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# Hydraulic Fracturing: Balancing Energy, Economy, and Environment in Pennsylvania

Robyn L. Froehlich

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HYDRAULIC FRACTURING: BALANCING ENERGY, ECONOMY,  
AND ENVIRONMENT IN PENNSYLVANIA

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of

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by

Robyn Lynn Froehlich

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Charles Town, WV

## Hydraulic Fracturing: Balancing Energy, Economy, Environment

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# Hydraulic Fracturing: Balancing Energy, Economy, Environment

## DEDICATION

I dedicate this thesis to my marvelous husband, Bob, and sweet little daughter, Dakota, for their unwavering love and support throughout the completion of this work.

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## ABSTRACT OF THE THESIS

### HYDRAULIC FRACTURING: BALANCING ENERGY, ECONOMY, AND ENVIRONMENT IN PENNSYLVANIA

By

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American Public University, February 22, 2015

Charles Town, WV

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Hydraulic fracturing operations, also known as fracking, have become a widely debated topic that has slowly arisen over the past decade. Fracking has provided a new method for the gas industry to extract domestic natural gas that was previously economically unattainable, therefore creating perceived benefits for the United States to bridge the energy gap while renewable sources are being further developed. It has also been assumed that it will boost waning local and state economies through gas extraction revenue. However, there are increasing concerns about the environmental safety of fracking, particularly the potential for water contamination and air pollution. The state-delegated policies that are charged with protecting the health and welfare of citizens are lacking the capability and consistency to meet that responsibility. This thesis analyzes the existing components of the Oil and Gas Act that regulate fracking in the state of Pennsylvania, and recommends policy changes that are be feasible to implement while still balancing the demands of the economy, environment, and energy production.

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## I. INTRODUCTION

Hydraulic fracturing operations, also known as fracking, have become a widely debated topic that has been continuously rising over the past decade. This occurrence has evolved primarily due to the fact that fracking involves two very sensitive and vital domestic issues – the ability to produce and meet energy demands, and the ongoing concern about adequate environmental protection and policy. While natural gas has been extracted from rock formations, refined and then distributed within the United States for many decades, the original conventional methods are significantly less impacting on the environment than unconventional methods that have emerged, which utilize hydraulic fracturing (Rabe & Borick, 2013). Conventional drilling methods extract gas from void spaces within rock formations where the gas stored in large quantities, requiring much shallower drilling distances, less water usage, and less underground fluid injection when compared to unconventional methods (Rabe & Borick, 2013). Conversely, unconventional methods involve a hydraulic fracturing process that requires drilling vertically and horizontally for thousands of feet through the subsurface of the earth, and then fracturing underlying rock formations using hydraulic fluid under high pressure to expose the gas embedded within deep shale plays, and then force it back to the surface (Palliser, 2012). The primary difference between the two processes is that conventional methods have minimal impact to the immediate environment because the gas is more readily extractable in large pockets underground, while gas harvested through unconventional methods is extracted from within very small fissures in shale formations, requiring a process that is technically demanding, uses extremely large amounts of resources, and has a much greater impact on the environment.

The process of hydraulic fracturing was developed in the late 1990s when technological advancements and rising oil prices provided the gas industry with an economical and profitable

method of extracting natural gas from much deeper depths and locations within the earth that were previously unattainable (Palliser, 2012). Since that time period, the number of gas wells have increased dramatically across the country, particularly in areas where shale gas was known but inaccessible – in Pennsylvania for example, 1,387 wells were drilled 2010, and a conservative estimate of over 10,000 wells are projected to be drilled by 2020 (Garmezzy, 2013). Nationally, natural gas production through unconventional methods grew twelve times from 2000 to 2010, and by 2011 it was producing a quarter of all gas extracted in the United States, and is on the fast track to produce half of gas yields in the country by 2035 (Energy Information Administration, 2011). As a result of fracking, there is a revitalized outlook within the gas industry, and as will be discussed in later sections, the gas boom has impacted local and state economies, employment, and communities in various ways. The debate is ongoing as to whether or not there will be a net positive, or at least neutral, impact achieved within all of these areas.

While there are various concerns about the impacts of fracking, the primary apprehension is tied to the perceived detrimental (and in some cases documented) environmental effects that are associated with the operations. First, the high volume of water that is consumed for each well poses a threat to water supplies in both rural areas that rely on private wells, as well as public municipal drinking water sources. Each well requires the injection of approximately five to nine million gallons of fracking fluid, and yet it is estimated that only half is reclaimed and treated or recycled, and the remaining fluid stays underground or slowly flows back to the surface years after production, with undetermined consequences to water quality (Palliser, 2012). An EPA report published in 2011 estimated that between 70 and 140 billion gallons of water are used for fracking operations, which equates to annual levels of water consumption for 50 to 80 cities with an average 50,000 population (EPA, 2011). These significant increases in water

usage can pose a threat to aquatic resources by disrupting the cycle of internal ecosystems that rely on available water sources. Secondly, there is a potential for water contamination that could affect drinking water sources, to include underground aquifers, water bodies and streams which could be caused by faulty well encasements, negligent and accidental spills, and undetermined amounts of contamination that can occur as a result of migrating fracking fluid through the earth's subsurface and ground water systems (Rabe & Borick, 2013). Additionally, the fluid used in the process is proprietary to the industry and is not required by law to be disclosed, but is known to consist of water, sand (or other medium used to "prop" open the rock fractures), and various chemicals including polysaccharides, hydrochloric acid, and methanol (Garmezy, 2013). Other environmental concerns are also generated by fracking – the release of methane gas from well heads has received growing attention because current and abandoned wells are not typically sealed well enough to prevent the leakage of methane, which has a global warming impact 20 times larger than the impact of carbon dioxide (EPA, n.d.), leading some scientists to believe that the touted clean-burning benefits of natural gas will likely have a larger greenhouse footprint than its counterparts such as oil and coal (Garmezy, 2013). Among additional issues are potential seismic disturbances, increased fuel consumption for truck transportation, premature road and infrastructure damage, site disturbance of forests, habitats and agricultural areas, and even a socio-economic impact caused by an increase of migrant gas workers that have no personal connection to the communities in which they work (Kelly, 2011).

For these reasons, there are clear concerns that fracking negatively impacts the health and welfare of citizens and their environment, while still having several perceived benefits. First and foremost, it is profitable for the oil and gas industry – and in turn politically influential, as well as having the potential to provide economic benefits that could boost state and local economies,

lower unemployment rates, and even temporarily solve the looming energy crisis as conventional oil and gas reserves are continuously depleted. Nearly half of the country's population relies on natural gas for various uses, to include residential and commercial heating, and industrial operations. This statistic has led to a divided opinion on fracking operations, as it is realized that this virtually untapped resource lying domestically beneath the country could provide energy independence – and perhaps exporting ventures - for an unknown period of time, minimizing the country's dependence on foreign oil and other more expensive energy sources.

Opponents argue that the focus should be shifting toward renewable resource capabilities instead of continuing to rely on fossil fuels for energy production. They also challenge that if a temporary solution exists, such as fracking, it will only further delay the progress of renewable energy advancements (while growing the wealth of the oil and gas industry). It is also contested that the oil and gas industry takes advantage of the minimal regulation that exists on a federal level, since the primary policy creation and enforcement authority of the industry are delegated to the state level. As can be imagined in a developing practice such as fracking, state policies vary widely throughout the country, from pro-drilling states such as Texas and North Dakota, which have extremely minimal regulation and enforcement, to New York that currently has a fracking ban until further research and evidence can be provided to demonstrate that unconventional drilling does not pose an environmental threat to their state population or ecosystem (Palliser, 2012). Even in states that do have policies in place, they are often inadequate to provide sufficient protection, or the state staffing that is charged with enforcement of the policies are understaffed to the point where they cannot keep up with the number of permits and often remote location of the well heads that each require inspection.

The industry has enjoyed the fact that domestic oil and gas extraction has been among the least regulated and enforced industrial operation for many years. It has historically operated this way to minimize the permitting and restrictive requirements that could potentially cause the industry to be outperformed by foreign sources. Many oil rich countries could produce and export oil at less cost due to many factors, among them being that they have an abundance of resources, varied pay and safety standards for workers, and minimal environmental and permitting regulations.

However, fracking may pose environmental consequences that could eventually cause a reactionary effect similar to what was seen several decades ago. The national environmental policies that were introduced in the 1960s and 70s provided a vital political shift toward increased protection of the environment, and were a resulting reaction to the industrial boom that was being experienced across the country. As states and cities grew in population and size, the increasing industrial impacts took their toll on the environment. For example, Pittsburgh Pennsylvania experienced sharp industrial growth during that time period and earned the merit of being city with the third largest amount of corporate headquarters in the country. However, the headquarters were primarily associated with heavy industry, and that distinction came with a price: by mid-morning, the smoke and smog were so thick that it produced a hazy cloud over the city and made it uncomfortable to breathe (Deitrich, 2008). As a result of the efforts of political leaders such as President Lyndon Johnson, regulations including the Clean Air Act, Water Quality Act, and Water Resource Planning Act were put into place to regulate industries and demonstrate the importance of environmental protection. President Johnson was quoted as saying “There is no excuse—and we should call a spade a spade—for chemical companies and oil refineries using our major rivers as pipelines for toxic waste. There is no excuse for

communities to use other people's rivers as a dump for their raw sewage" (National Park Service, n.d.). These Acts, among many others, were instrumental in providing the policy backbone that was needed to reduce the impact that the industrialized world was having on the environment. Years later, the impact of environmental policies has been evident – rivers that could previously be set on fire due to toxic dumping have been returned to pristine fishing locations, and air that was clouded with particulate matter over industrial cities is now safe to breathe. Perhaps in modern times the idea of water pollution may sound out of character due to the regulations that have been successfully set in place over 50 years ago with positive outcomes that are dramatic and evident, but many believe there is a looming environmental crisis within the oil and gas industry, and once again it may be reactionary environmental policy that will need to be created and then appropriately enforced in order to reverse the effects of fracking.

