DOES PLANNING BUILD RESILIENCE IN HYDRAULIC FRACTURING COMMUNITIES?

by

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ABSTRACT

CATHERINE WOLF UNDERWOOD. Does Planning Build Resilience in Hydraulic Fracturing Communities? (Under the direction of Dr. ROBERT H BOYER and DR. WEI-NING XIANG)

Despite its long history in the United States and abroad, the unconventional drilling industry, and specifically hydraulic fracturing technology, remain controversial. While the competing demands of energy from oil and gas are contrasted with environmental safety and protection, it is likely that unconventional drilling will remain a source of social friction and a wicked problem. From the viewpoint of social resilience in hydraulic fracturing communities, social conflict represents a potential threat to the bonds that are formed within a community. This research seeks to understand the impact of planning in communities that have implemented unconventional drilling technology by using a metric of litigation as a proxy for conflict. By seeking to illuminate how conflict is affected by both municipal and industry planning efforts this research seeks to answer the question of whether planning can reduce conflict and build resilience in communities where unconventional drilling is occurring. If conflict through litigation can be reduced through planning in these communities, then resilience may be preserved, enabling these extractive communities to reduce their exposure to disruption. This research begins with a quantitative analysis of the counties in Pennsylvania to determine which counties have detailed comprehensive plans that address unconventional drilling. The comprehensive plan data was then compared to the civil lawsuit data for each county to determine which counties have both detailed comprehensive plans and low rates of fracking related civil lawsuits. Using this quantitative data, three counties were chosen as case studies for the second phase of this research. Two counties demonstrating a high level of planning and a corresponding level of social resilience were selected (Sullivan and Clinton counties). For contrast, one county with a high level of planning, but a low

level of social resilience as measured by a high incidence of civil lawsuits per well was also studied (Lawrence). A series of semi structured interviews were conducted with community members and government staff to investigate the impact of planning in those counties relative to the unconventional drilling industry. While most unconventional drilling companies declined to be interviewed for this research, one company and an industry group were also interviewed. In Sullivan County, the social resilience appears to stem from the interconnectivity of residents, government, and industry that is encouraged by the strategic comprehensive plan and further nurtured through industry involvement in the community. In contrast, Clinton's plan provides a guiding vision for the industry, encouraging development upon prescribed paths that promotes conscientious and environmentally and socially responsible activity. In contrast, Lawrence county's plan addressing unconventional drilling but is stymied by a lack of reciprocal interconnectivity from industry, though the county as adapted by transitioning to related industry by leveraging their manufacturing know-how. Social resilience is notoriously difficult to measure, but this research does provide support for the theory that counties that engage in high levels of planning and also have fracking companies that are active in community engagement may have improved social resilience through the building of social bonds.

DEDICATION

To my two little girls. Grow up to be strong in the knowledge that the world holds no limits for you.

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1. INTRODUCTION

The concept of resilience was originally theorized in the 1970's and has been extrapolated broadly in the intervening half-century. A brief summary of the different definitions of resilience is presented later, however as prominently noted, the resilience of social-ecological systems (SES) can be defined as "the capacity of an SES to sustain human well-being in the face of disturbance and change, both by buffering shocks and by adapting or transforming in response to change (Biggs, Schluter, & Schoon, 2015, p. 22)." Taking as a given that social resilience is critical to our communities, then one primary goal of planning is then to constantly improve the resilience of our communities through a wide variety of planning efforts. In communities that are currently engaged in unconventional drilling, the importance of building social resilience is of upmost importance due to the inherent risks associated with the practice.

While the means to build resilience in our communities can vary widely based on community needs and focus, in hydraulic fracturing communities there are two competing factors that are universally present: the economic boost of natural gas extraction using unconventional drilling techniques, and the risks of environmental damage. While these two competing concerns remain at odds, and the resultant wicked problem is one that cannot be solved directly though planning. This research does not attempt to answer the question of what decision would be best for our Country, to use unconventional drilling techniques or not, but rather considers resilience in communities that have already chosen the path of hydraulic fracturing. The pertinent question is then how can planning help to build and maintain social resilience within communities that have already proceeded with unconventional drilling and so are beyond the point of weighing the potential risks and benefits. By extension, this research also examines how planning—that is

making and using plans— can improve local social resilience within the context of other extractive resource economies.

One of the key principles of resilience is to manage connectivity (Biggs, et al., 2012). This means that the more connections and interconnections with in a community, the better the flow of energy, materials, communication and the stronger the community bonds (Dakos, et al., 2015). Planning may thereby contribute to resilience through the reduction of social conflict in communities that have chosen a path of major and potentially conflict-laden change, such as unconventional drilling. Comprehensive planning may help to develop, nurture, and promote community bonds while articulating intentions about interdependent decisions before they occur. While there are many ways of building community bonds, and as many ways to damage them, this research the presence of litigation as a proxy for conflict within a community, and by extension its social resilience. Litigation is a win-lose way to resolve conflict, and thus a community in which more litigation takes place is burdened by the broken bonds between those involved in the lawsuits. While the result of a lawsuit is theoretically beneficial for the winner, of greater concern to this research is the resulting break in social bonds between the litigants due to the lawsuit itself. Therefore, the purpose of this research is to determine if planning mitigates social conflict relating to the unconventional drilling industry, and by extension whether planning increases local social resilience by articulating community intentions about the built environment.

Although scholars disagree on the nuances of the purpose of planning, one commonly cited reason for planning is to "promote public welfare (Moore, 1978, p. 388)." Planning may then be intended to guide stakeholders toward a consensus-driven, or at least generally accepted, direction that will contribute to a greater good. In contrast, litigation is the result of conflict between stakeholders: a collision path. From a resilience perspective, litigation is not a desirable means to

solve disputes. The process of litigation is a win-lose scenario, forcing a polarization which is detrimental to resilience building within a community. Therefore, a link may be made between the act and implementation of planning and the incidence of litigation. There are many arenas wherein conflict in the form of litigation is prevalent, including the energy industry related to hydraulic fracturing technology. An increase in resilience through reducing the conflict resulting from hydraulic fracturing may help communities to withstand the inevitable brittle boom-bust of natural resource extraction economies.

This research is directly relevant to the communities in Pennsylvania that are currently home to unconventional drilling activities, and also may more broadly help to illuminate social resilience in other extractive communities beyond the natural gas industry and may offer an opportunity to test the relationship between plans and resiliency at the community scale. The Marcellus Shale region is spanned by 37 counties engaged in unconventional drilling. As social resilience is reflected as the ability of a community to plan, react, and grow in response to disruption (Rodin, The Resilience Dividend Being Strong in a World Where Things Go Wrong, 2014), the resilience of the communities that are engaged in unconventional drilling is directly tied to the hydraulic fracturing industry both directly and through the support services that are impacted by it.

The first step of this research included gathering the unconventional drilling data from each of the counties in Pennsylvania from the Department of Environmental Protection. Once this data was compiled, the civil lawsuit data was obtained from the prothonotary offices in each of the unconventional drilling counties. This quantitative analysis was then used to make the case study selections. For this research we utilized the maximum variation technique to select three counties for study: Lawrence, Sullivan, and Clinton. Sullivan and Clinton were selected as positive cases, their similarities included in having active unconventional drilling, a low incidence of civil

lawsuits filed that involve fracking companies, and a high level of comprehensive planning pertaining to the unconventional drilling industry. Lawrence was chosen as a counterfactual case, with a high level of comprehensive planning but a high level of civil lawsuits.

The results of this research may help to illuminate a juxtaposition between how planning works to reduce conflict in fracking communities and how real-life practicalities play a role in unconventional drilling conflict. It appears that through comprehensive planning processes each county was able to articulate, as a corporate entity, what the unconventional drilling industry should look like in their county, and also how they would like to present themselves to the industry as a whole. From the context of planning theory, the unconventional drilling companies indicate their desired outcome – *their intent* - through community engagement, by enacting their company playbooks in pre-development due diligence prior to extraction. This community action (to develop a plan) then results in a cohesive approach to drilling development, that is then demonstrated to drilling companies through pre-drilling community engagement prior to development. Those companies that do not engage with the communities in which they operate are clearly at a disadvantage when compared to their more communicative counterparts, based on community feedback.

The following section provides a review of the relevant literature that informs this research, to include overviews of resilience theory, hydraulic fracturing, litigation surrounding hydraulic fracturing and planning, planning theory and conflict, and the regulatory environment in Pennsylvania. After the literature review, a methodology section outlines the research approach, discusses the various case study selection techniques, and specifies the research design approach for this project to include case study selection. Section 4 is devoted to the quantitative analysis portion of this research, and includes the evaluations of the comprehensive plans in each of the

unconventional drilling counties in Pennsylvania, the lawsuit data for each county, and the unconventional drilling in each county. This section concludes with a selection of three counties as case studies. Section 5 includes the case studies, including a summary of interviews with unconventional drilling industry insiders. Section 6 provides a discussion of the research and conclusions. References are then followed by a brief appendix containing tabulated data.

2. LITERATURE REVIEW

The purpose of this dissertation is to examine the influence of planning on local social resilience by using hydrofracturing as an opportunity to observe how well communities respond to major social and economic change. As such, the dissertation lies at the intersection of multiple areas of academic literature including resilience theory, planning, and the complex history of natural gas extraction. This chapter begins with a review of resilience theory, its origins, and its applicability to social systems. The adaptive cycle and its relevance to resilience planning is then reviewed in the context of oil and natural gas extraction through unconventional drilling. An overview of hydraulic fracturing and horizontal drilling is then provided, to include a summary of the benefits and drawbacks of the practice. The wicked nature of the debate between unconventional drilling and environmental concerns is then addressed. The literature review then addresses litigation in relation to conflict, both in general and in relation to hydraulic fracturing activities before transitioning to a discussion of planning theory. A discussion of planning theory and conflict as well as how planning may reduce litigation is included. A brief discussion is then provided on the relationship between planning and resilience theory. Finally, the literature review considers the regulatory environment in both Pennsylvania and North Dakota, as the backdrop to planning in those two states in which this research is focused and an explanation of the selection of Pennsylvania as the focus of this research.

2.1. Resilience Theory

The genesis of resilience theory rests in ecology. Since the seminal paper introducing the concept of ecological resilience (Holling, 1973), a plethora of definitions has been presented to further develop the concept. Holling proposed that resilience is a measure of an ecosystem's ability to persist despite influence, disruption, or changes to the fundamental system components without

changing the fundamental nature of the system's interrelationships. This definition was supplemented with the concept of stability, which Holling described as the ability of a system to return to its original state after some disruption (Holling, 1973, p. 17). By 1996 Holling had clarified his definition of stability with the term engineering resilience, which denotes the stability of a system and the speed of return to a steady state or near-equilibrium (Holling, 1996, p. 33) Stability as a resilience concept has evolved, and been incorporated into a complimentary definition of ecological resilience as the rate at which a system returns to equilibrium after a temporary disruption (Adger, 2000, p. 350).

Social resilience as a concept has trailed behind ecological resilience as a topic for definition, study, theory, and application. In 2000 Adger came close to defining social resilience but fell short by simply stating that it is merely the opposite of social vulnerability, though he cites Holling's previous ecological definitions (Adger, 2000, p. 348). The sociology discipline has embraced the concept of social resilience and significant research has furthered our understanding. Norris et. Al (2008) define resilience as a process that utilizes a set of dynamic and assessable tools that interact to facilitate a preferable outcome after a disturbance (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008, p. 131). This notion of a positive outcome being essential to the concept of resilience is seated within the fields of sociology and psychology, and contrasts starkly with the original ecological resilience concepts that denote possible outcomes of resilience to include extinction (Holling, 1973, p. 17) and eutrophication (Carpenter, Walker, Anderies, & Abel, 2001, p. 774) as being both resilient, though undesirable, states. This positive-outcome viewpoint is consistent with the approach to social resilience through the lens of ecosystem services, which acknowledges the interconnections between societies and their ecological environments, focusing on their combined state as the resilience of the ecosystem as a whole. If resilience, following the

definition established by Holling (Holling, Resilience and stability of ecological systems, 1973), is applied to the services that ecosystems provide to society (food, water, climate, recreation, etc.) (Biggs, et al., 2012, p. 423) then the resilience of ecosystem services is analogous to the positive-outcome oriented definition established by the sociology field. Judith Rodin, the president of the Rockefeller Foundation, presents the notion of resilience in a cross-disciplinary manner as being the ability of social systems or ecological systems at any scale to prepare, recover, and adapt in response to disruption (Rodin, The Resilience Dividend Being Strong in a World Where Things Go Wrong, 2014, p. Loc 107). This definition represents an inclusive approach that spans the ecology and sociology disciplines, and that specifically denotes an ability to not only plan for and adapt to natural and man-made perturbations, but also contemplates a measure of positive outcome from the experience. Rodin calls this positive outcome the *resilience dividend* (Rodin, The Resilience Dividend Being Strong in a World Where Things Go Wrong, 2014). Table 1 outlines a cross section of the available definitions of social resilience and the composite pieces as defined by a variety of viewpoints in academia.

Table 1 Various Definitions of Resilience Principles, Components, and Variables

Author	Year	Description	Principles, Components, or Variables of Resilience
Adger	2000	Resilience Indicators	Economic Factors: Economic growth Stability and distribution of income Environmental variability Demographic change Mobility and migration
Norris et. al.	2007	Networked Adaptive Capacities for Resilience	Economic Development Information and Communication Community Competence Social Capital
Biggs et.al.	2012	Principals of Resilience	Maintain Diversity and Redundancy Manage Connectivity Manage Slow Variables and Feedbacks Foster an Understanding of Social-Ecological Systems as Complex Adaptive Systems Encourage Learning and Experimentation Broaden Participation Promote Polycentric Governance Systems
Rodin	2014	Characteristics of Resilience	Aware Adaptive Diverse Integrated Self-Regulating
Marshall and Marshall	2007	Key Components of social Resilience	Perception of Risk in Approaching Change Ability to Plan, learn and Reorganize Perception of the ability to Cope with Change The Level of Interest in Adaption to Change

For this research, social resilience is defined as "the ability of human communities to withstand and recover from stresses, such as environmental change or social, economic or political upheaval (Stockholm Resilience Center, 2020)." This definition declines to separate the notion of positive

evolution as an outcome of disruption from the resilience framework, which is critical to the development of social resilience as a concept on a community scale. This research also depends on the building blocks of resilience as outlined above by Biggs et. Al, and as championed by the Stockholm Resilience Center.

Further resilience research has identified a benefit of social resilience beyond an ability of a community to withstand a disruption called the *resilience dividend*. This resilience dividend is the additional benefits realized by resilience communities beyond their abilities to withstand disasters during times when a disaster or disruption is not present (Rodin, 2017). The resilience dividend represents the real benefits of resilience building due to community activities that also build resilience, "the sum of benefits, over time, form a project investment based on resilience principles compared to one that is not…the "bonus" we receive from investing in a project designed to build resilience (Bridgett-Jones, 2017)."

2.2. The Adaptive Cycle and Resilience Planning

The adaptive cycle is a theoretical framework that can be used to describe the pattern of social or ecological evolution. This cycle is composed of four phases: exploitation, conservation, release and reorganization (Holling, 2001, p. 394). Of these four phases, exploitation and conservation represent slow phases wherein the system is developing and consuming resources, functioning essentially on a stable, slow, and consistent path (Holling, 2001, p. 394). The release and reorganization phases represent times of change and tumult in the social or ecological system in response to disruption of the system, such as a natural disaster, terrorist attack, or the discovery and exploitation of shale gas resources in a small town (Holling, 2001, p. 394). Both the release and reorganization phases represent fast changing, challenging situations for a social system such as a small town and represent the period in which social resilience will play the greatest role in

determining the timing and efficacy of the transition from the reorganization phase and the subsequent slowing and entering of the exploitation phase.

In the case of shale oil and gas or other single natural resources, the optimal time to build resiliency would be before the discovery of the boom-generating natural resource. Practically, however; it is unlikely that there are significant resources of great value yet to be discovered. In the case of hydraulic fracturing, the presence of shale oil and gas was known decades in advance of the technological advancements necessary to extract them economically. The advancements of unconventional (horizontal) drilling and hydraulic fracturing technologies between 2005 and 2010 enabled producers to extract oil and gas from shale formations which had previously been deemed too expensive to extract but were known to be present (Pless, 2012, p. 2). The high oil prices in 2007-2008 further encouraged the implementation of unconventional drilling technologies in pursuit of cheap American oil and natural gas (Brown & Yucel, 2013, pp. 1-2). The high oil prices that were endemic at the height of the recession may have pressed implementation of unconventional drilling technology faster than appropriate risk mitigation measures could be implemented. Essentially, the opportunity to build resilience in advance of fracking implementation was lost due to the fast and unforeseen entrance into the Great Recession and dramatic rise in energy prices that were pressuring the economy during that time frame.

The example of oil and gas extraction can be described through the lens of the adaptive cycle. The conventional oil and gas drilling that was common prior to 2008 (and continues today) represents the exploitation and conservation elements of the adaptive cycle. The resources (oil and gas) were being extracted using traditional methods, and imperatives such as the Energy Independence and Security Act of 2007 were intended to reduce consumer dependence on foreign oil and increase alternative fuel sources and usage (Office of the Press Secretary, 2007) thereby

conserving the resource and managing rising energy costs. The economic and political instability generated by the Great Recession of 2007-2009, and the swift implementation of unconventional drilling transitioned the industry from "conservation" to "release and reorganization" phases of the adaptive cycle. Unless prescient town planners, mayors, and citizens are actively working to develop resilience during this time, the likely result for impacted communities was the same boomtown challenges that have been well documented in a variety of resource-dependent arenas: social and ecological challenges such as housing inflation, price gouging, and homelessness (Weber, Geigle, & Barkdull, 2014, p. 66), road and utility infrastructure inadequacy, and strain on emergency services (Mason, Muehlenbachs, & Olmstead, 2015, p. 19).

2.3. Hydraulic Fracturing

This dissertation frames hydraulic fracturing, or "fracking" as a disruption to a local economy and social landscape. While fracking can be a large boon to a local economy, it can also represent a significant disruption to other aspects of social and ecosystem services (Weber, Geigle, & Barkdull, 2014, p. 62). Hydraulic fracturing technology is used in conjunction with horizontal drilling to extract oil and gas. Combined, these techniques are known as "unconventional drilling." These technological methods have both advocates and opponents. For some, the benefits of using hydraulic fracturing to extract oil and natural gas is easily worth the risks associated with it. For those that oppose the use of hydraulic fracturing the risks outweigh the benefits. The following section outlines the benefits of hydraulic fracturing as well as the arguments used to oppose it.

Unconventional drilling originated in North America (though it is also present worldwide). It has been employed in various forms since the late 1940s, but has undergone a technological revolution in the 21st century (Howarth, Ingraffea, & Engelder, 2011, p. 272). Advances in unconventional drilling technology, rising oil and gas prices, and mapping of the world's shale

reserves have promoted the practice from obscurity to prominence. The worldwide reserves of technically recoverable shale oil and gas are distributed among five continents and over 40 countries with top production in the United States, Russia, China and Argentina (U.S. Energy Information Administration, 2013). With such broad distribution of recoverable shale oil and gas reserves it is reasonable to speculate that the global use of hydraulic fracturing technology will continue to expand.

2.4. Benefits of Hydraulic Fracturing

The United States has been extracting crude oil since the 1860's, however extraction peaked in 1970 with 9,637 barrels per day. As of 2016, crude oil production in the United States was 8,857 barrels per day. A graph of the US production of crude oil from the mid 1920's through 2020 is provided below in Figure 1. Natural gas production began in the 1930's and peaked in 2015 at 27,065,460 million cubic feet (MCF) after a 50-year plateau at 20,000,000 MCF per year which extended from the 1970's through 2005. This rise and plateau in natural gas extraction can be seen in Figure 2. The notable rise in production of both crude oil and natural gas can be attributed at least in part to the invention of unconventional drilling, which originated in the 1940's and became widespread in North America by 2005 (U.S. Energy Information Administration, 2017). Although both oil and gas reserves show declines in production in 2016 from the previous year, these dips reflect market price declines in 2016 over the previous year (U.S. Energy Information Administration, 2016). Proved reserves are those that are recoverable in the current economic environment, which means that the implementation of unconventional drilling in 2005 served to greatly expand the volume of both oil and natural gas reserves in the United States. Figure 3 provides a side-by-side comparison of proved oil and natural gas reserves in the United

States, highlighting the benefits of the unconventional drilling technological advances in the mid-2000's.

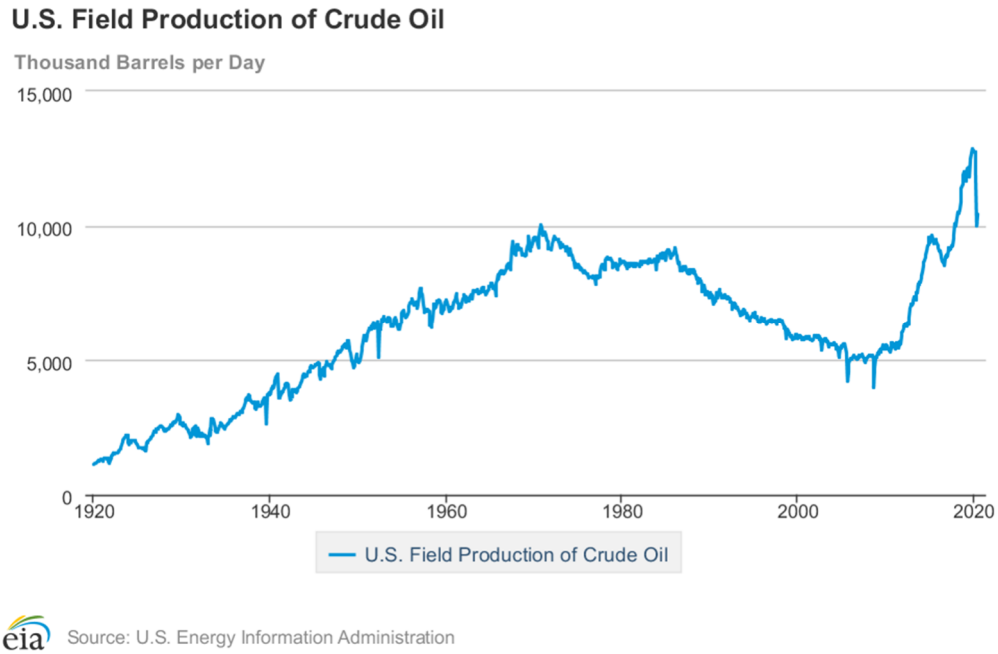

Figure 1 U.S. Field Production of Crude Oil
(U.S. Energy Information Administration, 2020)

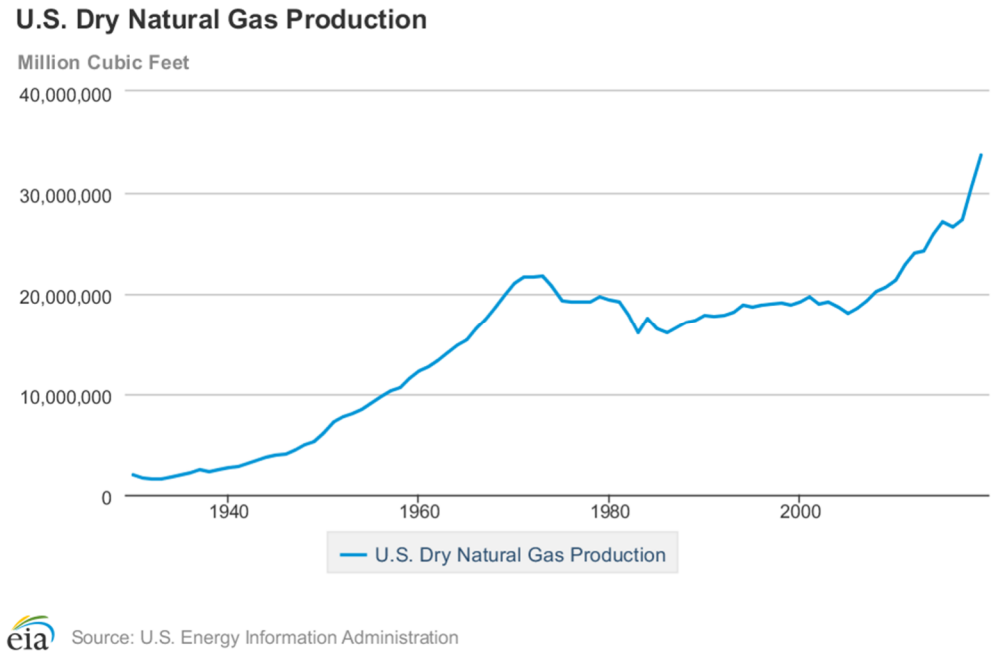

Figure 2 U.S. Dry Natural Gas Production
(U.S. Energy Information Administration, 2020)

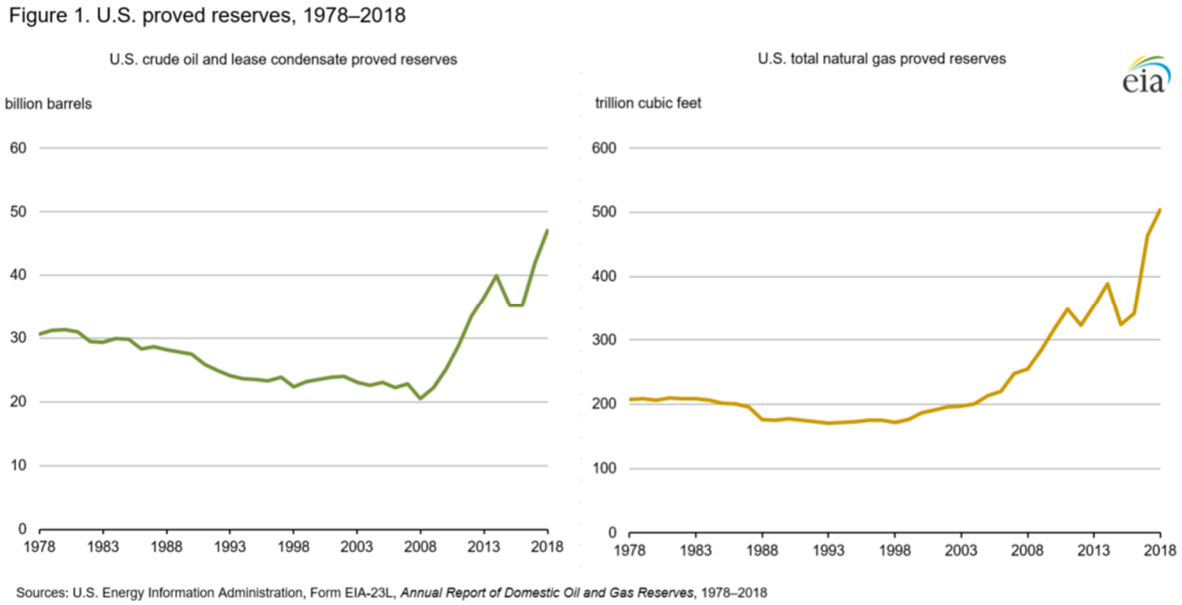

Figure 3 U.S. oil and natural gas proved reserves
(U.S. Energy Information Administration, 2019)

In addition to increasing the extractable reserves of oil and natural gas in the United States, hydraulic fracturing enables natural gas to displace coal market share as an energy source. This resulting increase in natural gas in the energy portfolio compared to coal could yield significant environmental benefits. When coal is burned the carbon dioxide (CO2) emissions range from 214-229 pounds of CO2 per million BTUs. In contrast, natural gas emits only 117 pounds of CO2 per million BTUs when burned (U.S. Energy Information Administration, 2017). There is a danger that the reduced volume of CO2 emissions due to natural gas combustion may be offset by the release of methane – a much more potent greenhouse gas - during production, processing, transmission and storage, and distribution of natural gas, which are necessary components of the use of natural gas as an energy production fuel. In 2012, natural gas extraction was the source of 23 percent of the anthropogenic (human-caused) methane emissions in the United States (Heath, Warner, Steinberg, & Brandt, 2015, p. 3). Coal mining, in contrast, generated only 11 percent of

the anthropogenic methane emissions in 2012 (Heath, Warner, Steinberg, & Brandt, 2015, p. 3). Methane has a greater global warming potential (GWP) than carbon dioxide over different time frames, and therefore is a relevant factor to consider (Farquharson, et al., 2017, p. 858). Despite the larger methane emissions of natural gas in comparison to coal the overall impact of greenhouse gas emissions due to an exchange of natural gas for coal in energy generation is a net reduction in global warming potential provided leakage of methane is controlled during the extraction process. Depending on the time frame analyzed, methane leakage rates of 2 percent to 8 percent in the 20-year to 100- year horizons respectively are sufficient to nullify the benefits of natural gas as an energy source in comparison to coal (Sanchez & Mays, 2015, p. 175), (Farquharson, et al., 2017, p. 868).

