appropriate depth, which is dependent on geographical location, the frack mixture is
able to fracture the rock below the surface and releases natural gas from the pores which is sent back to the surface (Marcellus Shale, 2011).

![Figure 1: Geographic spread of the Marcellus Shale illustrated in grey (Marcellus Shale, 2011).](image1.png)

![Figure 2: Vertical drilling to the depth of the Marcellus Shale as well as horizontal drilling that fracks the shale to expose, release, and direct gas back to the surface. (Brad Cole, Geology.com).](image2.png)

**Aftermath**

**Transportation of Frack Water**

There are potential risks and problems associated with fracking of the Marcellus Shale. To begin, the process of hydraulic fracturing requires 5.6 million gallons of water per well per day (Chesapeake Energy, 2010). One study in the New York Times (2011) projected that 260 million gallons of water was sent to water treatment plants. The results showed that 260 million gallons “would fill more than 28,800 tanker trucks, a line of which would stretch from about New York City to Richmond, VA” (Urbina). The concept of NIMBYism can adequately describe the nuisance that these trucks are presenting in small towns like yours. Not In My Backyard, or NIMBY, is the attitude that many local residents have on environmental issue. This refers to a household who would not register the problems of a polluting factory being put in on the other side of the country but would protest if it were located across the street. However there are other real concerns that arise with natural gas drilling. With the Marcellus Shale production in central Pennsylvania, there are several dozens of tanker trucks traveling on interstates as well as smaller roads through towns. Smith, 2009 writes that “there is an immense concern for what these trucks will do to roadways as they often make 1,000 deliveries per well”. The result has been an increase concern by citizens in surrounding towns who see the direct effects of these mass transportations each day.
Water Pollution

This boom also has the potential to threaten the quality of water that is being returned to waterways, after fracking. In 2009, the Fracturing Responsibility and Awareness of Chemicals Act was introduced in OPA legislature, which calls for “the chemical constituents used in the fracturing process” to be disclosed to the public (Frac Focus, 2012). Although companies began voluntarily disclosing the chemicals that they used in 2011, their use in general is still worrisome to the public. Due to these risks, many are worried that their water supply will be affected. In a documentary titled Gasland, narrator Josh Fox travels around the United States interviewing homeowners who have been affected by activities surrounding the Marcellus Shale. In many instances in Pennsylvania, there were families who were able to light the water that came from their faucet on fire. In a similar study done by Duke University, researchers found that levels of flammable methane gas in drinking water wells increased to dangerous levels when those water supplies were close to natural gas wells (Lustgarten, 2011). The result is a highly flammable faucet. Clearly, there is controversy surrounding this issue which is still relatively new in the state of Pennsylvania. Therefore, it is expected that new questions and concerns will arise as drilling continues to expand.

Exploitation of Land

Another way in which Central Pennsylvania may be affected is through the disappearance of state forest land to natural gas companies. A common hobby and source of recreation in Pennsylvania come from the sport of hunting. Natural gas drilling may begin to alter hobbies, like hunting, simply because we are running out or room to pursue them. Currently, 700,000 acres of the entire PA State Forest Land have been leased for gas drilling (Steiner, 2010). This constitutes roughly 1/3 of our entire State Forest Land and does not include the leasing of private land. It is important to bear in mind that this data was presented in 2010 and the drilling has been steadily increasing since then. Therefore, the loss is likely to be even larger than this statistic leads.

Susquehenna Valley Region

The Arrival of a New Industry

Currently the town of Shamokin Dam contains the “Sunbury Generation LP”. This site is responsible for treating residual waste from the natural gas drilling companies nearby. After a statement was made by the Department of Environmental Protection in April of 2011, calling this site to put a halt to production, the site ceased to treat water from shale operations. This was largely due to the fact that they were instructed to stop sending water out to be treated. The vice president of operations at the plant, said they had no plans at this point to continue with processing waste water from the natural gas industry (Socha, 2012). This is significant issue for
local residents. Being such a new topic, it is expected that regulations surrounding Marcellus Shale drilling and drilling wastes will continue to change.