Resultantly, disagreements continue about the safety of drilling in deep shale plays, which stems to the further conflict about what is the necessary level of regulation versus acceptable current industry practices. It must be determined what the most feasible environmental approach should be within this emerging field that produces a new domestic source of energy by extracting previously unattainable gas through unconventional methods, providing an energy source that could lessen reliance on foreign oil, and increase state employment and revenue opportunities. Opponents argue that hydraulic fracturing cause significant environmental impacts, including contamination of ground and surface water, air pollution, excessive water usage, increased seismic potential, impacted ecosystems, and socioeconomic issues. Since federal law primarily delegates the authority for oil and gas regulation to the state level, the future of environmental policy for fracking operations is already demonstrating varied levels of restriction throughout the gas states across the country, which

make up at least 30 states (Rabe & Borick, 2013). As Pennsylvania has risen to the second largest natural gas producer in the country, behind only Texas, attention has turned to the state legislation that could become a model, or at the very least, observed by other states, as the industry continues to unfold (Wagstaff, 2013). In Pennsylvania, fracking is regulated under the Oil and Gas Act (Title 58), and most recently under Act 13, which was passed in February 2012 under republican Governor Tom Corbett. Act 13 included many modifications to oil and gas regulation, which benefits the gas industry, most notably implementing restrictions on local municipalities and revoking their right to ban fracking and other restrictive zoning implications. This thesis focuses on the limitations within the Pennsylvania Oil and Gas Act, and specifically Act 13, which does not adequately address the environmental issues in order to effectively protect the welfare of the population and environment within the impacted area of hydraulic fracturing wells and associated operations. It is recognized that the state is politically controlled by pro-fracking parties in both legislative arms and until January 2015, by a republican governor, therefore the idea of reaching a decision to outright ban fracking, similar to the approaches of sister states Maryland and New York, may be an ideal but highly unlikely circumstance. This thesis examines various other policy revisions that may be feasible to be passed within the upcoming term of the incoming democratic Governor, Tom Wolf, instead of introducing proposed changes that may instead become stifled and lose gaining momentum for fracking reform. Within the study, the following research questions are addressed:

- What are the primary components of the Pennsylvania Oil and Gas Act that limit the environmental impacts of fracking?
- What are the environmental and health impacts that occur due to fracking under the Pennsylvania Oil and Gas Act?

- How are the economic benefits of fracking measured and effectively compared to the negative health and safety impacts?

## II. LITERATURE REVIEW

The concern about the environmental impacts caused by hydraulic fracturing, and subsequently the lack of regulation at the state level in Pennsylvania, has been consistently rising over the past decade as thousands of new unconventional wells are drilled each year, thereby increasing impacted populations and land areas. The pace of unconventional gas production has increased sharply since the end of the twentieth century, with only 0.8% of gas production being extracted by fracking in 1990, compared to 29.7% in 2011, with the expectation that it could account for 60% by 2035 (US EIA, 2012). It has become evident that fracking operations are not likely to reach the peak of their “boom” for decades, and the need for tighter regulations that regulate this relatively new practice and protect the health and welfare of the citizens and environment is greatly needed in Pennsylvania.

The oil and gas industry has enjoyed minimal regulatory oversight of its unconventional drilling operations in the state since the beginning of the fracking boom in the early 2000’s, particularly when compared to neighboring states New York and Maryland. The industry has been openly supported by Pennsylvania Governor Tom Corbett and his administration in various ways, to include minimizing requirements for drilling impact fees, as well as passing an amendment to the state’s Oil and Gas Act in 2012, also known as Act 13, that expanded the rights of unconventional drilling operations. (Wagstaff, 2013). Act 13 was signed into law on February 14, 2012 under House Bill 1950, and although the state’s public opinion about the Act is that it “provides for enhanced environmental protections for the development of

unconventional wells and for the collection and imposition of an impact fee for the development of unconventional well,” (DEP, n.d.), there are significant concerns and beliefs by municipal leaders, environmentalists, and researchers that Pennsylvania is heavily influenced by the gas industry and the Act has had minimal impact on the protection of the environment. The purpose of this thesis is to analyze the Act’s components, as well as the environmental impact data about fracking that has been collected since the early 2000’s in order to provide future policy recommendations that would improve the effectiveness of the state’s environmental regulations on unconventional drilling operations. There has been significant research and knowledge that has been accumulated on the effects and impacts of fracking, as well as emerging analyses and research that is being published about the concern of Pennsylvania’s lackluster policy establishment and enforcement. Three significant studies are reviewed below to examine the environmental impacts of fracking, the current perception of fracking at both the federal and state level in Pennsylvania, and the minimal regulation that exists within the Oil and Gas Act of 2012 (Act 13) to protect Pennsylvania citizens and their environment.

### Conventional Versus Unconventional Drilling

In research conducted by Holahan and Arnold (2013), they analyzed the primary differences between conventional and unconventional gas drilling, with the theory that regulators have attempted to utilize existing oil and gas policy to address environmental impacts associated with both types drilling. Due to the vast differences between the two operations, with unconventional drilling having a much more complex extraction process and thus severe environmental impact, Holahan and Arnold studied the outcome of applying conventional gas drilling regulations to the newer, unconventional processes, also referred to as hydraulic fracturing or fracking. While there are various environmental issues associated with hydraulic

fracturing, such as excessive water usage, deforestation, and destruction of infrastructure, the researchers focus primarily on the main and most wide-spread concern: water quality impacts and contamination. Their contribution to the literature involves the development of the theory that the institutions that are in place to manage and dispose of wastewater associated with conventional drilling are not equipped or prepared to adequately manage wastewater generated from unconventional drilling, particularly because the same regulations such as the use of conventional integration contracts and well spacing requirements do not provide the same level of environmental protection for hydraulic fracturing. Their concept was that these types of regulations provide suitable protection for point source pollution, which is a type of pollution created during drilling through inefficient processes or local spills that have the potential to pollute areas in the immediate vicinity of the drilling sites. However, fracking involves different geological conditions and types of shale plays, and the type of extraction process that is required increases the environmental impact in the form of non-point source pollution characteristics such as underground aquifer contamination, seismic activity, and widespread impact. Non-point source contamination is significantly more challenging to regulate than point source pollution because it is difficult to definitively locate the source of pollution and impose effective regulation. Furthermore, the researchers believed that conventional drilling regulations also closely modeled efficiency and economic waste within the gas industry – such that there was a self-motivation to follow environmental regulations because they also allowed for the most efficient extraction processes. They found this is not the case with unconventional drilling because the gas industry is not directly impacted economically or environmentally by issues associated with contaminated groundwater, deforestation, disruptions in ecosystems, or increased seismic activity. Well spacing and integration contracts do not address the issues of the multiple

fractures that are created over thousands of horizontal feet during fracking, creating a large span of groundwater pollution potential.

Their findings concluded that there is a need for the institutions charged with protecting the environment from fracking operations to adapt regulations in order to account for the differences between conventional and unconventional methods of drilling. Their approach is unique in that they do not take a staunch position against fracking, and instead recognize that it may be used as a resource needed to bridge the gap as renewable resource technology is further refined and developed for implementation on a level that could replace the reliance on fossil fuel resources. The potential for the U.S. to ban fracking in a similar manner as European countries is highly unlikely, as the U.S. prefers to “balance precaution against other considerations, most importantly, costs” (Ashford, 2006, pg 352). The economic benefits have outweighed most state’s considerations to ban, therefore it was recognized that other regulatory measures need to be specifically developed for fracking in order to minimize the levels of both economic waste and environmental impact. Examples of revised regulation include increased well spacing requirements, which would limit the number of wells as well as improve the likelihood of targeting the wells that are causing pollution concerns, however challenges still exist with the ability to identify fracking as a source of pollution. The primary conclusion of the study was that traditional methods of regulation do not adequately transfer to unconventional drilling operations, and studies need to be conducted and utilized to precisely develop policy to control fracking, which should be treated as a non-point source pollution source. The proposed thesis will build upon this discussion specifically within the state of Pennsylvania to provide feasible policy revision to the state’s Oil and Gas Act in order to adequately protect citizens and the environment from the impacts of unconventional drilling.

## Pennsylvania Oil and Gas Policy

The analysis completed by Rabe & Borick (2013) provided insight into the current status of Pennsylvania's fracking policy, and particularly explored the likelihood that their gas drilling regulations will influence the policy implementation of other states as regulation develops at the state level. Pennsylvania has become among the top states in unconventional natural gas drilling due to its proximity to the Marcellus shale play, and it has recently enacted far-reaching fracking regulations in 2012, which has the potential to become influential for other states that have been waiting to observe the successes and failures of various unconventional drilling policies throughout the country. Rabe & Borick provide examples of historical environmental regulation that has been created and implemented at state levels with the desire to demonstrate the willingness to be an early-mover on policy that will improve and protect quality of life within their respective states – thus, it has previously been desired by many states to “race to the top” to enforce policy with respect to climate change, air quality, and water quality in order to remain competitive with economic development that thrives in an environmentally protected environment. The state's policies instead took a “race to the bottom” approach, favoring short-term economic gain over long term environmental protection by taking the liberties of implementing their own state policy in the absence of federal regulation. The researchers explore the theories behind Pennsylvania's decisions on their policy implementation, recognizing that Governor Corbett had the ability to become instrumental in the state's role in energy and the environment, and it was clear that he had intentions of making Pennsylvania the top leader in gas production by encouraging drilling under minimal environmental regulation and impact fees. Despite Pennsylvania's storied past with depleted oil reserves and long-term environmental aftermath of coal mining, which then led to the growth of a lessons-learned approach of sound

environmental policy implementation, Rabe & Borick note that the state has yet again opted to lead the way in gas extraction without fully acknowledging the potential associated impacts that could persist for decades following the completion of hydraulic fracturing. They concluded that the state's most recent amendments to the Oil and Gas Act (Act 13) were developed to favor the gas industry through various components. First, the state did not require a severance tax, which is a typical tax that exists within oil and gas-rich states to offset negative externalities associated with extraction operations. Instead Pennsylvania enacted a complex impact fee that was delegated to the local government, while at the same time stripped the municipal governments of their zoning rights that regulate where, when, and how fracking can be conducted throughout the states. Additionally, the Act disregarded all existing concerns about cross-border contaminations, such as the tensions that exist with both Ohio and Maryland over deep well injection waste, spill contamination into neighboring watersheds, and increased air quality issues that spill across state borders. Therefore, it has been summarized that although Pennsylvania has been among the first states to implement fracking policy, it is not an indicator of its likelihood to be a model that will lead the way in policy development in other energy states due to the extreme measures that were taken in Act 13 to support drilling with minimal regard to external impacts. The proposed thesis can utilize this research to explore state policy alternatives that will attempt to balance energy extraction with environmental protection.