In 2017 approximately 180,000 people were employed in oil and gas extraction in the United States (Bureau of Labor Statistics, 2018). This represents an increase in employment from 2005 of 125,000 people. This increase in employment in the energy sector can be directly attributed to unconventional drilling technology that facilitated the current boom in extraction. This new energy sector was a great benefit to communities during the Great Recession, providing a new industry that was able to provide both employment to workers and royalty income to property owners. Rural areas of Pennsylvania with limited economic diversity were suddenly in a position to capitalize on this new technology.

2.5. Drawbacks of Hydraulic Fracturing

As an energy industry technology, hydraulic fracturing is not without negative environmental and social consequences. Concerns over drinking water contamination, water consumption, air pollution, and ground water pollution (Sovacool, 2014) have driven legislators to ban the process across scales, ranging from the municipality level (e.g. the City of Philadelphia) to the country

level (e.g. France). The fast-paced development of fracking operations in areas such as rural Pennsylvania, North Dakota, and Texas stands in contrast with the complete halt or ban in other areas such as New York. Despite exhaustive research on the environmental impacts of hydraulic fracturing it remains unclear whether unconventional drilling can be conducted in an environmentally responsible manner. To further increase the complexity of the issue, the economic impacts of unconventional drilling for property owners, the oil and gas industry, and the economy cannot be understated or simplified (Sovacool, 2014; Melikoglu, 2014). Economic highs such as a producing well for an oil company can yield great economic pay-off for both property owners (leases) and the oil company in revenues. Economic lows, sometimes involving the same individuals and companies that previously benefited, can include both environmental and social degradation (Sovacool, 2014, p. 256).

The Environmental Protection Agency's (EPA's) report on the "Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources" thst was released for external review in June 2015 states that on a national basis the impacts of hydraulic fracturing on drinking water have not been widespread or systemic and that the incidence of drinking water contamination has been small compared to the large number of hydraulically fractured wells. This report has been widely disputed, most prominently by the EPA's own Science Advisory Board (SAB) whose review states that the EPA's report is "comprehensive but lacking" and elucidates concerns regarding the major findings of the report. Notably, the SAB took issue with the EPA report's conclusions that indicate that the sweeping generalization that hydraulic fracturing has not led to widespread drinking water contamination was not adequately defined or quantitatively supported. This contradictory information, from two arms of the same organization, is indicative of the political challenges associated with hydraulic fracturing technologies. Without consensus

regarding the risk associated with using hydraulic fracturing techniques for the extraction of oil and natural gas, it is challenging for decision makers at all levels of government to appropriately assess that risk for use in policy or legislation.

Based on the environmental challenges associated with hydraulic fracturing, and even the EPA cannot definitively quantify what those risks are, some regions simply ban the practice rather than engage in its risks. The United States had approximately 200 Trillion Cubic Feet (TCF) in proved reserves of natural gas in 2005 (U.S. Energy Information Administration, 2016). By 2014, this volume had increased to over 380 TCF (U.S. Energy Information Administration, 2016). This increase in proved reserves is the consequence of multiple factors including: new source discoveries, expansion of existing reserves, production, prices, and technology (U.S. Energy Information Administration, 2016). As oil prices rise on the global market the volume of oil and gas that can be extracted economically increases due to the shifting break-even point for extraction. Similarly, as technology improves (better materials, new techniques, etc.) and extraction becomes more efficient and therefore less costly, the break-even point for extraction drops, increasing proven reserves. This means that should hydraulic fracturing technology be halted; the potential result would be a reduction in the proved reserves as known sources of oil and gas in the US and across the world become economically and technologically inaccessible using traditional drilling techniques. Although it is impossible to know exactly what the impacts of this sudden retraction of shale oil and gas from the market would be for certain, possible consequences could include increased reliance on OPEC countries by developing countries, domestic fuel shortages, rising energy prices, etc. The broad adoption of unconventional drilling for the purposes off shale oil and natural gas extraction represents an investment that would be challenging, on many levels, to reverse.

2.6. A Wicked Problem

While the challenges that unconventional drilling companies face are scientific problems with finite solutions (though admittedly challenging ones), such as how to prevent chemical spills, how to avoid subsidence, etc., the greater questions around the industry are much more complex. As described by Rittel and Webber, "planning problems are wicked problems (Rittel & Webber, 1973, p. 6)." Wicked problems are issues whose very definition and extent are themselves sources of disagreement. The issues associated with unconventional drilling are very different depending on the perspective of different actors, at different scales, in an unwinding fracking drama. This type of problem can be identified by ten characteristics outlined by Rittel and Webber, but two of those characteristics are readily apparent in the planning challenges of unconventional drilling are the following (Rittel & Webber, 1973, pp. 162-167) :

a. Solutions to wicked problems are no true of false, but good or bad
b. Every wicked problem can be considered a symptom of another problem

It is easy to see how planning solutions around the unconventional drilling industry are either good or bad versus being true or false. Those in the industry operate under a presumption that the activity can be under-taken with a low or reasonable amount of risk, and that the operations can be conducted safely. Therefore, a decision to eliminate the practice due to potential risks would be clearly bad and have dire economic consequences from a pro-drilling standpoint catastrophically impacting oil and gas companies, supply chain contractors, etc. In contrast, as a resident who believes that the risks far outweigh the potential benefits, allowing drilling despite potential water contamination, earthquakes, subsidence, air pollution, etc. is also a clearly bad choice. So, the question of whether to use unconventional drilling, or not, is clearly one with wicked implications.

From the higher level of the energy industry and the US macroeconomy, the wicked nature of unconventional drilling clearly becomes a symptom of other issues. United States politicians have long expressed a desire to be energy independent. In 2007 President Bush signed the Energy Independence and Security Act (EISA) which articulated both goals and strategies for eliminating the need for the import of foreign energy (oil and gas) while simultaneously increasing the US market share of renewable energy (United States Environmental Protection Agency, 2019). The unconventional drilling industry plays an important role in compliance with the EISA as the means to obtain oil (predominantly in Texas and the Dakotas) and natural gas (Pennsylvania), cleaner energy sources than coal and a ready alternative to purchasing foreign oil. Without the need for American oil and natural gas as an energy source, conflict around unconventional drilling would be reduced, however these external geopolitical pressures maintain the wickedness of the problem.

2.7. Litigation and Conflict

Pertaining to the unconventional drilling industry, planning plays an intermediary role in the interface between industry and community. Therefore, the presence of social conflict in relation to the unconventional drilling industry could represent a failure in the planning process, wherein there is disruption despite planning efforts. This research uses litigation, or more specifically civil lawsuits, as a measure of this social conflict in fracking communities.

Litigation is a means to resolve a dispute between two entities though interpretations of the law. This means of dispute resolution ultimately results in a single "winner" and single "loser". Without a means of peaceful and mutually beneficial resolution, the risk then in filing a lawsuit is that the filer may lose (Parselle, 2006). Although the risks are significant, according to Trubek et al., in what they call ordinary litigation the likelihood of success for the plaintiff is sufficient to overcome the costs and risks of litigation. Or, put another way, because attorneys are often paid

based on their success, particularly in small lawsuits, they are disinclined to accept lawsuits wherein they are likely to lose, thereby tipping the scales in favor of plaintiffs (Trubek, Sarat, Felstiner, Kritzer, & Grossman, 1983). In the United States, the cost of litigation in 2011 was 1.66 percent of the US gross domestic product (GDP) (McKnight & Hinton, 2013, p. 2). When compared to Canada (1.19 percent GPD) and the United Kingdom (1.05 percent GDP) (McKnight & Hinton, 2013, p. 2) as the closest in comparison to the United States, the cost of litigation to the American economy is significant. While noteworthy, these statistics do not explain why litigation is so prevalent in the United States.

One theory why lawsuits are so prevalent is that as a society we litigate because it satisfies basic needs including: vindication, empowerment, public hearing, legitimacy, and justice (Parselle, 2006). The first element, vindication, may be anchored within a notion of American Exceptionalism (Lipset, 1996). Lipset, building on the seminal works by Robert Merton, suggests that American society has elevated the values of financial success and social elitism above more base values such as socially acceptable (and beneficial) behavior, which has led to a nation that values "the win" above all else (Lipset, 1996). This willingness to engage in a win-lose scenario to achieve a desired end supports the evolution of a litigious society.

This aggressive behavior in American culture can be demonstrated through an example from game theory. When Robert Axelrod solicited entries into his original Prisoner's Dilemma programming game the winner was a simplistic entry that exhibited the characteristics of niceness (the program would not defect first) and forgiveness (the program would not retaliate in the case of a single defection) called TIT FOR TAT (Axelrod, 1980). After running his experiment with the original programs, Axelrod then re-solicited entries for his game, and included with his solicitation a description of the core concepts of the original winner. Despite Axelrod's warning

that the winner of the original game was both "nice" and "forgiving," the second round of entries also failed to defeat TIT FOR TAT, primarily because the programmers for both rounds of games predominantly focused on predatory programming traits (Axelrod, 1980). Although the programmers were told that non-predatory programming decisions performed better in the game, they overwhelmingly chose to attempt to take advantage of the congenial TIT FOR TAT construct with more aggressive win-lose (rather than win-less-together) choices. This example illustrates the societal focus on an individual win, despite the risk, having greater value than a lesser but shared option.

The prevalence of litigation in the United States is demonstrable at the national level. According to a report by the U.S. Chamber Institute for Legal Reform, the United States spent approximately 1.66% of GDP in liability costs in 2013 (McKnight & Hinton, 2013, p. 2). This is more than twice the cost burden borne by all but Canada (1.19%) and the United Kingdom (1.05) of those surveyed. Therefore, while the risk and cost of litigation may be worthwhile from the individual litigant's perspective, the cost to the United States as an economy is significant impediment to international competitiveness (McKnight & Hinton, 2013, p. 6).

2.7.1. Litigation and Hydraulic Fracturing

Litigation within the hydraulic fracturing context can provide many examples of the burden of lawsuits on both sides of conflict. The case *Ely vs Cabot Oil & Gas Company* is a prime example of the costs of litigation, and the associated risks. In 2009 a lawsuit was filed in Pennsylvania that alleged that the Cabot Oil & Gas Company (Cabot) was responsible for the contamination of the drinking water that served 19 families in the towns of Dimock and Montrose, PA. The suit alleged that due to hydraulic fracturing activities by Cabot Oil and Gas Corporation dissolved methane, natural gas, and other toxins contaminated the drinking water wells (Fiorentino V. Cabot Oil and

Gas Corporation, 2010) of the affected residents resulting in a host of physical and emotional ailments (Fiorentino V. Cabot Oil and Gas Corporation, 2010). In 2010 several of the original complaints were dismissed, winnowing the range of potential responsibility for Cabot. Two years later, in 2012 several of the original 19 families named as plaintiffs in the lawsuit settled with Cabot in a confidential agreement (Arnold & Porter LLP, 2016). By 2014 the case was proceeding with a winnowed list of 10 plaintiffs (Ely V. Cabot Oil & Gas Corp., 2014) who eventually won a judgement of $4.24 million in March of 2016. The judgment was short lived, however, and on March 31, 2017 a judge overturned the verdict and dictated that the plaintiffs either settle the suit with Cabot or re-try the case due to lack of evidence supporting the Ely case, missteps by the Ely attorney, and insufficient evidence to support the $4.24 million-dollar award.

The tumultuous Ely v. Cabot lawsuit embodies a failure among the fracking company, the landowners, the residents, and the municipality to agree on mutually beneficial outcomes of drilling *before* the drilling process had begun. Instead, quarreling parties attempted to resolve disagreements through litigation, which ultimately resulted in losses to everyone. Although the award of $4.24 million is superficially a "win" for the plaintiffs, the subsequent overturning of the verdict represents a stunning change in fortunes on both sides of the conflict. Although at different points in time both the Ely's and Cabot Oil & Gas were winners in the lawsuit, they are both losers as well. Furthermore, the call for re-trial or settlement as part of the 2017 ruling dictates further involvement in the conflict for both parties. A confidential settlement was finally reached in the case in 2017.

2.8. Planning Theory and Conflict

It remains unclear whether confrontation is in our nature (as those that seek to dominate in the case of conflict according to game theory) or in our culture (by virtue of the value of American

exceptionalism). Regardless of the source, the question then becomes not "why is there so much conflict leading to litigation," but rather, how can conflict (and subsequent litigation) be avoided *and* disagreements be resolved. Fortunately, at its core mitigating conflict may be the driving force behind the planning profession.

Although most planning theorists agree that planning is generally a morally positive undertaking, there remain diverse views about the ideal or actual role of plans and planning professionals in contemporary cities and regions. Yiftachel, for example, suggests that planning is advertised by both the practitioners and theorists as a pursuit for betterment of society and the public good, simply because both groups have a vested interest in maintaining that idealistic perception. In contrast to this idealization, Yiftachel highlights systemic subjugation by the planning profession to include territorial, procedural, socioeconomic, and cultural oppression which entrenches the preexisting power of the elites (Yiftachel, 1998, p. 403). It is relatively easy to find examples of planning oppression from these categories. For example, the practice of redlining – a practice that discourage mortgage lending in certain areas of American cities in the twentieth century - represents a clear example of territorial control to perpetuate racial segregation (Aaronson, Hartley, & Bhashkar, 2017, p. 2). Similarly, the act of political gerrymandering of voting districts based on race in North Carolina (subsequently ruled to be unconstitutional) represents an act of planners' procedural discrimination through marginalization.

Similarly, both Foucault and Flyvbjerg discuss the interplay between power and rationality which highlights the inherent challenges in planning. Foucault implies that all relationships should be viewed through the lens of power dynamics, and power cannot be separated from the actions of a society (Foucault, 1982, p. 795). Furthermore, Foucault notes that political power is characterized by rationalization by those in power (Foucault, 1982, p. 779). Subsequently,

Flyvbjerg supported Foucault's hypothesis through his case study of the traffic planning in Aalborg which presents a compelling argument for the impact of rationality wielded by those in power within a planning context (Flyvbjerg, 1998). For both Flyvberg and Foucault, the dynamics of power play a much greater role in planning decisions than the altruistic goals of idealistic planners. While Stein and Harper observe that a comprehensive planning theory cannot effectively be generated from this power-centric perspective because it may cause other, more salient reasoning to be overlooked (Stein & Harper, 2003, p. 131), the notion that power within relationships may dictate outcomes within a planning context should be not dismissed.

Despite these critiques, many professional planners and theorists have suggested a variety of reasons for why we plan which are based in a benevolent interpretation of planners, and the planning profession more generally. Klosterman suggests that planning serves four discrete purposes: to champion the needs of the community over the individual, to regulate the individual to prevent adverse effects to the greater group, to become an information nexus for decision making, and to protect distributional needs of the community (Klosterman, 1996, p. 162). The core objective of the planning profession is to protect the greater good from individualistic decisions (Klosterman, 1996, p. 162). This theory, supported by the Prisoner's Dilemma and the Tragedy of the Commons, presupposes that a competitive free-market society without coercive regulation is unsustainable because as each member acts in their own best interest common pool resources such as shared public infrastructure will either disappear or lose functionality. Moore (1978) suggests that planning is a justifiable pursuit within the arena of public goods, as the Tragedy of the Commons highlights that a free market economy is unadaptable to shared resources. Therefore, planning decisions interfere in the free market but are explicitly and uncontrovertibly designed to champion the public good and reduce market failure (Moore, 1978, p. 396). If it is

accepted that the dual role of the planner is to both represent those without power, and to shepherd and prioritize shared community assets, then it is logical to then anticipate that the actions of planners may help to mitigate conflict of stakeholders within those contexts. Ostrom suggests that the planner can take an active role in governing the commons through an adaptive governance approach (Ostrom, 2008, p. 17). She suggests that through the application of accurate and relevant information, addressing conflict over policy and governance when it arises, incorporating formal and informal rules to increase compliance, providing infrastructure, and encouraging change and adaptation as situations change may limit the tragedy of common-pool resources (Ostrom, 2008, p. 17).

Hopkins suggests that plans are used to help overcome "dynamics failure," or situations that are vulnerable to the "4 I's": interdependence, indivisibility, irreversibility, and imperfect foresight (Hopkins, 2001, p. 25). For example, conditions such as the progression of residential land development embody these conditions. The development is interdependent: A school may be needed if a subdivision is built, but if either the school or the subdivision is not constructed the value of the other is compromised. Similarly, the infrastructure is indivisible: for a subdivision to be constructed the road infrastructure must be improved sufficiently to carry the traffic generated by the new residents, and conversely the road won't need to be improved until the subdivision is constructed, and the new traffic has been generated. Development is inherently irreversible: once the subdivision is constructed it cannot simply be relocated at low cost. And finally, land development is based on imperfect foresight: market conditions may change unexpectedly such as the market collapse of 2008 rendering drastically different outcomes from those anticipated.

If litigation is a means to resolve conflict that has already occurred, then it is reasonable to extrapolate that by mitigating conflict through communication about interdependent decisions,

conflicting parties may evade costly litigation. Within a planning context there are innumerable opportunities for conflict to arise which may fall under the four situational constructs that lead to dynamics failure as described by Hopkins. For example, if a school and subdivision are interdependent, and the subdivision is constructed but the school funding is diverted, then subdivision developer may choose to sue the school system. Similarly, if road improvements and subdivision construction are indivisible, there may be disagreements between the stakeholders regarding cost sharing. The irreversible construction of a road which adversely impacts an engendered species could lead to environmental litigation, or the simple presence of expansive clay or rock on a construction site could lead to litigation by the site contractor or owner if imperfect foresight yielded insufficient contractual contingencies. In this scenario the individual components of development include large monetary investment and are impossible to implement incrementally such that a dynamics failure is likely if any single component fails. Hopkins suggests that plans may play a role in shifting the construct of space-consensus-control to a more agile time-plan-coalition narrative, evading dynamics failure (Hopkins, 2014, p. 316).

2.9. How Can Planning Reduce Litigation?

Regardless of which planning theory is applied, plans are both used to guide - and are influenced by- decisions in the built environment. In effect, plans are used to signal the aspiration, intent and commitment of future action (Boyer & Hokins, 2016, p. 17), with the means of obtaining that effect varying based on the planning approach that is employed. By signaling intent, plans may have the benefit of reducing conflict in the same manner that a car blinker reduces the likelihood of an automobile collision. Each planning theory may signal that intent in different ways, but each approach may reduce conflict that may have otherwise ensued.

If plans are used as Yiftachel describes, then the purpose of planning is to maintain control and power over others. Through this viewpoint, a plan may reduce conflict through limiting the

opportunity of others to object through controlling or subjugating measures. The act of planning would serve to limit the free-will of others. Although this is one means of planning, there are other effective and less hostile approaches to reducing conflict.

Flyvberg's rationality in planning approach would lead a planner to generate plans for the justification of political decision making (in lieu of political decision making based on well researched and defensible planning). In this "ends justify the means" type scenario, power is the essential tool in planning action.

In Hopkins approach to planning, the signaling of intent by planners to those inside and outside the planning profession enables stakeholders to progress towards their end-goals by incorporating the stated intent of others into planned actions. This approach relies on the mutual benefit and transparency of others to guide decisions which impact the built environment and avert system failures.

2.10. Regulatory Environment

The preponderance of regulation that applies to hydraulic fracturing is governed at the state level. In 2005, the Energy Policy Act of 2005 modifies the Safe Drinking Water Act (42 U.S.C. 300h(d)) to exclude "the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities" (2005, p. 119 STAT. 694). Through this legislative change, the Federal Government abdicated responsibly for environmental protection from hydraulic fracturing activities in favor of the states. The impact of this de-regulation at the federal level has been a broad spectrum of state-based legislation which now governs the hydraulic fracturing industry (Shapiro & Warner, 2013, p. 480).

The Pennsylvania Department of Environmental Protection (PADEP) Passed Chapter 78a. Unconventional Wells on October 8, 2016. The purpose of this new regulation was to protect the environment and the public in the oil and gas region of Pennsylvania (2016). This represents the first division of legislation in Pennsylvania separating conventional drilling for oil and natural gas and unconventional drilling. The 2016 revision that strengthened the environmental protections by regulating unconventional drilling companies. These new revisions specifically address points of high water and air contamination risk in the unconventional drilling process to include (2016):

- Prohibiting the use of pits for storage of drill cuttings and waste fluids.
- Vandalism protection for storage tanks.
- Secondary containment for possible contaminants and drill rigs.

The new regulation also includes increased permitting requirements for unconventional drilling practices including both new permit requirements for disposal of drill cuttings and a water management plan requirement. Guidance on the installation of gathering lines under streams and temporary pipelines was also provided. Additionally, waste fluid from hydraulic fracturing cannot be re-used for other purposes (such as de-icing or dust control) and unconventional drill operations are now required to report monthly both their product and waste. The new regulation also requires that the driller conduct an evaluation of the well site to determine if it is to be installed within 200' of sensitive public infrastructure (such as parks, schools, wetlands, etc.) or within 1000' of a well, water intake or reservoir. A detailed evaluation of historic oil and gas wells (including questionnaires, data base search, and map review) ranging from present day through the 1850's) is also required to establish if there is a weakness in the soil condition which could allow migration of contaminants from the fracking layers to the shallower water table. The predrilling survey establishes means and methods for determining the pre-existing water supply conditions adjacent

to any unconventionally drilling site but does not specify that pre-drilling water testing be conducted. The regulation stipulates that any quality or quantity impacts must be addressed by the well operator who causes the impairment to the same level as pre-existing conditions.

The Pennsylvania Department of Environmental Protection's Mission is "to protect Pennsylvania's air, land and water from pollution and to provide for the health and safety of its citizens through a cleaner environment." A review of the rule 78a clearly adheres to this mission statement by narrowing focus to the protection of the environment from pollution, while refraining from commentary regarding the controversial nature of the hydraulic fracturing industry. This narrow focus places limits on the bounds of responsible legislation, and no testing requirement of nearby potable water wells is required within the new regulation.

2.11. Pennsylvania and Zoning Rights

On 8 February 2012, the state of Pennsylvania passed legislation entitled "Act 13" which prohibited individual municipalities from regulating hydraulic fracturing activities through zoning and land use planning. This legislation was challenged almost immediately in a lawsuit that was upheld by the lower court but partially struck down by the State Supreme Court in 2016. The portions of "Act 13" that remain in place at the time of this writing are the impact fees which are assessed on gas wells within the Marcellus Shale formation. These impact fees are based on the price of natural gas and represent a diminishing fee as a well produces throughout its lifetime. After this controversial legislation, zoning regulation governing hydraulic fracturing activities has been implemented on a micro level across the state of Pennsylvania. Both due to the Act 13 legislation and the inherently rural nature of many of Pennsylvania's Counties, may local municipalities in the State do not have zoning ordinances. Figure 4 shows which municipalities had zoning ordinances in place as of February 2014.

