

An Ethical Approach to Hydraulic Fracturing

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Abstract—The following discourse will attempt to weigh the ethical issues concerning hydraulic fracturing. The current technology will be reviewed, along with its impacts on the public. Workable solutions will be offered and each weighed in order to find a solution that is acceptable to both the oil and gas industry and the concerned public.

Keywords: *hydraulic fracturing, fracking, shale, Marcellus, gas*

I. INTRODUCTION

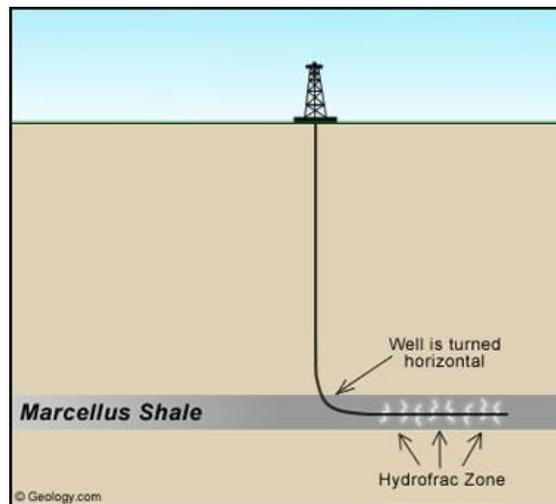
The United States of America is one of the largest energy consumers in the world. Due to the limited development of national energy supplies, the U.S. has been forced to import much of the energy resources consumed in the country. In order to reduce this dependency on foreign sources, the oil and gas industry has begun to exploit different types of previously unavailable resources. Due to technology advances, oil and natural gas can be extracted from sands in Canada and shale formations found throughout North America. While the new energy sources are a welcome development, what are the costs of these new technologies? Recent media coverage has highlighted hydraulic fracturing in particular. Some states and towns have action by banning hydraulic fracturing due to concerns of pollution of water supplies [Sinding, 10].

Hydraulic fracturing allows gas and oil deposits buried deep underground to be collected for consumption. Some deposits reside in rock formations that are porous but impermeable; the gas and oil cannot traverse the rock. Hydraulic fracturing works by injecting, at high pressures, water and other chemicals down a well to fracture the petroleum laden rock. The fractures release the oil and gas from the rock by providing a path to the well bore.

Initial attempts to use hydraulic fracturing or fracking were successful until the water pressure was removed. The fractures would immediately close due to the immense pressures found thousands of feet below [King, 4]. To resolve this issue sand, ceramics, metallic beads and other materials were added to the fracturing fluid. These materials, called proppants, are forced into the fractures where the particles hold the fractures open.

Figure 1. A typical horizontal wellbore

[King, 4]



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Most companies keep their fracking fluid solutions a secret. While water is the main ingredient, other chemicals are used to create the fracturing fluid. The additives to the fracking water can include acid, anti-bacterial agents, gelling agents, surfactants, and corrosion inhibitors [Chesapeake Energy, 2].

Fracking has been in existence since the 1940s but has only recently become economically feasible. The main development has been the advent of horizontal drilling. Instead of a vertical well only accessing a cross-section of the gas laden rock, a drill bit can directed sideways through the length of the target area increasing the total surface area the well bore accesses. Since a well bore consists of a vertical well and then a horizontal run through the target rock, the vertical section can host more than one horizontal section. A single vertical well can have several different horizontal runs increasing the economic return for a single vertical well [King, 4]. Additionally, global demand for petroleum and the resulting price increase has made hydraulic fracturing more profitable.

There are several areas throughout the United States that have developed a fracking industry. The Barnett shale formation in Texas was one of the first areas to be developed. Other areas in the continental United States include the Haynesville and Fayette shale of Texas, Louisiana, and Arkansas, the Bakken shale of North Dakota, and the Niobrara shale of Colorado, Wyoming, and Nebraska. Of primary interest for this discussion is the Marcellus shale formation located in the southern tier of New York State, the western half of Pennsylvania, the eastern half of Ohio, and most of West Virginia [King, 4].