**Disrupting Spiritual Beliefs**

In a protest against new legislation limiting a municipalities control over where drilling can occur, a local interfaith group made their voices heard. Believing that the earth and environment was not created with the intentions of human destruction, religious affiliates did not want drillers entering into their towns. The interfaith Sacred Earth Coalition called for a repeal of the recently passed legislation and had much support in their protest. Pastor of the United in Christ Lutheran Church in West Milton claimed that the new law was an assault on God’s creation, public health, the vulnerable, and the sanctity of communities (Socha, 2012). Other religious groups who showed up to represent the cause included St. Matthew’s Episcopal in Lewisburg and the Unitarian Universalist Congregation from Northumberland. The varying groups all agree on the fact that they care about the sacredness of the Earth and its waters (Socha, 2012). It is very clear that residents living around the Susquehanna Valley Region are invested in this issue.

**Disturbances Senses**

In other natural gas relation production, the company Moran has recently come into Sunbury’s Caketown in May of 2011. This waste water transfer site branches into Sunbury from Watsontown and brought along with it much controversy. The local concern is that the trucks which contain mixed substances are giving off strong odors and appear to contain soil, rock, mud, and woodchips. Not knowing the exact composition of what the trucks are hauling in and out led one resident straight to the city’s code office. Another resident, also enraged, expressed his concern about the unknown substance by saying “We live here. We have to breathe it. Looking at it doesn’t bother me, but breathing it in, because we don’t know what it is, does” (Troutman and Newhouse, 2011).

**Governments Response**

The government’s response to the public’s concern has been largely variable. Whereas the residents are concerned about public health government officials see multiple perspectives to the recent drilling. Some government views the Marcellus Shale industry as a threat to their town’s health but others see it as an opportunity for growth through both economic and employment gains. They believe that its opening will increase the amount of potential local jobs similar to past booms that have transformed the area such as the mining of anthracite coal. They also feel that the people in the river town have always been reliant on the factories in town and that this factory will be no different. It is an adjustment of attitudes that they believe will happen with time (Troutman and Newhouse, 2011).

By Taylor Funk
### Pennsylvania Curriculum Standards Met

**Academic Standards for Environment and Ecology**

*June 1, 2009 FINAL*

Grades 3-8, 10, 12

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**Pennsylvania Department of Education**

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#### 4.2. Watersheds and Wetlands

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<th><strong>4.2.3. GRADE 3</strong></th>
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<th><strong>4.2.6. GRADE 6</strong></th>
<th><strong>4.2.7. GRADE 7</strong></th>
<th><strong>4.2.8. GRADE 8</strong></th>
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**XL INTRODUCTION**

This document includes Environment and Ecology standards that describe what students should know and be able to do in these areas:

- 4.2.3: Watersheds and Wetlands
- 4.2.4: Natural Resources
- 4.2.5: Agriculture and Society

The Declaration of Rights, Article 7 of the Pennsylvania Constitution states in Section 27: "The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and aesthetic values of the environment. Pennsylvania’s public natural resources are the common property of all people, including generations yet to exist. In matters of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people." To this end, it is our responsibility to develop a curriculum that is aware of and concerned about the total environment and has the knowledge and skills to work toward solutions to current problems and the prevention of new ones.

Environment and Ecology is grounded in the complexities of the world we live in and is sustainable. It examines the world’s natural processes and systems, Environment and Ecology places major emphasis in the real-world. Allowing students to understand, through a sound academic content base, how their everyday lives evolve around their use of the natural world and the resources it provides.

These standards establish the essential elements of what students should know and be able to do at the end of grades four, seven, ten, and twelve. The sequential nature of this document reflects the need for rigorous academic content that students will be expected to achieve. The document continues all strands across the grade levels with increasing depth of difficulty as the students mature intellectually.

The study of Environment and Ecology will allow students to be active participants and problem solvers in real issues that affect them, their homes, schools, and communities.

A glossary is included to assist the reader in understanding terminology contained in the standards.

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**Draft**

June 1, 2009
### 4.2 Watersheds and Wetlands

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<tbody>
<tr>
<td>4.3 C. Identify plants and animals that live in lakes, ponds, streams, and wetlands.</td>
<td>4.3 A. Explain how freshwater organisms are adapted to their environment. <em>Explain the life cycles of organisms in a freshwater environment.</em></td>
<td>4.3 C. Identify physical, chemical, and biological factors that affect water quality.</td>
<td>4.3 C. Identify natural and human-made factors that affect water quality.</td>
<td>4.3 C. Use appropriate tools and techniques to analyze a freshwater environment. <em>Interpret physical, chemical, and biological data as a means of assessing the environmental quality of a freshwater environment.</em></td>
<td>4.3 C. Describe how a diversity index is used to assess water quality.</td>
<td>4.3 C. Explain the relationship between water quality and the diversity of life in a freshwater ecosystem. <em>Explain how limiting factors affect the growth and reproduction of freshwater organisms.</em></td>
<td>4.3 C. Analyze the effects of policies and regulations on various governmental levels on water quality. <em>Assess the intended and unintended effects of public policies and regulations relating to water quality.</em></td>
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### 4.3 Natural Resources