### Municipal Level Regulations

Building on research similar to Rabe & Borick (2013), Devin Wagstaff (2013) explored fracking policy in Pennsylvania on a micro-government level following the enactment of Pennsylvania's 2012 oil and gas legislation under Act 13. His research involves an analysis of the rights that exist for municipalities under the state's Municipal Planning Code (MPC) to

regulate the permissions and zoning laws that impact hydraulic fracturing. There are discrepancies between the MPC and the state's Oil and Gas Act (OGA) of 1984 (with subsequent amendments), and gas leaseholders of land argue that it would be unconstitutional if the MPC could override the OGA and allow local government to ban or limit fracking. Wagstaff recognized the discrepancies between Act 13 and the rights of local government, and demonstrated this unresolved issue through the analysis and outcome of several court cases. It was found that the court has effectively set an upper and lower limit on the allowable actions that a municipality can take to mitigate the negative impacts associated with fracking. On the upper limit, the local governments have been granted the flexibility to restrict the location and proximity of existing gas wells, but on the lower limit, restrictions were placed on the ability of municipalities to direct how operations will be conducted – which also includes any regulation involving environmental protection. He concluded that the state's Oil and Gas Act of 2012 leaves many questions that remain unanswered and will likely lead to further litigation in the future. This research will assist with the proposed thesis by providing emphasis on the areas of the OGA that are unclear and in need of revision to properly protect the citizens and resources of Pennsylvania.

Due to the controversial nature of hydraulic fracturing, particularly in Pennsylvania because of its leading role as the epicenter of the Marcellus gas play, significant research exists that explores all facets of unconventional drilling. Many economists, political leaders, and citizens believe that fracking will provide the much-needed boost to the U.S. economy for decades to come, while scientists and environmental experts unilaterally agree that water quality impacts are a rising concern. The OGA of 2012 will be further analyzed using existing research in order to adequately revise the policy to address environmental protection.

### III. METHODOLOGY

#### Project Research Design

The primary design for this thesis takes an explanatory research approach, focusing on the reasons why policy decisions are made under various influences. In the gas industry, the influences are wide and significant, varying between large industry influences, economic factors, rising energy demands in the midst of lingering resources, and environmental concerns. When so many factors play a role in government decision-making and policy creation, often the deepest pockets have the loudest voice and largest influences unless there are negative impacts associated with an approved operation or industry that can cause harm or inconvenience to others. Unfortunately, the environment is often among the last factors considered when evaluating policy within the oil and gas industry, as has been the case with hydraulic fracturing. Creating and connecting these types of relationships will create a causal chain that may provide an explanation to the reasoning behind policy decisions, and furthermore lead to suggestions that can provide insight to future policy revision and creations that better balance the terms and interests of all parties and stakeholders.

Through a historical review of the Pennsylvania Oil and Gas Act, in addition to the consideration and evaluation of external factors that affect fracking policy, the thesis will develop relevant correlations that will in turn provide recommended policy revisions to address the environmental impacts currently being observed across the state of Pennsylvania. It is the goal of this study to invoke thought about the reasons behind lacking environmental policy and suggest considerations that should be given not only to policy revisions, but also to policy creation for future industrial operations that impact the environment. Too often the United States has acted in a reactionary mode when considering environmental protection, such as the

industrial impacts that caused the major environmental policies that were enacted in the 1960s and 70s, or the clean-up efforts of the Chesapeake Bay watershed that were driven by pollution instead of implementing proper storm water management policies (EPA, n.d.). Instead, the government and general population would achieve more effective results if the impacts of a new industrial process were fully researched, analyzed, and regulated prior to allowing operations to occur. While it is realized that industrial pressures can influence political decisions, there is a significant amount of convincing evidence that has confirmed that fracking causes severe environmental consequences, and enacting adequate policy at the state level has the potential to prevent and control unsafe practices in Pennsylvania.

#### Data Collection Technique

This thesis will provide recommendations to address the limitations of the Pennsylvania Oil and Gas Act's ability to effectively protect the safety and welfare of the population and environment with respect to unconventional drilling methods. A qualitative approach is utilized through the incorporation of observations about current policy using the viewpoints of various stakeholders, to include industry representatives, political leaders, environmental advocates, environmental researchers, and the general public, who have the potential to experience both the beneficial and negative impacts of fracking. Building a theory using inductive reasoning will guide the data toward a suggested conclusion, with the intention to determine the reasoning behind the current decisions about the Oil and Gas Policy. It will also provide insight about the likelihood of change and revisions in the future that will benefit the environmental protection aspect of fracking while still being feasibly passed in the pro-fracking Pennsylvania legislative system. The primary objective is to describe and explain the relationships that exist among the stakeholders in order to drive toward a conclusion that will address the primary objectives of

fracking, while balancing the environmental requirements that protect human life and related ecosystems. Several policy recommendations will be analyzed against existing policy to generate discussion and consideration for future changes.

### Conceptual Framework

Pennsylvania has been involved with hydraulic fracturing for nearing two decades, and there is no indication that the environmental concerns surrounding these unconventional drilling practices will deter the state's willingness to allow fracking. Republican Governor Tom Corbett, the current governor through 2014, has publicly stated that he intends to make Pennsylvania the "energy Capital of the United States" (Pollock, 2012). The incoming democratic governor, Tom Wolf, campaigned on a platform that he would increase the capabilities, staffing, and funding for the Department of Environmental Protection (DEP) to sufficiently provide oversight of drilling operations, impose a severance tax, and ensure responsible drilling, but he does not intend to consider a ban on fracking or do a thorough investigation of the environmental consequences (Tom Wolf, 2014). Therefore, with the pending change in political leaders, there is potential for the Oil and Gas Act to be revised to improve environmental protection and protection of the citizens from fracking operations. The Oil and Gas Act has four primary purposes, which in summary are designed to promote the development of oil and gas resources while protecting the health, safety and environment of the impacted area (Clovis, 2009). Therefore, the Act broadly requires that protection shall occur, however the implementation of the plan for operations involving unconventional drilling operations does not adequately satisfy the Act's purpose.

The decision to create and enforce regulation on oil and gas operations lies primarily with the states, and due to Pennsylvania's vast amount of shale gas resources and interest in extraction through unconventional methods, the regulation that is put into place by this state demonstrates

an “early-mover” decision that becomes an example for other states to evaluate and consider (Rabe & Borick, pg 323). Although Pennsylvania has often served as a model in the effort to employ effective and protective environmental policy, the most recent amendments to the Oil and Gas Act in 2012, which falls under the responsibility of the Bureau of Oil and Gas Management within the state Department of Environmental Protection (DEP), have sided favorably with the oil and gas industry and minimized environmental regulation for fracking operations (Wagstaff, 2013). It becomes even more evident that Pennsylvania’s split control of the house made it difficult to pass any legislation that would hinder the gas industry, as a proposed 5% severance tax, which is the average tax in the top fifteen fossil fuel producing states, was disapproved in 2004 (Fitzgerald, 2013).

There is a legitimate cause for concern regarding the environmental impacts that fracking operations cause within its immediate drilling area and to underground water sources and surface waters, so much that several European countries, including Switzerland, France, and parts of Germany, have banned fracking until research can prove it is safe (Garmezy, 2013). The primary concern is degraded water quality due to the dangerous levels of total dissolved solids, chloride, barium, calcium, and even radioactivity that is brought to the surface from thousands of feet below the ground during the injection process (Palliser, 2013). Additionally, there are a myriad of other concerns associated with fracking operations, such as an immense amount of water usage, increased levels of methane concentrations in air and water, loss of wilderness, and premature destruction to state infrastructure and roadways (Garmezy, 2013). The average fracking operation requires the injection of approximately five to nine million gallons of fracking fluid per well, comprised of water chemicals and sand, however only nine to 35% of the fluid is recovered during the extraction and recovery process; the remaining fluid stays underground and

has the potential to migrate through the rock or faulty well casing and pollute groundwater aquifers (Holloway & Rudd, 2013). In addition, the water that does get reclaimed is collected and must be treated at municipal wastewater treatment plants, which are not often designed to remove all of the contaminants contained in fracking fluid. In 2008, this situation affected Pennsylvania's Monongahela River, where treated wastewater contained salty sediments and caused the corrosion of manufacturing equipment and residential dishwashers and other appliances. To address the issue, the Department of Environmental Protection (DEP) redirected the discharge to another location and diluted the river by unlocking upstream dams (Sapien, 2009). While recognizing that the DEP needed to eliminate the problem as rapidly as possible for the residents, businesses and industries, this solution did not address the long-term policy requirements needed to prevent the same issues in the future. It is one of many examples that demonstrates the DEP is understaffed, minimally supported through policy, and incapable of providing adequate oversight and enforcement within the gas industry. Although natural gas is touted as a cleaner burning, more efficient and environmental source of energy, a 2011 study done by Cornell University has demonstrated that the amount of greenhouse gasses emitted for one unit of fracked gas exceeds the amount of one unit of other traditional energy sources such as coal, thereby eliminating the benefit of utilizing natural gas over those sources (Palliser, 2013).