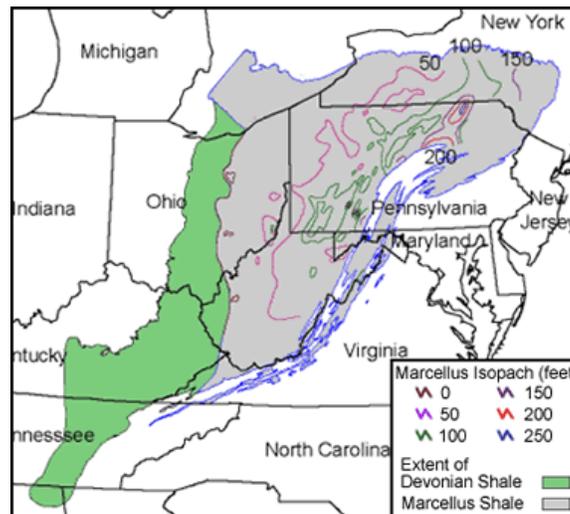


Figure 2. The Marcellus Shale Formation [King, 4]

According to the New York State Department of Environmental Conservation, the Marcellus shale formation may contain as much as 489 trillion cubic feet of natural gas; this is a significant natural resource. With the current estimated one year usage of gas in New York at 1.1 trillion cubic feet, this reservoir represents an energy supply that could potentially last over 400 years [NYDEC, 5].

With the use of any new technology, there are always unforeseen complications that become evident after the new technology emerges; hydraulic fracturing is no exception. During the fracking process water and other chemicals previously mentioned are pumped at high pressures into the well to fracture the rock. The sheer quantity of water needed is enormous and can put a strain on the local watershed in which the well is located. According to the Chesapeake Energy Corporation, a single well being hydraulically fractured may consume up to 5 million gallons of fresh water [Chesapeake Energy, 3]. While New York does not suffer from a water shortage, it is still a precious commodity that cannot be squandered.

In addition to the original chemicals of the fracturing fluid, the flowback water is laden with salt and heavy metals such as barium, strontium, and radium [AP, 1]. Once the fracturing process is complete, the issue then becomes what to do with 5 million gallons of flowback. The water cannot be simply drained onto the ground where the

mixture could enter the local watershed. Instead, the wastewater must be treated in some way to make the water safe for return to the environment.

Hydraulic fracturing is an invasive process. Several large drilling rigs need to be in place where the well will be placed. These rigs are supported by large generators, fuel trucks, water tanks, fracking fluid collection systems, evaporators, personnel support shelters, and other various pieces of equipment. The small roads in some northeast towns will be damaged by large and increased truck traffic to the drilling site [NYDEC, 7].

The last issue deals with the mineral rights that landowners often lease to oil and gas companies. In many cases, a bank will not lend money towards the purchase of land where the mineral rights have been previously leased. This, in effect, locks out the landowner from selling their property to a buyer who would need a traditional loan. Often there is language in the mortgage contract that states that the mineral rights of the property cannot be leased. If the landowner does lease the mineral rights this could be in violation of the mortgage contract and banks could ask for the balance to be paid in full or foreclose on the property [Urbina, 12].

In 2009, New York State enacted a moratorium on hydraulic fracturing in order to study the effects the process has on the surrounding environment [Sinding, 10]. New York is in a unique situation where the actions and results of hydraulic fracturing of the Marcellus shale in Pennsylvania can be studied.

Several events have occurred in Pennsylvania and expose the risks associated with hydraulic fracturing. In the township of Dimock, Pennsylvania, the water supply for 14 homes was contaminated with methane gas. An investigation revealed that the drilling company had installed defective well casings, allowing natural gas to migrate to the local water supply. Another resident of Dimock had their water well explode on New Year's day of 2009 due to methane buildup inside the well [Rubinkam, 9].

Three other events in Pennsylvania have resulted in contamination of the environment. The first event consisted of the release of 60,000 gallons of fracturing fluid. Approximately 10,000 gallons of the fluid overtopped a berm designed to contain such a spill. Some portion of the raw fracking fluid managed to reach the tributary of a larger creek. . The second incident was the uncontrolled release of flowback water. As mentioned, this fluid contains salt, heavy metals, and the chemicals used to assist fracturing process [NYDEC, 7].



Figure 3. Burning methane in tap water [Richard, 8]

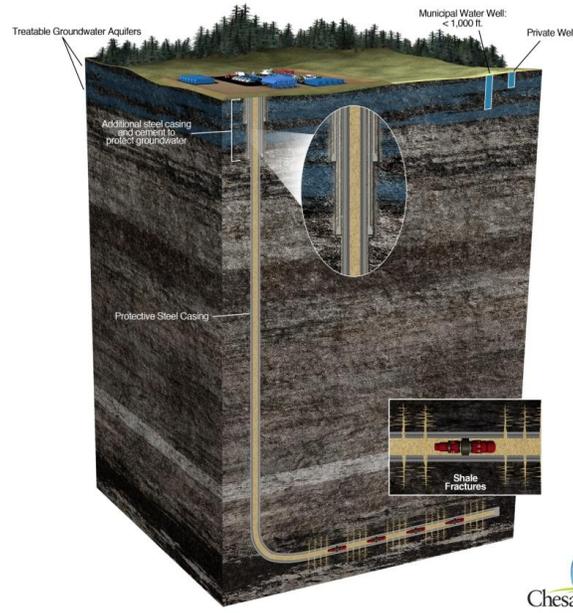


Figure 4. Proper well casing to protect the aquifer [Chesapeake Energy, 2]

The last event was the release of poorly treated effluent. The insufficient treatment of fracking fluid at a water treatment plant resulted in benzene being released into the Allegheny River. The concentration of Benzene, a known carcinogen, downstream from the treatment plant was 28 times the allowable amount under Federal regulations [Urbina, 11].