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<tbody>
<tr>
<td>4.3 A. Identify the natural resources used to make various products.</td>
<td>4.3 A. Identify ways humans depend on natural resources for survival. <em>Describe the process of converting raw materials to consumer goods.</em></td>
<td>4.3 A. Intentionally Blank</td>
<td>4.3 A. Intentionally Blank</td>
<td>4.3 A. Explain how products are derived from natural resources. <em>Identify resources used to provide humans with energy, food, employment, housing and water.</em></td>
<td>4.3 A. Compare and contrast alternative sources of energy.</td>
<td>4.3 A. Evaluate factors affecting the use of natural resources. <em>Evaluate the effect of consumer demands on natural resources.</em></td>
<td>4.3 A. Evaluate the advantages and disadvantages of using renewable and nonrenewable resources. <em>Explain how consumption rate affects the sustainability of resource use.</em></td>
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**Grades 3-8, 10, 12**

**Environment and Ecology**

Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:
# 4.3. Natural Resources

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### Identifying Local Natural Resources
- Identify the geographic origins of various natural resources.
- Intentionally blank.

### Exploring the Distribution and Management of Natural Resources
- Intentionally blank.
- Intentionally blank.

### Environmental Education
- Differentiate between resource use: conservation, preservation, and exploitation.

### Impact of Human Activities on Natural Resources
- Analyze factors that influence the local, regional, national, and global availability of natural resources.
- Compare the use of natural resources in different countries.
- Analyze the social, economic, and political factors that affect the distribution of natural resources (e.g., wars, political systems, class, and racism).

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# 4.5. Humans and the Environment

## Environment and Ecology

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### Identifying Resources from the Environment for their Survival
- Intentionally blank.

### Examining Historical Events
- Intentionally blank.

### Describing the Development of Civilization
- Intentionally blank.

### Explaining Best Management Practices (BMP)
- BMP can be used to mitigate environmental problems.

### Explaining Role of Public Policy
- Intentionally blank.

### Analyzing How Technology Influences the Sustainable Use of Natural Resources
- Analyze how consumer demand drives the development of technology enabling the sustainable use of natural resources.
### 4.5. Humans and the Environment

**Waste Management**

<table>
<thead>
<tr>
<th>4.5.3. D.</th>
<th>Describe how waste is generated.</th>
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<tr>
<td>4.5.4. D.</td>
<td>Identify sources of waste derived from the use of natural resources.</td>
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<tr>
<td>4.5.5. D.</td>
<td>Identify those items that can be recycled and those that cannot.</td>
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<td>4.5.6. D.</td>
<td>Describe how everyday activities may affect the environment.</td>
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#### Human Health Issues

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<td>4.5.4. E.</td>
<td>Identify different ways human health can be affected by pollution.</td>
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<td>4.5.6. E.</td>
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<tr>
<td>4.5.7. E.</td>
<td>Describe how length and degree of exposure to pollutants may affect human health.</td>
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#### 4.5.3. E. Describe the impact of occupational exposure to pollutants:
- Analyze laws and regulations designed to protect human health.
- Analyze efforts to prevent, control, and/or reduce pollution through cost and benefit analysis and risk management.

#### 4.5.10. D. Evaluate waste management practices:
- Analyze current solid waste regulations.
- Research the impact of new and emerging technologies in the use, reuse, recycling, and disposal of materials.
- Evaluate ways that waste could be reduced during the production of specific products.

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**PDF Version of State Requirements**

[http://www.pdesas.org/standard/standardsdownloads](http://www.pdesas.org/standard/standardsdownloads)
Possible Classroom Lessons & Activities

- How Big is Big Worksheet
  - Use this document to explore the amount land and water needed to sustain Marcellus Shale Drilling. This will allow students to put into perspective just how much natural resource depletion is occurring in their environment. Answer Key

  - This link is to a short clip/song on fracking. It is catchy and a visual way for students to learn the basics on the Marcellus Shale play in Pennsylvania.
RESOURCES