Although there is a demonstrated need for regulation, the challenge lies within the need to change the political paradigm, which is currently financially influenced by the gas industry – between 2007 and 2011, the industry lobbied \$21.6 million to state officials (Yeoman, 2013). The first step is to question the “industry’s social license to operate,” (Yeoman, 2013) in order to influence public opinion and educate citizens about not only the benefits, but also the

environmental hazards of fracking. Once pressure is placed upon the state and enough public support is achieved, policy can be accepted and adopted, and the Oil and Gas Act can be amended to effectively address the concerns with hydraulic fracturing.

#### Limitations of the Study

This project will research the existing Pennsylvania Oil and Gas Act, as it pertains to fracking in order to establish a framework that can be used to develop policy revisions that balance energy projection with environmental protection. There will be a combination of both qualitative and quantitative data utilized to gather information on known environmental concerns associated with fracking, as well as an examination of the economic benefits that have been observed in the state. Due to the time limits of the course, the examination will focus on the impacts that have occurred in recent years to provide the most relevant data that can be used to shape the need for revised environmental policy. An examination of federal policy will be conducted to understand the delegation authority to the states, and likewise a review of the state regulations will provide insight to the capabilities and limitations at the state government level. Limitations of the thesis also include the depth of examination that each environmental impact is warranted and analyzed. For example, there is often controversy that exists about the amount of water contamination and other environmental impacts that occur as a result of fracking, however it is known that there is a baseline level of pollution – including water, land, and air that inevitably occurs during the fracking process, and there is also a high level of uncertainty about the potential for future contamination through underground water migration in upcoming years and decades. These types of inconclusive evidence must be acknowledged and incorporated into the overall recommendations. Through the use of data extrapolation and documented research, conclusions will be generated to provoke thought and consideration about future policy revisions. The

project will summarize the primary components of the Oil and Gas Act specific to hydraulic fracturing that could benefit from being revised, and also explore other policy considerations that are not currently addressed in order to provide adequate protection of the safety and welfare of the citizens and environment.

#### IV. RESULTS

##### Oil & Gas Regulation: Federal Impacts and Influence

Federal law has minimal influence on hydraulic fracturing at the operational level. While there are several environmental acts that could encompass and regulate fracking, the political influence in the early 2000s acted swiftly ahead of the gas boom and paved the way for unconventional drilling methods to be employed with minimal permitting restrictions or delays. There has been some discussion among policy experts about the need to regulate fracking on a federal level to establish a clear baseline of environmental protection among all states, and to demonstrate the importance of the regulation from a federal viewpoint. However, this approach would require a significant amount of political support across both parties, as well the ability to demonstrate an uncontested confirmation of pollution issues associated with fracking, neither of which are likely to be achieved in the final years of the Obama administration or in the first several years of a president with still unknown political viewpoints.

An example of the issues associated with federal oversight, as well as a demonstration of the existing turmoil that is present between opposing parties is the means in which the regulation of fracking as it pertains to the Clean Water Act (CWA) was decided upon in the last decade of the twentieth century. As water pollution is one of the prime concerns about fracking operations, the CWA is a key Act in the discussions surrounding hydraulic fracturing regulation. As shown in the outcome of the case study described below, environmentalists and the oil and gas industry

continue to be at odds with existing federal regulation. The Clean Water Act (and subsequently the Safe Drinking Water Act (SDWA)) is designed to protect the discharge of pollutants into regulated waterways, which was instrumental in providing the backbone needed to clean up the nation's waters when there was minimal regulation on operations involving wastewater discharges, varying from slaughterhouse discharge to byproducts of chemical and fertilizer plants. However, there was an amendment that was passed in 1987 that essentially exempted all components of the oil and gas industry – exploration, processing, and production – from meeting the same regulations required of all other industries and operations. These minimal regulations remained in place until 1997, which was during the Clinton Administration and several years before the fracking boom (and controversy) began, so there was minimal public attention on the case. It wasn't until the 11<sup>th</sup> Circuit of the United States Court of Appeals ordered the Environmental Protection Agency (EPA) to start regulating fracking under the SDWA, which was initiated as a result of fracking operations that occurred in 1989 in which a coalbed gas well in the state of Alabama was alleged to have contaminated the residential water supply, that federal oversight was considered. The case cited Part C, Section 1421 within the SDWA, which is the section that gives the authority to regulate underground injection wells (Lathem, 2009). This section provided a mandate that by 1977, all states must successfully implement a program to protect ground water and other sources that could be impacted by injection operations. There were six classes of wells designated, which ranged from hazardous storage, carbon dioxide disposal, and injection of brines and fluids as a by-product of oil and gas drilling, which are defined as Class II wells. There are currently over 150,000 wells regulated under Class II, with most being Enhanced Recovery Wells, which use an injection well to inject fluid underground, and then several surrounding production wells actually extract the available gas. The primary

issue is that injection wells are not used for hydraulic fracturing – so although fluid is being injected, the UIC does not apply unless the fluid contains diesel fuel, which most industrial practices have eliminated to avoid regulation.

Therefore, the EPA has never regulated fracking operations, despite the fact that injection wells are defined as a shaft with a hole that is deeper than it is wide used to inject fluid for various reasons, to include waste disposal, storage, and even most practices associated with oil production and mining, (EPA, n.d.). Although fracking operations causes millions of gallons of fracking fluid and other contaminants to remain permanently underground following the drilling process, it had not considered to be regulated, and is instead classified as a secondary operation to the primary process of gas extraction. This was perhaps intentionally unregulated for various reasons – it was not yet a widespread type of drilling operation due to its high cost, interest groups may have ensured that fracking stayed clear of regulation requirements because they the drilling future was headed in that direction, and there simply may not have been enough documented cases of water contamination and associated issues with fracking that created cause for concern.

It took a lengthy eight year process and numerous denied petitions to the EPA and Alabama Department of Environmental Management to finally achieve an outcome in support of the residents' case. The Court ordered the EPA to conduct studies to determine the risks associated with fracking, and it was this courts' findings that appeared to be the turning point toward the beginning of fracking regulation in the country. It was not without a struggle, and the EPA was continuously supported by various interest groups, to include the Coalbed Methane Association of Alabama and Colorado Oil and Gas Association, and pressured the Agency to petition the requirement of researching the potential risks that fracking poses to drinking water

(Latham, 2009). It was very clear throughout the back and forth discussion between stakeholders for nearly three years that there was a disconnect between the feasibility of economically employing fracking as a method of gas extraction, and also regulating the process under the EPA's UIC program, which would involve hearings and costly delays that would make fracking less appealing. Furthermore, confusion about how the EPA would regulate fracking came into discussion, since the only case filed to date concerning water contamination due to fracking had occurred in Alabama, so the EPA needed to decide if they would apply the rule only in Alabama, or create new nationwide regulations. The EPA outcome resulted in a memo that was distributed to state Oil and Gas Boards, stating that despite their original interpretation that fracking was not to be regulated as underground injection, it was changing their position and was now requiring Alabama to regulate fracking under UIC. The state Oil and Gas Board quickly petitioned the ruling, and cited that it was unconstitutional to single out one state's UIC program, and also argued that there has not been sufficient proof or complaints that water contamination occurs as a result of fracking (Latham, 2009). The EPA and other environmental groups fired back, stating that no official reports had ever been released to confirm the number of water contamination incidents, and also accused U.S. Senators who supported fracking of telling half-truths about the impacts of fracking. This case continued until 2001, with the final outcome being that Alabama would be regulated under the UIC Class II well program for all coalbed methane fracking wells, but no other national policy was established.

The discussion about regulating fracking under the Safe Drinking Water Act continued for several years, and the EPA eventually did release a report in 2004, concluding that there was little or no threat found to drinking water as a result of fracking (EPA, n.d.), and that there is no need to revise existing regulation in order to include fracking as a regulated activity under the

SDWA, and also affirmed that there is no need to conduct more studies on the topic of fracking (EPA, 2004). The report summarized the conclusion that when fracking fluids are injected, the “mitigating effects of dilution and dispersion, adsorption, and biodegradation, minimize the possibility that chemicals included in fracturing fluids would adversely affect underground sources of drinking water” (EPA, 2004, p. 7-3). Essentially, the popular yet misinformed concept of “dilution is the solution to pollution” has once again surfaced as a resolution to a difficult topic that is in need of balancing between the health and safety of the general public and the deep pockets and political influence of the oil and gas industry. However, not long after the report was released, a whistleblower named Weston Wilson, who was an environmental engineer in the EPA, publicly released information that questioned the validity and legitimacy of the study (Palliser, 2012). He stated that it had been influenced by industry lobbyists and stakeholder groups and accurate scientific data was not used, which led to unsound conclusions that were designed to meet the desires of the oil and gas industry. The EPA Inspector General Nikki Tinsley confirmed that Wilson’s assertions were accurate, and there was significant documentation that was withheld from the report, some of which negated the entire conclusion of the original report, stating that fracking that is unregulated poses a threat to human health and the environment, and that there is a potential for fracking fluid to cause long-term effects to water supplies after drilling operations are concluded. At a minimum, Wilson pointed to the fact that there was inconclusive evidence to confirm that fracking operations were safe, and suggested that a supplemental study be conducted to accurately consider all the risks (Wilson, 2004).

Meanwhile, upon the change in Presidential control in 2000 from the democratic administration under President Bill Clinton to the republican control of President George W. Bush and his staff, there was a renewed beginning for fracking operations, as it was

acknowledged that President Bush supported domestic energy policies. It was under his administration that one of the most impacting Acts was passed that has since impeded the ability of the government to regulate fracking. Under the direction of Vice President Dick Cheney, an Energy Task Force was formed to evaluate energy policies, and revise if necessary. Cheney had previously served as Chairman and CEO of Halliburton Company from 1995 to 2000 (which happened to patent hydraulic fracturing several decades earlier), and it was well known that he also supported President Bush's views on domestic energy production and the oil and gas industry, and would oppose any regulation that inhibited the ability for the industry to operate freely, such as restrictive environmental policy.