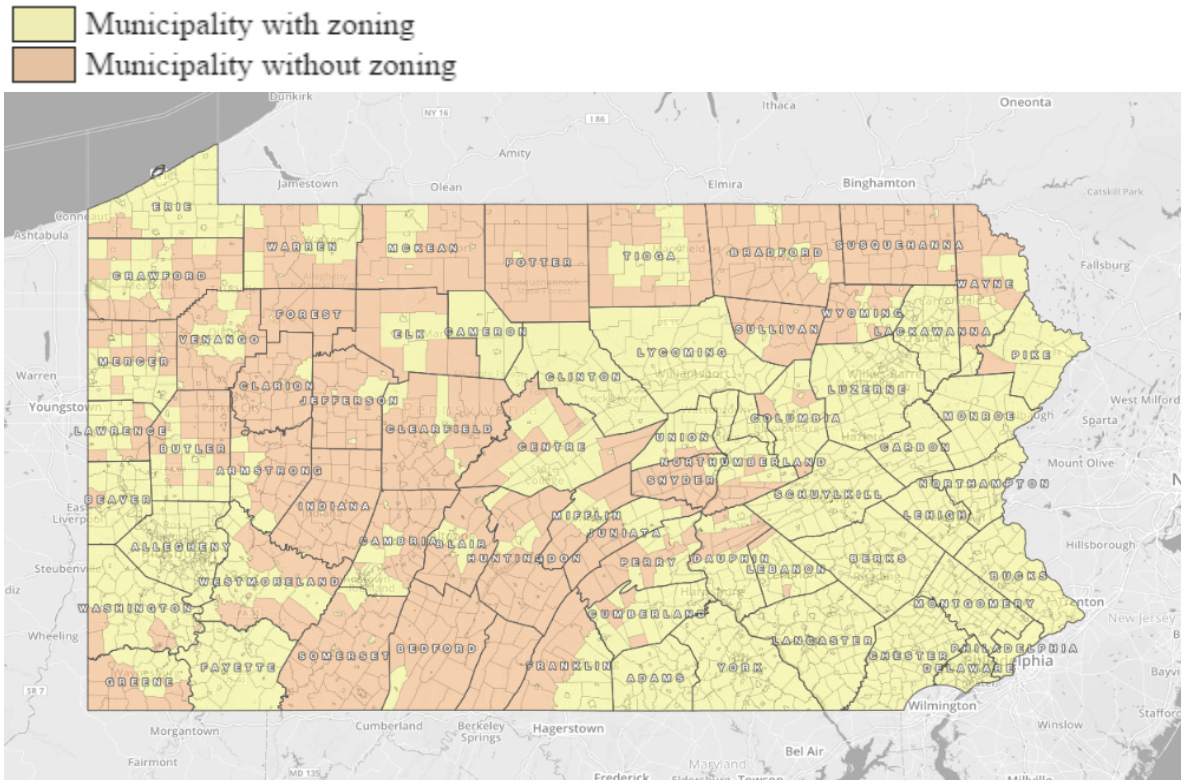

Figure 4 Municipalities with zoning ordinances in Pennsylvania as of February 2014 (https://stateimpact.npr.org/pennsylvania/zoning/#8/41.117/-77.470)

Although the regulatory environment in Pennsylvania changed significantly after Act 13 (and the subsequent State Supreme Court ruling in 2016 which instituted a partial repeal of Act 13), there are counties in Pennsylvania with full zoning ordinance coverage, and those with very little or no zoning ordinances which are located within the Marcellus shale region of the state. Nearly all the counties in Pennsylvania have comprehensive plans, though not all of them meet the State's requirement to be updated every ten years. The combination of Act 13 and the PADEP environmental regulation outlined above have resulted in a patchwork of regulatory guidance across the State. The impact of this guidance is that counties have taken differing approaches to planning pertaining to the unconventional drilling industry. Some counties have chosen to leave unconventional drilling guidance entirely up to the State, deferring to the PADEP for regulation. Other counties have chosen to address unconventional drilling in their plans, not ignoring the role

of State regulation but rather developing plans that address unconventional drilling within their areas in concert with this overarching regulation.

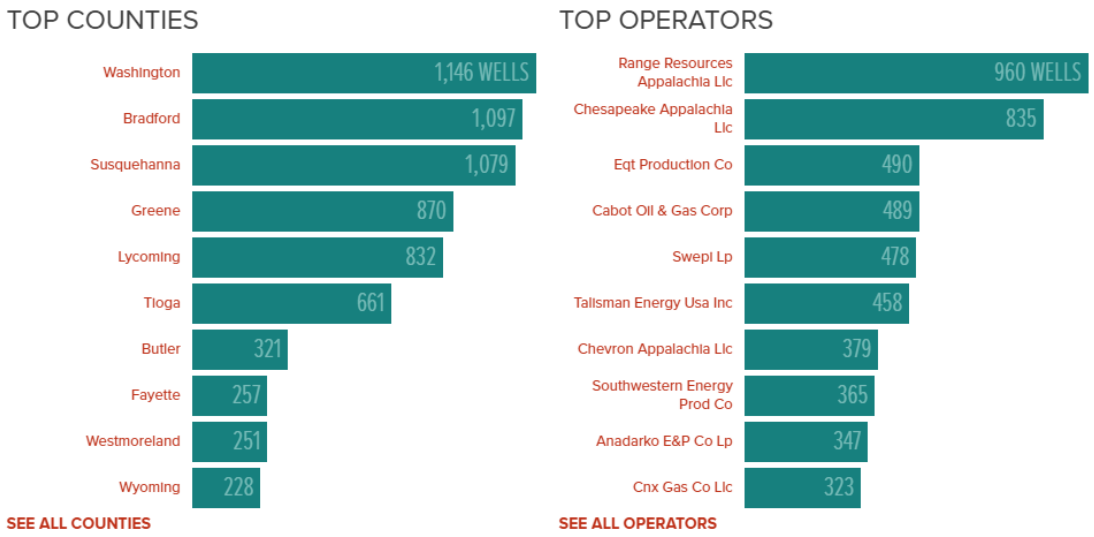

Figure 5 Top Counties for Unconventional Drilling in Pennsylvania
(Amico, DeBelius, Detrow, & Stiles, Shale Play: Natural Gas Drilling in Pennsylvania, 2011)

3. METHODOLOGY

The purpose of this research is to determine if comprehensive plans impact the resilience of communities that are affected by hydraulic fracturing. The advent of unconventional drilling represents a significant disruption to the social fabric of a region. This disruption can be simultaneously positive (economic development, population gain, tax revenue) and negative (environmental impacts, strain on public resources), and can strain the resilience of the affected region. This research seeks to determine if comprehensive plans may successfully build and/or protect the resilience of communities that are impacted by unconventional drilling. Because social resilience reflects a community's ability to incorporate disruption without changing its fundamental nature, a resilient community must be able to find alternatives to conflict resolution which reflect this ability to adapt. Lawsuits may be an indicator of a lack of social resilience because they represent a winner-versus-loser scenario wherein a compromise has already failed. Therefore, if a hydraulic fracturing community sees a reduction or decline in lawsuits due to a comprehensive plan, industry plans, or a combination of the two, the resilience of the community may have been increased through the application of planning.

One of the reasons for selecting Pennsylvania as the focus of this research was because hydraulic fracturing has been employed in this state for many years. This has allowed the state to experience both the benefits and drawbacks of hydraulic fracturing industry over time, providing opportunity for public and private sentiment, the unconventional drilling technology, environmental impacts, economic impacts, and lawsuits to mature in these areas. A case study research design was implemented for this project. The following section outlines the different case study selection approaches that were considered.

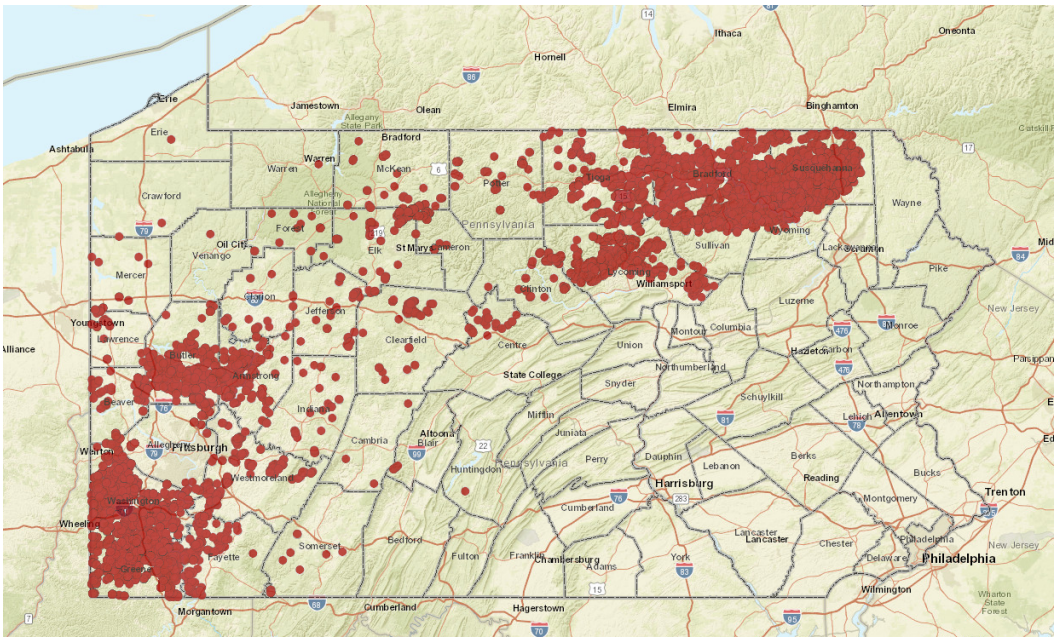

Figure 6 Unconventional Oil and Gas Wells in Pennsylvania on 10.18.2017
(Pennsylvania Department of Environmental Protection, 2017)

3.1. Case Study Research and Sample Case Selection

Case-study research is a small-sample method of scientific inquiry that is often dismissed by those that are focused on quantitative methods for a variety of reasons. In his well-known study of the development of a transit hub in downtown Aalborg, Flyvbjerg (Flyvbjerg, 1998) conducted a now-famous single-n study that has become the paradigm for case study research within the planning field. Subsequent to his research in Aalborg, Flyvbjerg proposed – and debunked - the most prevalent critiques of qualitative research methods by summarizing, and subsequently addressing, five commonly cited criticisms of case study research (see Table 1Table 2 A Flyvbjerg's Misunderstandings and Clarifications of Case Study Research). Avoiding these pitfalls through careful and deliberate case selection may maintain the empirical rigor of qualitative research and generate meaningful results. Only after the researcher fully understands the intent of her research can she then develop her qualitative research plan and begin to make information-based sample case selections (in contrast to random selection which can be more meaningful in quantitative

analysis). The next four sections describe four different methods for selecting information-oriented sample cases and how each method may be used for case study selection within the context of investigating conflict surrounding hydraulic fracturing. The last section is devoted to selecting and justifying one appropriate method for this research.

Table 2 A Flyvbjerg's Misunderstandings and Clarifications of Case Study Research

Misunderstanding	Flyvbjerg's Clarification
Context-independent knowledge (quantitative research) is more important than context-dependent knowledge (qualitative research).	To achieve knowledge mastery over a subject the depth of understanding must reach that which is achieved through case study research. In contrast, simple beginner level comprehension represents the understanding to be gained through a quantitative analysis. The human condition is complex and cannot be adequately described through the distilling of quantitative analysis to descriptive variables, the depth of understanding to adequately describe human interaction must therefore be context dependent.
Generalization cannot be made based on a single case example, and therefore a case study of n=1 cannot contribute to scientific advance.	Generalization based on large-n studies is overstated, and in converse generalization from careful and strategic case study selection yielding context-dependent examples can be highly valuable.
Case studies are useful in preliminary work to develop hypotheses but has limited application in testing hypotheses or developing relevant theory.	Careful case study selection can be helpful in both formulating and testing hypotheses but is not limited in usefulness to these areas of scientific inquiry. For example, deliberate selection of a case study to provide falsification can be used to disprove a hypothesis to great effect.
As case study selection is typically done openly, it is not possible to escape subjective bias, tainting results through the researcher's own values and perspective.	Case study research is at no greater risk of subjective bias than other research methods. Flyvbjerg notes that in his own experience case studies have the tendency of contradicting the researcher's preconceived notions, rather than validating them.
Reducing case study narratives into general propositions and theories is difficult	Although it is true that to distill a case study narrative can be difficult, it may be fallacious to try. The narrative driven by a good case study stands independently of summarization or generalization, the narrative itself being the end goal, rather than some future interpretative step upon completion of the research and narrative.

(Flyvbjerg, Five Misunderstandings About Case-Study Research, 2006)

3.2. Extreme/Deviant Case Selection

Although Flyvbjerg combines the extreme and deviant case study selection methods into a single category, there are distinct differences and similarities between the two approaches. In these approaches case studies - as the name implies - represent extreme or deviant examples to illustrate a concept or situation. In the case of extreme case selection, the cases are intended to share all (or as many as possible) characteristics (independent variables, X1, X2, X3) that yield differing results (dependent variable, Y). This case selection method is primarily used when the relationship between the variables are unknown, and the researcher is hoping to identify some link that may illuminate future research (Seawright & Gerring, 2008, p. 302). By selecting cases that represent extreme conditions, the researcher chooses examples that are most likely to yield a highly variable result in the dependent variable, and for that reason this method is typically used in situations wherein the researcher does not know, or cannot guess, the relationship between the independent and dependent variables that are under investigation (Seawright & Gerring, 2008).

Deviant case selection is often chosen in extreme cases wherein the subject being studied is such an outlier as to be valid for study in and of itself. Although some research designers are adamantly opposed to the single-case case study approach (King, Keohane, & Verba, 1994, p. 208), it is commonly applied in the medical field where outliers garner high interest.

Using an extreme case selection in this research could include selecting the county with the greatest number of lawsuits (or other metric to represent conflict) involving hydraulic fracturing in Pennsylvania, North Dakota, Texas, and Louisiana. Each case would then be viewed from two angles: what (if any) comprehensive planning addresses hydraulic fracturing is present in these counties (and parishes) and what types of fracking-related conflict are present (lawsuits, protests, violence, etc.) over a set time frame. In this approach there would be two different methods for selecting cases: based on extremes in the independent variable (X) or the dependent variable (Y).

Although Seawright makes a compelling argument for selecting cases based on the independent variable (X), the more common approach is to select extreme (or deviant) cases based on the dependent variable (Seawright, 2016) If cases were chosen based on the dependent variable (conflict, Y) and the study would hope to find common ground in the independent variable in each study (planning, X) which yielded the resulting conflict. The danger of this type of case study selection is that there may be insufficient variation in the dependent variable to make a causal inference from the research results (King, Keohane, & Verba, 1994, p. 129). Extreme case selection has the potential to identify common threads between the cases but does not include a scientific method type "control" for the experiment. If only cases wherein extreme instances of conflict are investigated, their experiment has no basis to understand how conflict can be avoided, because that scenario is not included in the study.

Table 3 Case Study Selection Summary

Selection Approach	Selection Basis	Benefits	Drawbacks
Option #1 (Selecting based on extremes in the Independent variable)	Extreme cases of planning	Planning addressing fracking would be in place in each study region.	Some extremes may yield little data because the extreme case could include New York State, for example, that has banned fracking completely.
Option #2 (Selecting based on extremes in the dependent variable)	Extreme cases of conflict	This may yield the most data to use in the analysis because a greater interplay between conflict and planning may be present.	There may be insufficient variation in the dependent variable (i.e., no control case).

Within a study that is intended to link conflict surrounding hydraulic fracturing and planning implementation, an extreme case selection approach could lead to the choice of studying Susquehanna County, or more specifically the town of Dimock. As the home county of the *Ely v.*

Cabot Oil and Gas lawsuit, this location has been a highly publicized nexus of conflict surrounding unconventional drilling. A study of this nature could uncover the details of the scenario that led to the well-known lawsuit, identifying a "what went wrong" type of result. This research would be explanatory in nature, generating a specific narrative about a specific occurrence. While there can be significant validity to this approach (the Aalborg study immediately comes to mind), other approaches may be preferred for this research.

The disadvantage of this type of case study selection is that it is unlikely to yield a valid causal inference to be made about why the link (if one is found) exists between planning and the conflict because it is likely to be a combination of factors. For a causal inference to be valid, the research design must be determinate, and in this scenario with only one case study for the design to be determinate the cause must be narrowed to a single observation (one equation, one unknown) which is highly unlikely in a social context (King, Keohane, & Verba, 1994, p. 210).

3.3. Maximum Variation Case Selection

When Boyer chose maximum variation case selection to choose ecovillages to study in his 2015 investigation of grass roots innovation for sustainability, he cited both a difficulty in controlling the explanatory (independent) variables and the challenges in separating social context from the studied phenomenon (Boyer, 2015, p. 324). This reasoning represents the hallmarks of maximum variation case selection. This approach is used to attempt to hold all other variables constant while observing the full range of variation in either X, Y, or both (Seawright & Gerring, 2008, p. 300).

This method would be appropriate for use in this research because it allows the researcher to choose representative cases from across the spectrum of possibility that are hypothetically likely to provide consistent results. The critical aspect of this methodology, however, is to make case study selections that effectively control for variables that are not part of the study. To most

effectively implement this method, selecting counties from a single state may provide the best results. This controls for regulations, history, leadership, culture, climate, and any number of other factors that vary across the United States. Hydraulic fracturing is used to extract both oil and natural gas (two fundamentally different products) and was being actively used in 34 states as of 2016 (Rubright, 2017). This broad potential data set is too diverse for effective case study research. To manage the diversity of the cases, limiting the research to Pennsylvania may yield the most useful results. Pennsylvania has large rural areas which may help to reduce the complexity of independent variables and make it easier to select counties with similar population statistics as a basis for the case study selection. In addition, some counties in Pennsylvania have comprehensive plans that address unconventional oil/gas wells, and some do not. Selecting a range of the independent variable (X – Planning) we can then study the effect on Y (conflict related to hydraulic fracturing) by controlling for other variables through selecting similar counties that have similar sociodemographic profiles but variable planning histories.

Independent Variable (X)	Dependent Variable (Y)
Has Planning	Fracking Conflict
Has Minimum Planning	
No Planning	

Figure 7 Maximum Variation Case Selection Matrix

The benefits of this case study selection approach include the ability of the researcher to hone-in on the study variables by selecting cases that are as similar as possible while allowing the independent variable to change. This allows the researcher to achieve a higher level of representativeness than with other methods (Seawright & Gerring, 2008, p. 301). One of the challenges to this method is the ability of the researcher to select cases that are similar in the non-studied variables. If there are uncontrolled-for variables that account for the differences in the dependent variable, the study loses its validity. Another pitfall occurs when the dependent variable

is not allowed to vary, eliminating the possibility of a comparison in the research and preventing meaningful causal inference (King, Keohane, & Verba, 1994, p. 109).

3.4. Critical Case Selection

This method is utilized by researchers who seek to supply a counterfactual argument based on the least likely case (Flyvbjerg, 2006, p. 230). A classic example of this approach is that to falsify the hypothesis that "all swans are white," the researcher simply searches for a single black swan in the most likely place for a black swan to be found, confirming or refuting the theory depending on the results (Flyvbjerg, 2006, p. 231). This method can be used to verify a hypothesis based on the least likely case, or disprove a hypothesis based on the most likely case. This method is effective at proving or disproving dichotomous hypothesis. For example, in the case of the swan, a black swan clearly disproves the theory that all swans are white – a swan is either white or it is not. Rahe (2013) used this method effectively in her dissertation by selecting communities that she determined would be the most likely to show social ties and those least likely to show local ties to test her hypothesis.

When Flyvbjerg argues that case studies are no more susceptible to bias than any other method, he notes that as a case study researcher delves deeply into the complexities of a case study the results often deviate from the assumptions the researched held at project conception. This was formed when he discovered that his (now famous) Aalborg case study was not a critical case, but rather a paradigmatic one of a different caste entirely. The selection of a critical case requires that the researcher know – or at least suspect – which cases are critical in advance of the case study selection. This foresight that is required to make an appropriate case selection may be beyond the reach of a novice researcher. If the researcher already knows where the black swan can be found it is easy to select the critical case, but if the researcher is simply looking up at the sky hoping to catch sight of a black swan on the wing, perhaps a different case study selection method would be a better choice. One means to determine the best critical cases for this approach (as employed by Rahe in her dissertation) is to utilize quantitative methods to select the critical cases, followed by using qualitative methods for the in-depth analysis.

More Conflict and Less Planning	More Planning & Less Conflict
Less Conflict and More Planning	Less Planning and Less Conflict

Figure 8 Critical Case Matrix

For this research, a critical case selection approach would be like the approach used by Rahe. Quantitative methods may be used to determine which counties have experienced more/less conflict and those that have more/less planning. Counties could be selected that have greater conflict and those that have lesser conflict. For contrast (and similar to Rahe), four communities could then be chosen to study, two with high rates of conflict and two with low rates of conflict while remaining as homogeneous across the sample as possible. The purpose of the case study selection would be to look for examples within the extremes. For example, looking for conflict in

areas with high levels of planning to confirm (or refute) the hypothesis that less conflict will be present in relation to hydraulic fracturing in those counties.

3.5. Paradigmatic Case Selection

A paradigmatic case is one that illuminates general characteristics of a concept or society that can be used as an example (Flyvbjerg, 2006, p. 232). These cases are used to set the foundational knowledge or measuring stick for others. Examples of this type of case study include the Flyvbjerg study of Aalborg, where the description of interplay between power, rationality, and planning in one small city has grown to become representative of the hierarchy of power and rationality. Similarly, Duncan's three case studies which describe the persistence of poverty in America are maximum variation selections, case studies that are representative of the research subject matter (Duncan, 1999), with one exception. It should be noted that Duncan's inclusion of Gray Mountain provides a contrast to the persistence of poverty which she describes in the other three locations – a paradigmatic choice as well but one of success rather than failure from the viewpoint of a community's escape from endemic poverty.

Selecting a paradigmatic case requires in-depth knowledge of a subject prior to making the case selection, because the purpose of choosing a specific case is that it will be representative of a certain phenomenon. Without that foreknowledge, it is virtually impossible to pick the most representative case of that phenomenon. In this way, the case should have few outliers or discrepancies, but rather should reflect the norm. This is the drawback of this type of case selection. If the paradigm is clear, however, it may be possible to select an appropriate case to study, but this seems rare. If this approach was used effectively, the results could be a highly impactful description of the interplay between hydraulic fracturing, conflict, and planning in America.

From the standpoint of this research, it would be difficult to select the paradigmatic case because broader evidence of the relationship between planning and conflict in the fracking industry would be necessary to make a selection. A highly-charged subject matter, those that are in opposition to hydraulic fracturing may choose to highlight Susquehanna County as the paradigm case, for example, due to its prominent position in the anti-fracking movie *Gasland* and the highly publicized Ely V. Cabot Oil & Gas lawsuit. A pro-fracking advocate would likely make a different choice, highlighting a county with a low incidence of citations by the Pennsylvania Department of Environmental Protection (PADEP). These examples of selection bias are extreme, but the challenge of avoiding selection bias in choosing a paradigm case may be difficult. It seems unlikely that an effective paradigmatic case selection would be possible at this stage of knowledge, though it may be possible after this research is complete.

In summary, although there are a variety of case selection approaches which could be used in this research design, the maximum variation technique represents the best choice at this time for this research. Choosing the best techniques in case selection is imperative to the research design and will dictate the validity of the results. Therefore, choosing carefully not only which cases to study but how the cases are to be selected is the first step to a successful qualitative study.

3.6. Research Design Approach

For this research the best approach for case study selection is to use a maximum variation technique to select the case studies to be investigated. This technique has several advantages. First, it does not require that the researcher know the outcome of the research to make the selection. This research is intended to illuminate the relationship between planning and conflict in hydraulic fracturing areas if such a relationship exists – a theory that is reasonable, but that has not been fully explained through previous study in fracking and planning theory. The lack of existing academic research on this topic makes it a good choice for a maximum variation selection approach. Second,

many of the regions that have high concentrations of hydraulic fracturing are also rural. This is beneficial for a maximum variation approach because the relative homogeneity of the case options help winnows the variables to a manageable level (Rahe, 2013). Third, to help in avoiding selection bias a quantitative analysis can be used to determine which counties are studied.

There are several pitfalls in selecting case studies. A few of the most common are indeterminate research designs, poor dependent variable selection, abstract concepts and selection bias (King, Keohane, & Verba, 1994). Indeterminate research designs occur when the number of causal variables is greater than the number of observations, or when two of the explanatory (independent) variables are perfectly correlated (King, Keohane, & Verba, 1994, p. 120). In other words, the number of case studies must exceed the number of independent variables that are being studied. In this case, if four case studies are chosen, the research design must be limited to a maximum of three unknowns for the result of the research to include a causal inference. This pitfall can be avoided by very carefully selecting the explanatory variables that are included in the study. Dependent variable selection is also important for the validity of the research design. An effective research design will ensure variation in the dependent variable, and that variation will reflect the phenomena that the research seeks to explain (King, Keohane, & Verba, 1994, p. 108). Abstract concepts should be avoided because they are difficult to measure (King, Keohane, & Verba, 1994, p. 109). For example, resilience would be a poor choice for a variable in the research design, because it is abstract, contested, and product of multiple other variables, but low crime rates used as an indicator for resilience could yield easily-interpreted results. Selection bias can occur when the researcher's personal biases influence case study selection. This can be as explicit as choosing only case studies that support the researcher's hypothesis or can be much subtler, such

as avoiding certain areas in a city-wide study because parking is difficult for the researcher to secure in a particular region.

	Pennsylvania	North Dakota
Pro's	Geographically closer to NC More familiar to the researcher Rural, but does have large urban areas High variation in comprehensive planning	Farther from NC – travel costly Less familiar to researcher Rural Consistent regulatory climate
Con's	Limited online public information Changing regulatory climate	Limited online information

Figure 9 State Selection Decision Matrix

3.7. Case Selection

The first step in case selection for this research was to choose a state for study. Preliminary research focused on Pennsylvania and North Dakota, as two states that rely heavily on hydraulic fracturing in the oil and natural gas extraction industries. These two states have fracking in common, but there are significant differences between them. Pennsylvania has a very different regulatory environment from North Dakota, and Pennsylvania extraction is primarily natural gas whereas North Dakota is typically shale oil. Because of these differences, controlling for these variables - variables that are not part of the study - would prove difficult. Therefore, the study was narrowed down to choosing counties within one state to control for these variables (Rahe, 2013, p. 36). By reviewing the advantages and disadvantages of each state, it was possible to determine that Pennsylvania was a better choice for the focus of this research because of the available information and its relative proximity to North Carolina (the researcher's home).

Once Pennsylvania was established as the research location, the next step was to transition to a review and classification of the comprehensive plans in each of the counties with unconventional drilling. In Pennsylvania, each county with unconventional wells has a comprehensive plan,

however the focus of each plan varies across counties. For reference, a summary of the counties with comprehensive plans that directly address the gas industry, and specifically unconventional drilling, is provided below in Table 4.