II. STUDENT LEARNING ACTIVITIES

This work is intended to develop the following student learning outcomes

- (a) Ability of a contemporary ethical issue
- (b) The ability for life-long learning
- (c) Disseminate the information in the form of research paper within ethical dimensions

III. ETHICAL ISSUES

The ethical issues surrounding hydraulic fracturing to extract natural gas are plentiful and complex. While fracking isn't a new technology, its use in the northeast corridor is a new development. The Marcellus shale formation should be developed to its full potential but the dilemma is how to balance that development while not affecting the people who call the land above the shale home. Communities are generally built where water is available and to have one's water supply contaminated by industry is not acceptable.

Should the gas industry be allowed to police themselves with no regulation? Should New York State and other states completely outlaw the fracking technique due to possible environmental catastrophe? Along with the potential problems inherent to the hydraulic fracturing process, there are some benefits to the industry as well. For the state, the influx of gas companies represents a new form of revenue that will be collected through permits and tax rolls. For the small towns and cities located in the southern tier of New York, the influx of workers to the drilling operations should bring welcome business. Lastly, to the landowners who have potential mineral rights, the gas industry will bring financial stability to them by leasing those rights.

IV. ETHICAL FRAMEWORK

This issue affects many people and the audience is large. The stakeholders include anyone who uses water in New York State. The employees and stock holders of the gas companies that will develop the shale formation are also stakeholders. And while not the largest group, the landowners have the potential to be the stakeholders impacted the most. The possible effects of hydraulic fracturing activities could spoil their water supply, make their property unsalable, and even deny the homeowner their life should an explosion occur. A solution must be found that can satisfy all of the stakeholders.

A. Common Morality

Common morality is something that every human on some scale experiences; it is a universal experience. Good examples of common morality principles might be Utilitarianism or Respect for Persons. Utilitarian ideals attempt to maximize the good of an action for the most number but applying this principle can impinge on the rights of a minority stakeholder or an individual. Another possible application of common morality to an ethical problem is the Respect for Persons, more specifically the Golden Rule. The Golden Rule states that one should treat others as one would want to be treated themselves. Reversibility examines one's actions from the opposing point of view and applying the same set of values and beliefs. While each principle has problems when applied alone, a combination of Utilitarianism and Respect for Persons should provide a solution suitable to all stakeholders in hydraulic fracturing.

B. Personal Ethics

Personal ethics is a personal set of beliefs or code that is learned. Sources of this learned code are religion, education, or familial upbringing. An ethical background influenced by those institutions might teach that one should treat other individuals with respect. That respect includes not endangering their homes and safety. Another aspect that might be gained from personal ethics is a respect and desire to protect one's natural surroundings. Lastly, one's personal ethics might guide one to put forth an honest approach to a problem, analyzing it from all sides. Clearly, personal ethics can be used to find an ethical solution to hydraulic fracturing.

C. Professional Ethics

Professional ethics is a code-based set of rules and obligations that are closely associated with a profession. Professional ethics borrows ideas and principles from common morality but are not the same. These rules and obligations speak to ideas such as protecting the public from harm while conducting one's job, acting in good faith for one's employer, and protecting the environment. Professional ethics can definitely help identify a good solution concerning hydraulic fracturing. Not only does professional ethics code call for the protection of the public from harm, it can also call for steps to be taken to protect the environment as well. During the engineering phase of any fracturing project, the engineers can use the ethics code from organizations such as the National Society for Professional Engineers to guide their decisions and actions.

V. SOLUTIONS FOR ETHICAL ISSUES

There is a limitless list of possible solutions to the problems hydraulic fracturing presents. Two extreme solutions will be discussed and then an attempt will be made to devise a creative middle ground where the solutions would be acceptable to both the public and the oil and gas industry.

The first extreme to be examined is to allow the oil and gas industry to develop the gas reserves without regulation and oversight. There would not be blatant attempts to pollute or harm the public where water resources are concerned but due to cost of implementing water monitoring, water treatment schemes, and engineering designs of systems to protect water resources, these costs would be minimized in order to maximize profits. The affects would be increased pollution of nearby watersheds, contaminated aquifers, and a general decline in population and property values due to the environmental damage done. This would be a worst case scenario.