Following the release of the task force report and through utilization of a supportive Congress, the Bush Administration signed into law the Energy Policy Act of 2005. Within the Act, its primary objectives were to provide loan guarantees and tax incentives in support of energy production – essentially subsidies for energy companies. However, buried within the legislation was a section about fracking, which provided a legally binding, plain language confirmation that exempted the fluids used in the process from being regulated under the Clean Water Act, Safe Drinking Water Act, Clean Air Act, and Comprehensive Environmental Response, Compensation, and Liability Act, which encompasses nearly all of the major federal standards that could be applicable to fracking. It specified that the industry does not need to disclose the chemical composition of fracking fluid, does not need to monitor or track the fluid once it is injected into the ground, and there is no requirement to monitor the well field area for contamination after drilling operations have ceased. The act was so evidently written in favor of the gas industry that it was nicknamed the “Halliburton Loopholes,” with sections of the act being influenced and even written by the American Petroleum Institute (API) (Merrill, 2013).

The Energy Act of 2005 remains as the current legislation that regulates fracking, and had remain uncontested until 2009 when a bill called the Fracturing Responsibility and Awareness of Chemicals Act (H.R. 1084), also known as FRAC Act, was introduced by democratic Senators and Representatives. The primary goal of the Act was to reverse the Energy Act of 2005 and require that fracking be regulated under Section 1421 of the Safe Drinking Water Act (UIC Program), and also require the disclosure of the chemicals used in the fracking fluid, primarily to be used for medical treatment of individuals who are experiencing symptoms of potable water contamination, such as nerve and neurological conditions (Lustgarten, 2009). Although this Act appears to provide minimal ground when compared to all of the other issues surrounding fracking, it would have at least provided a starting point to build the case against health and environmental harm that is being created by fracking. However, it was severely opposed by the oil and gas industry, citing that it would cause undue harm and added costs to the industry, and could cause half of the oil wells and a third of the gas wells to be closed in the United States (Lustgarten, 2009). While it can be speculated that the catastrophic picture portrayed by the industry is highly unlikely to occur, it is another example of the persuasive power that is used to block and manipulate legislation to benefit such a large and financially influential industry. At present, the bill remains stalled in the Senate and has a status of “Died (Referred to Committee)” (H.R. 1084, n.d.), and is unlikely to be acted upon during the Obama Administration.

Although federal administration of hydraulic fracturing would provide a capability to nationally regulate and influence the fracking industry, the subject remains so politically contested and divided, that it would remain in a state of indecisiveness for the foreseeable years to come, allowing thousands more wells to be drilled across the country with no regulation in

place. Although there are known issues surrounding fracking, there is a lack of documented evidence that provides an unquestionable doubt that it poses a severe risk to humans and the environment. There is a risk in making the assumption that fracking is safe due to the lack of supporting evidence, when the evidence needed – such as water and air monitoring, disclosure of chemical usage, and documented cases of medical conditions, remains within an unregulated industry and therefore creates a lack of documentation. Due to the reactionary methods in which the United States government historically acts, particularly in cases of environmental protection, it would require a nearly insurmountable effort to pass environmental regulation on a newly booming industry that is publicly touted to have so many benefits to the country. Unfortunately, it would likely take a high death toll, complete destruction of ecosystems that can be easily observed and reported, and other very visual consequences in order for fracking to reach enough public support on the national political playing field to embark on a change in favor of increased fracking regulation. Often times, environmental impact, particularly in the form of pollution that cannot be seen such as water contamination, is not enough to direct sweeping policy change unless it directly affects human life with immediate impact. It won't be until long term affects are linked to health issues and severe water contamination issues that fracking will receive the attention it deserves, and at that point the question will be asked, why hasn't anything been done about this before now? Thus, the theory that is concluded using inductive reasoning obtained through the analysis of the federal policy making process suggests that fracking regulation is best addressed on the state level, giving each state their ability to individually control regulation while providing a unique framework for each specific condition across the country. It will also enable citizens to have a more powerful voice when attempting to influence policy makers about the risks associated with fracking. There will undoubtedly be challenges associated with attempts

to regulate fracking within any level of government, however it has been demonstrated that the attempts at the federal level have been stalled and unsuccessful, and the EPA is heavily influenced through political pressure and industry stakeholders. Bringing the discussion to the state level will provide a smaller and more interconnected environment that will have a higher likelihood of success.

#### Pennsylvania Oil and Gas Act: Environmental Deficiencies

As discussed in the section above, the federal government chooses to delegate authority to the state to administer a state-run Oil and Gas program, in which the states have primary enforcement responsibility and also authority to create additional policy that does not otherwise invalidate existing federal policy. In the case of environmental permitting for fracking, there are many federal exemptions under the Energy Act of 2005 that apply to fracking operations that do not apply for other oil and gas operations. Therefore, it is essentially left for the state to decide what level of oversight will be implemented for their individual program. Several neighboring states of Pennsylvania have chosen to place a moratorium on fracking until further research is conducted and can reasonably conclude whether or not fracking poses a risk to human health and the environment. This thesis focuses on the theory that it is highly improbable that Pennsylvania will follow suit and implement a ban on fracking, given its status as the second largest drilling state and the continuously increasing number of wells that are unconventionally drilled each year. Instead, it focuses on the policy revisions that can be taken to increase the level of safety and reduce the environmental risk to humans and the environment. This can be accomplished through further modification of Act 13 of the Oil and Gas Act, passed in 2012 to clarify and confirm policy regulations associated with fracking.

As the fracking industry emerged across the country's gas states within for the first decade at the turn of the century, Pennsylvania had several factors that aligned simultaneously which created a welcoming and supportive environment for the gas industry. First, it has an abundant amount of gas resources that lies within the Marcellus shale play which is believed that "alone could provide enough natural gas to satisfy U.S. demand for at least a decade" (Pless, 2010, p. 1), with the only issue being that it was previously unattainable through conventional or other economical means. Secondly, although the Marcellus shale play extends well into adjacent states surrounding Pennsylvania, all states but Ohio had placed bans on fracking that are still in place today, driving the majority of the northeast drilling effort straight to Pennsylvania. And finally, the political arena was in its favor – when republican Governor Tom Corbett took office in 2010, he imposed several policies and appointed key personnel to his staff who were all in favor of fracking. Among those personnel appointments were Alan Walker to the Department of Community and Economic Development, who was a former domestic energy company executive, and Michael Krancer to the Secretary of the Department of Environmental Protection (DEP), who was formerly a litigation partner and advisor to domestic energy companies specializing in shale gas drilling, yet had minimal background in environmental policy. Adding to these elements was the fact that Governor Corbett had taken office following democratic Governor Ed Rendell, who had tried to (unsuccessfully) impose fracking regulations to address environmental impact and a 5% tax, which is the average national drilling tax, which would have boosted state revenue significantly (Rabe & Borick, 2013). Governor Rendell had left on relatively unpopular terms toward the end of his tenure, and Governor Corbett utilized his new position to recommend alternative policies and publicize his belief that fracking would bring

wealth and stability to Pennsylvania, and he even foretold the state as becoming the energy capital of the country.

Prior to passing Act 13, Governor Corbett utilized his growing support of the gas industry to make it administratively difficult for DEP inspectors to file a violation on gas drillers (Esack, 2014), and he also did not move to impose any type of severance tax or fee that would be collected from the gas companies to offset the costs and impacts of drilling. These two decisions set Pennsylvania apart from other northeastern states that either chose to impose a tax, an impact fee, or otherwise ban fracking as additional research is conducted. As a result, Pennsylvania has been impacted for several years and set a precedent that has become the anticipated standard in the state, which in turn caused an influx of the gas industry, all of whom greatly embraced the minimal environmental regulation and non-existent tax burden. In this section, the environmental consequences are compared to the regulations that are defined within Act 13 of the Oil and Gas Act. This comparison allows for objective reasoning when considering policy alternatives that will better protect the citizens and environment while still being feasible within a state political climate that is supported and deeply influenced by the gas industry.

There are numerous impacts associated with fracking, many of which exceed the scope of this thesis, such as water supply and shortage concerns, air pollution and quality, seismic occurrences, socio-economic and demographic impact, and destruction of land surface such as forests and natural habitats. Although all impacts warrant discussion and concern, this section will focus primarily on the impacts that fracking has on water quality and wastewater disposal and treatment.

One of the revisions under Act 13 concerning the protection of water sources is the setback distances that are required between a well head and a water supply source or stream.

The Act established a 1,000 foot setback from a water source, with an allowable exemption if they receive written permission from the water purveyor, and a 300 foot setback (which was an increase from the previous requirement of 100 feet) from the edge of a disturbed drilling area to a solid-blue line or water body shown on a United States Geological Survey (USGS) map, with a waiver allowance if the operator can prove additional measures are taken to protect the water source (DEP, n.d.). If there is a stream or body of water that is not shown as a blue line of the USGS map, then the setback is reduced to only 100 feet (DEP, n.d.). When considering the amount of gas transportation, earth disruption, wastewater storage and transferring, and chemical exposure that exists on a gas well site, these numbers begin to appear very small and insignificant, and highly unlikely to protect a water source from a spill, mishap, or underground methane migration. In a peer-reviewed study conducted by Duke University, these assumptions are confirmed based on the sampling and analysis of 141 Pennsylvania water well samples located between one to four kilometers from a gas well (Darrah, Down, Jackson, Karr, Osborn, Poreda, Vengosh, Warner, & Zhao, 2012). Darrah, et al's research studied the levels of concentration of methane, propane, and ethane, all by-products of fracking operations, present within water sources of nearby homes. Their research reliably concluded that water supplies within the study distance are 82% more likely to have dissolved methane within their water, and homes located within one kilometer or less from gas wells have concentration levels six times higher. Furthermore 20% of the closer homes had levels that exceeded the threshold of 28 milligrams per liter set by the U.S. Department of Interior. Similar results were concluded for propane and ethane, but at lesser rates (30% and 10%). Using these research conclusions, it appears that a logical conclusion would be to implement an offset distance that protects the safety and welfare of citizen, while also funding additional research and encouraging the gas

industry to develop safer drilling techniques. Methane gas, while known to be a severe contributor to the greenhouse gas and global warming impact, can cause many other risks to human life. It is highly flammable, and as it becomes exposed to the air through faucets in a home, it rises and concentrates to levels that can lead to fires and blasts. Additionally, it can replace oxygen, posing suffocation risks, or other mild side-effects such as dizziness and headaches, in areas that are not ventilated. Minimal knowledge exists about whether or not methane is toxic to humans, so although it is not recognized by any government as a hazard, there is no scientific evidence that disproves any health impacts of methane inhalation (Peltier, 2014).