For example, in Crawford County, the comprehensive plan was updated in 2014, and directly addresses both conventional and unconventional drilling throughout the document. This emphasis includes a section on the oil and gas industry in the county, and reference to current and future oil and gas extraction in multiple sections of the plan. In contrast, Greene County's comprehensive plan was last updated in 1977, and so does not cite unconventional drilling at all, as it pre-dates the fracking boom in the United States. For the purpose of this research, to determine if comprehensive plans have an impact on the conflict that surrounds the hydraulic fracturing industry, county level comprehensive plans will be assigned to different categories based on their handling of the oil and gas industry using the following criteria:

Table 4 Comprehensive Plans in Counties with Unconventional Wells

County	Comprehensive Plan
Allegheny	Allegheny Places, The Allegheny County Comprehensive Plan, December 2008
Armstrong	Armstrong County Comprehensive Plan, 2005
Beaver	Beaver County Comprehensive Plan, 13 May 2010
Blair	Blair County Comprehensive Plan, 2005
Bradford	Bradford County, Comprehensive Plan March 11, 2004
Butler	Butler County Comprehensive Plan, 1997
Cambria	Cambria County 2011 Comprehensive Plan Update
Cameron	Cameron County Comprehensive Plan, 1969
	Cameron County Transportation Plan, 2006
Centre	Centre County Comprehensive Plan
Clarion	Clarion County Comprehensive Plan, November 9, 2004
Clearfield	Clearfield County Comprehensive Plan, 2006
Clinton	Clinton County Comprehensive Plan, 2014
Crawford	2014 Comprehensive Plan, Cultivating Crawford, Growing a Community
Elk	Elk County Comprehensive Plan, 1999
Erie	Erie County Comprehensive Plan, 2002-2003
Fayette	Fayette County Comprehensive Plan 2000
Forest	Forest County Comprehensive Plan, October 2013
Greene	Green County Comprehensive Plan, 1977
Indiana	Where We Live… A Comprehensive Plan for Indiana County, August 22, 2012
Jefferson	Jefferson County Comprehensive Plan, 2018
Lawrence	Focus Lawrence County Comprehensive Plan Update, October 2016
Lycoming	Countywide Comprehensive Plan 2018
McKean	McKean County Comprehensive Plan, December 18, 2007
Mercer	Mercer County Comprehensive Plan, April 27, 2006
Potter	Potter County Comprehensive Plan, 2003
Somerset	Somerset County Comprehensive Plan Update, August 2006
Sullivan	Sullivan County Comprehensive Plan, January 18, 2011
Susquehanna	Susquehanna County Comprehensive Development Plan Update, November 12, 2013
Tioga	Tioga County Comprehensive Plan Update – 2030, December 2017
Venango	Venango County Comprehensive Plan, January 1, 2005
Warren	Warren County 2005 Comprehensive Plan Update
Washington	Washington County Comprehensive Plan, November 23, 2005
Westmoreland	Westmoreland County Comprehensive Plan, January 2005
Wyoming	Wyoming County Comprehensive Plan, 1997

Level 1: A county's current comprehensive plan was published before 2006 and is too old to adequately address unconventional drilling, or the current plan dates from 2017 or later, which is too recent for adequate lawsuit data to exist.

Level 2: A county's comprehensive plan has been updated since 2006, however it does not address the oil and gas industry or hydraulic fracturing/unconventional drilling.

Level 3: A county's comprehensive plan makes mention of the gas industry, or hydraulic fracturing/unconventional drilling, however it does not have a section or chapter dedicated to the industry and no special emphasis is placed on it. An example of a Level 3 reference is found in Beaver County's comprehensive plan. This plan makes note that there is unconventional drilling for natural gas within the county and identifies unconventional drilling as a potential threat to natural resources in the future:

> "To date, there has been little gas drilling in Beaver County, however many gas companies have negotiated leases with landowners for the gas rights beneath their land. When economic conditions improve, these companies will undoubtedly exercise these rights to drill for natural gas." (Pashek Associates, May, 2010)

The Beaver County comprehensive plan notes that unconventional drilling is occurring and is likely to continue to occur in the future but does not dedicate sections to the industry or attempt to guide the future of the industry within the county.

Level 4: A county's comprehensive plan includes a section or chapter dedicated to the natural gas industry and/or hydraulic fracturing/unconventional drilling. Clinton County's comprehensive plan is an example of a level 4 comprehensive plan. This plan has a section entitled "Marcellus Shale Gas Resource Trends and Issues." Current and future fracking trends, workforce development, and environmental impacts are discussed in this section dedicated to the

unconventional drilling industry in Clinton County. This comprehensive plan dedicates a notable and detailed section to unconventional drilling, as well as noting the relationship between unconventional drilling and other aspects of the comprehensive plan such as economic development, natural resources, and housing trends.

Concurrent with the selection of the comprehensive plans and unconventional well data, the third component of the quantitative portion of this research was to determine what the lawsuit landscape looks like within each selected county. The prothonotary of each county in Pennsylvania is the elected official that is responsible for the civil lawsuits within the county. These officials (or their representatives) were contacted through phone, mail, fax, email and in person to obtain the lawsuit data for each county. The data collection procedure was as follows:

First, the Pennsylvania Department of Environmental Protection (PADEP) website was queried to determine which companies have (or have had) unconventional wells in PA. This included all wells that were drilled and does not include well permits that were not acted upon. The list of companies with current or past active wells was then searched in the prothonotary database in each county to determine the number of civil lawsuits that name an unconventional drilling company (as either the litigant or defendant). This includes all lawsuits that were filed and does not distinguish between those that were settled versus those that proceeded through the litigation process.

Because this research looks at the conflict surrounding the application of hydraulic fracturing technology, the database does not distinguish between lawsuits thar originated with hydraulic fracturing companies versus those that originated with landowners or other stakeholders. Criminal lawsuits were not considered, because it is unlikely that comprehensive plans would have an impact on the criminality of a company or individual. Civil lawsuits are those that address disputes

between private parties such as individuals or companies. In contrast, criminal lawsuits are those in which a crime has been committed (or is thought to have been committed) which constitutes an act against the applicable level of government (city, state, county or federal). The lawsuit data that was collected was then cross-referenced with the comprehensive plan analysis. This allowed the researcher to view the levels of planning pertaining to unconventional drilling in each county in comparison with the number of civil lawsuits filed in those counties involving the unconventional drilling industry. This comparison then allowed the researcher to select three counties for further study.

Once the quantitative comparison was completed, the research activities then transitioned to an interview phase wherein the researcher interviewed individuals from the three primary groups of stakeholders in the hydraulic fracturing industry: government, industry, and community. The purpose of these semi-structured interviews was to discuss in depth the planning in each county from the perspective of community, government, and (if possible) the unconventional drilling company industry. The interviews explored the relationships between the stakeholders to better understand the social bonds between the industry stakeholders and the impact of plans on those relationships.

For the government interviews, members of the planning community in each selected county were interviewed in semi-structured interviews. The purpose of these interviews was to obtain a clear picture of the goal of the comprehensive plan in each county in relation to unconventional drilling, and to determine if those goals are perceived to be met by the community. The other purpose of the government interviews was the to determine how the county government officials address the industry, and how that public stance relates to the active comprehensive plans and the community relationships with industry. It was anticipated that one semi-structured interview

would be performed with a senior planner or planning director in each selected county. Additionally, county commissioners from each of the studied counties were interviewed to discuss the county's relationship with unconventional drilling, the county's approach to drilling, and the community, government, and industry interactions surrounding the industry. Most commissioners that were contacted were willing to engage in an interview, thought the responses from the planners were mixed, some being amenable to being interviewed and some declining.

Industry interviews were requested from every unconventional drilling company that was identified as engaging in hydraulically fractured wells in each of the selected counties. Unfortunately, only one active unconventional drilling company agreed to be interviewed for this research. Fortunately, an interview was also conducted with a state-wide industry advocacy group, which provided additional perspective from the unconventional drilling industry to help illuminate the impact of planning on the industry. Why this reticence was encountered, and the implications are discussed in detail in Section 5.4.

Community interviews were secured through a combination of snowballing and internet searches for contacts from local community organizations such as historical societies, chambers of commerce, tourism boards, Rotary Clubs, local businesses, and other community organizations. The interviewees were typically contacted by phone and asked to participate in short 20-45 minute interview. Of note, emailed interview requests were almost universally ignored or declined by community members. These interviews were semi-structured in nature and were

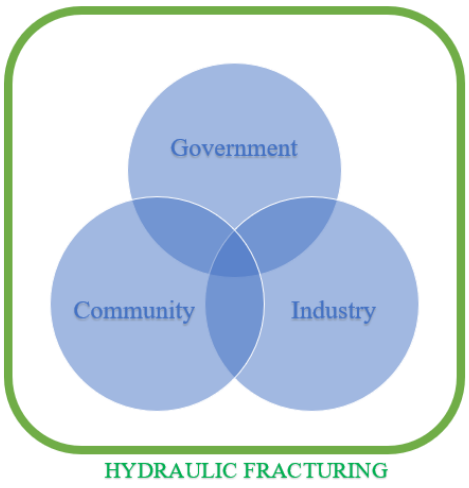

Figure 10 Stakeholders

allowed to range according to the perspective of the interviewee on topics relating to the unconventional drilling industry that were of particular interest of importance to them. For example, a landscape architect expressed interest in the potential environmental impacts and visual impacts caused by unconventional drilling. In contrast, an attorney expressed interest in the lack of perceived civil lawsuits relating to fracking, and wondered if the legal field has been lax or slow on their own education about the topic – rendering them ill-prepared and therefore unlikely to initiate lawsuits involving the industry. The original research intent was to balance the number of interviews between those that strongly support and those the strongly object to the hydraulic fracturing/unconventional drilling industry. It became clear, however, that a 50/50 distribution of those that support the industry versus those that do not would skew the perception of the counties because in general the counties studied and their inhabitants are in favor of unconventional drilling. It became apparent throughout the interviews in all three case counties that those in favor of the industry greatly outnumber those that are opposed.

The next section includes the quantitative data obtained through the procedure outlined in this section and makes an argument for the selection of the three counties chosen as case studies.

4. DATA COLLECTION

4.1. Unconventional Wells

The Pennsylvania Department of Environmental Protection regulates unconventional drilling activities in Pennsylvania and maintains an online database that tracks unconventional and conventional gas wells within the state. This website was used to ascertain which counties currently are operating unconventional wells. 1 contains a list of the counties in Pennsylvania that have (or have had) active unconventional wells from 2005 to 2018. The counties which have not engaged in any hydraulic fracturing activities are not included in this table for brevity. Of note: Bedford, Blair, Cambria, Fulton, Huntingdon, and Somerset Counties issued a join comprehensive plan in 2018 entitled "Alleghenies Ahead" which does not directly address unconventional drilling.

4.2. Comprehensive Plan Evaluation

The comprehensive plans for each of the counties listed in Table 3A-2 were evaluated based on their level of consideration of the oil and natural gas industry as described in section 3.7

Case Selection. Brief summaries are provided below for those comprehensive plans rated level 3 (passing reference to the oil and gas industry in the comprehensive plan) or level 4 (significant integration of oil and gas industry in the comprehensive plan). Those counties ranking level 1 or level 2 are not summarized below. Counties below are listed in alphabetical order.

Allegheny County, Level 3, 2008: This plan was originally written in 2008, with a partial update in 2014. This county includes City of Pittsburgh and both Carnegie Mellon University and the University of Pittsburgh, among other universities. The comprehensive plan specifically identifies resource extraction as a chapter heading, but limits mention of gas extraction to a statement that local decision makers have little authority to regulate in this area. Specifically, the

plan identifies abandoned coal mines as causing detriment to the county, listing water quality impacts, subsidence, and mine fires as the primary challenges of resource extraction in the county. The plan specifically states that "The county's role in mitigating the negative effects of mining activities is minimal. The greater responsibility lies with the State and federal agencies and the mining industry (The Plan, 2008, pp. 4F-4)" The primary foci of this plan seem to be on up-and-coming industry like tech and start-ups, and focus on promoting the historical and livable nature of the area by capitalizing on the assets of Pittsburgh and the universities in the county.

Beaver County, Level 3, 2010: This plan includes a small section which is dedicated to natural gas exploration. This section identifies the large water consumption and subsequent water quality impacts as potential results from increased drilling, but also states that "to date, there has been little gas drilling in Beaver County, however many gas companies have negotiated leases with landowners for the gas rights beneath their lane. When economic conditions improve, these companies will undoubtedly exercise these rights to drill for natural gas (2010, p. 123)."

Cambria County, Level 4, 2011: This plan has a section which directly addresses the Marcellus Shale region and natural gas extraction, while also acknowledging the limitations placed on municipalities to regulate the industry. The plan also refers to the natural gas industry throughout the document in relation to items such as economic development and potential for future growth. Specifically addressing the unconventional drilling industry, the plan states that

"alternate energy production and supportive industries should be a priority of the suggested economic partnership focusing on businesses and industries producing and/or supporting alternative energy forms including Marcellus Shale gas, wind power, geothermal, electric production and clean coal production and application." (Cambria County, 2010)

This focus on being an energy county is perpetuated throughout the planning document, which is consistent with the County's website which calls Cambria County *Pennsylvania's Energy County*.

Clearfield County, Level 3, 2006: This plan identifies the Marcellus Shale and the potential for natural gas extraction; however, it does not provide special emphasis on developing this industry. Instead, the plan addresses other alternative energy sources such as biomass and geothermal as potential energy sources for the future. This comprehensive plan is supplemented by the Clearfield County Economic Plan, however because this plan was developed in 2002 and has not been updated, it does not provide additional clarity on the natural gas industry.

Clinton County, Level 4, 2014: This comprehensive plan states that the "increasing pace of change and impacts from Marcellus Shale gas exploration convinced the Clinton County Planning Commission to conduct its [comprehensive plan] update early (Clinton County Comprehensive Plan, 2014, p. 7)." Furthermore, an entire section entitled Marcellus Shale Gas Resource Trends and Issues is included to address the natural gas extraction industry. The plan states that the reason for the 2014 update was due to the prevalence and importance of unconventional drilling in the county. The impacts (and potential impacts) of fracking are considered throughout the plan, and the plan states that, "nearly 1,000 new gas-industry related jobs were recently added in Clinton County (Clinton County Comprehensive Plan, 2014, p. 32)."

Crawford County, Level 4, 2014: This comprehensive plan integrates unconventional drilling and the oil and gas industry considerations throughout the plan. These issues are addressed at every level and the plan recognizes and emphasizes the potential for economic growth due to the implementation of hydraulic fracturing technology.

Forest County, Level 4, 2013: This plan addresses the economic status of Forest County as in decline and identifies gas extraction as the greatest potential economic savior for the county in the future. The plan addresses oil and gas extraction (both conventional and unconventional) in its role and relationship to other major issues, such as transportation infrastructure, jobs, housing, etc.

Indiana County, Level 4, 2012: This comprehensive plan discusses both unconventional drilling and the fracking industry throughout, to include in sections dedicated to community facilities and utilities, water and sewer facilities, housing, and protection of natural resources, and in the future land use plan. Gas well drilling is an integral component to this comprehensive plan, and is identified as a major sector for growth at the time of writing of the plan including "from January through July 2012 the Department of Environmental Protection issued 24 gas drilling permits within the County (2012, p. 4.19)."

Jefferson County, Level 3, 2018: The Jefferson County comprehensive plan notes the presence of unconventional and traditional drilling for natural gas within its borders, but does not make specific mention of the practice in the goals, objectives, or recommendations moving forward.

Lawrence County, Level 4, 2016: This comprehensive plan identifies natural gas as a potentially important private sector industry for the county, and recommends that a natural gas task force be created to jointly address natural gas development by both the public and private sector shareholders. The plan also acknowledges that there is the potential for future growth in this area. Notably, this comprehensive plan suggests the following actions be taken pertaining to the unconventional drilling industry (Mackin Engineering Company, 2016, p. 118):

1. Form a County Natural Gas Task Force: ad hoc committee to address public and private sector impacts and opportunities related to natural gas development.

2. Develop a countywide official map and coordinate with mid-stream gas companies to plan for new gas and liquid pipelines and other facilities

McKean County, Level 3, 2007: This plan mentions that there were 30 extraction-related businesses in McKean County (in 2007) that were related to the oil and gas industry and also notes that there is potential for growth in this area in the future. However, there is no mention of unconventional drilling in the county beyond this basic reference.

Sullivan County, Level 4, 2011: This plan specifically addresses unconventional drilling in both acknowledging that the county is likely a good candidate throughout for the gas industry, and notes the environmental concerns associated with drilling. The plan discusses job training to support the industry as well as land use planning and other areas of focus related to the shale gas industry. Providing explicit support for growth in the unconventional drilling industry, Sullivan County's comprehensive plan includes "support and participate in the Sullivan County Marcellus Gas Task Force" and "identify, develop, and promote suitable locations foro commercial and business development related to the Marcellus gas industry" as primary objectives of the plan (Sullivan County Planning & Economic Development Office and Cummings & Smith, Inc., 2011, p. 123). A summary of the comprehensive plan data is provided below in Figure 11 Comprehensive Plan Summary.

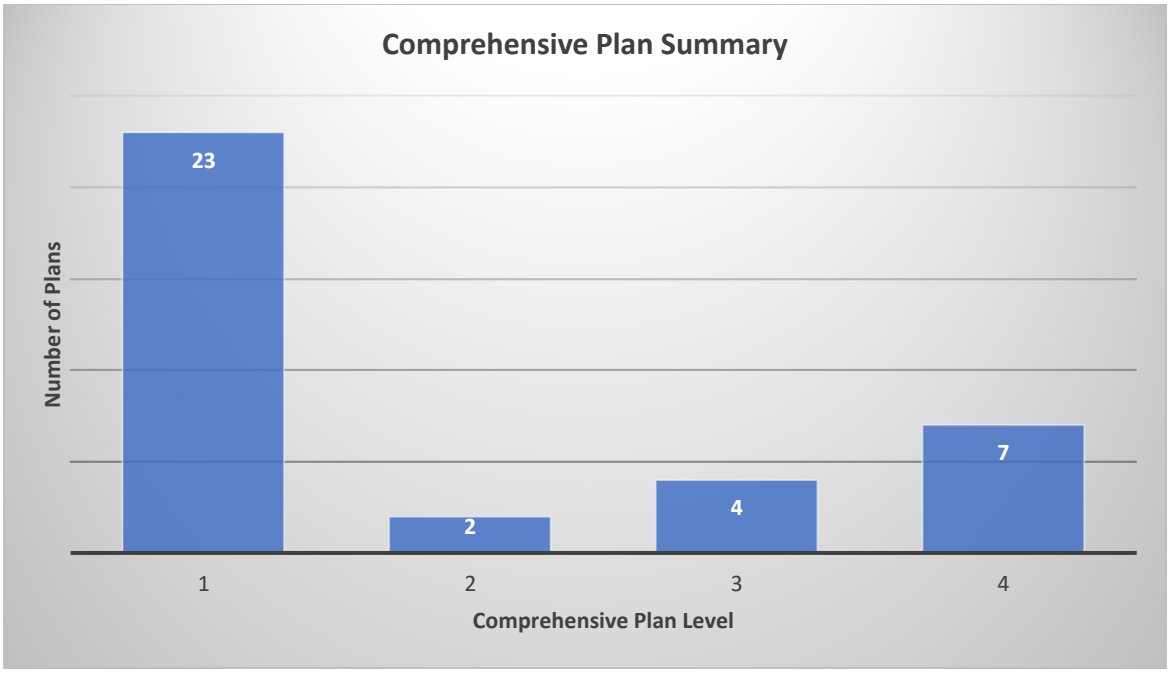

Figure 11 Comprehensive Plan Summary

4.3. Quantitative Analysis

It is anticipated that comprehensive plans that address hydraulic fracturing play a role in reducing social conflict in counties that engage in this industry as measured through litigation. This reduction in conflict is anticipated to signal the resilience of communities that have active hydraulic fracturing activities in their counties. In counties with a relatively low number of lawsuits, the social bonds within the community would therefore be healthier and better developed to include the three stakeholders in the unconventional drilling industry: community, industry, and government, thereby demonstrating a higher resilience in the community.

The first component of this research is to evaluate the counties that have unconventional wells within their borders to determine the quantity of lawsuits realized in each county relative to the number of unconventional wells. There are 36 counties in Pennsylvania that have unconventional wells. The following table shows the number of unconventional wells in each

county, and the number of civil lawsuits that involve the companies operating unconventional wells in those counties.

4.4. Correlation

The Pearson's correlation coefficient was used to evaluate the correlation between the number of wells for each county and the corresponding number of lawsuits in each of those counties. This coefficient is used to evaluate the linear correlation between two data sets. In this case, the correlation is evaluated between the number of lawsuits and the number of wells, to determine if there is a linear relationship between them (if the number of lawsuits increases when the number of wells increase). When there is a direct positive correlation between the two sets of data the Pearson's coefficient would then be p=1.0, and a direct negative correlation would be p=-1.0. For those data sets that have no linear correlation a Pearson's coefficient of zero would result. Looking at the entire data set, the correlation between unconventional wells and lawsuits is as follows:

$$r'(34) = .92, p<.001$$

This is a very high level of correlation, which was anticipated. Those counties with many unconventional wells also have a larger number of lawsuits, and those counties with a smaller number of unconventional wells have a smaller number of lawsuits. When the data is parsed further, the correlation between unconventional wells and lawsuits for counties that have level 1, 2, and 3 comprehensive plans (plans that do not address the unconventional drilling industry in a meaningful way) is as follows:

$$r'(27) = .91, p<.001$$

The correlation between the entire data set and the counties without comprehensive plans that directly address unconventional drilling is therefore also highly correlated. When the dataset is

then parsed to include only the counties with a high level of planning, however, the correlation drops to no longer be statistically significant (assumes a significance level of 0.1):

$$r'(5) = .48, p = .276.$$

The purpose of this statistical evaluation was to help determine which counties should be selected for further investigation. Because the correlation between unconventional wells and lawsuits is insignificant for counties that have high levels of planning that addresses the unconventional drilling industry, the question then becomes why is there a lack of correlation between lawsuits and unconventional wells – and is the high level of planning the causal factor behind this statistical finding.

While the Pearson's correlation coefficient was a valuable tool in evaluating this data, there were other correlations that were not controlled for in this quantitative evaluation. The relative measure of urban versus rural is not evaluated here, for example. While each of the three counties evaluated are small, Lawrence is larger than Sullivan or Clinton in population, of which a significant portion reside in the county seat, New Castle. The Pearson's coefficient was not used to account for this relative measure of urban versus rural within the data set. Similarly, the nature of each unconventional drilling company is a nuance that is not captured by this evaluation. Based on the interviews (particularly in Sullivan County), the different unconventional drilling companies have diverse approaches to community involvement, and place differing levels of priority on outreach, engagement, and reputation. Although it was not directly addressed in interviews, this may be extrapolated to also mean differing levels of priority on safety practices, environmental protection, and profits among unconventional drillers, potentially impacting levels of litigation. The data was also not evaluated from the perspective of number of operators versus wells within each region. The impact of multiple unconventional drilling companies operating a

smaller number of wells each versus a smaller number of unconventional drilling companies drilling more wells within a county was not investigated. Nor was the impact of larger unconventional drilling companies versus smaller companies operating in each county. These variations within the drilling companies may impact the level of litigation but are not controlled for here. One other factor that was not controlled for in this research is the availability of attorneys experienced in litigation related to gas rights, lease agreements, or other unconventional drilling related subjects in each area studied. Interviews in both Sullivan and Lawrence Counties identified a paucity of available and qualified attorneys in those areas as potentially impacting litigation in those areas.

4.5. Lawsuits Per Well

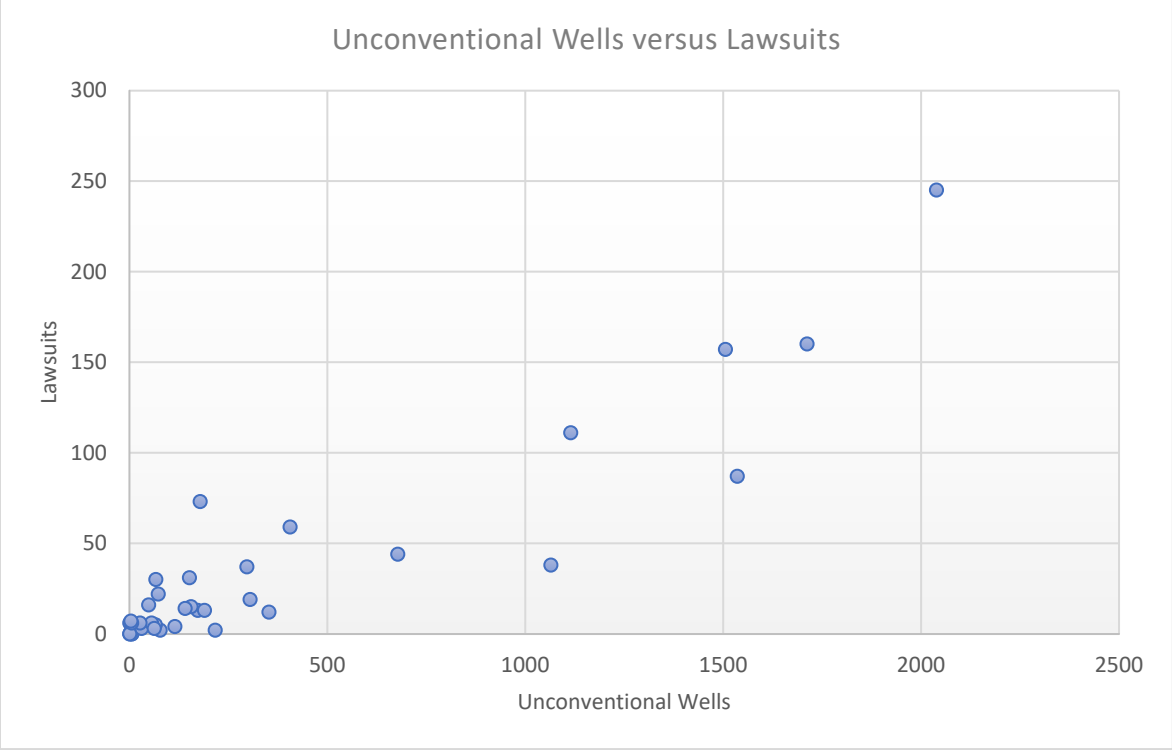

Figure 12 Unconventional Wells versus Lawsuits

A scatter plot of the unconventional wells versus lawsuits is provided in Figure 12. When the data evaluated on a lawsuits per well basis, the data ranges from 6 lawsuits per well to 0 lawsuits per

well. The average lawsuits per well for the entire dataset is 0.36 lawsuits per well. The counties with level 1, 2, and 3 comprehensive plans have an average of 0.41 lawsuits per well with a standard deviation of 1.13. In contrast, the counties which have a level 4 comprehensive plan have an average of 0.16 lawsuits per well with a standard deviation of 0.13. There are three counties within the data set of level 1, 2, and 3 comprehensive plans which are significant outliers. Erie County has only 1 unconventional well, but the company operating that well has been named in 6 lawsuits between 2004-2013. This statistic of 6 lawsuits per well skews the dataset. When Erie County is removed from the dataset, however, the result is that the average becomes 0.21 lawsuits per well. This is a large drop in average lawsuits per well, however it is still larger than the average lawsuits per well for counties with level 4 comprehensive plans.