This scenario might illustrate the effects of only applying Utilitarian principles to the situation. The "good" in this situation would be economic benefits felt by the gas employees and shareholders of the gas companies. Small

businesses around the around the drilling site would also benefit increased activity brought in by personnel working the gas field. While land owners who sign over mineral rights may experience economic gain, they do so at great risk to their property values should a problem with the local water supplies arise.

As a cost of unregulated development of the shale gas, the rights of property owners and nearby communities could be impinged. Any number of problems could occur to pollute the local surface water. If the unregulated gas wells leak gas into the local water supply, land owners and communities that use that supply could be impacted. While bottled water could be provided or potable water trucked in, the quality of life of all parties using the water would be impacted.

The other extreme would be heavy government regulation to the point where no activity could occur. New York State could make the regulations so strict or hydraulic fracturing so cost prohibitive that no drilling could occur and no resources could be collected. While there currently is a moratorium in New York on high-volume hydraulic fracturing, this is only temporary until the proper rules and regulations can be developed.

From a Utilitarian viewpoint, the stakeholder experiencing the greatest good might be those New York residents who might otherwise be negatively impacted by drilling activity. These stakeholders would experience a status quo where no new economic activity is generated but their water supply and quality of life is not impacted either. The gas companies might be negatively impacted if the moratorium continued indefinitely. The gas companies could lose the rights to the leases they have signed with property owners and potential money from the gas that is not collected.

From a Respect for Persons standpoint, the rights of landowners who would benefit from signing over mineral rights would be impinged. Instead of collecting royalties from the gas companies, the state would be dictating how those landowners could use their property and the minerals under the surface.

There are many issues and stakeholders interested in the hydraulic fracturing situation but a common ground can be found and solutions are possible to ensure safe collection of natural gas. The creative middle ground can include a mix of regulations and strategies that allow industry to progress and the public be protected. Such regulations would include

- Set a minimum distance between hydraulic fracturing activity and public water supplies
- Demand full disclosure of fracturing fluid chemicals before drilling permits are issued
- Specify retention and collection systems that can collect and hold all fracking fluid used on site to prevent spills
- Specify comprehensive periodic water testing in areas near drill sites
- Create remediation fund in which all drilling companies must contribute to cover accidents resulting from hydraulic fracturing
- Outsource water used in drilling, possibly using recycled water
- Fund research into environmentally compatible chemicals to use in the fracking process
- Specify the plan for treatment and disposal of all fracking fluids and materials

While these recommendations put a financial strain on the gas companies, they are the stakeholder that has the means and knowledge to make fracking safe. It is also possible that a collective agreement could be reached where, in exchange for jobs and the economic lift the industry will bring, the public and the gas companies could fund the construction of a centralized water treatment plant specifically designed to treat water used in fracking. The city of Niagara Falls has expressed an interest in accepting frack water at their treatment plant as a source of revenue. The treatment plant in this city has extra capability due to the treatment of contaminated water from the Love Canal Superfund site [8].

As part of the moratorium on high-volume fracking, New York has devised a list of recommended actions to allow drilling to occur safely. The published list included many of the recommendations mentioned above with additional recommendations. The additional points include prohibiting drilling in the watersheds of New York City and Syracuse, prohibiting drilling in aquifers and within 500 feet of an aquifer border, and specifying additional well casings to prevent the migration gas out of the well [NYDEC, 6].

VI. IMPACT OF ETHICAL RESOLUTIONS

The recommended actions in the list above will protect the residents of New York from water contamination. Several of the points directly address the use of water and how to minimize the chances of cross contamination. Other points address the physical systems of drill sites such as spill containment and reclamation of used water. In all, these recommendations will allow the Marcellus shale to be exploited safely while bringing economic activity to the State of New York and the small towns and cities located on the shale formation.

VII. CONCLUSION

Hydraulic fracturing of wells is a resource intensive process. Millions of gallons of water are needed, toxic chemicals are used and generated during the process, and there is a potential to contaminate nearby water supplies. While hydraulic fracturing sounds like a process best left alone, it has the potential to unlock a large supply of gas to help ease the reliance of the U.S. on foreign energy supplies. When the industry is regulated properly and rules established that clearly define how the process can be completed safely, the public and the gas and oil companies will benefit. The creative middle ground between no regulation and over regulation will allow the Marcellus shale to be developed for the benefit of all stakeholders.

VIII. ACKNOWLEDGEMENT

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X. Biography

Andrew Potter was born in Glen Ridge, NJ and moved to small town in the western New York Finger Lakes region. After graduating from high school Andrew enlisted in the Air Force where he served as satellite and wideband radio technician. Andrew was stationed at Eglin Air Force for the majority of his service commitment and is currently employed there as an electronics technician on Eglin Test and Training Contract.