There are also additional water pollution concerns that exist in addition to methane migration, which is the risk of fracking fluid contamination through various methods, including faulty well casings, spills and mishaps, disruption of previously blocked subsurface migration pathways that become opened due to the high pressure associated with fracking, and the gradual migration of the millions of gallons of residual fracking fluid that is left behind following the completion of a well. As unconventional drilling involves not only vertical drilling, but also horizontal drilling for thousands of feet, the far-reaching potential for fracking fluid migration is a widely unexplored area due to the difficulty of researching impacts and fluid migration several thousand feet below the surface. However, what is known is that a drilled well creates a conduit among many layers of geologic conditions, and if the cement in the casings does not remain intact for the life of the well, there is potential for the migration of numerous chemicals and toxic materials, both generated by the fracking fluid itself, but also by migration of heavy metals such as uranium, strontium, radium, and barium, some of which have radioactive characteristics. Secondary operations that are used for fracking, such as underground injection of wastewater,

have been confirmed to cause shifts in nearby faults, creating increased seismic disturbances and posing a threat to the integrity of well casings (Palliser, 2012). Despite the API recommendation that well casings should extend 100 feet past the lowest underground source of drinking water, only four states uphold that regulation, and Pennsylvania cuts that distance in half to 50 feet (Gottlieb, Krupnick, Richardson, & Wiseman, 2013).

Spills and accidents also remain a significant source of contamination as well, as there were 134 spills reported between January 2011 to June 2012 (DEP, n.d.) in Pennsylvania. The spills associated with natural gas incidents are often not minimal, on-site spills that remain contained within the localized soil – instead they can largely impact streams, residents, and their property. Examples in Pennsylvania include a leak in a fracking wastewater pipe that killed fish for three quarters of a mile in Cross Creek Park, and an eight thousand gallon leak of fracking fluids in Dimock, PA that resulted in a fish kill and erratic behavior of fish in local streams, and later formed into a lawsuit filed by residents who claimed their water was contaminated by fracking, and they have since suffered from neurological and gastrointestinal illnesses, and blood tests have shown exposure to heavy metals (Drajem, 2013).

In addition to water pollution, an equally threatening risk is the concern about fracking wastewater treatment and disposal. Although a significant portion of the millions of gallons of fracking fluid is left underground during the fracking process and during the life of the well (which poses its own inherent issues), there are still several million gallons that are collected with the gas extraction process, which must be adequately treated before being released back into the water cycle. The current options available to dispose of fracking fluid include trucking it off-site to a wastewater treatment plant, treat to a minimal standard for recycling, or injecting the wastewater underground. It has been determined that most conventional wastewater treatment

processes (those that handle wastewater from residential, commercial, and some industrial operations) cannot adequately treat the chemicals that are present in fracking wastewater. The treatment of fracking wastewater can impair the treatment system by disrupting or killing the microbes used in the process, and does not remove chlorides, iodides, or bromides from the wastewater (Phillips, 2014). As a result, a study conducted by Stanford and Duke Universities, found that when these substances were not removed from the fracking water, the treated discharge could then be used as a portion of intake water to a potable water treatment plant or private well, and when mixed with chlorine during the potable treatment process, it could form carcinogens such as bromines. The conventional treatment plants are also not equipped to remove any radioactivity within the fluid, so it also gets passed through the system and back into waterways. These issues are known by the DEP, and in 2011 they “asked” the Marcellus Shale Commission to stop using conventional treatment plants for their fracking fluid, although no regulation has ever been implemented (Phillips, 2014). There are also many unethical practices that occur, such as allowing fracking fluid to leak out of containment areas over time, or trucking the fluid to secluded areas and discharging. Since gas sites are spread out far across the country, often in remote areas, the current number of DEP staffing and inspectors are unable to be present at frequent enough intervals during the fracking operations to verify safe and legal practices.

The gas industry’s need for wastewater treatment has led to several innovative technologies and the construction of specialized treatment plants designed to treat solely fracking wastewater from the Marcellus shale drilling. While that is a good first step, there have been issues found with these treatment systems, such as the failure to reduce the radioactive, chloride and bromide concentrations to safe levels during their processes; the lack of regulation and oversight that is placed on the treatment plants to ensure adequate treatment; and the unsolved

challenges of how to safely dispose of the large amounts of contaminated, toxic, and radioactive sludge that is removed from the wastewater (Warner, Christie, Jackson, & Vengosh, 2013). New technologies continue to emerge, fueled by the need to adequately treat wastewater despite the lack of regulation. At Ohio University, development of an on-site treatment system is underway, with the discovery that the majority of the toxic substances can be removed through similar treatment processes used in power plants and refining industries, and the treated water can be reused in the fracking process on-site (Carow & Nairn, 2013). This research was funded by non-profit organizations, however if regulation was set in place to require advanced treatment of fracking wastewater, the development of the technology would be funded, reviewed, and put into operation, as the gas industry would have a greater motivation to utilize this technology.

Markedly, there are ongoing environmental deficiencies in the Pennsylvania Oil and Gas Act 13. This section covered only a portion of the impacts that are caused by hydraulic fracturing, which will only continue to grow larger as the industry expands in Pennsylvania. Within the current state policy, there are minimal restrictions, inspection and oversight capabilities, and general acknowledgement that the concerns are significant and potentially detrimental to human health and the environment. Using the comparison between many of the Act's existing regulations and the levels of regulation that are recommended as a result of scientific research and evidence, field testing, and observations, Act 13 simply does not provide the echelon of safety that is expected from a state government. First, the 1,000 foot offset distance from a well head is less than a third of the 3,240 foot distance that has been studied and recommended by peer-reviewed research. Pennsylvania should consider increasing the distance, and instead of requiring it from the well head, it should be offset from the entire well site to include wastewater storage pits, to at least a 3,000 foot offset. In many practices, such as

engineering, most calculations include a factor of safety to provide additional assurance of the design – so providing only the recommended safe distance should be the minimum consideration. Secondly, the 50 foot well casing depth below the drinking water level requirement does not match the 100 foot depth recommendation of the API. Again, meeting a documented minimum, while it may still not be fully adequate to protect from the risks for fracking, would at least extend the safety net further past known water supplies. Thirdly, the issues of wastewater discharge is currently highly unregulated in the industry. The prime example was when DEP simply made a “request” to the gas industry to change their treatment practices because it was causing harmful, carcinogenic effects to downstream waterways. Other than regulation that concerns wastewater containment practices, such as requiring a lined pit with excess capacity, and also having an approved contingency plan in case of a spill or accident, there is minimal regulation that governs the practice of treating fracking wastewater. This situation varies greatly from other industrial practices such as pharmaceutical and fertilizer manufacturing, which are held to higher standards and regulations than the minimally regulated oil and gas industry. There are known and developing methods that could be employed at fracking sites to adequately treat wastewater, however there is no enforceable standard to which the industry must be held accountable. Act 13 could be revised to address minimum levels of treatment required for fracking wastewater, and also limit the types of treatment facilities that can be utilized. Setting such regulation would drive the industry to develop the most economical way to meet the requirement, such as the implementation of on-site recycling processes that treat and dispose of waste to acceptable safe levels.

Finally, regulation is only as effective as it is enforceable. The Act should provide an overhaul to an aging, 25-year old inspection program that has been severely underfunded in

consistently growing industry. The DEP is understaffed and as a result, the state Auditor General, Eugene DePasquale, stated in a 2014 report that the Department did not always issue proper administrative orders to the gas industry when water contamination was identified, nor did they consistently notify the public when water quality complaints were received (Esack, 2014). Without the state having an appropriately staffed department that can effectively oversee fracking operations, there is an increased risk to the public and the environment, and furthermore there is an incomplete history of documented issues associated with fracking. The lack of staffing was effectively summarized by state auditor, who said it's "like firefighters trying to put out a five-alarm fire with a 20-foot garden hose," (Esack, 2014). Similar to the state Department of Transportation (DOT), which has a combination of state inspectors and hired consultant inspectors designed to adequately oversee their \$2.5 billion highway and bridge construction budget (Corbett, 2014), the DEP should make annual adjustments to their inspector staffing requirements, and also enhance their coverage requirements by modeling the DOT's mix of both state inspectors and hired consultant inspectors. Act 13 did expand its response coverage by allowing the DEP to engage in contracts with well control specialty companies, however this is only in response to an emergency, and does not address prevention and general oversight processes.

These revisions are far from a guarantee that water resources will not be contaminated, but they make an appropriate next step toward recognizing the risks associated with fracking. Simply put, the oil and gas industry has enjoyed minimal regulation for decades, and prior to fracking, their operations have been less evasive and have had less uncertainty surrounding the processes. Fracking has entered an entirely new set of environmental circumstances that are being treated under the regulations that still cater to the industry's best interests. As more states

become impacted by fracking and face regulatory decisions, setting quality standards in Pennsylvania will better solidify and demonstrate the state's priority of balancing environmental protection against economic gain. Pennsylvania has historically been a leader of environmental protection in recent decades (Rabe & Borick, 2013), and they once again have the opportunity to create a model that will be observed and potentially supported by other states. As long as decisions are made using sound scientific evidence and adequate comparisons to similar regulations that occur in other industries, there will always be logical reasoning and supporting guidance that will justify policy decisions.