Similar to Erie County, Venango and Warren Counties have a much greater incidence than average of lawsuits, with Venango at 1 lawsuit per well (6 unconventional wells and 6 lawsuits) and Warren with 1.75 lawsuits per well with only 4 unconventional wells total. In contrast, Blair, Cambria, Huntingdon, and Bedford Counties each have a small number of unconventional wells (1-7) and none of the companies engaging in unconventional drilling in those counties have been named in a civil lawsuit. Although the statistics for the lawsuits per well for Erie, Venango, and Warren are outliers, there does not appear to be any reason or justification for removing them from the dataset. The timing of the lawsuits and the nature appear to be consistent with the rest of the dataset. On the opposite end of the spectrum, there are only four counties within the dataset that have not experienced any lawsuits that have impacted unconventional drilling companies: Blair (6 wells), Huntingdon (1 well), Bedford (1 well), Cambria (7 wells). Blair, Huntingdon, and Bedford all have level 1 comprehensive plans, while Cambria has a level 4 comprehensive plan.

In looking at the seven counties with level 4 comprehensive plans, Sullivan, Clinton, and Lawrence Counties have relatively high concentrations of unconventional wells, whereas Indiana, Forest, Cambria, and Crawford have significant conventional well drilling ongoing in addition to unconventional wells. Because this research looks to study the social resilience within unconventional drilling communities, this indicates that Sullivan, Clinton and Lawrence Counties would be preferable for further study because the data will be less influenced by the traditional natural gas drilling industry which is also prevalent in Pennsylvania. A summary of the level 4 comprehensive plans compared to unconventional and conventional wells, in addition to lawsuits per unconventional well is provided in Table 5.

Table 5 Level 4 Comprehensive Plans Compared to Wells, lawsuits, and lawsuits per well

Comp. Plan Level	County	Comp. Plan Publish Year	Conventional Wells	Unconventional Wells	Total Active Wells	Lawsuits	Lawsuits Per Well
4	Sullivan	2011	0	124	124	13	0.10
4	Clinton	2014	74	115	150	4	0.03
4	Lawrence	2016	3	73	58	22	0.30
4	Indiana	2012	1821	56	1875	17	0.30
4	Forest	2013	1944	31	1954	3	0.10
4	Cambria	2011	122	7	124	0	0.00
4	Crawford	2014	893	4	894	1	0.25

In looking a Sullivan, Clinton and Lawrence Counties, in addition to these three counties having low numbers of conventional wells, they also present an interesting variety in conflict. Both Sullivan and Clinton have significantly low ratios of lawsuits per well (0.1 and 0.03 respectively). Both levels of conflict are significantly below the average for the entire dataset (0.41) and are also significantly below the average for only the level 4 comprehensive plan subset (0.16). By a metric of litigation, therefore, it appears that Sullivan and Clinton Counties are more

socially resilient than Lawrence County, which has a litigation ration of 0.30 lawsuits per well, significantly higher than the average of the level 4 comprehensive plan subset. Lawrence County does have few lawsuits per well than the entire dataset average of 0.41, however if the outlier counties were removed from the dataset Lawrence County would have more conflict than average.

4.6. Lawsuits Per Company

The dataset was also sorted based on unconventional drilling company. Many of the companies that operate in the Appalachian region of Pennsylvania have unconventional drilling operations in multiple counties. For example, EQT Production Co. have 1023 unconventional wells across 13 counties. The lawsuits per well in these counties ranges from 0 to 1 with an average of 0.15 lawsuits per well across all counties in which EQT Production Co. operates unconventional wells. Of the 13 counties in which EQT operates, only one county – Indiana – has a comprehensive plan level 4. In this county EQT has experienced 0.2 lawsuits per well – or 1 lawsuit and five total wells. The tabulated lawsuits per company data is provided in the Appendix in **Error! Reference source not found.**. It is important to note that the correlation between lawsuits per well on a company basis differs from the lawsuits per well on a countywide basis:

$$r'(92) = .86, p < .001.$$

This correlation between unconventional wells and lawsuits on a company basis is less than the overall correlation between unconventional wells and lawsuits on a per county basis, which implies that there are company-specific factors to consider in the conflict around unconventional drilling. These potential differences will be considered during the case study analysis.

5. CASE STUDIES

The purpose of this research is to explore the relationship between planning and conflict around the unconventional drilling industry through the lens of lawsuits as a measure for resilience. Therefore, the case study selection focused on the counties where active comprehensive planning has occurred, using the previously described metrics as level 4 plans. This winnowed down the case study options to seven counties: Sullivan, Clinton, Lawrence, Cambria, Forest, Crawford, and Indiana. The maximum variation technique for case study selection provides guidance for case study selection from this point. This technique suggests that the researcher select the greatest variation possible in the independent variable (x – comprehensive planning) to study the impact of differences in the independent variable on the dependent variable (y – conflict).

Based on the lawsuit and comprehensive plan data provided in the previous section, the following counties were selected for an in-depth look and the interaction between their comprehensive plans and hydraulic fracturing lawsuits: Sullivan, Clinton, and Lawrence. Each of these counties exhibits a high level of planning, though each comprehensive plan is unique and addresses the unconventional drilling industry in different ways. Equally important, each of these counties are focused primarily on unconventional drilling and have little competing conventional drilling industry to confuse the data. In addition, the following reasoning was also used to eliminate the other counties for case studies: Cambria has no lawsuits, which makes it an outlier in the dataset. It also only has 7 unconventional wells, and therefore is not representative of the greater data set. Indiana does have more wells than Cambria, but still a lower number than the other options at 56 unconventional wells. Indiana is also located relatively close to Pittsburg, a large City with a geographically large influence which may impact the results of the data. Forest was similar to Indiana and Cambria with a relatively low number of unconventional wells at 31, and also has experienced only 3 total lawsuits with a population of 7,279. This small population

coupled with only 3 lawsuits could make it difficult to conduct the case studies and glean useable data (smaller pool of potential interviews). Crawford, as with Cambria, only has 4 unconventional wells, and as such a limited experience with the phenomena that this research seeks to study. In this way, the three counties selected for case studies are Sullivan County, Clinton County, and Lawrence County.

One aspect shared by all three of the counties studied is the ACT 13 impact fees. These fees are paid by the unconventional drilling companies to the State, who then distributes them to the individual counties based on the natural gas extraction that occurred in those counties from unconventional wells. These impact fee payments are summarized in Figure 13. As illuminated by the figure below, the value of those impacts fees varies widely between the three counties studied, however even in the leanest years since the inception of the Act 13 Impact fees the counties with unconventional wells have reaped a small but significant benefit from the unconventional drilling industry. While none of the people interviewed specifically mentioned the impacts fees during the interviews, it is reasonable to interpret that these impact fees may provide a small incentive for county administrations to look favorably on the unconventional drilling industry. It is unlikely, however to be sufficient to drive any major decision-making regarding the industry, as the impacts fees are relatively small in comparison to the overall county budgets in the three counties studied. The state does not dictate how the funds are used, giving each county the discretion to decide how to allocate the funds. Sullivan County, for example, allocated its 2016 impact fees to tax reductions ($163,729.73), information technology ($10,000), judicial services ($188,400.00), and their capital reserve fund ($32,182.35) for a total of $394,312.08. For perspective, this represents 0.22% of the total revenue for Sullivan County in 2016.

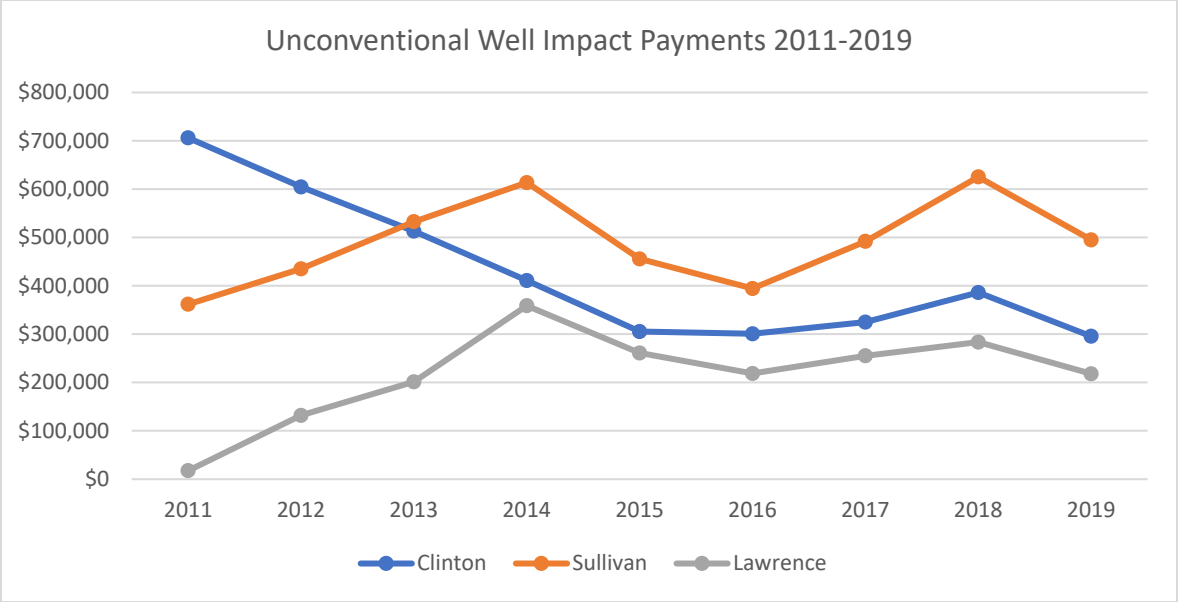

Figure 13 Unconventional Well Impact Fee Payments 2011-2019 (Pennsylvania Public Utility Commission, 2020)

These three case studies represent a variety in the dependent variable – conflict. Both Sullivan County and Clinton County have low levels of conflict relating to the unconventional drilling industry, and so demonstrate higher levels of social resilience than Lawrence County. Lawrence County has a higher level of conflict as measured by litigation, and so demonstrates a lower level of social resilience than either Clinton or Sullivan. The following case studies take a deeper look into each of the selected counties. A summary of the interviews that were completed is provided in Table 6.

Table 6 Interviews

County	Government	Private Sector	Male/Female
Sullivan	2	5	4 Male /3 Female
Clinton	1	3	3 Male /1Female
Lawrence	2	4	2 Male /4 Female
Industry		2	2Male /0 Female
Total	5	14	11 Male /8 Female

The government interviews included the county planner for each county (except Clinton, whose planner declined to be interviewed) and a County Commissioner in each of the counties. Planning commission members were also interviewed, however as the planning commission position is not full-time and those interviews were conducted of people that also held full-time employment those interviews are classified under the community column in Table 6. For the community interviews, county citizens were found by through their work, to include both for-profit and not-for profit organizations such as historical societies, chambers of commerce, tourism groups, rotary, real estate businesses, landscape architects, etc. The interviews were conducted by phone, with one exception being an emailed discussion followed by a follow-up interview by phone. Snowball-sampling was also employed, as each interviewee was asked for suggestions for other residents to contact based on the interview subject matter.

The interviews followed a semi-structured approach. A general list of questions for each category of interview is included in the Appendix. While the questions listed provided the basis for each interview, the topics were encouraged to expand into the areas of interest for each interviewee. For example a retired attorney in Lawrence County was interested in discussing his thoughts as to why the local lawyers had not pursued more lawsuits pertaining to the

unconventional drilling industry in his county, and has some thoughts as to their reasoning. Similarly, a Clinton County resident with experience with the tourism industry was able to extrapolate about the relationship between the unconventional drilling industry and the tourism industry.

While each of the unconventional drilling companies with well permits in the three counties studied were called to request an interview, the each either declined or failed to return my messages. However, one of the gas companies provided an introduction to a spokesperson for the Marcellus Shale Coalition, a nonprofit group that provides lobbying, technical assistance, and other industry support. The Marcellus Shale Coalition representative also provided an introduction to a representative to an unconventional drilling company that was willing to be interviewed because they do not operate in the three counties being studied. In total, two industry interviews were conducted.

Once all interviews were completed, a story was formed for each of the three counties, answering some of the fundamental questions relating to this research. Based on the responses, the predominant views and values pertaining to the unconventional drilling industry were summarized in the following case studies. The interviews were also reviewed for information on conflict and cooperation surrounding the industry, and how the community and government in each of the three counties approaches conflict. For example, do people establish relationships with the drilling companies, and thereby leverage those relationships when issue arise? Or in contrast, are the relationships contested, leading to escalation in the case of problems? Once the interviews were reviewed through this context of community, government, and industry relationships and the story of each county was summarized, the data was then evaluated from a viewpoint of social

resilience to evaluate each county's approach to the industry, both through planning and through community response, to resilience building techniques.

5.1. Sullivan County

Sullivan County is in the North-Eastern corner of the State of Pennsylvania, and is bordered by Wyoming, Bradford, Tioga, and Lycoming (counties that also have unconventional wells) as well as Lackawanna, Luzerne, and Columbia (that do not have unconventional wells). The geography is mountainous, with a predominantly rural population. The county seat is Laporte, PA, a small town with a population estimate of 451 in 2017. The county has been experiencing a population decline since 2010, with a population of 6,428 in 2010 decreasing to an estimated 6,071 estimated in 2018. This represents a population decline of 5.6 percent over an 8-year period. The median age is 50.3 years, the oldest county studied and almost 10 years older than the national median. This aging population and population decline were both mentioned by many interviewees as key factors in their concerns and viewpoints about Sullivan County and the unconventional drilling industry. The population has a 92.7 percent attainment rate of high school or higher (statistically better than either Lawrence or Clinton), with 5.1 percent holding associate degrees, 13.5 percent with bachelors' degrees, and 9.7 percent with graduate or professional degrees. The median earnings is $31,250 for adults 25 years and over, and the median household income is $60,515. 13.4 percent of individuals in the county are below the poverty level, significantly higher than the national average poverty rate of 10.5 percent. The economics of Sullivan County for all sectors includes 155 establishments, with the top 5 industries (by annual payroll) including healthcare and social assistance (40.4 percent), retail trade (12.5 percent), manufacturing (9.2 percent), construction (5.7 percent), and transportation and warehousing (4.1 percent). Mining, quarrying, and oil and gas extraction, however, were not included in the tabulation because with only 2 establishments in the county in 2016 the Census declined to publish the data to preserve the privacy

rights of the establishments involved. Based on this data it is difficult to ascertain the specific impact of unconventional drilling on the economy of the county. It is fair to interpret, however, that the impact of this industry is an important element of the economy of the county because in 2012, with 3 establishments the impact of mining, quarrying, and oil and gas extraction was 4.4 percent of the annual payroll of the county. Both the poverty rate and the lack of jobs and opportunities resulting in outmigration from the county were recurring themes in the Sullivan County interviews, both from government and community members. The balance of trying to maintain the sense of community and culture in the County while also trying to keep and improve job and income opportunities, particularly for young people was also commonly cited as important by Sullivan County residents.

5.1.1. Sullivan County – Government

The current Sullivan County comprehensive plan was published in 2011. In the 2011 plan, the county included deliberate mention of a potentially significant economic benefit of the unconventional drilling industry, noting that, "based on recently developed wells in adjoining counties it is believed there is great potential for gas recovery in Sullivan County, with corresponding economic benefits (Sullivan County Planning & Economic Development Office and Cummings & Smith, Inc., 2011, p. 38)." The plan does not lay out in detail the anticipated economic boost from unconventional drilling, there are no statistics or projections included, for example. Furthermore, the plan notes that, "a strong interest in community planning in Sullivan County was felt perhaps due to the anticipated impacts of gas well exploration in the Marcellus Shale formation throughout northern Pennsylvania. There are a host of issues related to Marcellus Shale formation including well locations and impacts, associated spin off development, water and transportation impacts (Sullivan County Planning & Economic Development Office and Cummings & Smith, Inc., 2011, p. 10)." The 2020 update to the plan is anticipated to build upon

the 2011 references to unconventional drilling because the volume of unconventional drilling has increased over the last 10 years, resulting in a greater significance of the industry. The county has included unconventional drilling both in the past comprehensive plan and in the current update of the plan because of the importance of the industry to the county and based on a desire to include all important industries in the plan. Explained one government representative, "I assume that section will be a little bigger just because in the last 10 years…it has increased here in this area." This relatively conservative description of the current comprehensive plan re-write and the relative importance of unconventional drilling in the county appears to be intentionally understated, and is consistent with the county's explicit approach to drilling in Sullivan County.

According to the county planning staff interviewed, the purpose of the comprehensive plan for the county is three-fold: to inform visitors and contractors about the county, to support the county in the writing of requests for proposals (RFP's) and grants, and to help to guide county decisions. "The comp plan is actually used for lots of types of grants that we receive. [Planning staff] looks at the comp plan to see if we would be a good fit for certain things, and in that case it works really well because it's already all there…" explained one county commissioner. When county staff were asked if and why unconventional drilling would be included in the in the new 2020 comprehensive plan update, the response was somewhat mixed. One staff member indicated that, "[unconventional drilling] has to be addressed [in the 2020 comprehensive plan] as a major income source." However, that same individual also noted that, "government has less to do with drilling activity, it is entirely up to the public and businesses. It is an issue that takes care of itself." In Pennsylvania the Department of Environmental Protection (DEP) performs permit application review for unconventional wells, and also engages in enforcement activities for the industry, and the government employee's interpretation was that there is no ability in the county to influence the

industry, as the regulation of the industry is managed at the State level. Similarly, another county employee indicated agreement that there is likely no impact of the comprehensive plan on the unconventional drilling industry, or, "if there is an effect, it is minimal."

When asked about conflict surrounding the unconventional drilling industry, county staff indicated that there is little conflict surrounding the practice in Sullivan County. Staff indicated that anecdotally the high concentration of poverty in the county leads to a relatively consistent positive outlook at the industry as an opportunity for additional income for residents, the idea being that those in poverty would not look beyond the potential for royalty payments or jobs and are unconcerned with any real or perceived drawbacks associated with the industry. Though this this viewpoint was voiced by a government employee, it is important to note that all other interviewees indicated that poverty in Sullivan County was not a factor in the community's viewpoint on unconventional drilling in the county. From the government perspective, it appears that there is a comfortable balance between the environmental preservation and the damage caused by unconventional drilling in Sullivan County, that "Sullivan County is a very beautiful place. We do have gas drilling, but it is not overwhelming the county in any way." A county commissioner agreed that the prevalence of poverty within the county is likely to be one of the primary drivers for the near universal support for the unconventional drilling industry, as it provides the potential for additional income for property owners with limited resources. The combined challenges of population loss due to lack of opportunity and high poverty rates in Sullivan make unconventional drilling a good option for the county, but only if the industry functions safely and without environmental or cultural impact which seems to be the opposite end of the teeter totter for the area. This balancing act is guided by the comprehensive plan, which presents a cautious affirmation, and by county staff through their approach to unconventional drilling.

Notably, Sullivan County makes a significant effort to present a deliberately neutral stance towards the unconventional drilling industry. This neutrality is not an indifferent attitude on the part of the county but rather a strategic and active choice on the part of the county commissioners. County commissioners actively work to present a non-biased attitude towards the unconventional drilling industry, and this neutrality effectively allows for the industry to develop resources within Sullivan County on its own terms. The commissioners have traditionally kept the unconventional drilling industry out of county politics. As described by a county commissioner, "you know, I really don't believe it does [play a factor in elections] …and it might be because we are neutral." This was supported by the members of the community, who also indicated that the county commission does not actively tip the scales of balance relating to the industry.

When asked why the volume of lawsuits relating to unconventional drilling might be lower in Sullivan County compared to other counties, the county commissioner indicated that the "people in Sullivan County – our first thought is not lawsuits. If people think they were wronged, they will try to first work it out with the actual industry first before a lawsuit… and maybe they are being treated ok."

5.1.2. Sullivan County – Community

In general, the greater population in Sullivan County is not actively engaged in the comprehensive planning currently underway. None of the community residents that were interviewed were actively engaged in the development of the 2011 comprehensive plan, or the current revision of the plan that is currently ongoing. Awareness of the existence of the plan was somewhat mixed, though between residents who are more active in the governance of the community and those with other interests. While most of the residents were not aware of the re-write, several did indicate a general awareness that the comprehensive plan was being re-written, though were not personally involved and did not indicate an intent to get involved in the public

input portion of the plan development. The county did indicate that public input is welcome, and that the public meetings for the comprehensive plan re-write are advertised in the local paper. A past county commissioner that was interviewed indicated knowledge of the plan and the plan intent, however, indicated that the unconventional drilling industry is not impacted by the comprehensive plan (either past or current re-write).

When asked directly about the county government's stance on unconventional drilling, both community and government interviewees agreed that the county is neutral regarding the industry. This does not appear to be an accidental neutrality, but rather an intentional and reasoned approach to the industry. When asked if the county should recruit or promote more drilling a member of the Chamber of Commerce reasoned that, " if somebody said … in order for this to happen we've got to tear up… the local track trail or we have to tear up …Sullivan Falls or something like that [we] would be like 'No way I don't want you doing that' … because that's what makes our community what it is and what draws people also is the beauty of it. And you know and all the stuff that you can do when you visit the county." This sense of place was shared by several other interviewees, who collectively indicated that what makes the county special needs to be preserved first, and then other considerations such as the economic benefits of an industry like unconventional drilling would be considered second. As one resident involved in economic development in the county described it, "the drilling has brought a lot of business to the county…and it has brought a lot of workers to the county that wouldn't ordinarily be here." The importance of community culture, and protecting the county's natural resources was often mentioned by interviewees when asked about the community values and general viewpoint about the unconventional drilling industry.

Everyone that was interviewed indicated that the economic benefit of unconventional drilling in the county is a boon to the community. The economic benefits were generally grouped into

bringing in workers with disposable income from elsewhere to the county and providing jobs for local citizens so that they do not have to travel outside of the county for work. In contrast only a fraction of the interviewees mentioned the gas royalties as an economic benefit to the community, possibly because the number of landowners receiving royalties is small compared to those with employment with unconventional drilling companies directly or through a subcontractor or support business. Several interviewees mentioned also that there are several private landowners in Sullivan County that have multiple well leases – concentrating the royalties paid among those large landholders means that the economic impact for a larger portion of the population in Sullivan County is through jobs to a greater extent than through royalties.

Many of the interviewees indicate that another benefit of the industry is the influx of people to the county. While many of the workers may not live in the county, "the drilling has brought a lot of business to the county…and has brought a lot of workers that wouldn't ordinarily [come] here." Sullivan County is rural in nature, with state parks topping travel guide attractions lists. Sullivan county has limited amenities such as restaurants, bars, movie theaters or malls to support their small population of just over 6,000 people. Because of this, "people were choosing to stay in the surrounding counties…If I was a 22 year old single [guy] working for the gas company and I had a choice between [staying] in Bradford County where there is, you know, … 10 times the things to do…[I would live in Bradford County too]" explained one older resident. Bradford County is adjacent to Sullivan County to the North and boasts a population of 61,304 in comparison to Sullivan County's modest 6,177 population. Bradford also enjoys a higher median household income ($51,547 versus $47,346), lower poverty rate (12.0 percent versus 13.4 percent) and younger population (44.5 median age versus 53.1 median age) (United States Census, 2018). In short, Bradford County has more people, and more recreation alternatives than Sullivan County,

and interview subjects explained that it is a more attractive place of residence for working age employees of the unconventional drilling industry. While the lure of the adjacent counties notably provides a draw away from Sullivan for gas company employee dollars, the small businesses in Sullivan also clearly benefit from the industry and the money that it brings.

Nearly all the people interviewed mentioned that the industry provides good jobs for local youth as commercial drivers hauling water for the gas industry. The retention of young workers seems to be a concern of many in the county. As one person phrased it, "we used to have three major exports: we export timber, we export milk, and we export our young people." Hauling water for the gas companies is seen as good work for youth in the county and is seen as an alternative to the other good option of joining the military. "As far as economics; the few people here who can, are supported by the jobs offered by the gas industry..." was a sentiment was reiterated by several times, including the good timing of the start of unconventional drilling in the county around the 2008 timeframe when there was economic hardship due to the economic collapse and the great recession. "It came along in 2008 and that's when the housing industry really took a dump. We had quite a few sawmills here at the time, and unfortunately they ended up going out of business and a lot of the drivers owned their own trucks and were able to take their racks off and put on water tanks and haul water for the gas industry…" explained on resident.

While workers and jobs were the two most cited impacts, one interviewee also highlighted the impacts of corporate money for local events, "some of the larger drilling companies like Chesapeake…have been wonderful sponsors and donors." Sullivan County is host to a variety of annual festivals and events, to include the Sullivan County Fall Festival and Lumberjack competition, the Sullivan County Fair, and the Sullivan County Bowhunters Festival (among others). The gas companies also, "have contributed to the local fire and ambulance companies."

This is important to the population because Sullivan County is 452 square miles, with only 6,071 residents as of 2018. This means that county resources in areas such as law enforcement, fire protection, and ambulance services are strained by the large geographical area of coverage with a very small population base.

Of those interviewed, several individuals are directly impacted by the unconventional drilling industry. Commonly traffic was cited as a common impact, though sometimes accompanied with notes that while the companies increase traffic on the roads, they also pay for roadway repairs. One resident with property leased to a hydraulic fracturing company explained it as, "if there's a problem with a well (not necessarily the well because we don't understand that) [but] with a roadway, with traffic (like right now they're hauling a lot of water to the sites to frack) if they're going too fast we complain and we don't call the state police we call the company." While the evaluation of that resident was an overall good experience with the fracking company, another resident indicated an opposite experience. A resident with a well on a family member's property described the gas company as, "I'm going to say initially when they first came to the area again this was something new for us and Chesapeake tried to be a good neighbor. Again, they had money. They were throwing money around. They go to the fair nearby with cows and pays you know outrageous amounts of money and donate the animal back and the kids would option it off again. They threw money around and then money got tight and they quit being good neighbors."

Gas royalties were described both as having a large impact on the population and a relatively small impact depending on perspective. In describing the royalties paid to elderly and fixed income residents one interviewee said, "a lot of the folks who live up here retired and the lease payments that were given to the individual land owners was an economic boom to the people…A lot of farms basically survive because of it." In contrast, another county resident with an active

well lease explained that, “we have [what’s] called a century farm I can trace it back to the warranty maps. Now we signed-on not because we need the money, but because we believe that it's time for this country to take their own commodities.” A third resident with natural gas royalties but a more fraught relationship with the gas company stated that, “when they first started paying, they were paying fairly well. Then they got in the financial trouble and they started claiming postproduction costs. So, when the natural gas comes out of the ground they're saying they're now charging the land owners a certain percentage for them to get it to market. Therefore, actually my father before he passed away …he received 7 percent of what he should have received.”