#### Pennsylvania Oil and Gas Act: Economic Balance

One of the criticisms toward Pennsylvania's minimal fracking regulation was that the state was missing the opportunity to increase their revenue base by imposing a severance tax to offset the impacts of fracking and provide a benefit to the state. Severance taxes are imposed in 26 of the 31 states that have been proven or are believed to have shale gas potential. In Pennsylvania, despite having an enormous number of wells and amount of natural gas production in the country, is one of those 5 states without a tax (Gottlieb, et al, 2013). The purpose of a severance tax is to impose a tax on a natural resource that is severed from the source, while also ensuring that the energy industry bears some of the cost incurred by the local area in which the fracking is conducted, such as infrastructure costs and repairs, particularly because most of the energy companies and their employees do not live within the state in which the drilling occurs. An example of the amount of revenue that is generated by fracking taxes can be clearly demonstrated in Texas, the country's largest oil and gas state, which brought in \$3.4 billion dollars in oil and gas severance taxes in Fiscal Year 2013, according to (Baker, 2013). However, even in Texas there are challenges with policy exemption abuse and loopholes that

impact the overall economic benefits and revenue generated by the oil and gas industry. For example, wells that are designated as “high cost” are exempted from the state’s 7.5% severance tax, which include most unconventional wells that are drilled using hydraulic fracturing. Compared to two decades ago, when only 5% of Texas’ gas wells were considered “high cost”, that number has increased sharply to 55% in 2011, and as a result the state is now considering policy modifications to decrease the amount of exemptions that exist, which exclude tax requirements on fracking (Gottlieb, et al, 2013). Estimates in neighboring state Ohio, that is in the midst of developing their own severance tax (which as of 2014 has not yet been passed through the state house and senate due to political disagreements), could potentially recognize a revenue income of \$650 million to \$1 billion over the next five years if a tax is successfully imposed (Lemov, 2012). While these figures would provide a significant increase to state budgets, opponents of fracking taxes argue that implementing or increasing a severance tax would drive drillers out of states and into neighboring states that have shale potential. This argument would hold more merit if the ability to extract gas existed in abundance across the country and there was minimal concern about the ability to locate areas that are rich in shale gas potential. However, in revisiting the discussion about the Ohio gas fracking tax, the oil and gas industry has the potential to net between \$130 and \$550 billion from its production within the same timeframe of five years (Lemov, 2012). The shale gas states certainly have leverage over the industry, as the gas industry is highly unlikely to turn away from a significant profit because it was required to pay a tax, particularly if the tax was within the average range of 5% that exists among most of the oil and gas states (Gottlieb, et al, 2013).

Under Governor Corbett’s Act 13, Pennsylvania has elected to impose an impact fee that is designed to collect fees for each gas well that is drilled, which has collected approximately

\$200 million per year between 2011 and 2013 (Miller, 2014). This funding is divided in a 60/40 split, with 60% going to counties that have applied to receive funds and have been impacted by drilling, and 40% going into a Marcellus Legacy Fund, which is used for various state infrastructure and environmental projects.

While there is much heterogeneity in the taxation systems that exist at the state level, the decisions that are made by the country's top producers have a potential to serve as a model to other states (or at least will be closely observed) as the gas industry develops over the coming decades. As noted in Rabe and Borick's research (2013), it remains to be seen whether the "early mover" states will significantly influence future policy across the nation, as has historically been demonstrated in previous environmental policy, where states attempt to set a standard that may be implemented by others to create a homogeneous state approach in the absence of federal government regulations. With a newly appointed democratic state governor, Tom Wolf, who recently took office in 2015, there is potential for revised fracking policy to be implemented that will put Pennsylvania in line with its competing shale gas states. His campaign ran on the promise of implementing the 5% severance tax that was previously attempted by Governor Rendell in 2010. Although his estimates stated that the severance tax would increase fracking revenue from the current \$200 million to \$1 billion per year are believed to be inflated due to falling gas prices (Miller, 2014), it is still agreed upon that the revenue would be nearly triple the existing amount. In comparison to a state budget of \$29.1 billion, (Corbett, 2014), fracking has the potential to provide nearly 2.5% of the budget from severance taxes, which does not include other general corporate taxes.

One of the biggest challenges when creating and implementing environmental policy is the attempt to balance economic and environmental risk. Despite scientific evidence that may

exist to justify environmental restrictions due to the harmful nature or proven risks associated with a particular activity, there will always be opponents who will attempt to achieve their optimal gain despite impacts to other people or the environment. Undoubtedly, any policy has the potential to be overreaching and deemed unconstitutional, and environmental policy is often at the forefront of those accusations. Additionally, it requires consideration of the value of a human life, and the value of quality of life. For example, it is well-documented that air quality is impacted by the emissions generated from the millions of personal and commercial vehicles that are driven daily in the United States, so much so that air pollution levels are monitored in urban areas and alerts are issued if the levels rise to unsafe conditions. However, it has been an ongoing effort for decades to appropriately regulate the emissions levels of automobiles due to the pressure of the automobile effort, coupled with the lack of desire for people to change their driving preferences for an environmental initiative.

This argument as it pertains to fracking implores the question, what is the minimal amount of economic benefit to the state of Pennsylvania that should be observed in an effort to offset the environmental, human health, infrastructural, and socio-economic impacts that will occur, and have the potential to occur, as a result of fracking operations? There is certainly not a clear answer, as the political factor and stakeholders will continuously influence statistics, reports, and trends that are used to generate such policy decisions. However, historical data can provide a baseline to review impacts associated with a particular operation, and also provide a review of issues that are ongoing or developing without a specific cost yet associated with the impact. Although fracking is relatively new to the centuries-old oil and gas industry, there are now documented impacts associated with fracking which can be used to justify the need for offsetting tax revenue, and the reasons are numerous. They can include impacts associated with

drinking water contamination, natural resource destruction, decreases in home value and other localized economic impacts, illness of nearby residents and employees, and public infrastructure damage, such as roadways, water supply facilities, emergency response needs, cleanup of abandoned wells, and seismic damage related to wastewater disposal (Dutzik, Ridlington, & Rumpler, 2012). While the extent of these economic damages will not be discussed in detail within the scope of this thesis, a brief overview based upon the research conducted by Dutzik, et al, is warranted to analyze the broad impact that occurs in comparison to the amount of revenue that is generated by the fracking industry. Their research and findings included the following environmental and health impacts that have been associated with fracking: in 2010, Pennsylvania estimated that \$265 million would be required to repair damaged roadways located within the Marcellus shale play; the Texas State Water Plan outlines a \$400 million water infrastructure plan to provide waning water resources to arid regions of the state that are impacted by fracking; agricultural impacts have been observed in Pennsylvania, demonstrated by an 18.5% decrease in milk production from 2007 to 2010, with loss of livestock due to fracking spills and decreased water supplies cited to be the primary cause; disruptions and fragments to mule deer habitats have caused a 56% drop in their population within a prime hunting lands in Wyoming, which support a \$340 million hunting and wildlife watching industry; and finally, land clearing within Pennsylvania's forests associated with fracking operations will cause an increase in pollutant discharge within the impaired Chesapeake Bay watershed, and the cost to offset the pollution levels will cost between \$1.5 and \$4 million. These costs are examples of calculated impacts, with the knowledge that there are many other unreported, undocumented, and perhaps unrealized impacts that are brought about by fracking.

It may be argued that oil and gas permitting requirements already hold oil and gas companies accountable for the cleanup of known contamination that affect the health and well-being of nearby residents, thereby negating the need to provide additional sources of revenue to the state. However, this point does not accurately address several associated issues, which include the need for government to provide increased emergency response efforts in fracking areas, costs associated with protecting and supporting residents while causes of pollution (and potential litigation) is determined, the need for increased environmental staffing to properly implement and uphold policies as the gas industry grows, the concern that it may take years to identify costly fracking impacts, and most importantly, many impacts do not actually violate existing laws. For example, water extraction permits are legally obtained, public roads are legally utilized, and land clearing agreements are made with the state's land management agencies. Yet impacts occur on a large scale because of the massive volume of resources that fracking requires, and it will be the state and local municipal governments that will be required to maintain and improve their infrastructure as years go on.

Thus, there are many factors to consider when deciding upon the most appropriate tax to implement on a growing industry within Pennsylvania. However, as with most controversial topics, many Pennsylvanians have chosen their stance based upon the information that has been provided to them. In a recent public perception poll conducted in 2014 as a joint effort by the University of Michigan, Muhlenberg College's Institute of Public Opinion, and the University of Montreal, researchers conducted over 800 telephone surveys in Pennsylvania and New York to secure their responses to various questions about fracking in their state (Borick, Rabe, & Lachapelle, 2014). In the poll, survey questions were asked that reviewed the public support of fracking taxes and fees that have and could be implemented in Pennsylvania. Interestingly,

despite the (perhaps industry-fueled) concern the oil and gas industry would pull their rigs and take their operations to other states if a tax was imposed, a large majority (62%) of residents supported the implementation of a severance tax, and a slightly lower majority (57%) did not believe that it would cause drillers to leave the state (Borick, et al, 2014). With the results of this survey indicating public support for a severance tax, coupled with the fact that the gubernatorial elections selected a democratic governor with similar viewpoints, it is evident that timely consideration should be given to revising the Act 13 policy provisions to implement a severance tax. Furthermore, through an analysis and comparison of the various state severance taxes that exist across the country, it would be feasible to implement a tax as high as 7.5% and still be within the (high) range of tax policies. There would be a need to carefully draft tax requirements to minimize exemptions and loopholes, which seem to have plagued governmental gas policies for years. However if the political leaders are not being as heavily funded by the gas industry as they have been during the republican-controlled term, there may be less influencing capability for future policy. Pennsylvania should use the fact that they are a major gas-producing state to their advantage – the gas industry has taken many years to establish and mobilize their equipment, land leases, water supplies, and road networks within the state, so the potential of a severance tax is unlikely to cause them to demobilize their equipment to another state with a slightly smaller tax. Implementing a higher tax such as 7.5%, couple with tighten environmental regulation, would demonstrate Pennsylvania's concern for the high state costs and impacts associated with fracking, and also that the state and its residents have enough pride in the quality of their communities that they will not succumb to the pressures of the industry. With Pennsylvania having the benefit of being a leading state in the gas industry that has undoubtedly risen into the spotlight as other states observe their policy successes and failures, they have the

opportunity to set a high standard that could be modeled and implemented across the United States.

## V. DISCUSSION

### Fracking Future: Energy Production Versus Environmental Sacrifice

There is no question that the United States is highly supportive of the oil and gas industry. After all, it dominated the economic market by generating 45% of the top 10 public company revenues, and 48% of the profits, and bringing in \$992 billion in commercial sales with a profit of \$77 billion (Peltier, 2013). This thesis recognizes that banning a market that is expected to double in shale gas production by 2040 (Peltier, 2013), while literally fueling an energy demand that is continuously growing annually, is a highly likely occurrence given the political and financial influences of the industry. Although the growth rate of electricity demand has slowed over the past several decades, market trends still reflect an average annual increase in electric demand ranging from 0.7% to 0.9%, from over 3,000 billion kilowatt-hours (kWh) in 2012 to nearly 5,000 billion kWh in 2040 (U.S. EIA, 2014).

Over half of the homes and commercial establishments in the country are supplied by natural gas, and lower prices have caused an increase in natural gas utilization as a primary energy source, rising to 25% among other sources including coal, oil, nuclear, and hydroelectric) (McElroy & Liu, 2013). In 1986, the amount of supply and demand for natural gas was approximately equal, followed by a period of lagging production that was supplemented by Canada and other exports – however by 2010, 30% of natural gas production in the United States was provided by fracking, and there is a strong interest to begin export operations to higher-priced areas of Europe and Asia (McElroy & Liu, 2013).

All of these data points and trends are indications that the rising gas industry is here to stay, and its influence on politics, policy, and economic decision-making are increasing at the same rate. However, environmental concerns are steadily increasing at the same time, and it is difficult to find a reference to hydraulic fracturing that does not mention the many elements of associated risk. The oil and gas industry has long been supported as a means to produce domestic energy and minimize our reliance on oil and gas rich countries that do not always align with our international viewpoints and objectives. As such, the industry has in turn been supported by policy that favored drilling and production operations in an effort to keep pace with competing sources. However, the public opinion about fracking and its impacts may turn to a less supportive stance if the goal of exporting resources becomes a reality by the industry. In that case, the industry will become the primary beneficiary of exports, while large portions of the country remain environmentally impacted with unknown levels of consequences. Although because the majority of well sites and directly impacted areas are remote, rural, and sometimes low-income communities, national media attention does not always appropriately cover incidents when compared to flashy headlines of urban news stories – and it is instead left to environmental groups and far-leaning journalists to cover the story. Another barrier facing the environmental policy challenge is the “not in my backyard” approach that is taken by the industry and even land owners who are looking for convenient sources of income as the result of the resources located below their property. Estimates indicate that approximately half of the leased land in the Marcellus region is owned by out-of-state residents who do not rely on the resources, water supply, or quality of life provided by the community (Garmezy, 2013). This high rate of leased land owned by non-residents is likely not by coincidence, as once the lease is paid the gas

industry has minimal oversight by property owners, who are often the most protective of their own land.

In Pennsylvania, the gateway to minimal regulation had been opened by the Corbett administration, and it is now up to the new Governor to uphold his campaign promises and recognize the risks and the potentially long-term consequences that fracking produces across the state. Making policy changes in the northeastern part of the country would be more highly supported when compared to southern states that have been embedded with the oil and gas industry for many decades. Adjacent states, through more restrictive policy or moratoriums, have created a localized environment that could embrace policy change in an effort to restrict the unknown level of impacts that could be recognized by the state, all in exchange for several million dollars that will be undoubtedly used in its entirety to address the increased infrastructural, environmental, emergency and police response impacts that are included in the package deal of fracking. In the end, without policy change the only guarantee is that the oil and gas industry will grow more dominant, financially stable, and politically influential.

### Summary

The fracking industry has taken the country by storm over the past fifteen years, and Pennsylvania is at the forefront of the movement involving unconventional gas drilling operations. This movement was created as a result of a series of events that led to a perfect storm of scenarios that made Pennsylvania one of the most attractive states to initiate the drilling movement. First, the Marcellus shale formation extends across the majority of the state and is rich with untapped gas since it had been previously unattainable due to uneconomical fracking practices. Secondly, there were minimal fracking laws in place at a time when neighboring states banned fracking operations, creating an attractive location and unrestrictive environment

for drillers that had few other options to drill in the northeast. Finally, Pennsylvania's climate and geography provide adequate water resources coupled with plenty of rural areas that could be used for drilling unconventional wells.

Therefore, Pennsylvania has experienced rapid unconventional drilling growth that many argue the state was unequipped and unprepared to handle from a policy perspective. Others believe that Governor Tom Corbett, a known drilling proponent who accepted over one million campaign dollars for each election cycle, intentionally created a supportive fracking environment in an attempt to rapidly grow the industry in Pennsylvania (Rabe & Borick, 2013). It is likely a combination of both scenarios that have forced the state into facing some critical decisions over the coming years, when determining the balance between known (and unknown) environmental risks and harm associated with fracking, and the economic profit that the industry is believed to bring to the state.

The Act 13's revisions to the state Oil and Gas Act were said to have been drafted to generate income for the state through the impact fee, as well as tighten safety regulations to better protect citizens. Within this thesis, a review of several of the Act's components were compared and analyzed referencing scientific evidence, historical data and observations, as well as the cost of fracking impacts to the state. This analysis was completed in an effort to prove the theory that the Act's regulations do not meet the required minimum standards to adequately provide environmental protection. While the scope of this comparison involved only several components of the Act, it was found that all policy areas that were examined, to include water quality and contamination regulations, fracking wastewater treatment requirements, and impact fee assessments, could all be greatly improved upon to provide policy that more closely balances the impacts of fracking. As with any industry, particularly energy production, there is always an

environmental tradeoff associated with an operation. However, it is imperative to identify those tradeoffs and develop policy that minimizes severe impacts to quality of life to citizens, future generations, and the environment. Act 13 does not provide this necessary balance, and the state will experience those impacts for years to come.

Another portion of Act 13 that warrants discussion is the imposed restriction of authority on local municipalities that disable them from enacting zoning laws that would prohibit or inhibit oil and gas operations beyond the restrictions that are in place by the Act. Essentially, it rendered the local governments powerless from controlling how they operate, safeguard, and govern their communities. This provision was not well received by local governments, and a resultant lawsuit, *Robinson Township v. Commonwealth*, was filed with the Pennsylvania Supreme Court in an effort to deem the zoning restrictions unconstitutional (Cusick, 2014). The court decided in a 4-2 decision in December 2013 that these sections were unconstitutional, and an appeal by the Corbett administration January 2014 was denied (Cusick, 2014). Therefore, although the restriction is no longer in place, the Supreme Court questioned whether or not Act 13 can still be upheld without being enacted in its entirety. The final determination of the Act's authority still lies pending with the lower Commonwealth courts. Thus, if the Act needs to be redrafted and adopted, it provides an opportunity for the new Governor, Tom Wolf, to review the policy and make revisions that best suit the interests of Pennsylvanians, and not solely the gas industry.

### Recommendations

The Pennsylvania Oil and Gas Act 2013 was implemented in 2012 with the intent to impart new impact fees in order to increase state revenue and offset government costs associated with fracking, as well as increase environmental regulations to better protect citizens and ecosystems.

The revisions to the state's existing Oil and Gas Act arguably had minimal positive improvement to either of these two objectives, and instead continued to greatly favor the gas industry. It is recommended that an entire overhaul of the Act be considered by the incoming administration of Governor Wolf, because of the various components that were analyzed, all were insufficient and did not meet minimum standards, nor did they account for any additional factors of safety. The components analyzed included the minimum setback distance from well sites to water sources, the required distance of well casings below the drinking water level, fracking wastewater treatment regulations, insufficient amounts of government staffing and inspectors, and the benefits of the impact fee. In addition, there is an array of other issues that need to be evaluated, ranging from air quality regulations to seismic impact caused by the underground injection of such large amounts of water under great pressure.

Despite concerns about driving away the gas industry through stricter policy, or a lack of public support for tighter regulations, there is an indication that there are mixed opinions about fracking, and also about whether or not there are confirmed risks associated. In the same previously referenced public perception poll conducted by Borick, et al in 2014, their findings concluded that a only slight majority of Pennsylvania residents (54%) support fracking, while 55% believe that "experts are still divided" about the level of risk that fracking causes in the Commonwealth. These types of figures suggest that the public verdict is still open on fracking, and it may come down to who has the louder voice in the policy battle. Coupled with a reexamination of the Act's effectiveness, environmental lobbyists must continue to demonstrate the need for revisions based on sound evidence and new research that continuously becomes available as the years pass and fracking operations continue. The recommended revisions to the Act are a solid first step toward enhanced protection from an industry giant that places profit

before environmental protection. Time will be the demonstrator of the full impacts of fracking, and future comparisons between fracking states with varying regulations, as well as states without fracking, will provide insight to risks. Unfortunately, some risks may cause long-term effects that are difficult to reverse, such as potential contamination of underground aquifers, streams, and bodies of water, as well as disruption of ecosystems and animal habitats. The United States, including the individual states, have a duty to protect the health and wellbeing of Americans from industry giants and unsafe practices. Despite the economic impact that the oil and gas industry has on the country, fracking has taken the risks to an unacceptable level that must be balanced with adequate protection.

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