Of the community interviews, there was only 1 interviewee that indicated that they would consider entering a lawsuit against an unconventional drilling company, though also noted that they had not done so. When asked why not, the response was that, “I'm gonna say time. I don't have the time to invest into it. I don't have the knowledge; I really don't know. [maybe] if I had an attorney who would I go to I don't feel comfortable with really any attorney that I've talked to.” In this case, the interviewee’s parent had entered into an agreement with one of the larger unconventional drilling companies in Pennsylvania. The lease was signed during the timeframe when gas prices were high, and the industry was very profitable. The royalty payments initially were as expected, and the process progressed smoothly. Over time, however, as gas prices dropped the company began to charge “post-production costs” to the property owners, reducing the agreed-upon royalty payments. The interviewee indicated that he reviewed a statement from the gas company upon his parents passing and discovered that the last royalty payment made to his parent was “7 percent of what he should have received.” When asked what the royalty contract said about postproduction costs the interviewee indicated that the contract was mute on the subject. While the contract may not have addressed this scenario, it is not unreasonable for the property owner to

be unhappy with the resultant reduced royalties. There are numerous lawsuits filed in Pennsylvania (and across the country) by royalty owners that involve the company in question and challenge the company's practices around claiming post production costs and using backhanded and unethical practices to reduce royalty payments (Lustgarten, 2013). Claims against the company include selling their gas to subsidiaries below market rate, paying royalties off the reduced rate, and then selling the gas again by the subsidiary at market rate (Lustgarten, 2013). While it is unlikely that these practices are limited to the one company involved with this interviewee's family, that company was mentioned specifically during different interviews as being somewhat less forthright than other companies operating in Sullivan County. An interview was requested from the company involved with the dispute, but they did not respond. Each of the other unconventional drilling companies in Sullivan County was also contacted for interviews, and while one company entertained the idea of an interview, they, along with all of the others, declined to be included in this research.

One aspect of Sullivan County which became apparent in both the community and government interviews was a preference for governance with the minimum level of control or impact on residents. For example, one community member indicated that a past attempt by the county to develop zoning was met with forceful opposition, "the real nature for the county and for a good percentage of those people are 'you're not gonna tell me what to do with my land' We had one of the meetings and … I would say 100 or 150 people at that meeting and there were probably two that were really in favor of it. Yeah probably another half a dozen that went with an open mind. The rest of them were in there with not only 'no' but 'hell no.'" Although many of residents were not aware of the Comprehensive Plan, the general sentiment was that government should not influence industry, to include within the Comprehensive Plan and in official county operations.

Sullivan County is extremely rural, with a small population and limited resources. Despite these relatively sparse resources, however, the county presents a carefully neutral approach to unconventional drilling in the county. The neutral positioning of the political class is reinforced by a comprehensive plan that addresses the industry but does not include any calls to action or direct influence on the unconventional drilling industry. Not to imply that the income from the fracking industry is not important to the county, the income from jobs and royalties was described many times as a game-changer for homeowners. Similarly, the jobs from the unconventional drilling industry provide much needed employment in the county, and a reason for youth to stay in the region, or to return home after time away. Rather, both the community and government appear to be in agreement with the comprehensive plan, that, "the economic gains that may be realized from the Marcellus Shale gas field will hopefully last for several decades and be achieved without adverse impact to other established economic forces in Sullivan County, i.e. forestry, agriculture, tourism and outdoor recreational pursuits. (Sullivan County Planning & Economic Development Office and Cummings & Smith, Inc., 2011, p. 123)."

In contrast to the lack of overt inclusion in county politics, the unconventional drilling companies in Sullivan County appear to put great efforts into their community outreach within the county. Both in the form of sponsorships and other financial and social investments, as well as in fostering relationships with lessors, the unconventional industry in Sullivan appears to bridge the gap between the local community needs and fiscal considerations.

5.2. Clinton County

Clinton County is in the northern-central portion of the state, approximately 130 miles equidistant from both Philadelphia and Pittsburgh. Like Sullivan, it is a mountainous county with a predominantly rural population. In addition to the county's own industry, it is bordered by a majority of counties with unconventional drilling, including Lycoming, Tioga, Potter, Cameron,

Clearfield, and Centre. Union County, the only non-unconventional drilling neighbor of Clinton borders the county to the South-East. The Clinton County Seat is Lock Haven, which had a population of 9,108 in 2018. In similar circumstances to both Sullivan and Lawrence counties, the Clinton County population has also been decreasing over the last 8 years, with a population estimate of 39,238 in 2010 reducing to approximately 38,684 in 2018, a decline of 1.4 percent over that timeframe. The median age is 39.5, the youngest county by median age considered in this research by almost 5 years, and the closest to the USA median age of 38.2 years. There is only a small measure of diversity in Clinton County, with 1.5 percent black or African American, 0.1 percent American Indian and Alaska native, 0.7 percent Asian, and 1.1 percent two or more races, making it the youngest but also the least diverse of the counties studied. The high school attainment rate is 87.7 percent (quite low compared to both Sullivan and Lawrence), with 9.5 percent of the population holding associate degrees, 11.3 percent bachelor's degrees, and 6.7 percent graduate or professional degrees. The median earnings is $33,183, with $25,544 for high school graduates, $33,998 for associates degrees, $41,713 for bachelor's degrees, and $63,531 for graduate or professional degrees. The median household income is $47,990. In short, in Clinton County the education level is lower than the other counties studied and has the highest poverty rate of 17.2 percent living below the poverty level. The largest economic contributors to Clinton County include manufacturing (41.0 percent), retail trade (12.0 percent), healthcare and social assistance (11.9 percent), construction (6.1 percent), and transportation and warehousing (4.1 percent). There is no published data describing the impact of unconventional drilling in the state over the last 10 years, so the impact of the industry cannot be ascertained through the census data. In 2016 there were only 7 establishments identified in the dataset with a NAICS code indicating mining, quarrying, and oil and gas extraction.

Clinton county is unique among the three counties studied because it is home to Lock Haven University. The university has a long history, being established in 1870 as the Central State Normal School and undergoing numerous evolutions in name and focus since that time. Currently, the school is undergoing another transition, as it has announced a future integration with two other Pennsylvania state institutions, Mansfield University (Tioga County) and Bloomsburg University (Columbia County). Lock Haven University offers undergraduate degrees in several areas of study relating to the unconventional drilling industry, to include environmental and sustainability studies and geology. Based on the limited information available on the Lock Haven University website, it does not appear that the university actively conducts research or engages in the unconventional drilling industry in Clinton County, however University staff were unavailable for comment at the time of this research for comment, possibly due to the impacts of the corona virus pandemic. It appears that the departments that could reasonably be involved in the unconventional drilling indsutry at the school are small in size, possibly with limited numbers of staff that does not include someone specifically engaged in unconventional drilling related research.

In looking at the comprehensive plan for Clinton County, it appears that the County is actively engaged in the unconventional drilling industry, and that the county is focused on increasing and recruiting more unconventional drilling. For example, beginning with the executive summary, "in North Central Pennsylvania, the increasing pace of change and impacts from Marcellus Shale gas exploration convinced the Clinton County Planning Commission to conduct its update early (Clinton County Comprehensive Plan, 2014, p. 5)." Understanding the importance of jobs in counties like Clinton (as well as Sullivan and Lawrence Counties) the statistic presented in the comprehensive plan that "nearly 1,000 new shale gas-industry related jobs were recently added in Clinton County (Clinton County Comprehensive Plan, 2014, p. 32)" also implies that the industry

is a stand-out in a county with a relatively small population of approximately 39,000 residents. The comprehensive plan continues to provide a detailed analysis of the existing (in 2014) conditions in the natural gas industry in the county, potential for future exploration and expansion, and the benefits, challenges, and concerns with expanding the unconventional drilling industry in the future. This detailed plan represents a focused, intentional, and detailed path for the unconventional drilling industry in Clinton County, and as such it was anticipated that this detailed content in the comprehensive plan would be echoed in highly anticipated interviews. Surprisingly, there was a clear and distinct difference between the general enthusiasm and importance of the unconventional drilling industry apparent in the comprehensive plan and the impressions of the industry by those interviewed in both the government and private sectors.

5.2.1. Clinton County – Government

It was anticipated that with a comprehensive plan that provides extensive detail regarding unconventional drilling industry that the government would present a strong pro-drilling culture within the county, possibly paired with active recruitment or incentivizing through the Chamber of Commerce or other organizations. This does not appear to be the case, however, as explained by a county commissioner, "it's a private industry. I don't think that county should be involved in that sort of thing, personally [recruiting or incentivizing], but I don't think to my knowledge that we would." A similar response was obtained in answer to whether the county government is publicly supportive or against the industry in general, "I've never seen it come up in a commissioner's election." That same commissioner went on to explain that, "I'd say we don't have any real impact from drilling whatsoever with in the county, as far as revenue or anything [royalties] go on to the State." And one of the most striking differences between Clinton County and the other two counties studied in this research began to come clear. The preponderance of unconventional wells in Clinton County are on state owned lands – not private property. The

comprehensive plan quantifies the unconventional drilling industry at the time of the update as the following, "since 2009, 94 Marcellus wells have been drilling in Clinton County. Ninety percent of these have been on State Forest land. Lycoming County and others in the northern tier have experienced much more drilling activity, and much of that has been on private land."

This state-owned land and the concentration of unconventional drilling on it rather than on private property appears to account in large part for the disconnect between the comprehensive plan and the responses by both government and community interviewees. Clinton County is approximately 542,378 acres in size, and approximately 311,325 acres of that land area is owned by the State of Pennsylvania (Clinton County Comprehensive Plan, 2014, p. 71). Moreover, the northern portion of the state that is over the Marcellus Shale is also the region that is encompassed by this state-owned property. As a result, the preponderance of unconventional wells in Clinton County have been drilled on state owned lands. The impact of this is twofold: the royalties are being paid to the state rather than to individual property owners, and the wells are located deep within a region with little access, heavy forest vegetation, and are far from busy roads, making them hard to see and easy to miss. Even finding a well pad may not be easy in Clinton County explained one resident, "they're not sitting out along the main highway, that's for sure. They're up on top of the mountain and back end…you have to know where you're going to find them." In essence, the industry is present in the county, though it has declined significantly in recent years (similar to both Sullivan and Lawrence Counties due to the low gas prices), but what is still present does not bring in the royalties to private individuals that it would on private property and remains "out of sight, out of mind" for both county residents and government representatives.

A somewhat unsolved mystery remains, however, why Clinton County decided to update its comprehensive plan taking such pains to incorporate the unconventional drilling industry when

most wells were located on private property. One resident that was involved in the 2014 re-write of the comprehensive plan as a planning commission member explained that, "you have to understand people, politicians and folks like myself [a past planning commission member], we feel it's a disadvantage to have so much of our land untaxable because its state property and the amount of reimbursement we get per acre from the state is ridiculous for the maintenance of the area, you know? So I think that's probably the biggest resentment or biggest problem." While it is unclear how the comprehensive plan would directly address the issue of large swaths of the county remaining untaxed due to state ownership, it is possible that the plan's detail was intended to provide a push to extract funding from those state owned properties (ACT 13 does include a provision for some funding returning to the counties for unconventional drilling conducted on state land). Of note, the current planning director who may be able to shed additional light on this topic declined to be interviewed. An effort was made to find the previous planning director (who held that position during the writing of the comprehensive plan update) but was not successful.

5.2.2. Clinton County – Community

A reticence was observed from community members in Clinton County to be interviewed for this research. As one resident explained, "Clinton County doesn't often get asked" to participate in this type of research, and so people may be surprised or unsure what their contribution may be. Despite this initial reticence, several interviews were conducted with Clinton County residents. One of the reasons cited for this hesitancy to discuss this topic was the political nature of people's viewpoints of the unconventional drilling industry. "It's not about the comprehensive plan, it's more about an individuals' political view" explained one resident referencing the political climate in Clinton County. In the 2016 presidential election Pennsylvania voted for President Trump (the GOP Candidate) by a thin margin, edging out Secretary Clinton (the Democratic Candidate) by 68,236 votes, a margin of only 1.2 percent. However, in Clinton County, the margin of victory for

President Trump was much higher, with 65.4 percent of the vote going for President Trump and only 30.5 percent going for Secretary Clinton (NPR, 2020)." This right-leaning political viewpoint may entwine with the viewpoint relating to unconventional drilling in Clinton County, which appears to lean much farther to the right than the State at large. Being a political topic in the area, however, does not mean that the county government engages explicitly in politics relating to this topic. When asked directly if hydraulic fracturing or unconventional drilling impacted county politics a County Commissioner indicated that "I have never seen it come up in a commissioner's election."

Clinton County in general appears to be in favor of unconventional drilling. While a county commissioner indicated that the county presents a neutral county culture around the industry, the comprehensive plan in fully engaged in addressing the industry. Similarly, residents indicated that the county government, "is definitely pro [the unconventional drilling industry]." Other residents, though, take pragmatic viewpoint about the industry, "[in Clinton County] we only have natural resource extraction industries. Starting with logging, and then natural gas, we have to extract to survive…" explained one resident embodying this practical viewpoint. The unconventional drilling industry in Clinton is predominantly on public lands, however, so the likelihood of securing royalties is low. Though royalties are slim, the potential for labor-type jobs through the industry is sufficient to make people amenable to the industry. One resident did imply, though, that unconventional drilling in Clinton County, "[is like] the golden goose, we just opened the window and it came in" meaning that when natural gas that was recoverable through unconventional drilling was found in Clinton County the immediate impact was to embrace the industry as a viable economic savior for the relatively poor and less-educated population of especially the more rural areas in the county. When unconventional drilling first came to Clinton

County there were groups that would come to public hearings and the like to object to the practice, but, "[there is] not a lot of engagement anymore, the groups were very futile and they [eventually] dissipated…" remembered one resident, indicating that possibly when the industry first began those that objected to the practice were sufficiently outnumbered that they may have simply stopped objecting to the practice though they may continue to privately disagree with it.

The comprehensive plan devotes a section to the potential impacts to tourism of the industry, and when asked about those impacts the county residents did not observe any negative impacts due to unconventional drilling. As one resident explained, "The [biggest potential] adverse impact due to unconventional drilling is visual, and we don't have a lot of that. Adversely, [the unconventional drilling industry] re-built many of the rural roads and paved them or improved the gravel surfaces so that more remote parts of the county are easier to get to." This improvement to the transportation infrastructure paid for by the unconventional drilling industry may have had the result of opening up the remote areas of county to tourism due to better access for (what was previously) remote activities such as 4-wheeling and hiking and fishing. Explained one resident talking about the comprehensive plan update in 2014 and its push for tourism in northern Clinton County, "[there are] no industries at all up here [northern Clinton County] so we were trying to pitch forward the idea that we should concentrate on tourism…[when the roads are damaged] the gas companies are required to come in and fix them and when they fix them its naturally a betterment, probably, to what was there to start with."

Community interaction by unconventional drilling companies seems to have dwindled over time. "In the beginning they tried to be involved, give money to the volunteer fire department, that sort of thing," explained one resident "but they don't make investments like that anymore." When asked if the change in approaches was due to the tightening of margins for profit in the

industry (no longer having the cash available for public outreach staff and activities) the answer was clear, “no, they figured out that they don’t have to. The people that they need don’t have [money], and the lack of education [they don’t have to].” Another resident involved with the Chamber of Commerce added, “if we get someone that comes here that wants to do something…and add to the economy, invest and create jobs or retain jobs we’re gonna work with them 99 times out of a 100.”

In summary, Clinton County has a highly detailed and thought-out plan that provides guidelines for an unconventional drilling industry boom that has not occurred. Though there are certainly those that do not support the industry in Clinton County, the majority of citizens appear to support it, and while the government presents a more confused stance on the industry evidence from the Chamber of Commerce indicates that there is general support for further unconventional drilling in Clinton County in the future from both private and public County leadership. While there is no apparent solution for the conundrum of the bulk of wells being located on state lands and thereby decreasing the benefit to the county when compared to wells on private property, for now that seems to be an annoyance more than a problem – any income is better than no income when it comes to resource extraction. None of the people interviewed in Clinton County had ever considered entering into a lawsuit pertaining to an unconventional drilling company.

5.3. Lawrence County

Lawrence County is in the middle of the western edge of the Ohio border approximately 40 miles north-east of Pittsburg. The county seat is New Castle, which had a population of 21,797 in 2018. In comparison to both Clinton and Sullivan Counties which are mountainous in geography, Lawrence County is agricultural with more gradual and rolling terrain. Like Clinton and Sullivan, Lawrence County has been experiencing a loss of population since 2010. The 2010 population was 91,108, dropping to an estimated 86,184 in 2018, a 5.4 percent drop in only 8 years, so though

the county is larger than the other two counties studied it also has suffered from outmigration in the last decade. The median age is 44.9, approximately 5 years younger than Sullivan County and 5 years older than Clinton County, though still older than the median age in the United States. The population is more diverse than either Sullivan or Clinton, with 93 percent white, 3.6 percent black or African American, 0.1 percent American Indian or Alaska Native, 0.5 percent Asian, and 2.3 percent two or more races. High school attainment in Lawrence County is 89.9 percent, with 9 percent of the population attaining associate's degrees, 13.6 percent bachelor's degrees, and 7.2 percent graduate or professional degrees. For the population with high school diplomas the median income is $33,900, slightly decreasing to $33,403 for associate's degrees, $46,495 for bachelor's degrees, and $58,783 for professional or graduate degrees. Despite the high school education attainment in Lawrence County being on par with the country's average and the county's relative close proximity to the large urban area of Pittsburg, the poverty rate in Lawrence County of 14.0 percent is well over the national average. Lawrence County has the largest economy of the case study counties, with 1,929 establishments included in the 2016 census dataset. The top five industries in the county based on annual payroll include healthcare and social assistance (24.7 percent), manufacturing (19.6 percent), construction (10.3 percent), retail trade (9.7 percent), wholesale trade (6.3 percent). Unlike Clinton and Sullivan Counties, Lawrence has published mining, quarrying, and oil and gas extraction values with 10 establishments totaling 0.8 percent of the county's total annual payroll.

Lawrence County has transitioned over the last two decades from an extraction economy to a processing economy. Initially, the county incorporated the references to unconventional drilling in the 2016 update but by that point the drilling had already peaked in Lawrence County. "…by the time the comp plan actually was completed drilling had already started to die down" explained

a government staff member that was involved in both the 2004 and 2016 comprehensive plan updates. While the county does not have a booming unconventional drilling extraction industry there are two large construction projects in the area which have directly impacted the economy – and the relationships – within the county. First the regional power plant was converted from coal burning to natural gas in 2016. This plant conversion both generated significant jobs during the conversion, and also saved the plant from a slated closure in 2015 (WMFJ 21, 2013). The other major shift in the gas industry affecting Lawrence County was the construction of an ethane cracker plant in neighboring Beaver County. The purpose of this plant is to convert ethane (a by-product of the natural gas process) into ethylene which his used in the manufacturing of plastics (Danahy, Frazier, McDevitt, & Phillips, n.d.). Operated by Shell Chemical Appalachia LLC, this plant has employed up to 6,000 people during construction, and will employ 600 people while operational (Danahy, Frazier, McDevitt, & Phillips, n.d.). While the plant is in adjoining Beaver County, the proximity (only about 22 miles south from New Castle, Lawrence County's largest City, and about 11 miles south of the Lawrence/Beaver County line) means that although the primary economic benefit of the plant remains in Beaver County, the secondary benefits of employment and increased business activity will directly impact the economy of Lawrence County. As explained by a Lawrence County planner when asked if the ethane cracker plant is going to have a large impact on Lawrence County "I hope so…I mean, it's not far from here at all…it's not far for people you know…so I hope so, yeah definitely. I know that we are planning on that."

5.3.1. Lawrence County – Government

The Lawrence County comprehensive plan – entitled Focus Lawrence County – was published in October 2016 as an update to the preexisting 2004 comprehensive plan. Interspersed with these two major updates to the plan, there have been several interstitial updates, predominantly focusing

on housing and greenways. This is unique among the counties studied, in that the comprehensive plan in Lawrence County is a living document, with frequent changes based on need. As described by a member of the Planning staff, "we did an update in 2004, then we updated the comp plan to include a green waste plan … in 2007, and then we updated the economic development section in 2010, and then the update in 2016." Although the advent of the ethane cracker plant in Beaver County and the conversion of the regional coal power plant to natural gas are both significant to the county and have occurred since the comprehensive plan publish date there have been no recent updates to the plan to address these two natural gas related changes in the county to date.

The comprehensive plan update for Lawrence County directly addresses the unconventional drilling industry in several areas. The plan first addresses the importance of the industry by noting that, "while Marcellus Shale activity has not impacted Lawrence County to the extent of that in Butler, Fayette, and Washington counties, well permits within the county have been increasing in recent years, to a high of 89 permits in 2014. The Utica Shale has the potential to become an even bigger natural gas resource in the county than Marcellus (Mackin Engineering Company, 2016, p. 52)." This foreshadowing of natural gas extraction growth has not materialized as anticipated, however, as a County Commissioner explained, "… we've not had that many new wells drilling within the last three or four years. So we did see somewhat of a peak back around 2014 or so, and a lot of that has gone away." Based on this statement, it appears that the comprehensive plan authors were anticipating a continued increase in the unconventional drilling in Lawrence County which did not materialize in the following years.

Anticipating this potential increase in unconventional drilling activity, however, Focus Lawrence County makes two very specific recommendations for action in the plan to promote sustainable development practices: 1) "form a County Natural Gas Task Force: ad hoc committee

to address public and private sector impacts and opportunities related to natural gas development." And 2) "Develop a countywide official map and coordinate with mid-stream gas companies to plan for new gas and liquid pipelines and other facilities (Mackin Engineering Company, 2016, p. 118)." The task force was created, and one of the members of the task force was interviewed as part of this research. The task force was maintained through the Lawrence County Economic Development Corporation but it was not focused on unconventional drilling, "we worked with a consultant and it was not so much about trying to market us for more gas drilling, it was more the processing. It was taking advantage of what was going to go on in Monaca [the ethane cracker plant]." The task force was active and meeting for several years before responsibilities for economic development transitioned to the Chamber of Commerce. While there is currently overlap between the current Chamber of Commerce and the old task force, the Chamber now focuses on, "doing a lot of business retention activities… we haven't done attraction activities." With these evolving and transitioning responsibilities, the need for the task force diminished, and it ceased to meet in 2017. The second suggestion was not acted upon, and there was never a map created for the unconventional drilling or natural gas industry resulting from the adoption of the 2016 comprehensive plan.

When asked if the county has an official viewpoint on the unconventional drilling industry, a County Commissioner explained, "…from the formal standpoint, the answer's no. I think for a more informal standpoint, and I'll only speak for myself, I think the benefits have outweighed the negatives of it, and from an economic standpoint it has been very helpful." Others in the county have described the county Government as being much more supportive of the industry, however, as one resident explained about the county's stance on unconventional drilling, "it's definitely not negative. I would say it's more a pro." Residents that approve and those that disapprove of

unconventional drilling both indicated that the county government was in favor of the industry for Lawrence County. This positive outlook on the industry appears to be shared by the Commissioners, however the government employees maintain a more cautious viewpoint, "we don't actively promote it… that all falls under the municipalities and our commissioners … those governing bodies are the ones that decide, and we're here to support them the best we can."

The support of unconventional drilling at the government level appears to be primarily economic, though not necessary due to a support of unconventional drilling as an end, but rather due to its indirect role in the conversion of the power plant to natural gas and the recent construction of the ethane cracker plant in Beaver County. Though the comprehensive plan outlines a path for natural gas development in the county, the explicit focus of the government is to promote supporting and peripheral industries related to this recent development, "we're a manufacturing county. You look at the number of manufacturing jobs that we have and it's…extremely strong."

5.3.2. Lawrence County – Community

Four of the six interviewees in Lawrence County were either involved in some way in the 2016 comprehensive plan or were aware of its existence and use. This relatively high interest in the planning tasks and county operations was one way in which Lawrence County stands out among the other counties researched for this project. One interviewee describing her multiple roles in the community explained, "I'm a member of the planning commission as well as the executive director of the economic development corporation," for example. Others take an active role in the community, "My activism is by example…" one resident explains, taking special interest in community beautification projects and working on various committees using her expertise in landscape architecture and horticulture for the benefit of the community. Though those interviewed were predominantly active in volunteer roles in the community, that does not mean

that those interviewed were homogenous in their viewpoints on the unconventional drilling industry. On one side of the spectrum there are those that vehemently oppose the industry "as far as I'm concerned, as a method of extraction is shouldn't be used at all." In contrast, there are those that feel that feel that the industry is predominantly beneficial, "It was tremendously impactful. I mean, you wouldn't believe people and how much money they got [through] leasing of the gas rights. People [were] very enthusiastic about that." Not everyone indicated a strong preference for or against the industry, with one resident explaining, "I don't think that the oil and gas industry has had any effect on our culture… it is varied as part of our county, but is it not an overwhelming overpowering force." Those interviewed were universally in favor of the two gas-related projects referenced here, the support for the unconventional drilling industry itself was mixed. Some residents feel like the benefits clearly outweigh the risks because of both the royalties paid to property owners and the employment and peripheral industries that are supported by the industry. Other residents feel like the risks and long-term environmental issues outweigh the benefits, and that the industry should be shut down all together. These anti-fracking sentiments were directed solely at the drilling companies and did not also reflect any disgruntlement with those that benefit from the industry. It is a feeling that the industry is here, people may as well profit from it, even though it would be better if it wasn't here at all.

The Lawrence County community appears to be mixed in support versus criticism of the industry, but with a small group of vocal opponents that do not support the unconventional drilling activities within the community at all. As one interviewee described it "the people that were protesting the gas drilling were making themselves very vocal, almost to the point where they were obnoxious and there was no reasonableness. I think that the majority of people here were trying to be reasonable, they wanted to have the benefits of the gas drilling dollars that came in from

leasing their gas, as well as the jobs that were created." This idea that people that are against the unconventional drilling industry do not present their opinions in an effective way was also noted in Sullivan County interviews, and signifies a larger trend within the industry where those who oppose the practice are seen as being unreasonable in their protest of the industry, or as community outsiders rather than local and reasoned objectors, whereas those in support are more measured and cool headed. One explanation for this perception is that the actions of a relatively small number of high-profile activists receive news coverage that shapes people's perception. The approaches of the two sides of the debate are starkly different, and the approach of those that are in disagreement with the industry appears to detract from the argument of those against fracking by alienating those whose opinions on the industry are in the middle ground.

The reasons for residents being against the industry were somewhat varied. One resident stated that "people don't like noise. They don't like change. So a lot of people near fracking will get upset, and they are worried about the noise." A similar but stronger viewpoint was voiced by another resident who explained "as far as I'm concerned, this method of extraction should not be used at all, especially since the benefit is not coming to the communities, its being sold elsewhere, it's been sold to China… you've got the company coming in and essentially raping… in the process that is causing earthquakes, poisoning water systems, and who knows what the long term damage is." While it is important to note that this resident also indicated that these impacts where felt by others, as a resident of New Castle these impacts were not felt directly. The residents that voiced concerns about the industry largely fell into these two categories, with negative opinions about the industry in Lawrence County being shaped either by direct and unpleasant impacts due to unconventional drilling operations, or environmental risks. These objections to the unconventional

drilling industry are not uncommon in Pennsylvania or the United States in general and there is a preponderance of research which supports these viewpoints.

While there were certainly interviewees that do not support the unconventional drilling industry, even those that described themselves as being against unconventional drilling did also describe the industry as providing economic benefits to the county. “There is a lot of resistance to it, but the support for it… I would say is primarily driven by money” explained one resident. “the only thing fracking has positively affected in employment is supply companies cropping up to provide support.” The issue of supply companies was a thread that crossed several interviews and may be tied to Lawrence County’s past as a manufacturing hub. In 1893 the Greer Tin Mill opened in New Castle, PA, and became the largest tin mill in the world (Lawrence County Historical Society, 2005). Tin and steel are not the only manufacturing product in New Castle, fireworks also became a traditional New Castle product with two large firework companies originating in the 1800’s and still manufacturing today. A large rail corporation (Kasgro), and several industrial parts manufacturers are also located in Lawrence County (Gardan Manufacturing Co., Inc., New Castle Manufacturing Company, and Praxair Surface Technologies are just a few). This manufacturing history, while making Lawrence County a prime location for the processing sector of the natural gas industry, also may play a role in the mixed feelings about the unconventional drilling industry. When talking about the history of the county, one resident explained “[Lawrence County] comes with an industrial past. It used to be a booming place. People earned a decent living, even blue collar workers. People could afford a family and a home and the town [New Castle] was thriving. As a City we never really reinvented ourselves and we are still struggling with that sort of disfunction, factories, ex industrial, and we have not found the new ground. We

are sort of underearning, if you will, and have a mindset that won't quire allow us to move into something new…New Castle is uniquely resistant to change"

The personal and community impact from unconventional drilling was described universally by the interviewees as low, which includes both those in support and in opposition to the practice. When asked if she was directly impacted by the industry one interviewee who was not in favor of the industry explained, "other than environmental impacts, I'm not impacted, I live in the City." This viewpoint was voiced by several interviewees, who live in the more urban center of New Castle and have no immediate financial stake in the changes that are a consequence of the natural gas industry. The overall county perception is that, "[people are] proponents of fracking because it would bring in money, and all kinds of things. Perhaps some industries." This is not described as a feckless approach to fracking, but rather a thoughtful and contemplative pro-fracking approach by the county and residents.

The direct economic impact from unconventional drilling in the county was predominantly described as relatively low. As one resident explained, "we were all excited about the opportunities for the shale gas industry, what it would mean from the standpoint of investment, and especially our agricultural areas where we have a lot of farms and Amish…their farms were struggling trying to make a living [from] the gas rights they sold off… a lot of other farmers were really interested … large land holders." The overall impact of the leases, however, did not seem to extend as far as anticipated, and by the time the comprehensive plan was highlighting unconventional drilling as a potential income source for the future the drilling of new wells was already on the decline. While this local unconventional drilling industry has cooled, however, the reliance of Lawrence County on the greater industry has greatly increased with the conversion of the coal power plant to natural gas and the construction of the ethane cracker plant. Explained one

resident, “those jobs that are created and that industry that’s starting are all plusses to us.” The residents from Lawrence are already enjoying the benefits of employment at the ethane cracker plant in the real estate market as one landlord explained, “I have people that will live in my facilities here in Lawrence County and jus drive the short bit to the fracking plant… it’s because it’s cheaper to live in Lawrence County than it is near the fracking plant, so I get benefitted.”

The unconventional drilling companies that operate in Lawrence County declined to be interviewed for this research, but the viewpoint of both residents and government seemed to indicate that the companies have been operating in the county in an above board and legal manner: “I think the fracking industry has made its way by going the legal way.” The unconventional drilling companies, however, have not made an impact on the Lawrence County by being part of the community from a social perspective. “HilCorp hired people and went about their business. But it was [people from outside] ... that just moved from state to state and they just follow the industry…I don’t think that there was a great emphasis on becoming a community member. That’s not what they were about” described one resident when asked about unconventional drilling company involvement in the community. Another resident echoed those sentiments saying, “I see no evidence that they’re trying to be part of the community at any point in the problem.” A third community member opined, “I think they stand apart. They keep their business going…they would be better if they schmoozed.”

Of those interviewed, there were only two people who indicated a willingness to enter into a lawsuit against an unconventional drilling company. One interviewee simply thought that the industry should not conduct unconventional drilling operations at all “from a long term financial perspective I would say no [we should not use unconventional drilling]…the damage left behind and done by unconventional drilling ends up leaving people poorer with water systems and you

name it." This interviewee did not have a personal situation that would illicit a lawsuit, however, the viewpoint was based on general views on the industry rather than personal experiences, and thus the individual had no need to enter into a lawsuit. The second person who indicated a willingness (though not a particular need) to enter a lawsuit against an unconventional drilling company is a retired lawyer who presented a unique viewpoint. The retired lawyer explained "the fracking hasn't shown his head very much in lawsuits here because I don't think [the lawyers] have turned their attention to it… these lawyers are handling auto industry cases and accident cases but they don't bring [unconventional drilling] cases, I don't know why." This was a new idea, that lawsuits in this area are somewhat depressed because the attorneys in the area are unfamiliar with the industry, and therefore do not accept or encourage cases in that area. Another interesting idea from the retired lawyer is that "the fracking industry [has] the best lawyers, and they've [talked to] the municipalities within the county…making sure [of] their safety regulations…[making sure they] conform to the noise regulations…stuff like that." This was a unique idea, that the unconventional drilling companies use their phalanx of lawyers to ensure that they are operating within all of the local ordinances thereby insulating themselves from any potential lawsuit by complying meticulously with all applicable laws and regulations.

The Lawrence County interviews shared a thread of unconventional drilling being on the decline within the county. While a few indicated that this decline was good, most people felt that the unconventional drilling industry is a positive for the county, citing jobs, royalties, and support industries as the reason. Both the conversion from coal to natural gas of the regional power plant and the construction of the ethane cracker plant in neighboring Beaver County were universally described as positive developments for Lawrence County. This generally positive outlook among the county residents is echoed by county government. While the government does not explicitly

recruit more unconventional drilling to the county, County Commissioners are openly in support of the unconventional drilling industry and are supportive of the unconventional drilling operations that are still occurring within the county limits. The comprehensive plan's positive and inclusive approach to unconventional drilling echoes both the community and government viewpoints on the subject. While the unconventional drilling companies that operate in Lawrence County declined to be interviewed, the common consensus among interviewees was that those companies that operate in Lawrence have chosen not to actively engage in the community, but rather stand apart from the community at large.

The community of Lawrence County stood out among Clinton and Sullivan counties as being more urban, and less dependent on extraction industries than the other two counties. A combination of the higher concentration of manufacturing in Lawrence, and the larger population center of New Castle, gives the impression of an "us" and "them" in the sense of the urban population describing an industry that impacts others from the rural areas, rather than a direct involvement of residents in Clinton and Sullivan counties. The nearby ethane cracker plant, though a direct result of the unconventional drilling industry, is more akin to manufacturing than to extraction in activities, though it is also dependent on fracking in Pennsylvania (and elsewhere) for its materials for operations. A high poverty rate in Lawrence County is akin to those in Sullivan and Clinton, but it may be more manufacturing based than due to reduced natural gas extraction due to the low gas prices of the last few years, which adds further to the subtle differences between Lawrence County's interviews describing unconventional drilling as a rural phenomenon experienced by others, versus the more socially integrated concern of those in Sullivan County in particular.

5.4. Industry

The lawsuit data secured for each county includes the companies which operate (and have operated in the past) unconventional wells in each of the three counties included in the case studies. Unfortunately, none of the companies involved in unconventional drilling in Sullivan, Clinton, or Lawrence were willing to be interviewed at first contact. One company, however, did provide a contact to the Marcellus Shale Coalition. This organization was formed by industry insiders as a lobbying and industry-support organization for organizations involved with "exploration and production, midstream, and supply chain partners in the Appalachian Basin and across the county to address issues regarding the production of clean, job-creating, American natural gas from the Marcellus and Utica Shale plays (Marcellus Shale Coalition, 2019)". The Marcellus Shale Coalition engages lobbying activities at state and local levels in support of the natural gas industry. More than just a lobbying organization, however, the Marcellus Shale Coalition also provides problem solving services to those within the industry, such as technical expertise in securing permits through the Pennsylvania Department of Environmental Protection.

Through an introduction at the Marcellus Shale Coalition, one unconventional drilling company did agree to be interviewed for this research. Operating in one of the subject counties through an acquisition of another drilling company rather than directly, this company consented to an interview, and provided insight into the industry's viewpoints relative to this research.

The reticence of companies that are active in the three subject counties – and the Marcellus Shale region in general, is neither by mistake nor a fluke. The Marcellus Shale Coalition (MSC) provided insight into the reticence of gas companies as "… they've been burned so many times… by schools that will either go ahead and do a study without reaching out to industry or …they've gotten their language mixed up." The one unconventional drilling company representative that consented to be interviewed used nearly identical language to describe the reticence of the industry

to be interviewed "there's the danger of being misquoted… we've been burned so many times by the same stuff voluntarily that there's no benefit in doing it." This sentiment was seconded by a regional manager at one of the companies who stated that he would be happy to talk to me for this research but was denied permission by the corporate office, explaining that the company "has been burned to many times before, and with an election coming up…" The notion of politics playing a role in the decisions was also raised by the MSC, referencing a recent, and purportedly inaccurate report by a Statewide politician lambasting the fracking industry with old and out-of-date data "…and he's going to be running for governor." This disinterest does not appear to be born from a desire to ignore research – the Marcellus Shale Coalition commissions its own studies for the purposes of the industry, but rather a fear of impacting one of the most important aspects of the industry in general as well as individual companies: reputation.

Reputation appears to be valued by the unconventional drilling companies – and the Marcellus Shale Coalition – as a top priority for preservation. When asked how civil lawsuits impact the industry, the MSC indicated that "I wouldn't say monetarily it matters to them. I think that they want to make sure that they don't have that local perception that they're out there doing the wrong thing. It's more of a perception issue. I think it's important to them to have a clean reputation above and beyond everything else." This emphasis on building and maintaining reputation amid the companies involved in the fracking industry appears to extend to their philosophy in interactions with the community. The unconventional drilling company that was interviewed also indicated that lawsuits play a relatively minor role in their operations "fear of lawsuits is not a driver [for us]." That does not mean that they are not important, though. The interviewee went on to explain that "whether it's a lawsuit or it's a public complaint or it's a violation that we get from the DEP…we care. We don't want to piss people off, you know, we're not out there to be litigious….

We will try to do whatever we can to [avoid] a lawsuit. But, if we're in the right, we will definitely go down that path." These competing desires to both avoid litigious conflict but a willingness to self-defend was further explained "we don't have staff attorneys to do it, so it matters to us, but it's also based on principle…we're not going to compromise if we know we're in the right."

When asked about how companies see themselves in relation to the counties that they work in the MCA indicated that the companies now view themselves as part of those communities. The unconventional drilling company that was interviewed also indicated a desire to incorporate into the community "number one, we want to be good [for] he community…we all live in Pennsylvania. We all live in the area where our wells are…we really care about where we work." This ideal that the unconventional drilling company is invested in the communities in which it operates is supported by its mission statement which states that they "strive to be a partner of choice with landowners, operators, suppliers and regulatory authorities through our unwavering commitment to responsible and ethical business conduct, safe operations, environmental stewardship and by implementing industry best operating practices. We believe that adhering to our core values allows us to achieve optimum performance while creating trust and lasting relationships within the industry, as well as throughout our community (Penn Energy Resources, 2018)." While the scope of this research does not extend to interviews in the counties in which this company operates, anecdotally at least it appears that the are operating in a manner consistent with their stated values. Available lawsuit data shows the company to have 309 wells in Pennsylvania and only 5 lawsuits, (not including the recently acquired bankrupt unconventional drilling company and the inherited lawsuits that were obtained through the acquisition). This yields a lawsuit rate of .02 lawsuits per well, substantially below average for the region (1.02 lawsuits per well) and also well below the median (0.10 lawsuits per well). Also importantly, a quick google search of the company does not

return new articles or other media implying any nefarious or problematic issues with the company. Based on these two metrics, and in conversation with the company representative, it appears that the company interviewed operates in the manner in which it describes its operations, with relatively little conflict and larger community involvement in the Counties in which it operates.

This apparent focus on community involvement does appear to have evolved, as the industry began with the advent of unconventional drilling the companies brought in the initial workforce from elsewhere and were less invested in the communities. Over time, however, the companies seem to have transitioned to a more involved approach to community outreach "they have local government affairs and public affairs professionals that engage with the local municipality [and] other local organizations. They engage in fundraising efforts to help the community." This observation by the MCA was supported by the interviews in Sullivan County, for example, as one Sullivan County citizen elaborated "they have sponsored a lot of the events, and it has made a lot of the events that we bring to the community possible because of their contributions." While this perspective was reiterated multiple times in the Sullivan County interviews, the Lawrence County interviews did not elicit the same response, as one resident phrased it, " I see no evidence that they're trying to be part of the community at any point."

While the MSC and the interviewed company both presented a community-centric approach to unconventional drilling development, supported by details from Sullivan County interviews, it appears that all unconventional drilling companies are not the same when it comes to interaction with the community. Of the three counties included in these case studies, there are approximately 13 different unconventional drilling companies with active (or closed) wells. Not all those companies appear to successfully maintain good relationships with the communities in which they are located, or possibly they do not make establishing relationships in those communities a priority.

In Lawrence County almost all of the interviewees indicated that the unconventional drilling companies in that area stand apart from the community and are not truly part of the community. Similarly, in Sullivan County one company was named repeatedly as being a problem in the county, (poor treatment of landholders holding leases being the primary complaint) whereas the other companies were viewed much more favorable light. Unfortunately none of the companies that operated in Sullivan County were willing to be interviewed for this research, however it appears that not all unconventional drilling companies operate with the same operating ethos, and the differences in how they operate may directly impact community sentiment around both the unconventional drilling companies specifically and the industry in general.

One thing that (may) set the company that was interviewed apart from the others in their industry was their viewpoint on selecting an area for unconventional drilling operations. While their primary focus is on choosing locations with the optimal geology for unconventional drilling and gas extraction, however second to that they "try to work with the communities. If there's a community [where] there's a groundswell that doesn't want us [that's a problem for us]…if that was a priority area, we would probably work with the townships to drill and develop those areas." In this way the company looks for areas where they are wanted, rather than trying to force drilling in areas where the local population is against the practice. The interviewee did indicate that they do not review or consider comprehensive plans before they settle on a location to explore and develop unconventional wells, however they do perform substantial social due diligence upfront prior to seeking development permits in conjunction with the geological investigation.

None of the counties that were studied had shared their comprehensive plans with any of the companies that engaged in unconventional drilling within their areas. While this was a surprise, it does not mean that the unconventional drilling companies enter into an area via geology-induced

tunnel vision. While only one unconventional drilling company was willing to be interviewed for this research, they made clear that they consider the community's feedback when they are making the decision on where to drill. This upfront community engagement, to include meeting with county staff as well as managers, commissioners, planning board members, etc. along with neighborhood meetings demonstrates a desire on the part of the unconventional drilling company to reduce the social conflict surrounding the practice from an early stage in the process. This also implies that communities that demonstrate a desire to not have wells drilled within their areas may be empowered to prevent the practice from beginning – or expanding – through similar community engagement. Not to imply that a rowdy protest at a community meeting would be effective, there are several references to this type of activism uncovered in this research that indicates that this is both ineffective and also may discourage others who may be swayed to that point of view from joining that side of the argument. From the context of planning theory, the unconventional drilling companies indicate their desired outcome – *their intent* - through community engagement, by enacting their company playbooks in pre-development due diligence prior to extractor. This acts as a proffer to the community, indicating a planned action, and allowing communities to respond in kind, through community response.

It is unfortunate that more companies within the unconventional drilling industry did not consent to being interviewed, there are several important take-aways from the discussions that were possible. While it is easy to think of the unconventional drilling companies as a monolithic group, the reality appears to be more complex with different companies exhibiting different behaviors relating to social interactions and priorities. One thing that they companies all seem to have in common, however, is an industry-wide reticence to engage with researchers (or presumably the media) due to a well-developed fear of misrepresentation. It does seem that social

engagement and incorporation into the fabric of a community does impact individual's opinions about the industry, and that those opinions in the communities may translate to acceptance – or not – by the community of the unconventional drilling companies specifically on a case by case basis, as well as impressions of the industry within the greater context of gas extraction within the Counties.

6. DISCUSSION

The purpose of this research is to investigate the relationship between plans (and planning) and social resilience in hydraulic fracturing communities. Using civil litigation as a measuring stick for social conflict and therefore an indicator for (lower) social resilience, three counties were studied to determine if there is a link between the comprehensive plans of each county and their social resilience vis-à-vis unconventional drilling. The three selected case study counties included in this research were chosen because they were similar over a range of metrics. That similarity extended to the greatest extent possible in geographical size and population, their rural natures, and comprehensive plans that explicitly address unconventional drilling. Sullivan and Clinton Counties have a low level of civil litigation in relation to the unconventional drilling industry, and therefore were assumed to have a high level of social resilience. In contrast, Lawrence County has a high level of civil litigation involving the unconventional drilling industry, and therefore represents the counterfactual case, a county with a low level of social resilience. The Lawrence County comprehensive plan is a level 4 plan consistent with the others, but significantly less detailed than Sullivan or Clinton Counties, meaning that it has a comparatively high level of planning but with little explicit guidance. Despite being chosen for their (theoretical) similarities, each of the counties chosen represent different applications of planning.

Each of the counties studied represents a different planning approach, and a different resilience dividend from that approach (Rodin, The Resilience Dividend Being Strong in a World Where Things Go Wrong, 2014). Sullivan County's strategic plan coupled with an engaged population and community-integrated industry builds on interconnectivity to promote resilience. This interconnectivity further benefits the community though monopolizing on those community-industry-government bonds to manage slow variables and feedbacks further increasing resilience around the unconventional drilling industry in Sullivan County. Clinton County provides a

detailed and broad vision of expansion of the unconventional drilling industry that formulates a detailed and inclusive approach, broadening participation. Even Lawrence County, the county selected as a non-resilient case from a social conflict perspective, has demonstrated an adaptation in response to industry opportunities that capitalizes on workforce capabilities to maintain diversity and redundancy, promoting resilience.

Table 7 Planning and Resilience Synopsis

County	Planning Approach	Resilience Impact
Sullivan	Leverages existing and developing social interconnections in a ***strategic*** planning approach.	By presenting strategy while remaining neutral through the comprehensive plan elected officials nurture organic social interconnections between government, community, and industry, ***managing connectivity*** and enabling the management of ***slow variables and feedbacks*** through that social network.
Clinton	Applies a ***visioning*** approach to guide and facilitate unconventional drilling in a safe and sustainable manner that is inclusive, benefitting everyone.	Effectively ***broadens participation***, through two separate avenues. Effectively and broadly engaging the community by clearly identifying all the different stakeholders in industry, and through unconventional drilling on State lands distributes benefits from drilling (royalties) to all members of the state through state income and budget. Essentially, all residents are beneficiaries of the development, and the risks are more evenly distributed through distancing from privately held property.
Lawrence	Presents a limited ***agenda*** approach suggesting actions pertaining to both the unconventional drilling industry and related industrial development.	Through adaptation and transition Lawrence County has achieved industrial diversity (***maintain diversity and redundancy***).

6.1. Sullivan County

The Sullivan County comprehensive plan addresses unconventional drilling differently from Clinton and Lawrence Counties. Whereas Clinton County's plan is meticulously detailed, and Lawrence County's plan is brief, the Sullivan County plan is in the middle. Describing the potential for unconventional drilling in Sullivan County, the comprehensive plan explains that "the

entire county is underlain by Marcellus shale, a bedrock formation that has recently become of interest for natural gas recovery through a deep well directional dwelling and hydraulic fracturing process. Based on recently developed wells in adjoining counties, it is believed there is great potential for gas recovery in Sullivan County, with corresponding benefits (Sullivan County Planning & Economic Development Office and Cummings & Smith, Inc., 2011, p. 38)." This relatively low-emotion delivery of a potential for high economic impact in Sullivan County is reflective of the comprehensive plan as a whole. The County plan functions strategically by presenting a deliberately neutral approach to the industry, which is mirrored by county government officials. The description for potential economic benefits is coupled in the plan with a goal and prioritization of "strike[ing] a balance between the development and use of natural resources and the protection of the environment for the benefit of citizens, seasonal residents and visitors of Sullivan County (Sullivan County Planning & Economic Development Office and Cummings & Smith, Inc., 2011, p. 122)." This cautious approach to the industry is offset with the goal of preserving the county's environment. This actively avoids planning to preserve power as observed by Flyvbjerg, steering the county away from rationalization (it won't hurt the environment so we should frac) (Flyvbjerg, 1998). Instead this approach is proceeding with unconventional drilling with conscious and deliberate awareness of the benefits and risks (we may frac, as long as we account for the risks). This deliberate and cautious planning approach follows the strategy approach to planning, as this approach is "arguably the most inclusive, and the most fundamental notion of plans, because it is the most explicit about the relationships among interdependent actions, their consequences, intentions, uncertainty, and outcomes. Strategies address most completely the problems of interdependence, indivisibility, irreversibility, and imperfect foresight (Hopkins, 2001, p. 41)." In the case of Sullivan County, the comprehensive plan establishes goals

to “strike a balance between the development and use of natural resources.” This goal then guides unconventional drilling in Sullivan County based on this strategic approach. The effect of this strategic approach is then for the unconventional drilling industry to evolve through developing interconnections between industry, community and government that are necessary to meet those strategic goals.

It remains unclear if the plan was first, or the community and government prioritization of balance between the unconventional drilling industry and the environment was first, however the impact from a planning perspective remains a cohesive and interconnected set of relationships among the disparate unconventional drilling stakeholders. This interconnectivity is important to social resilience because “high levels of connectivity between different social groups increase information-sharing and help develop the trust and reciprocity necessary for collective action (Dakos, et al., 2015, pp. 87-88).” The county policy of strategic neutrality encourages unconventional drilling development within the county to grow organically, and the approach of the unconventional drilling companies within the county encourages the development of social bonds between residents, business, and government. As one resident described her relationship with a nearby unconventional drilling company, “some of the larger drilling companies like Chesapeake…have been wonderful sponsors and donors,” a sentiment echoed among many of those interviewed as a hallmark of the drilling companies in Sullivan County. With one notable exception, the companies that operate unconventional drilling activities in Sullivan County actively incorporate their businesses and personnel into the county fabric. This approach clearly encourages the building of social bonds between industry and the community, and industry and government. Based on these social bonds, the county appears strongly socially resilient with complex and well developed social bonds. In essence, the interconnected but diverse stakeholders

put into practice the idea that "social network connectivity can facilitate resilience of ecosystem services through enhanced governance (Dakos, et al., 2015, p. 88)."

This resilience appears to be further nurtured through a demonstrated ability, due to those social connections, to manage slow variables and feedbacks relating to unconventional drilling operations. The primary concern with unconventional drilling is a potential for large disruption to the system in the form of environmental damage. For example, a large flow-back water spill could be considered disruption in the system, potentially resulting in a regime shift (Biggs, Gordon, Raudsepp-Hearne, Schluter, & Walker, 2015). The environmental regulations in place and administered by the Department of Environmental Protection are intended to prevent these types of disruptions, though failures in the system are at the heart of the conflict around the unconventional drilling industry. In resilient systems, smaller scale feedbacks from slow variables are important to observe, communicate, and react. The social interconnectivity observed in Sullivan County makes managing these slow variables and feedbacks easier because the system engages and includes a broad network of stakeholders. An example of slow variables and feedbacks within this system would be slow deterioration of a roadway that is being used by trucks transporting chemicals used in fracking. A resident observing that deterioration, and then discussing it with the company using the road, who then coordinates with the county to plan and complete repairs, is an example of managing slow variables and feedbacks within the system. This variable recognition, followed by action, is an example of resilience that is made possible by the social interconnections in the county. As one resident described her actions when issues arise "if there's a problem with a well…we don't call the state police we call the company." From a resilience standpoint, the ability to recognize a potential problem, and to address it in a proactive manner encourages members of the community to engage in managing slow variables and

feedbacks, a hallmark of resiliency (Biggs, et al., 2012). In particular, "the complexity of living systems of people and nature emerges not from a random association of a large number of interacting factors rather from a smaller number of controlling processes. These systems are self-organized, and a small set of critical processes create and maintain this self-organization (Holling, 2001, p. 391)." In the case of Sullivan County, small and incremental issues that may culminate in larger environmental or social issues may be addressed through communication and interconnections between the community and the unconventional drilling companies, building resilience through managing the slow variables and facilitation feedbacks expeditiously and before more significant conflict becomes likely.

6.2. Clinton County

Clinton and Sullivan counties were chosen as case studies due to their high levels of comprehensive planning and low levels of conflict, indicating socially resilient communities pertaining to the unconventional drilling industry. The Clinton County comprehensive plan is by far the most thorough plan that was reviewed, and includes a detailed calculation outlining the available property for unconventional drilling development. Furthermore, the Clinton County comprehensive plan describes in detail how potential areas for future energy development are narrowed down from the greater county area, removing "land mass that is not underlain by the Marcellus Shale, Wild Areas, where no drilling is permitted, all areas where the slope is steeper than 20 percent (because drilling is not economically feasible) and the area of Dominion Energy's Leidy Storage Field and a buffer zone around it (2014, p. 77)." A description outlines how, where, and why areas may develop based on the calculation provided above, as well as considerations such as the local geology, omitting downtown areas that would be unsuitable for unconventional drilling development, and the maximum density of wells on each well pad (2014, p. 77). This

highly detailed plan also addresses economic considerations, potential environmental impacts, and outlines the current (at the time of writing) status of unconventional drilling in the county.

In planning terms, the Clinton County plan effectively outlines a vision for the continued implementation of unconventional drilling within the county. According to planning theory, "a vision could be described as a normative forecast: a desired future that can work if people can be persuaded that it can and will come true (Hopkins, 2001, p. 38)." In the case of Clinton County, the vision is a strong, active, and expanding unconventional drilling industry situated in remote areas of the county, providing jobs and economic stimulus, but that considers and suggests strategies for avoiding environmental degradation, specifically water contamination. The Clinton plan even makes recommendations specifically for individual property owners "considering leasing their property for gas well construction (2014, p. 82)" to notably include recommending pre-drilling water baseline testing, a common sense suggestion that expands on the Pennsylvania Department of Environmental Protection regulations that describe water quality baseline testing but does not mandate it.

While it appears to be viewed as somewhat of an opportunity lost for the Clinton County government regarding tax base, this means that both the risks and rewards are shouldered by the entire community. Rather than being concentrated among a small number of individual property owners the royalties from unconventional drilling extraction are paid to the State from these well sites, and then from state coffers it would (presumably) be used in a way that benefits the residents of the state. Similarly, the immediate environmental risks and potential costs of remediation are also shared by the state's residents as a whole, being on state property rather than private property. This does not preclude impacts on individuals in a high-impact environmental disaster, but it does reduce the likelihood of individual property degradation. This shared risk and reward further

reduces the opportunity for conflict surrounding the industry and encourages the development of social bonds through shared experience. Rather than a source of potential friction between adjacent landowners, for example, the vision of the comprehensive plan encourages remote gas development and collective benefit, which can be linked to an increase (or at least less damage) to social resilience. As one community member explained, "they're not sitting out along the main highway, that's for sure. They're up on top of the mountain and back end…you have to know where you're going to find them."

Despite the explicit frustration voiced by Clinton County elected representatives at the inaccessible income that could otherwise be gleaned from state-owned land were it instead private property, the result is a means of allocating and protecting common goods, precisely as predicted by public goods planning theory (Moore, 1978). Unconventional drilling in remote and state-owned property in areas like northern Clinton County results in greater physical distance between the risks associated with unconventional drilling (water, noise, and air pollution, in particular) and privately-owned assets. This physical distance thereby flattens the risk curve for individuals by sharing the risk among all residents rather than focusing it sharply on adjacent landowners. Similarly, the benefits of royalties are received by the State, rather than individuals, thereby distributing the reward more in line with the risks involved. This is commensurate with the use and distribution of water as a resource, wherein it is collected, treated, and distributed by public utilities, rather than as an extractive commodity. While there are differences as well (extraction of gas is done by private companies whereas municipal reservoirs are public), viewing the resource as a community asset rather than as a commodity appears to play a role in lessening the impact of conflict in relation to the natural gas resource extraction.

From a resilience standpoint, Clinton County has not achieved the same level of interconnections that have benefitted Sullivan County, however they have capitalized on a different aspect of resilience building: broadening participation (Biggs, Schluter, & Schoon, 2015). Through two separate paths: developing the detailed and extensive comprehensive plan through the public participation process, and through the development of unconventional drilling in state owned lands, they have broadened participation in the unconventional drilling industry. Broadening participation builds resilience in social-ecological systems through "establishing processes that are deliberative and support forming or developing relationships," and by "promot[ing] understanding of the system through increased knowledge (Leitch, Cundill, Schultz, & Meek, 2015)." The comprehensive plan is detailed and is inclusive of multiple aspects of the unconventional drilling industry, such as economic impacts (both direct and indirect), work force development touching on the local educational institutions, infrastructure interests such as road condition and needs, and water quality and quantity issues. This broadly comprehensive approach serves to identify the stakeholders that are involved, and by extension broadens the participation in the industry expansion by clearly and comprehensively identifying *who* is involved and *why* their involvement is important. It also increases the understanding of the industry, and how it relates to the environment and economy within the county.

The second means of broadening participation is through the development of unconventional wells on public property. The stakeholders expanded in Clinton County from those directly and indirectly impacted by the industry itself to all taxpayers in the state as beneficiaries of royalties (through the State budget) due to gas extraction on state (publicly) owned land. In essence, everyone in Clinton County is a royalty-earning stakeholder, though the income source is certainly indirect. This public aspect promotes the governance and distribution of income from the local to

state level, broadening the decision makers to the state officials, elected through the democratic process. It is important to note, however, that none of those interviewed perceived the income from state-owned land royalties as coming to them as individuals, but the sentiment was rather that "The State" was earning the royalties, disconnected and other from state residents. This may be an opportunity to further increase resilience in the county, to promote the "good" things that the State of Pennsylvania does with unconventional drilling royalties to further promote the use of those funds as benefitting everyone to expand participation even further. Resilience theory "suggests that participation can contribute to enhances resilience of ecosystem services, [but] actual attainment of this enhanced resilience depends on factors such as the participants, the process, and the social and institutional environment (Leitch, Cundill, Schultz, & Meek, 2015, p. 211), which means that resilience is not a guaranteed outcome of broadening participation. In this case the state government plays a role, which means that the risk of rationalization of unconventional drilling despite the risks at a State level may undermine more resilience building actions at the County level.

6.3. Lawrence County

Lawrence County was chosen as a case study because of its relatively low level of planning (when compared to Sullivan and Clinton Counties, though it still represents a high level of planning compared to the other counties in Pennsylvania), and also relatively high level of conflict indicating a lack of social resilience in comparison to Sullivan and Clinton Counties. While the comprehensive plan for Lawrence County clearly addresses the unconventional drilling industry (and was identified as a level 4 comprehensive plan during the initial phases of this research), to the extent of making suggestions pertaining to the industry moving forward (forming a committee to address impacts and opportunities relating to the unconventional drilling industry and developing a county-wide map to coordinate and plan for new natural gas development), it fails to

present a fully detailed vision for the future of the industry in the county. The plan discusses the impact of unconventional drilling as increasing in the years preceding the 2016 re-write and anticipates additional growth in both the Marcellus and Utica shale regions to impact the county. These plan components pertaining to unconventional drilling do not go into depth in the plan, but they do signal a desire and intent on the behalf of the county and citizens to support further unconventional drilling industry within the county. In essence, the comprehensive plan is signaling to the unconventional drilling industry stakeholders the intention of further activities, though it lacks a detailed description or vision for the future. This signaling of intent is consistent with theory, that "the role of [a] plan as information exchange can be useful to organization in pursuing their distinct, if overlapping interests (Boyer & Hokins, 2016, p. 47)," This level of comprehensive planning would then imply a higher level of social resilience than is apparent based on the litigation data for Lawrence County.

While planning theory notes that plans act to address social challenges that are interdependent, indivisible, irreversible, and suffer from imperfect foresight (Hopkins, 2001), theory also informs us that "there are several distinct agents with different geographic, functional, and temporal interests or jurisdictions that are partially overlapping, and effects of actions taken by any one of these agents are in some way interdependent with actions of the other agents (Hopkins & Knapp, 2018, p. 275)." In the case of Lawrence County, while the comprehensive plan provides signal of intent to the community and industry stakeholders, interviews indicate that the industry response fails provide an adequate interconnected response to the County's Plan. Specifically, while two of the unconventional drilling companies in Lawrence County were able to effectively operate a combined 17 unconventional wells without a single lawsuit, the remaining company, Hilcorp Energy Co. amassed 22 lawsuits while drilling only 56 wells. This lawsuit to well ratio of 0.39

lawsuits per well is well over the average rate of lawsuits for counties with detailed comprehensive plans (level 4 plans). This high rate of lawsuits indicates a low level of trust between the gas company (Hilcorp) and the community, a statement that was supported by Lawrence County interviews. This high level of lawsuits also represents a lack of social resilience, with demonstrably low social connectivity and a deficit in managing slow variables and feedbacks. When one resident explained, "other than environmental impacts, I'm not impacted, I live in the City" a distinction is made between "us" and "them," those that live in the city and those that do not. This type of categorization indicates a lack of the social ties in diverse networks that help to build resilience through "high levels of connectivity between different social groups (Dakos, et al., 2015, p. 87)."

When asked how the unconventional drilling companies integrate with the community in Lawrence County, the response from residents was universally consistent, "HilCorp hired people and went about their business. But it was [people from outside]... that just moved from state to state and they just follow the industry…I don't think that there was a great emphasis on becoming a community member. *That's not what they were about.*" Or as another resident described the unconventional drilling companies in general (not specifying one in particular), "I think they stand apart..." This aloof approach from the unconventional drilling company that is solely engaged in the lawsuits, and the unconventional drilling companies in general, represents a failure to develop the interconnections that support social resilience within the community. It also represents a missed opportunity by the unconventional drilling companies to encourage resilience through encouraging learning and broadening participation, two fundamentals of resilience building that would be relatively low cost and easy to implement but that are not being leveraged currently. To effectively address complex planning issues (such as unconventional drilling) multiple plans from

multiple stakeholders must interact to be effective, and in this case one stakeholder group appears to be letting those interconnections languish, diminishing the social resilience of the community as a whole.

While Lawrence County's resilience may be stressed by the lack of interconnections surrounding the unconventional drilling industry, from another perspective the county demonstrates a more auspicious tendency. The development of the ethane cracker plant in neighboring Beaver County has allowed Lawrence County to leverage its manufacturing prowess to promote social resilience through maintaining diversity and redundancy. Resilience theory suggests that "diversity is widely held to be important for resilience because it provides options for responding to change and disturbance (Kotschy, Biggs, Daw, Folke, & West, 2015, p. 51)." In essence, the diversity in industry may cushion Lawrence County from a future economic disruption. Though the ethane cracker plant is not physically located within Lawrence County, the close proximity to Lawrence with its workforce skilled in manufacturing provides an able workforce to Shell Energy Corp. and also enhances the employment for the County representing a win-win situation. In effect, though Lawrence County does not exhibit social resilience relating to the unconventional drilling industry directly, it has obtained a measure of resilience instead through its diversification in manufacturing capabilities.

This transition and reorganization represent a round of the adaptive cycle and exhibits a measure of resilience in incorporating and reacting to disruption. Through the adaptive cycle, the exploitation (discovery and initial extraction of fracking-recoverable natural gas) transitioned to conservation (unconventional drilling extraction and conservation of the industry, including development on the comprehensive plan and managing environmental risks) that then proceeded to a release (conflict surrounding the industry, notably a high incidence of civil lawsuits) followed

by reorganization (with a focus transitioning from unconventional drilling to the ethane cracker plant and associated industry) (Holling, 2001). This timely and effective adaptation from unconventional drilling to a related by independent industry leveraged the county's existing workforce experienced in manufacturing, without sacrificing community identity.

6.4. Conclusions

There were several unanticipated findings in this research. First, it became clear from the beginning that unconventional drilling companies are not a homogeneous group. Corporate culture, adherence to safety and environmental regulations, and actions within the community are all elements that may impact the relationship between an unconventional drilling company, government, and the community. As long as these elements vary widely among companies engaged in unconventional drilling the community reactions to those companies may vary equally widely. Based on interviewee responses; both government officials and residents seem to value and expect a higher level of community engagement from industry than they are currently seeing in their communities in both Clinton and Lawrence Counties.

Companies that do not impress residents with their community engagement may be failing to create an effective plan to engage and interact with their community, resulting in a fragmented implementation of planning. In contrast, in Sullivan County most of the interviewees indicated a level of satisfaction with the unconventional drilling companies in their county, except for one company that was named by several interviewees as being a bad apple. While the unconventional drilling company that did participate in this research indicated its strong commitment to community engagement and focus on maintaining reputation, it is clear that how the unconventional drilling companies act – and interact – with their communities is important in forming the perceptions of the residents and elected officials that they impact. These perceptions

may manifest in willingness, or reluctance, to pursue litigation as a means of solving potential problems rather than a more amiable approach to addressing conflict when it occurs.

Even as unconventional drilling companies are not the same, the high-level comprehensive plans also differed county by county. While none of the unconventional drilling companies engage directly with the comprehensive plans in the counties in which they operate, there is clearly value in the detail provided by the plans in Clinton and Sullivan Counties. It is not sufficient to merely note that unconventional drilling for natural gas may occur in the county, it is important to guide that development to the greatest extent practicable to minimize adverse impacts and maximize benefit to the community.

Although both Sullivan and Clinton use different approaches to comprehensive planning, the planning impact on social resilience from a viewpoint of unconventional drilling is certainly beneficial. Clinton County provides a vision for the future with its comprehensive plan that guides unconventional drilling development and encourages confidence and security within the community promoting resilience through broadening participation in the industry. Sullivan County, in contrast, provides strategic guidance for the industry that promotes a collaborative and intercommunicative approach to unconventional drilling that involves government, industry and citizen stakeholders that builds resilience through managing connectivity and managing slow variables and feedbacks. These planning techniques represent approaches to comprehensive planning that have been shown to increase resilience in unconventional drilling communities that would be worthy of emulation in other geographical areas or extractive industry communities. In Lawrence county some of the pitfalls of failing to develop a plan that effectively encourages social resilience can be seen, though through diversification the county has successfully held onto social

resilience though maintaining diversity and redundancy in spite of, rather than because of, the lack of planning interactions in that community.

Using litigation as an indicator for conflict was effective for this research but should be used with caution as a proxy for resilience. For this study, the three counties chosen were all rural with high levels of poverty, and all exhibited a relatively low propensity for litigation as a general baseline (as qualitatively determined through interviews). It is possible that should a study attempt to use litigation in geographical areas with greater affluence, or attempt to use both high income and low income areas within the same study but in contrast, the result of using litigation as a metric for conflict would likely be skewed. The other consideration that is not captured by using litigation as a proxy for resilience is the impact of outside money on the dynamics of social conflict. Several interviews from across the counties studied identified outside interest groups as likely sources of conflict surrounding the unconventional drilling industry. This outside influence is not controlled for in this study, and although it does not appear to have undermined the results presented here (in these counties "outsiders" are easily identified by locals and were reported as such in interviews), in larger population counties where "everyone does not know everyone" the result may be outside influence that is not captured accurately.

This research appears to have succeeded in answering some questions about social resilience in hydraulic fracturing communities. It seems clear that the existing social bonds in Sullivan County, combined with strong comprehensive planning and socially active unconventional drilling companies have resulted in a socially resilient unconventional drilling community. Similarly, the visioning comprehensive plan in Clinton County has been effective in preparing for unconventional drilling development and guiding the existing industry in that county, reducing conflict, and increasing resilience pertaining to the industry. While Lawrence County's

resilience hinges on leveraging existing workforce skills to maintain redundancy, they have successfully strengthened their social resilience through adaptation. Each of these approaches to resilience building may be effective in the right context or fail in the wrong one. For example, Lawrence County may not have been able to leverage the comprehensive plan of Sullivan County without the pre-existing social interconnections demonstrated by Sullivan County. Despite this potential pitfall, however, it seems clear that the resilience building techniques established in the Sullivan and Clinton County comprehensive plans may be effective in building resilience in unconventional drilling communities in rural areas that share characteristics with the counties studied here. To extrapolate further, other extractive communities that are rural in nature and share depressed economic states are likely to benefit from plans that are modeled after those developed by Clinton and Sullivan Counties. Unfortunately, not every county is likely to share the specific and transferrable skills shown in Lawrence County, and developing resilience through developing redundancy may represent a greater challenge. Further research may build on this study to consider how more urban counties build resilience around the unconventional drilling industry, for example. Another area of interest would be to investigate rural counties in other regions (such as Texas and North Dakota) to determine if the resilience building techniques employed in rural Pennsylvania are in use in those areas, and if so, are they effective.

The resilience of the three counties studied seems to have been increased through resilience building techniques applied through their plans, but in addition to that increased resilience in response to a potential disruption a resilience dividend may also have been realized. For example, Clinton County's plan expands industry stakeholders to included groups that may have otherwise not considered themselves to be impacted by the unconventional drilling industry, such as the tourism industry. Initially, the plan contemplated a potential degradation of tourism in the County

due to disruption the natural beauty of the forested areas, reducing the demand for all-terrain vehicles (ATVs) and other off-road motorsport activities. In contrast, however, the stable and sustainable unconventional drilling industry has improved access to the remote parts of the state land within Clinton County, thereby achieving the opposite result. In this example, the resilience building activities in Clinton County (broadening participation) have had an add-on benefit of increasing recreational use of the county's resources. This added benefit is an example of a resilience dividend for Clinton County, "the "bonus" we receive from investing in a project designed to build resilience (Bridgett-Jones, 2017)."

This research does not reduce the wicked nature of this industry, but rather addresses a subset of the problem that has shed some of its wickedness though choosing one path that some have chosen to take (the choice to use unconventional drilling) and then considering how to improve the human condition after that choice has been made. While wicked problems are irreducible (Rittel & Webber, 1973), in this case the wicked problem itself is not reduced but rather a subset of the problem is tackled. The communities studied here have already made the decision to engage in unconventional drilling – hydraulic fracturing – despite the environmental risks. It is the conflicting nature of the greater problem, trying to balance the benefits of drilling with the risks of environmental degradation that cause wickedness. By only looking at communities that are actively engaged in unconventional drilling, the problem is then reduced to a much less wicked subset of the problem – if we are going to drill either way, how do we increase the resilience in the community in a way that benefits everyone? This fundamental goal of planning, to look out for the greater good (Moore, 1978), is the origin of this research. Comprehensive planning aligned with social resilience building techniques in counties that are actively engaging in unconventional

drilling may build social resilience in those communities, and furthermore may realize resilience dividends beyond their ability to overcome disruption.

In summary, Sullivan, Clinton, and Lawrence Counties are similar on paper, but each is unique in economic, geographical, geological, and social conditions that have yielded different comprehensive plans and strategies for social resilience. Detailed plans that present a vision for unconventional drilling, and those that encourage the development of interconnections between industry, community and government may yield improved resilience over those communities that do not. Similarly, those communities that can leverage their workforce to develop and maintain diversity may exhibit resilience despite some challenges.

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8. APPENDIX 1

Table 8 Oil and Gas Wells in Pennsylvania Sorted by Number of Unconventional Wells

	County	Comprehensive Plan Publish Year	Conventional Wells	Unconventional Wells	Total Active Wells
1	Washington	2005	602	1619	2221
2	Susquehanna	2003	0	1391	1391
3	Greene	1977	800	1211	2011
4	Bradford	2004	6	1187	1193
5	Lycoming	2018	2	853	855
6	Tioga	2017	11	728	739
7	Butler	1997	99	519	618
8	Fayette	2000	1327	284	1611
9	Westmoreland	2005	1598	267	1865
10	Wyoming	1997	0	248	248
11	Armstrong	2005	1866	243	2109
12	Elk	1999	763	143	906
13	Allegheny	2008	312	138	450
14	Sullivan	2011	0	124	124
15	McKean	2007	4408	116	4524
16	Beaver	2010	2	104	106
17	Clearfield	2006	701	98	799
18	Clinton	2014	74	76	150
19	Potter	2003	260	74	334
20	Lawrence	2016	3	55	58
21	Mercer	2006	751	51	802
22	Cameron	1969	0	48	48
23	Jefferson	2018	1258	44	1302
24	Indiana	2012	1821	33	1875
25	Centre		78	31	109
26	Clarion	2004	985	23	1008
27	Somerset	2006	2	17	19
28	Forest	2013	1944	10	1954
29	Blair	2005	0	6	6
30	Cambria	2011	122	2	124
31	Venango	2005	1103	1	1104
32	Crawford	2014	893	1	894
33	Huntingdon	2003/2018	2	1	3
34	Erie	2002-2003	154	1	154
35	Bedford	2018	10	1	10

(Pennsylvania Department of Environmental Protection, n.d.)

Table 9 Comprehensive Plan Summary

County	Comp Plan Year	Comp Plan Level	Notes
Allegheny	2008	3	
Armstrong	2005	1	
Beaver	2010	3	
Bedford	2018	1	New shared plan in 2018
Blair	2005	1	
Bradford	2004	1	
Butler	1997	1	
Cambria	2011	4	
Cameron	1969	1	Planned to update in partnership with Potter and McKean Counties in 2018
Centre	2003	1	Center Region Comp plan 2013
Clarion	2004	1	
Clearfield	2006	3	
Clinton	2014	4	
Crawford	2014	4	
Elk	1999	1	
Erie	2002		
Fayette	2000	1	
Forest	2013	4	
Greene	1977	1	
Huntingdon	2018	1	New Comp plan in 2018
Indiana	2012	4	
Jefferson	2018	3	
Lawrence	2016	4	
Lycoming	2018	1	Update too recent for lawsuit data
McKean	2007	3	
Mercer	2006	2	
Potter	2003	1	
Somerset	2006	2	
Sullivan	2011	4	
Susquehanna	2003	1	
Tioga	2017	1	
Venango	2005	1	
Warren	2005	1	
Washington	2005	1	
Westmoreland	2005	1	
Wyoming	1997	1	update currently under review with EDC and not available for public review 5.17.18)

Table 10 Lawsuits Per Well Arranged by Unconventional Wells

County	Comprehensive Plan Publish Year	Unconventional Wells	Lawsuits	Lawsuits per Well
Washington	2005	2039	245	0.12
Susquehanna	2003	1712	160	0.09
Bradford	2004	1536	87	0.06
Greene	1977	1506	157	0.10
Tioga	2017	1115	111	0.10
Lycoming	2018	1065	38	0.04
Butler	1997	678	44	0.06
Westmoreland	2005	406	59	0.15
Fayette	2000	353	12	0.03
Wyoming	1997	305	19	0.06
Armstrong	2005	297	37	0.12
Elk	1999	217	2	0.01
Sullivan	2011	190	13	0.07
Allegheny	2008	179	73	0.41
Beaver	2010	173	13	0.08
Clearfield		156	15	0.10
McKean	2007	152	31	0.20
Potter	2003	141	14	0.10
Clinton	2014	115	4	0.03
Cameron	1969	78	2	0.03
Lawrence	2016	73	22	0.30
Jefferson	1991	67	30	0.45
Centre		66	5	0.08
Mercer	2006	63	3	0.05
Indiana	2012	56	6	0.11
Clarion	2004	49	16	0.33
Forest	2013	31	3	0.10
Somerset	2006	27	6	0.22
Cambria	2011	7	0	0.00
Venango	2005	6	6	1.00
Blair	2005	6	0	0.00
Warren	2005	4	7	1.75
Crawford	2014	4	1	0.25
Erie	2002	1	6	6.00
Huntingdon	2018	1	0	0.00
Bedford	2018	1	0	0.00

Interview Questions - Government

1. were you involved in the County's Comprehensive Plan update in 2014?
2. How does the comprehensive plan impact your County?
3. What does the County believe are the strengths of your comp plan?
4. Are there any stakeholders in your County that drive the inclusion of unconventional drilling in your comp plan?
5. Why did the County choose to include unconventional drilling (UD) as such a large component of the comp plan?
6. What is the purpose of the UD components of your comp plan?
7. How does the County think the comp plan is working?
8. When compared to other Counties in Pennsylvania that have unconventional wells, your County has a very small number of civil lawsuits per well per person – why do you think that might be the case?
9. Does the County government actively or intentionally promote a particular viewpoint or attitude regarding the practice of unconventional drilling in your County? Do you set the tone?
10. How important is UD to the economy of Lawrence County?
11. Does Lawrence County incentivize, recruit or otherwise promote UD economic development? How so?

Sullivan County Government Specific Questions:

1. When I spoke with the County Planner he indicated that a high poverty rate within the County may be responsible for the positive outlook on UD by the population in Sullivan County – it being viewed almost exclusively as an income source. Do you agree with this assessment?
2. How important is UD to the economy of Sullivan County? How does it rank in importance to the County compared to other industries?

Lawrence County Government Specific Questions:

1. Did the County form a county wide natural gas task force to address public and private sector impacts and opportunities related to natural gas development?
2. Did the County Develop a countywide official map and coordinate with mid-stream gas companies to plan for new gas and liquid pipelines and other facilities.

Clinton County Government Specific Questions:

1. 1,000 new jobs were added due to shale gas industry – can you elaborate?
2. Home price increases due to industry between 2010 and 2012 – how did that affect the county?
3. Most drilling in Clinton on state lands, not privately held property. Is that Strategy?
4. What is the impact of Clinton County's Leidy Storage Field?

Interview Questions – Community

1. Were you involved in the County's Comprehensive Plan development in 2014?
2. Why do you think that unconventional drilling (UD) is such a large component of the County's comp plan?
3. Do you think that the comprehensive plan impacts UD in your community?
4. How does the UD Industry impact your community?
5. What is the purpose of the UD components of your comp plan?
6. Do you think that UD companies consider your Comp plan in their decision to drill or not within your county?
7. Do you think that there should be changes to your comp plan in relation to UD?
8. When compared to other Counties in Pennsylvania that have unconventional wells, your County has a very small number of civil lawsuits per well per person – why do you think that might be the case?
9. Does the County government actively or intentionally promote a particular viewpoint or attitude regarding the practice of unconventional drilling in your County? Do you set the tone? If not, does a particular interest group do so in your County?
10. Are there people and/or groups that are vocally for and/or against unconventional drilling in your County?
11. How important is UD to the economy of Clinton County? How does it rank in importance to the County compared to other industries?
12. Does the community think that Lawrence County should incentivize, recruit, or otherwise promote UD economic development? Why or why not? How so?
13. Does the unconventional drilling industry impact you directly? How so?
14. Does the unconventional drilling industry impact your work or leisure activities? How so?
15. Have you ever been involved in a civil lawsuit that involved the unconventional drilling industry?
16. Have you ever considered filing a lawsuit that involved the unconventional drilling industry? What influences that decision?
17. I would like to speak with several citizens in Clinton that are active in the County. Can you recommend other people that I can reach out to in order to discuss this topic that might be willing to talk with me? I would like to speak to people from a variety of backgrounds and viewpoints.
18. Is there anything that you would like to add on this topic?

Interview Questions – Industry

1. How long has your company been drilling wells in XXX County?
2. There are a lot of Counties in PA that have natural gas – why did you choose XXX?
3. Did you consider non-scientific factors when you choose XXX?
4. Does the County culture impact your decision to drill in a county?
5. Are you aware that XXX County has a Comprehensive Plan? Have you ever seen or read it?
6. Understanding that regulation of unconventional drilling is done by DEP, do you consider the Community's stance on fracking when you choose a location?
7. Is there anything that a County can or should do, from your perspective, to indicate to you that drilling is wanted or unwanted in that county?
8. Do you consider potential legal conflict in your choice of UD location?
9. When compared to other Counties in Pennsylvania that have unconventional wells, your County has a very small number of civil lawsuits per well per person – why do you think that might be the case?
10. Would you consider counties with a higher rate of lawsuits per person per well less appealing to conduct drilling operations than counties with lower rates of lawsuits per person per well
11. What is good about operating in XXX County?
12. What is bad about operating in XXX County?
13. How does operating in XXX compare to operating in other Counties?
14. What do you view as your role in the community?
15. Jobs are often the first thing that people mention when you speak with them about unconventional drilling in XXX – do you bring jobs to XXX County? Do you know how many XXX County residents you employ (either directly or indirectly)?
16. Do you bring in workers from out of state or out of county?
17. What portion of your workers in XXX are from XXX, versus outside?
18. Were you involved in either the County's comprehensive plan development in 2010/2011 or the current re-write of the comprehensive plan?
19. Is there anything that you would like to add on this topic?